# Challenger®

## Terra Gator 3244
## Chassis

# SERVICE MANUAL
## 627333-A

NOTE TO THE RECIPIENT - This packet is one component of two or more components required to comprise a complete publication. The following items, shipped under separate part number, are used with this publication:

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**TERRA GATOR 3244**
**CHASSIS**

# Service Manual

## Volume

**Master No. 627333-A**

# Challenger®

## Terra Gator 3244
## Chassis

# SERVICE MANUAL
## 627333-A

# 01 - Introduction

## Contents

# Contents

# SAFETY

*IMPORTANT:* Any modifications to machine or systems not authorized by AGCO void warranty. This includes, but is not limited to hitches.

## FOLLOW SAFETY INSTRUCTIONS

**FIG. 1:** Carefully read, learn and understand all safety messages and information in this manual and on machine's safety signs. Keep safety signs in good condition. Replace missing or damaged safety signs. Make sure new machine components and repair parts include current safety signs. Replacement safety signs are available from local AGCO dealer.

Never operate machine or equipment without proper instruction and a complete understanding of control operation.

Learn how to properly operate machine and use all controls before operation. Do not allow anyone to operate machine, systems or perform service and maintenance procedures without proper instruction.

Keep machine, all components and systems in proper working condition. Modifications to machine, unauthorized by AGCO, may impair functionality and safety, affect machine life and void machine warranty.

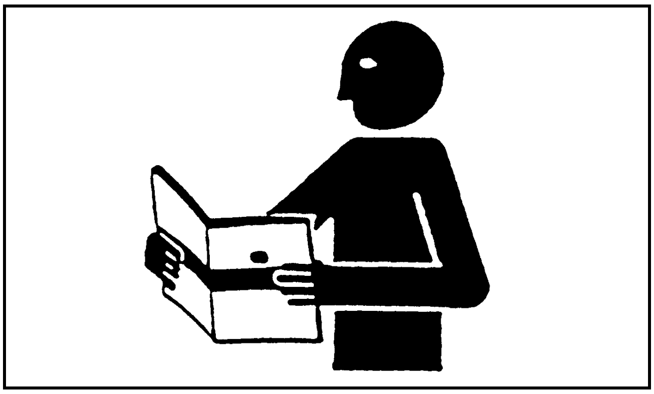

**FIG. 1**

## PREPARE FOR EMERGENCIES

**FIG. 2:** Be prepared if a fire starts. keep a first aid kit and fire extinguisher handy.

Dial 112 or your national emergency number in cases of emergency.

Keep emergency numbers for doctors, ambulance service, hospital and fire department readily available at all times.

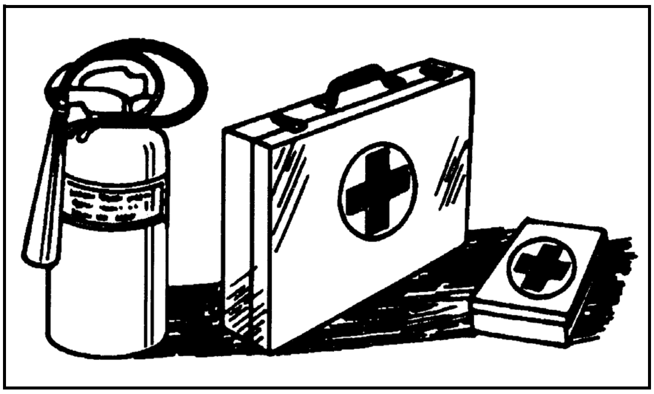

**FIG. 2**

## SAFETY ALERT SYMBOL

**FIG. 3:** This is the safety alert symbol and it means attention, become alert, safety is involved. Look for the safety alert symbol in this manual and on safety signs on machine, it directs attention to information involving operator safety and safety of others.

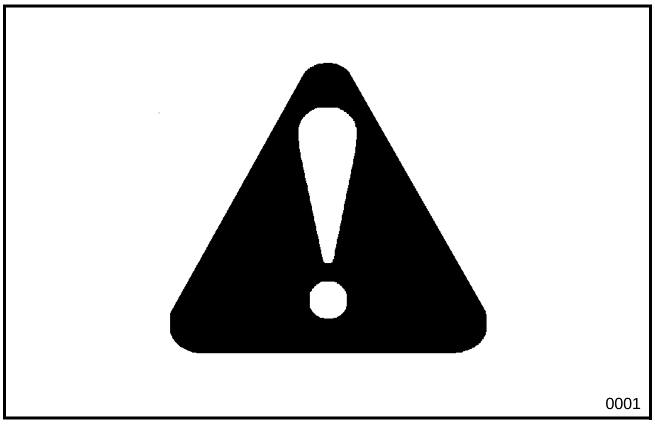


**FIG. 3**

## SIGNAL WORDS

Danger, warning or caution are used with the safety alert symbol. Learn to recognize these safety alerts and follow recommended precautions and safe practices.

**DANGER: Indicates imminently hazardous situation that, if not avoided, results in death or very serious injury.**

**WARNING: Indicates potentially hazardous situation that, if not avoided, could result in death or serious injury.**

**CAUTION: Indicates potentially hazardous situation that, if not avoided, may result in minor injury.**

## INFORMATIONAL MESSAGES

The words IMPORTANT and NOTE are not related to personal safety, but are used to give additional information and tips for operating and servicing machine.

*IMPORTANT: Identifies special instructions or procedures that, if not strictly observed, could result in damage to, or destruction of machine, attachments or environment.*

*NOTE: Identifies points of particular interest for more efficient and convenient operation or repair.*

## IMPORTANT SAFETY INFORMATION

Most personal injuries occur during product operation, maintenance or repair and are caused by failure to observe basic safety rules and precautions. In most cases, an injury can be avoided by recognizing hazardous situations before an injury occurs.

Operator must be alert to potential hazards and have the necessary training, skills and tools to perform functions properly.

Improper operation, lubrication, maintenance or repair of product can be hazardous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair of machine until reading and understanding associated information.

Safety precautions and warnings are provided in manual and on machine. If these hazard warnings are not heeded, bodily injury or death could occur to operator or bystanders.

Not every circumstance involving a potential hazard can be anticipated. Warnings in this publication and on machine are, therefore, not all inclusive. If a tool, procedure, work method or operating technique, not specifically recommended by AGCO is used, ensure it is safe for operator and others.

Make sure machine will not be damaged or be made unsafe by operation, lubrication, maintenance or repair procedures chosen. Information, specifications and illustrations in publication are on basis of information available at time publication was written.

Specifications, torques, pressures, measurements, adjustments, illustrations and other items can change at any time. These changes can affect service given to product. Obtain complete and most current information before starting any job. Local AGCO dealer has the most current information available.

**WARNING: When replacement parts are required for this product, AGCO recommends using AGCO replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material. Failure to heed this warning can lead to premature failures, product damage, personal injury or death.**

## GENERAL HAZARD INFORMATION

Do not start engine until area is free of personnel to avoid personal injury due to unexpected machine movement.

Know width of machine to maintain proper clearance when operating near fences or boundary obstacles.

As required, wear a hard hat, protective glasses and other protective equipment.

Do not wear loose clothing or jewelry that can snag on controls or other parts.

All protective guards and covers must be secured in place.

Keep machine free of foreign material. Remove debris, oil, tools and other items from deck, walkways and steps.

Secure lunchboxes, tools and other loose items not a part of machine.

Know appropriate work site hand signals, personnel authorized to give hand signals and only accept hand signals from one person.

Drain all liquids into a suitable container, never put maintenance fluids into glass containers.

Discard any drained fluids and filter elements according to local regulations.

Use all cleaning solutions with care.

Report all necessary repairs.

Do not allow unauthorized personnel on machine.

Do not smoke when servicing air conditioner or when refrigerant gas may be present. Inhaling fumes released from a flame that contacts air conditioner refrigerant can cause bodily harm or death.

Inhaling gas from air conditioner refrigerant through a lit cigarette can cause bodily harm or death.

Unless otherwise instructed, perform maintenance under the following conditions:

- Park on level ground
- Lower implements to ground
- Transmission control lever in park
- Stop engine
- Engine start switch is off and key removed
- Machine has cooled down

## Pressurized Air

Air under pressure can cause personal injury. When pressurized air is used for cleaning, wear a protective face shield, protective clothing and protective shoes.

Maximum air pressure for cleaning purposes must be below 205 kPa (30 PSI).

## Asbestos Information

AGCO equipment and replacement parts shipped from AGCO are asbestos-free. AGCO recommends use of only genuine AGCO replacement parts.

## Electrical Storm Injury Prevention

When lightning is striking in vicinity of machine, do not attempt to mount or dismount machine.

Do not leave operator sation during an electrical storm. Stay away from machine if on ground during an electrical storm.

## Mounting and Dismounting

Mount or dismount machine only at locations with steps and/or hand holds. Before mounting or dismounting, clean steps and hand holds. Inspect stairs and hand holds and make any necessary repairs.

Maintain three-point contact with steps and hand holds. Three-point contact is two feet and one hand or one foot and two hands.

Never mount or dismount a moving machine. Never jump from machine except in an emergency.

Do not carry tools or supplies when mounting or dismounting machine, use a hand line to pull equipment onto platform.

Do not use any controls as hand holds when entering or exiting operator compartment.

*IMPORTANT: Make sure steps are not adjusted too close to machine hood.*

A minimum dimension of 75 mm (2 in) between inside hand hold and hood must be maintained to allow room for operator's hand.

## Before Starting Engine

Start engine only from operator station. Never short across starter terminals or batteries. Shorting could damage electrical system or cause unexpected machine movement.

Adjust seat so full pedal travel can be achieved with operator's back against back of seat.

Make sure machine is equipped with a lighting system adequate for job conditions and all lights are in working order.

Ensure area is free of personnel before starting engine.

## Engine Starting

Move hydraulic controls to HOLD before starting engine.

Make sure transmission control lever is in PARK.

Diesel engine exhaust contains products of combustion which can be harmful to health. Always run engine in a well-ventilated area. Vent exhaust outside when in an enclosed area.

When engine is running and steering wheel is turned, machine will not turn with transmission control lever in PARK.

Ensure area is free of personnel to prevent injury due to unexpected machine movement.

## Before Operation

Ensure machine and surrounding area are free of personnel.

Clear all obstacles from path of machine. Beware of hazards such as wires, ditches, etc.

Be sure all windows are clean and either in the open or closed position.

Adjust rear view mirrors for best visibility for objects close to machine. Make sure horn, backup alarm, if equipped and all other warning devices are working properly.

Fasten seat belt securely, low around hips.

## Operation

Only operate machine while in operator seat. Seat belt must be fastened during operation. Only operate controls while engine is running.

Check for proper operation of all controls and protective devices while operating machine slowly in an open area.

Make sure no one will be endangered before moving machine.

Report any damage noted during operation and make any necessary repairs.

Do not drive machine near an overhang, edge of a cliff or near edge of an excavation.

If machine begins to sideslip on a grade, immediately dispose of load and turn machine downhill.

Take steps to avoid any ground condition that causes machine to tip.

A rollover can occur when working on hills, banks or slopes or when crossing ditches, ridges or other unexpected obstacles.

When possible, operate machine up and down slopes, avoid driving across slopes whenever possible.

Keep machine under control and do not overload beyond capacity.

Make sure towing devices are adequate for application.

Never straddle, or allow other personnel to straddle a wire cable.

Know maximum dimensions of machine.

When operating on icy roads, reduce travel speed.

After operating in muddy conditions, allow time for tires to reject debris and moisture before making high speed maneuvers. Wet, muddy tires impede machine’s steering.

If stability of machine is noticeably reduced, reduce travel speed.

Select a gear that controls machine speed when descending a hill.

Downshift if braking is required to control machine speed. Never coast down a hill with transmission in neutral.

## Parking

Park on a level surface. If parking on a grade is necessary, chock machine's tires.

Move transmission control lever to park.

Before stopping engine, move throttle control lever to low idle. Run engine at low idle speed for five minutes to allow turbocharger to cool.

Stop engine.

Turn engine start switch to off and remove key.

Turn battery disconnect switch to off.

## Operator Station

Any modifications to inside of operator station should not project into operator space. The addition of a radio, fire extinguisher and other equipment must be installed so defined operator space is maintained.

Any item brought into cab should not project into defined operator space. A lunchbox or other loose items must be secured. Objects must not pose an impact hazard in rough terrain or in the event of a rollover.

## Crushing and Cutting Prevention

Ensure proper support when working under machine. Do not depend on hydraulic cylinders to hold machine up. An implement can fall if a control lever is moved or if a hydraulic line breaks.

Never jump across starter solenoid terminals to start machine, unexpected movement could result.

Never attempt adjustments while machine is moving or engine is running.

Whenever there are attachment control linkages, clearance in linkage area changes with movement of attachment.

Stay clear of all rotating and moving parts.

Keep objects away from moving fan blades. Fan blades will throw and can cut objects.

Always wear gloves when handling wire cable and never use a kinked or frayed wire cable.

When striking a retainer pin may cause personal injury. Make sure there are no personnel in area. To avoid injury to eyes, wear protective glasses when striking retainer pins.

Chips or other debris may fly off objects when struck. Make sure no personnel will be injured by flying debris before striking.

## Hydraulic Safety

Machine uses high-pressure fluids for operation. If injured by escaping fluid, seek medical attention immediately.

- Remove hydraulic pressure by operating control lever(s) to all positions with engine shut off.
- Make sure all components in hydraulic system are clean and in good condition and connections are tightened properly.
- Immediately replace any worn, cut, flattened or crimped hoses and/or steel lines.
- Wear proper hand and eye protection when searching for a high-pressure leak.
- Use a piece of wood or cardboard to isolate leaks.
- Never use fingers or hands to search for leaks.
- Relieve system before loosening any hydraulic lines or connections. Use extra care when working on hydraulic circuits containing accumulators. High pressure can exist long after machine is shut down.
- Loosen connections slowly, keeping hands and fingers clear of loosened fittings.
- Tighten connections securely before applying pressure.
- Escaping fluid under high pressure can be almost invisible but can penetrate skin.
- Consult a doctor immediately if an escaping fluid injury is sustained. Serious reactions can result.
- Do not attempt any repairs to hydraulic lines, fittings or hoses by using tape, clamps or cements. Such repairs fail suddenly and create hazardous conditions.

## Chemical Safety

Do not perform any maintenance on machine until all chemicals have been thoroughly rinsed from outside and entire system has been flushed.

**DANGER: Contact with chemicals can cause injury or death.**

Select an area to fill, flush, calibrate and decontaminate machine. Select an area where hazardous chemicals will not drift or run off to contaminate people, animals, vegetation or water supply.

Follow instructions on all signs and labels.

Wear approved hand, eye and body protection.

Do not inhale dust or fumes.

Never use mouth to blow trash or debris from nozzles, tips or other parts which may contain chemical residue. Have spare tips or parts available for replacement.

Follow correct treatment on container if contact is made with chemicals or fertilizers.

Wash hands before touching face or mouth.

Clean machine after each use with correct method.

Get medical help immediately if signs of illness occur during or soon after use of dry or liquid agricultural chemicals or fertilizers.

The Material Safety Data Sheet (MSDS) provides specific details on hazardous chemical products such as physical and health hazards, safety procedures and emergency response techniques.

## EMERGENCY EXIT FROM CAB

**FIG. 4:** Understand the procedure to use the emergency exit from the Right Hand side of the cab before operating the vehicle.

1. Pull green tab located at the rear of the Right Hand Cab Window. This removes the glass seal.
2. Push out the Right Hand Cab Window and exit the vehicle.

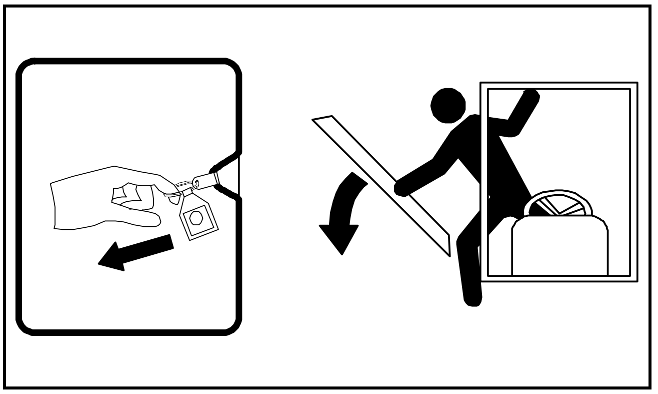

**FIG. 4**

## OPERATING THE VEHICLE SAFELY

**FIG. 5:** Wear a seat belt at all times.

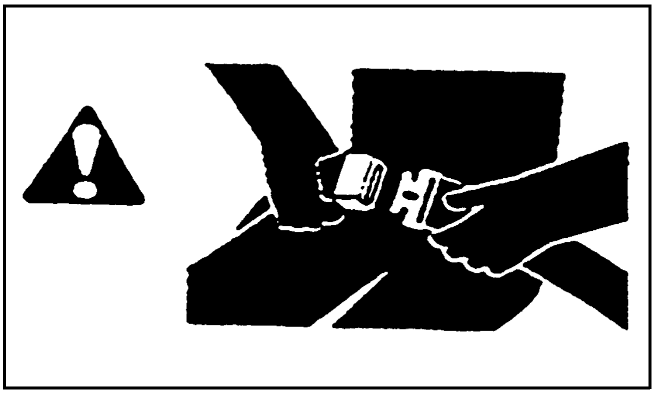

**FIG. 5**

**FIG. 6:** Make sure the operator and ladder areas are clean and dry to help prevent personal injuries.

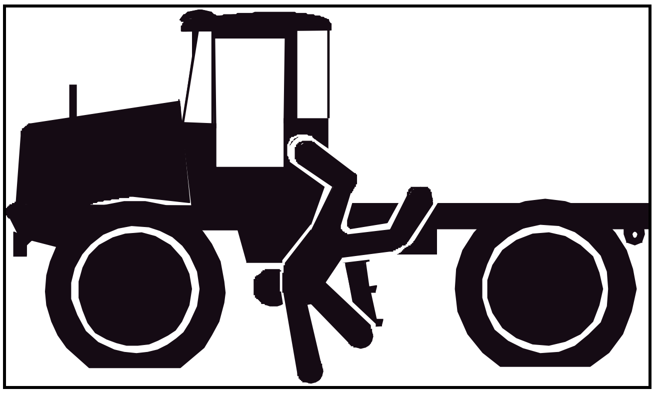

**FIG. 6**

- Make sure all wheel bolts are torqued to the proper specifications before operating the vehicle.
- Never permit any passengers on, or in the vehicle when it is in operation.
- Engage the Parking Brake and place the Drive Lever in the NEUTRAL position before starting the vehicle's engine.
- Stop the vehicle, turn off the engine and set the Parking Brake before inspecting any damage if an accident occurs.
- Stop the vehicle immediately if there is a failure in the engine, hydraulic system, or any vehicle system. Do not turn the key switch to the OFF position until the vehicle is stopped and the vehicle is shutdown properly.
- The operator must not exceed the speeds and loads listed on the tire load and inflation table in the Maintenance section.
- Tire inflation pressure must be maintained per the tire load and inflation table in the Maintenance section.
- Never get off a moving vehicle.

**FIG. 7:** When leaving the vehicle unattended, engage the Parking Brake and remove the key.

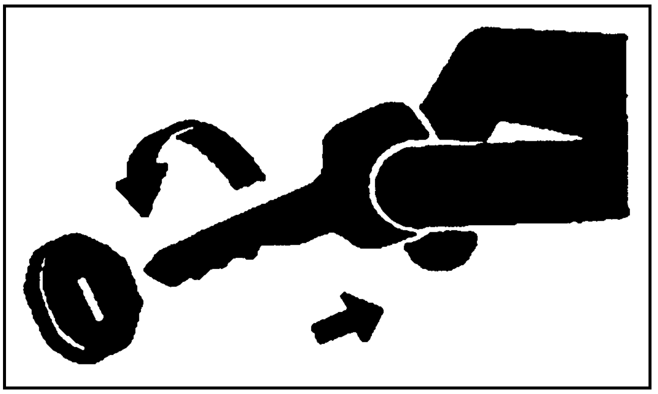

FIG. 7

## PREVENT VEHICLE RUNAWAY

**FIG. 8:** Avoid possible injury or death from vehicle runaway.

Never start the engine by shorting across the starter terminals. The engine will start, and the vehicle will move if normal circuitry is bypassed.

Never start the vehicle's engine while standing on the ground. Start the engine only from the operator's seat with the seat belt on, Drive Lever in the NEUTRAL position and the Parking Brake engaged.

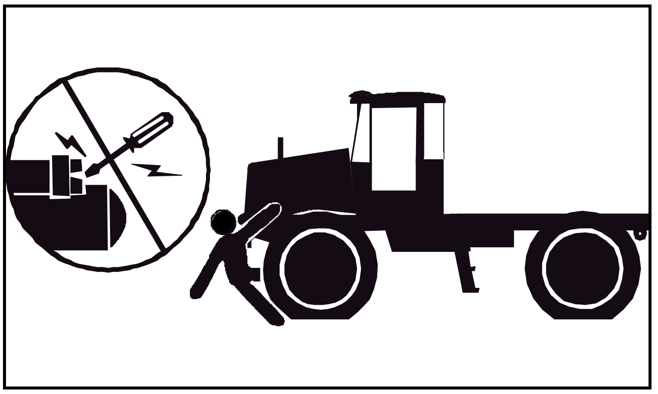

FIG. 8

## USE SAFETY LIGHTS AND DEVICES

To increase visibility, use the safety lights and devices provided with the vehicle. Whenever driving on public roads use Amber flashing Warning Lights and turn signals, unless prohibited by law. Keep safety items and features in the proper working order. Replace any missing or damaged components immediately.

## OPERATING ON SLOPES

**FIG. 9:** Keep the vehicle in a safe lower gear when going down slopes. Avoid holes, ditches and obstructions that may cause vehicle roll-over, especially on hillsides. Avoid sharp turns on hills.

When driving parralel on steep slopes be aware that vehicle doesn’t roll over.

Never drive near the edge of a gully or steep embankment.

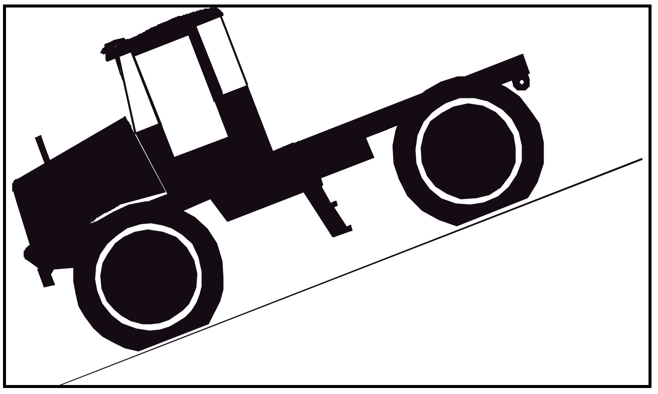

FIG. 9

## TRAVELING ON PUBLIC ROADS

**CAUTION: This vehicle was designed for applying chemicals and fertilizers in off-road use. Do not use the vehicle for transporting product over public roads. Chemical spills may occur resulting in environmental damage. A loaded vehicle driven on public roads also runs the high risk of tire failure. Personal Injury could result.**

ALWAYS walk around and visually inspect the vehicle before traveling on public roads. Check for damage and/or faulty components that can fail and create a hazard or unsafe condition. Make sure ALL vehicle systems operate properly including, but not limited to: Front Road Lights, Tail and Brake Lights, Hazard Warning Lights, Safety Lights, Parking Brake, Horn, Windshield Wiper and Washer, and Rear View Mirrors. Repair or replace any component that is not in proper working order.

Never drive at a speed that causes the vehicle to bounce or cause the loss of control.

Obey all traffic safety rules. Operate the vehicle with hazard warning lights ON, unless prohibited by law. It is the operator's responsibility to activate and use the road lights while traveling on public roads.

## STOPPING AND PARKING THE VEHICLE

Vehicle roll-over, collisions, runaway vehicles, and people being crushed under vehicles can occur when the vehicle's operator ignores operation safety procedures.

Signal before stopping, turning or slowing down on public roads, or anywhere it will cause a potential safety hazard.

Pull over to the side of the road before stopping the vehicle.

Be extremely careful when stopping the vehicle on slippery surfaces.

Be extremely careful when stopping with heavy loads.

Always engage the Parking Brake when the vehicle is stopped.

Remove the key to prevent any unauthorized personnel from operating the vehicle.

## SYSTEM BOOM SAFETY

**FIG. 10:** If you have a system with booms, make sure no personnel or objects are ever in the path of the booms before operating them. Especially, when retracting or extending the booms.

Be aware of the location of the booms at all times.

Before driving on public roads, retract and lock the booms if applicable.

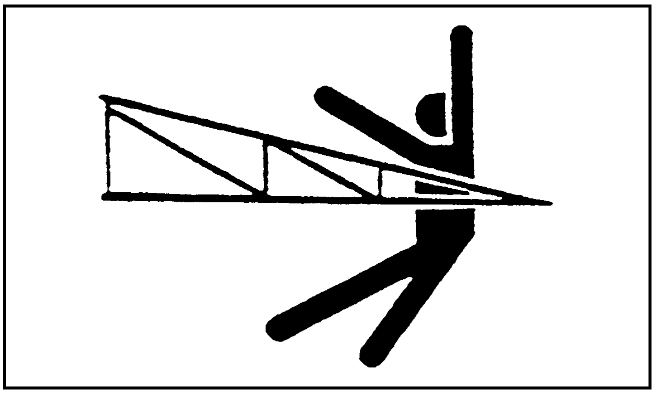

**FIG. 10**

## AVOID EYE CONTACT WITH RADAR

**FIG. 11:** Radar ground sensors emit a low intensity microwave signal. The microwave signal will not cause any ill effects during normal use. Although the intensity is low, to avoid eye damage, never look directly into the sensor while the sensor is in operation.

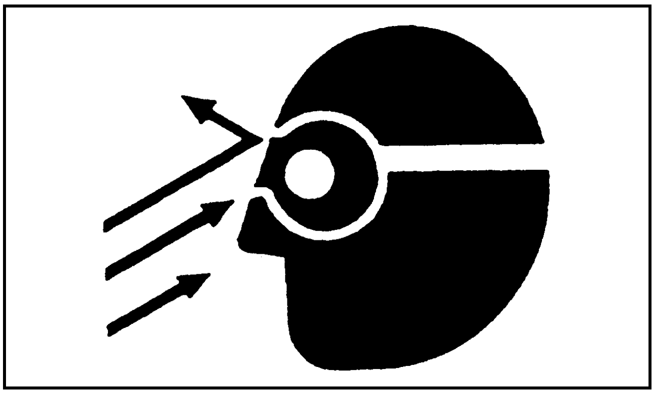

**FIG. 11**

## EXHAUST FUMES

**FIG. 12:** Always work in a Properly Ventilated Area.

Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, use the proper equipment to safely remove the exhaust fumes from the working area.

Always open the doors and get fresh outside air into the working area.

Never operate the vehicle's engine inside a building unless adequate ventilation is provided to safely and properly remove the exhaust fumes.

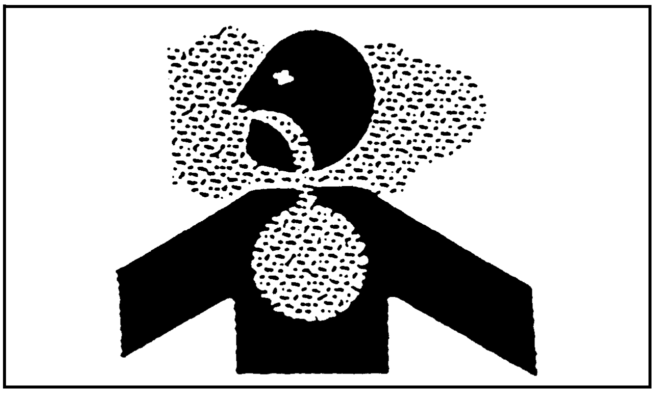

**FIG. 12**

## OVERHEAD ELECTRICAL POWER LINES

**FIG. 13:** Never let the vehicle come into contact with overhead power lines. All antennas must be bent over and secured in place any time overhead electrical power lines are near the vehicle. This can decrease the possibility that the vehicle may come into contact with an overhead power line when in operation or when the vehicle is transported.

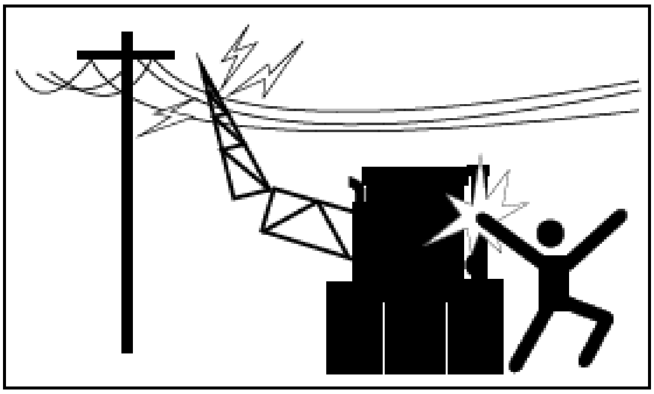

FIG. 13

## NOISE

**FIG. 14:** Long periods of exposure to high decibels or loud noise can cause hearing impairment or loss.

Wear proper hearing protection during periods of exposure to high decibels or loud noise.

Wear a proper hearing protective device such as earmuffs or earplugs to protect against high decibels and/or uncomfortable loud noises.

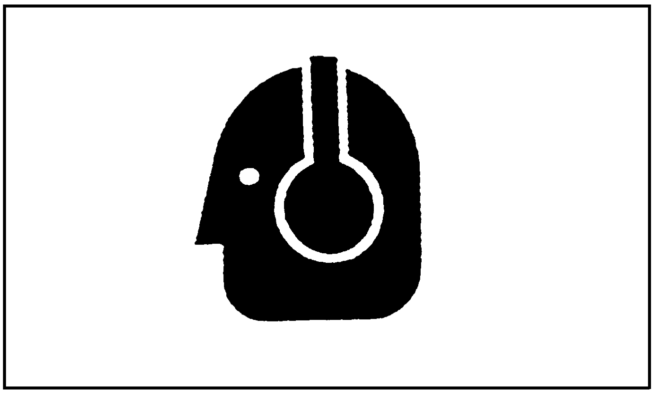

FIG. 14

## HANDLE FUEL SAFELY - AVOID FIRES

**FIG. 15:** Handle fuel with care: it is highly flammable.

Always stop the engine before refueling the vehicle.

Never refuel the vehicle while smoking.

Add fuel in a safe place, away from open flame or sparks.

Fill the fuel tank outdoors.

Never fill the fuel tank completely to the top of the fuel tank.

Clean up any spilled fuel immediately.

Never use diesel fuel, kerosene, gasoline or any flammable solvents for cleaning. Never use any flammable solvents for cleaning anything, EVER!

Prevent fire hazards by keeping the vehicle clean of any accumulated trash, grease and debris.

Always have a multipurpose dry chemical fire extinguisher filled and available during vehicle operation and adding fuel. Know how to use it.

FIG. 15

## STAY CLEAR OF ROTATING DRIVE LINES AND MOVING PARTS

**FIG. 16:** Entanglement in rotating drive lines or moving components will cause serious injury or death.

FIG. 16

**FIG. 17:** Keep all safety guards and shields in place at all times when operating the vehicle.

Turn the key switch to the OFF position. Remove the key from the switch to prevent unauthorized operation of the vehicle before removing any safety guards and shields.

Wear close fitting clothing. Stop the engine and make sure the drive lines are stopped before making any adjustments or performing any type of service on the engine or vehicle.

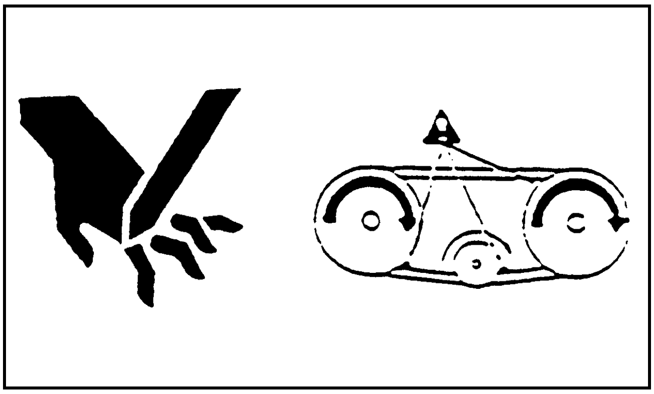

FIG. 17

## TOWING OTHER VEHICLES / TRAILERS / EQUIPMENT

**FIG. 18:** Towing of other vehicles without brakes is NOT approved by Challenger.

Using the vehicle for towing can create a safety hazard and can void the vehicle or system warranty.

## MODIFICATIONS

Welding or altering the chassis in any way (such as adding implement towing hitches) can cause damage or failure of components and create a safety hazard. Modifications not approved by Challenger can also void the vehicle or system warranty.

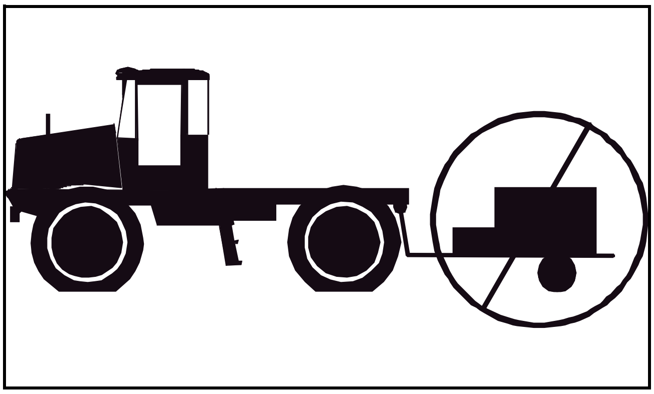

FIG. 18

## MAINTENANCE AND SERVICE SAFETY

**FIG. 19:** Read the maintenance and safety instructions and understand them before performing any maintenance procedures.

Never perform any maintenance procedures or repairs if the instructions and safety procedures are not fully understood. Only trained and qualified personnel should perform any maintenance procedures or repairs.

Never modify any equipment or add attachments not approved by Challenger.

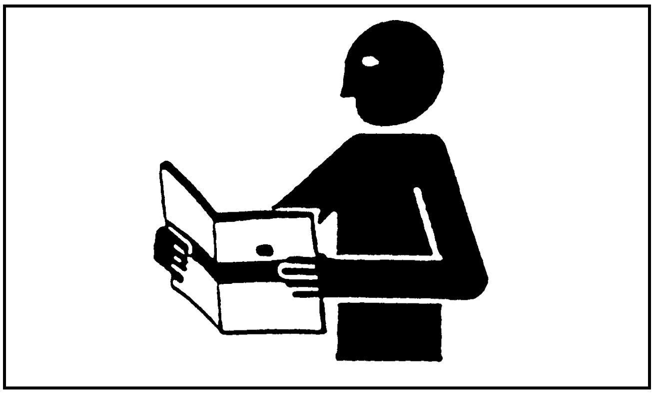

**FIG. 19**

## PRACTICE SAFE MAINTENANCE

**FIG. 20:** Never lubricate, service, or adjust the vehicle, any of its systems or components while they are moving.

Never wear a necktie, necklace, scarf or loose clothing when working near machine tools or moving parts.

Tie long hair behind the head and wear a hair net.

Remove rings and other jewelry to prevent electrical shorts or other personal injury when in contact with machine tools or moving parts.

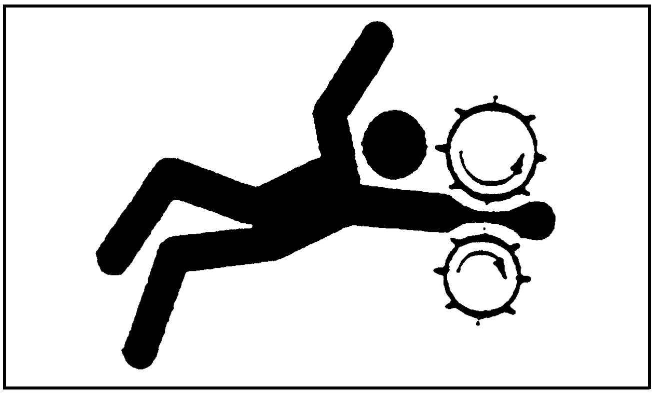

**FIG. 20**

**FIG. 21:** Stop the engine. Remove the key.

Allow the vehicle to cool.

Keep all parts in good condition and properly installed.

Fix any damaged vehicle, systems or component immediately.

Replace worn, damaged or broken parts immediately.

Remove any buildup of grease, oil or debris.

Disconnect the electrical system before making adjustments on electrical systems or welding on the vehicle.

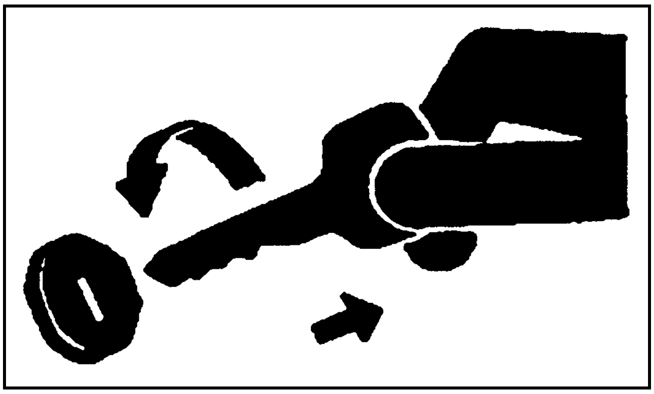

**FIG. 21**

## CHEMICAL SAFETY

### Operator Cabs

**FIG. 22:** Some cabs use filters that MAY NOT filter out dangerous chemicals.

Follow instructions given by the chemical manufacturer.

Cabs labeled as "**Enclosed Cabs for Pesticide Application Incorporating Respiratory Protection**" or "**ECPAR**" comply with ASAE S525 and EPA Worker Protection Standards for operating in a pesticide environment. This does not include fumigants. (Look for the **ECPAR** decal to check if the cab is an **ECPAR** cab.) However, to remain in compliance, **ECPAR** cabs MUST be operated with the door closed and the fan on MAX setting when applying or driving in a treated area. Operators must also avoid entering or exiting the cab in treated areas. Cabs must be equipped with the required filters and maintained properly. (See the Maintenance Section of this manual.)

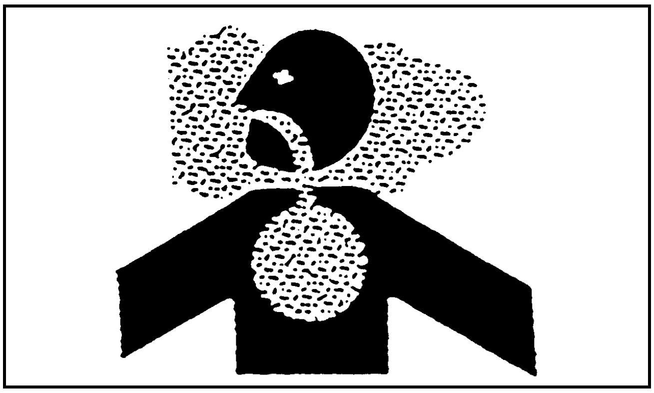

**FIG. 22**

**FIG. 23:** Never spray hazardous chemicals when the wind is in excess of the chemical manufacturer's recommendation. NEVER allow chemicals to contact the skin or eyes.

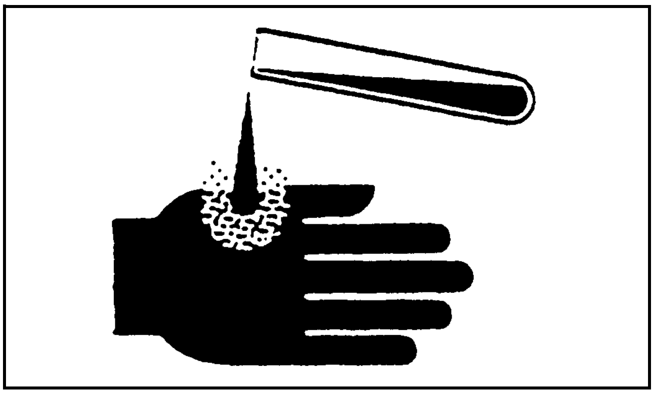

**FIG. 23**

**FIG. 24:** Always wear APPROVED protective equipment and clothing.

Before leaving the cab, wear personal protective equipment as required by pesticide use instructions and the chemical manufacturer recommendations. Before re-entering the cab, remove protective equipment and store; either outside the cab in a closed box or another type of sealable container. Inside the cab, use a pesticide resistant container such as a plastic bag or approved container. Clean shoes or boots to remove soil or other contaminant prior to entering the cab.

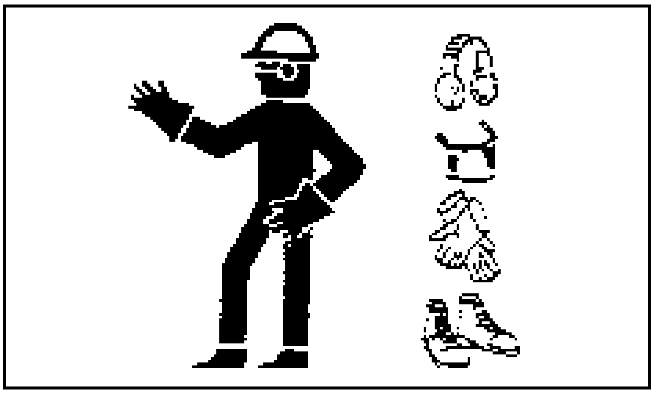

**FIG. 24**

Select a safe area to fill, flush, calibrate and decontaminate the vehicle. Select an area where hazardous chemicals will not drift or run off to contaminate people, animals, vegetation, water supply, etc.

If hazardous chemicals come in contact with the body, wash immediately according to the chemical manufacturer's recommendations.

Never place nozzles, tips or other parts to lips to blow out trash or debris. Have spare tips available for replacement.

**FIG. 25:** Clean the vehicle of hazardous chemicals after use. Hazardous chemical residue can build up on the inside and outside of the vehicle.

Direct exposure to hazardous chemicals can cause serious injury or death. Potentially hazardous chemicals used with Challenger equipment include such items as fuel, lubricants, coolants, hydraulic fluid, paints and adhesives.

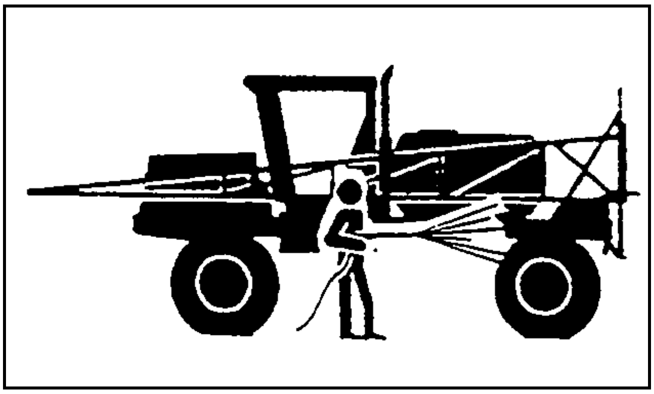

**FIG. 25**

**FIG. 26:** The Material Safety Data Sheet (MSDS) provides specific details on hazardous chemical products: physical and health hazards, safety procedures and emergency response techniques.

Check the MSDS before starting any project using a hazardous chemical. Know exactly what the risks are and how to do the project safely. Follow procedures and equipment recommendations.

(See the chemical manufacturer for MSDS's on chemical products used with Challenger equipment.)

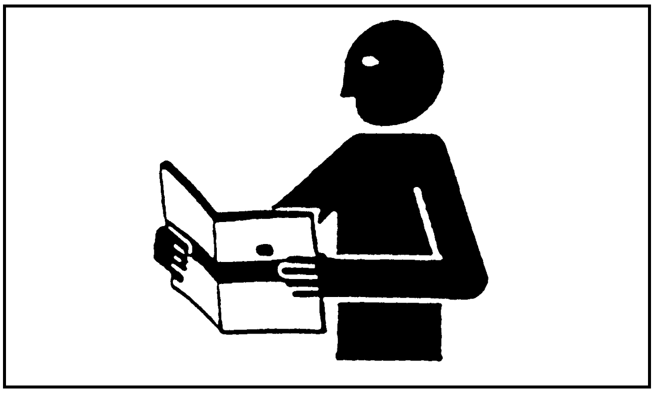

**FIG. 26**

## WEAR PROTECTIVE CLOTHING

**FIG. 27:** Wear close fitting clothes and the proper safety equipment required for the job.

Wear a suitable hearing protection device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

Prolonged exposure to high decibels or loud noise can cause hearing impairment or loss of hearing.

Operating equipment safely requires the full attention of the operator. Never wear radio or music headphones while operating the vehicle.

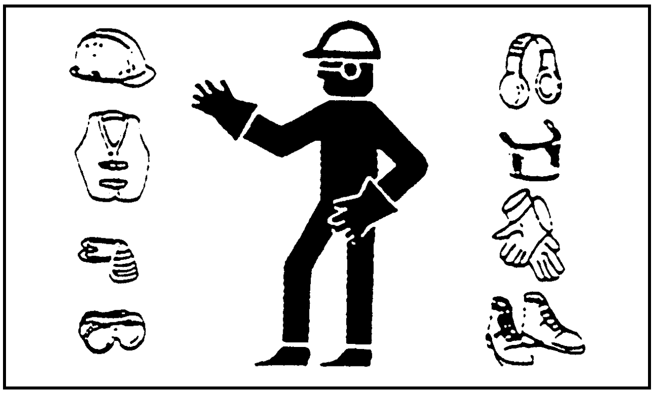

**FIG. 27**

## WORK IN A CLEAN AREA

**FIG. 28:** Thoroughly clean the work area, the vehicle, systems, and components before starting a job. Dirty and greasy areas can create work hazards.

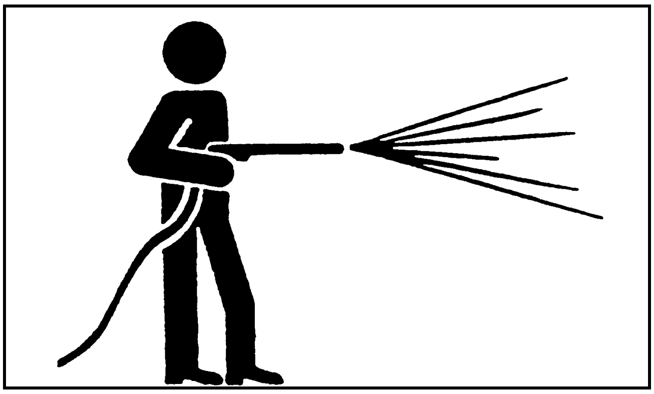

**FIG. 28**

## UNDERSTAND CORRECT SERVICE

**FIG. 29:** Light your working area properly, adequately and safely.

Use proper safety lights with wire safety cages. Exposed bulbs can ignite fluids.

Catch draining fluids in proper containers.

Never use beverage containers that could mislead personnel to drink from them.

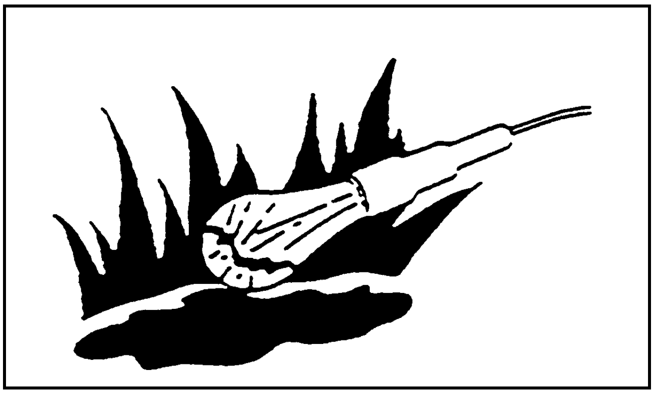

**FIG. 29**

## USE PROPER TOOLS

**FIG. 30:** Make-shift tools and procedures can create safety hazards. Use only the proper equipment and procedures.

Use power tools only to loosen threaded parts and fasteners.

Use only U.S. tools with U.S. fasteners and metric tools with metric fasteners.

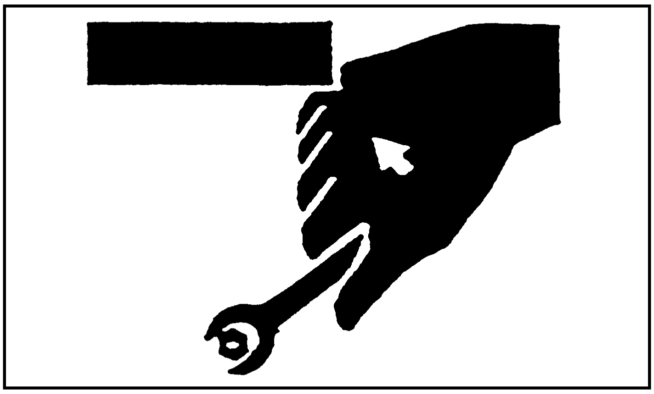

FIG. 30

## SUPPORT MACHINE PROPERLY

**FIG. 31:** Never support the vehicle on cinder blocks, hollow tiles or supports that may crumble.

Never work under a vehicle that is only supported by a jack. Use wheel chocks.

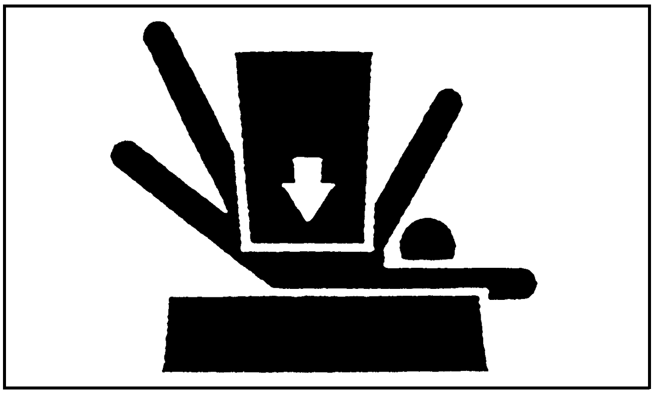

FIG. 31

## PROPER LIFTING EQUIPMENT

**FIG. 32:** Lifting incorrectly can cause severe injury or vehicle damage.

Follow the procedures recommended in the proper manual for removal and installation of components of this vehicle, systems or components.

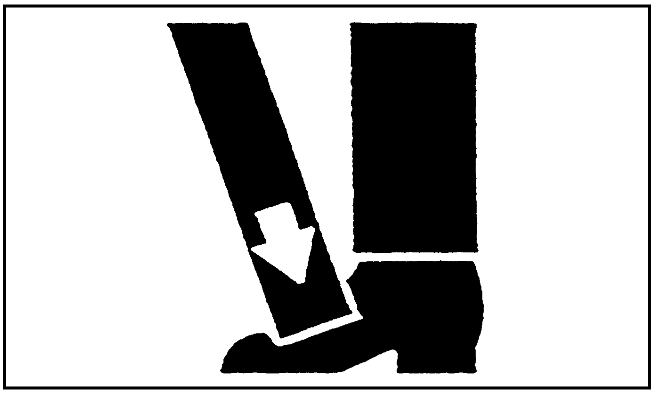

FIG. 32

## HIGH-PRESSURE FLUIDS

**FIG. 33:** AVOID HIGH-PRESSURE FLUIDS

Escaping fluid under pressure can penetrate the skin causing serious injury.

The vehicle must be stopped and cooled before checking fluids. Use caution when removing radiator caps, plugs, grease fittings or pressure taps.

Never open pressure lines when they are under pressure. Release all pressure before doing maintenance or repairs on any pressure system.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

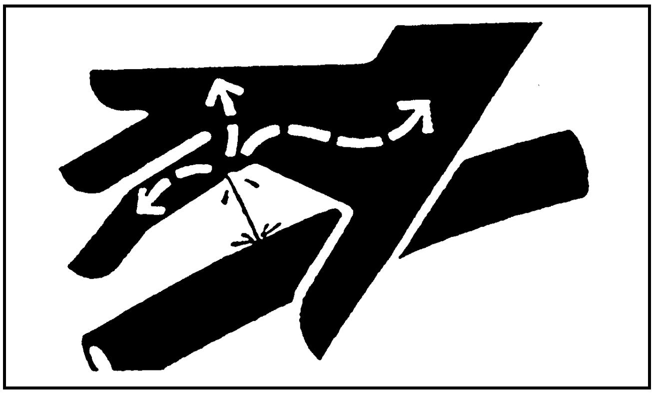

**FIG. 33**

**FIG. 34:** Search for leaks with a piece of wood or cardboard. Protect hands and body from high pressure fluids. Do not use your hands!

Never open hydraulic lines or fuel lines when they are under pressure. Hydraulic fluid or diesel fuel under pressure can cut the skin, cause bad burns, eye injury or skin irritation.

If an accident does occur, get medical help immediately if any personnel are injured by hydraulic fluid or fuel.

Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.

Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.

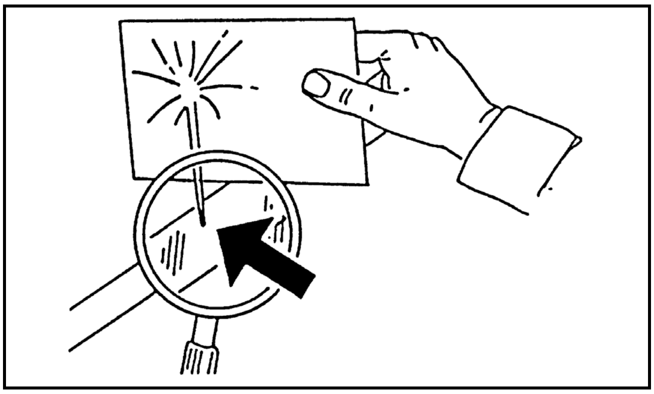

**FIG. 34**

## HYDRAULIC HOSES

*IMPORTANT: Hydraulic hoses have a limited working live. By weather influences and use under heavy conditions and normal aging the working live reduce.*

Therefore is checking of hydraulic hoses by damaging and aging important for good functioning of your machine and the safety of the user and the environment.

Replace immediately damaged and leaking hydraulic hoses.

## AVOID HEATING NEAR PRESSURIZED FLUID LINES

**FIG. 35:** Never heat by welding, soldering or using a torch near pressurized fluid lines or other flammable materials.

Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to personnel and bystanders.

**FIG. 35**

## SERVICE COOLING SYSTEM SAFELY

**FIG. 36:** Explosive release of fluids from pressurized cooling systems can cause serious burns.

Shut off the engine. Remove the filler cap only when it is cool enough to touch with bare hands. Slowly, loosen the filler cap to the first stop to relieve any pressure before removing the cap completely.

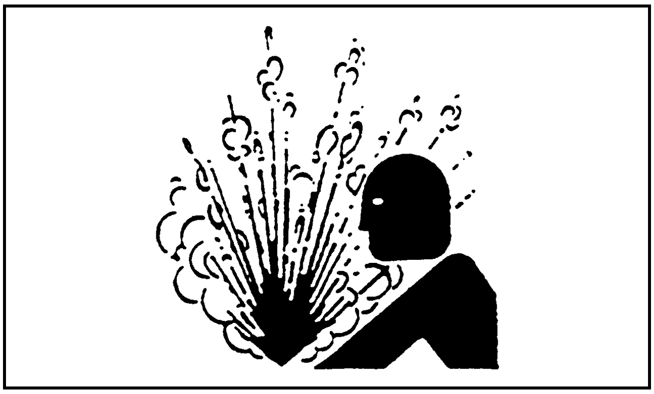

**FIG. 36**

## REMOVE PAINT BEFORE WELDING OR HEATING

**FIG. 37:** Avoid potentially toxic fumes and dust. Hazardous fumes can be generated when paint is heated by welding, soldering or using a torch.

Always work outside in a well-ventilated area. Dispose of paint and solvent properly.

Always remove paint before welding or heating. Wear an approved respirator to sand or grind paint, avoid breathing the dust.

If using solvent or paint stripper, remove the stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from the area. Allow fumes to disperse before welding or heating.

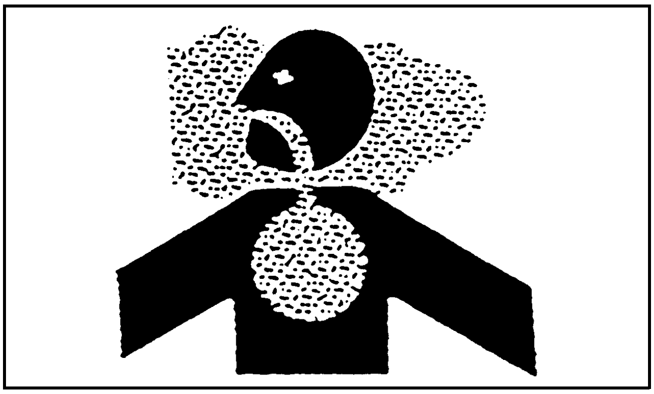

**FIG. 37**

## BATTERIES

**FIG. 38:** A lead acid battery will generate flammable and explosive gases. Keep sparks and flames away from the battery.

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

If acid contacts eyes, skin or clothing, flush with water immediately. If acid contacts eyes get immediate medical help.

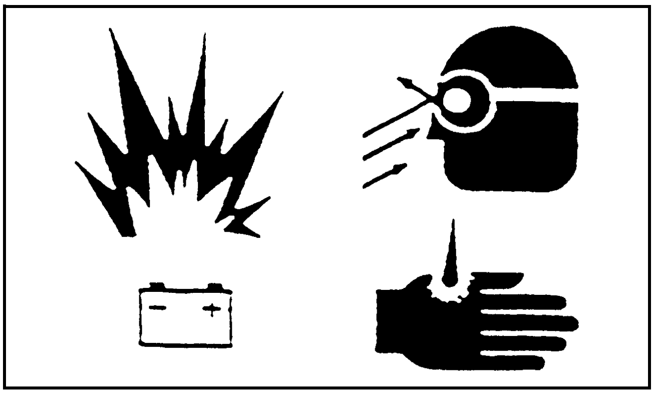

**FIG. 38**

## TIRES AND WHEELS

**FIG. 39:** Never weld on a wheel or rim that has a tire on it.

Never attempt to mount or remove a tire unless using the proper equipment, tire safety cage, instructions, training and are qualified to perform the work safely. Failure to follow the correct procedures when mounting a tire on a wheel or rim can cause an explosion and serious injury.

Tire repairs procedures must be performed by trained and qualified personnel.

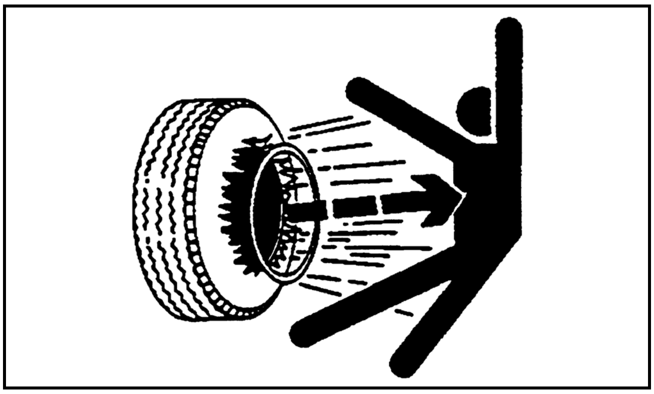

**FIG. 39**

## DISPOSE OF WASTE PROPERLY

**FIG. 40:** Improper disposal of potentially harmful waste can threaten the environment and ecology. Potentially harmful waste used with Challenger vehicles include such items as oil, fuel, fluids and batteries.

Use leak proof containers when draining fluids. Never use food or beverage containers that may mislead someone to drink from them.

Never pour harmful waste onto the ground, down a drain, or into any water source.

Air Conditioning refrigerants escaping into the atmosphere can damage the Earth's atmosphere. Government regulations require a certified air conditioning service center to recover and recycle used air conditioning refrigerants.

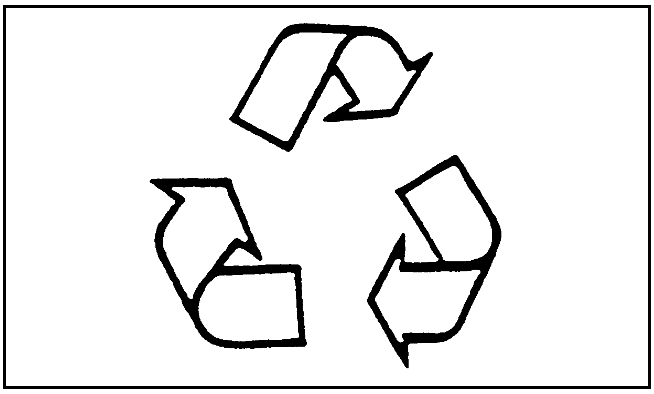

**FIG. 40**

## MOBILE RADIO INSTALLATIONS

Under no circumstances should a mobile radio antenna be mounted to the rear of the cab or antenna cable be routed near harness or electrical system controllers or near operator controls. Failure to follow these precautions could expose the operator to radio frequency energy levels higher than recommended by the American National Standards Institute (ANSI) / Electro Magnetic Compatibility (EMC) and/or could cause undesirable performance of electrically controlled systems.

## MAINTENANCE IN THE ARTICULATION JOINT (HINGE) AREA

**FIG. 41:** Before performing maintenance in the area of the articulation joint or the steering hydraulic cylinders the following procedure MUST be followed:

1. Steer the vehicle into the straight ahead position.
2. Shut the engine off and remove ignition key, lock the cab door after leaving the cab so that nobody can accidentally turn the steering wheel.
3. Move the Articulation Lock Turnbuckle from the Storage position to the transport/maintenance position

This work area is a confined space and lacks clearance for a person if the vehcile steering is accidentally turned. This situation could reslut in serious injury or death.

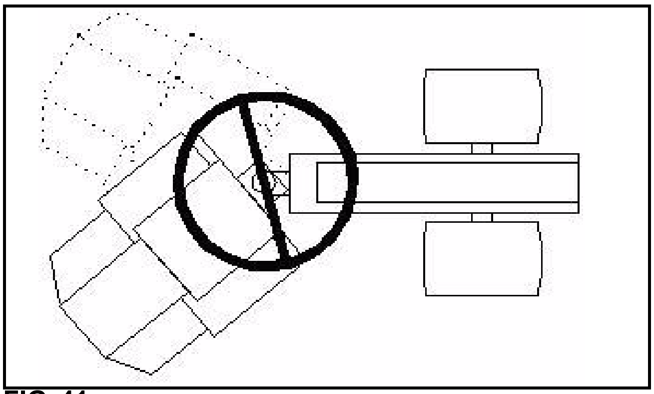

**FIG. 41**

## SAFETY TREAD AND GRIP MATERIAL

Replace safety treads when worn, damaged or missing.
Replace hand, anti-slip strips, rails and steps if they become damaged.

## SAFETY AND SERVICE DECAL LOCATIONS CHASSIS

**WARNING: Carefully read and understand all safety signs on your vehicle. Failure to read and understand all safety signs may result in personal injury or death. Always be aware of a safety hazard. Make sure new equipment components and repair parts include the current safety signs.**

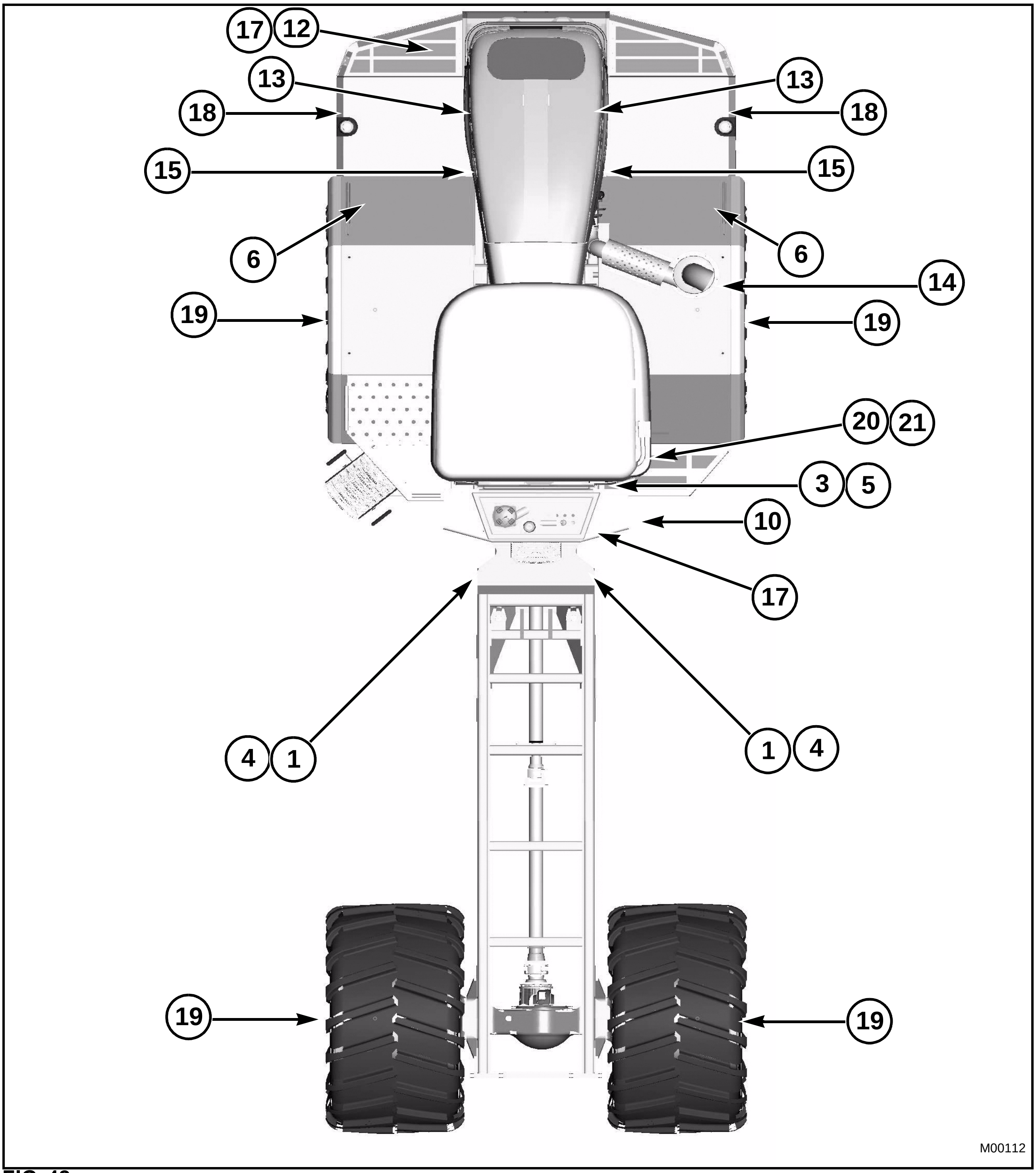


**FIG. 42**

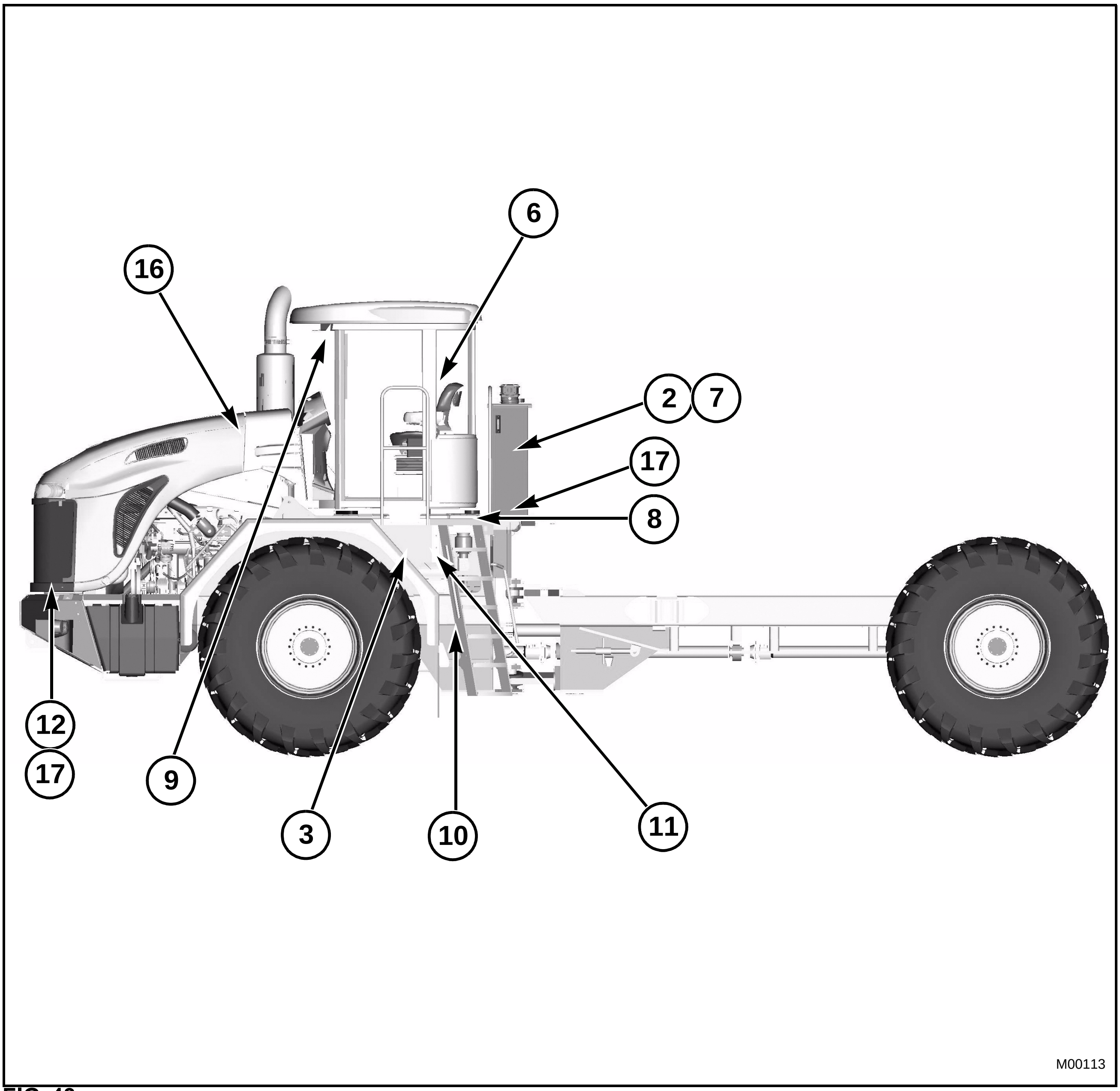


FIG. 43

**FIG. 44:**

1. Caution - No clearance for person in the working area of the machine.


FIG. 44

**FIG. 45:**

2. Warning - External hydraulic system filled with ISO VG 46.

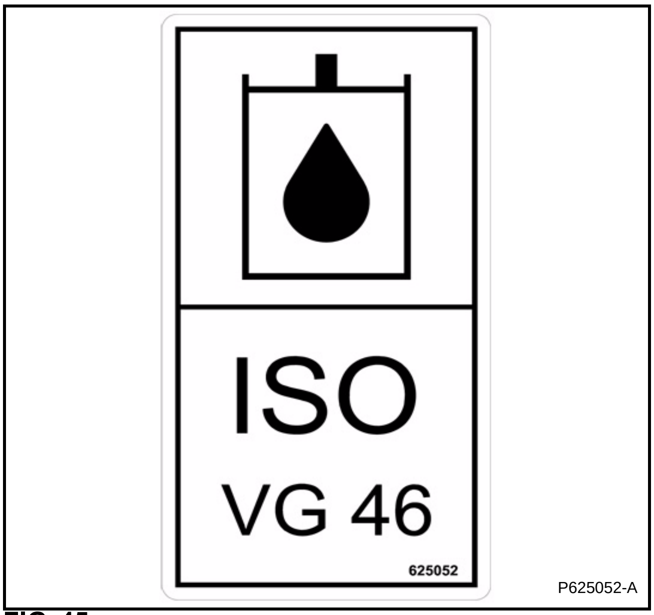


FIG. 45

**FIG. 46:**

3. Caution - Do not work under the cab, when the Safety pin is not mounted.

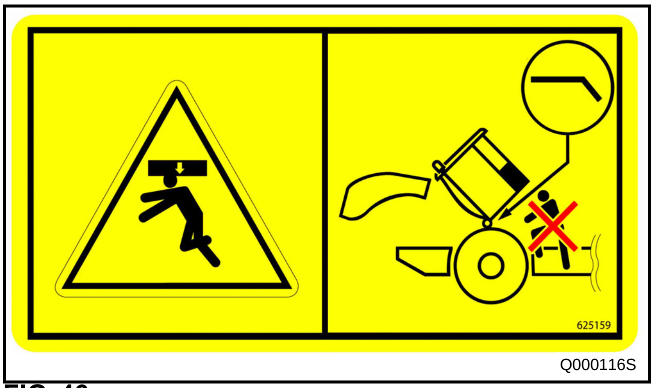


FIG. 46

**FIG. 47:**

4. Danger - No clearance for person in this area when turning vehicle. Keep distance/pinching hazard.

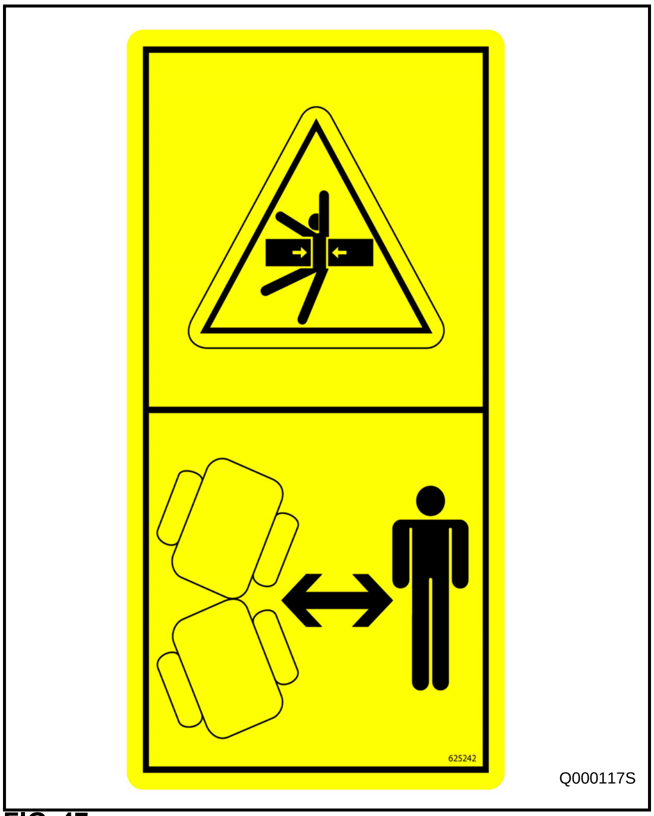


FIG. 47

**FIG. 48:**

5. Warning - Tipping over order cabin.
   i. Open engine hood;
   ii. Dismount side panels engine hood;
   iii. Check if there are no loose parts in the cab, and everything is ready to tip over the cab;
   iv. Dismount safety pin;
   v. Tip over cab;
   vi. Mount safety pin.

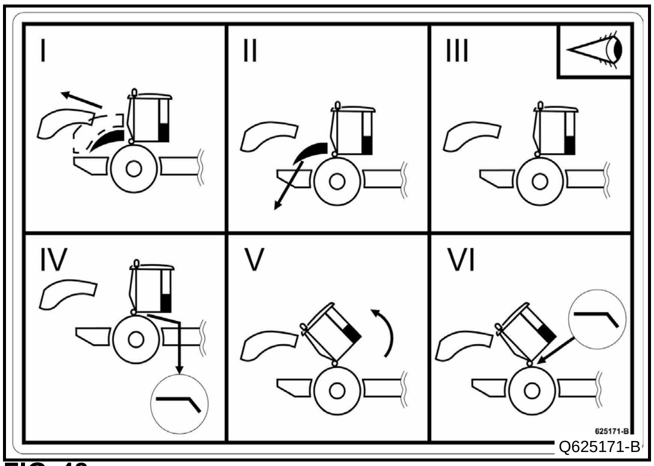


FIG. 48

**FIG. 49:**

6. Read and understand the operators manual. This decal is in a vertical and in a horizontal position available.


FIG. 49

**FIG. 50:**

7. Warning - Beware of leaking hydraulic lines/hoses.


FIG. 50

**FIG. 51:**

8. Secondary Fresh Air Filter.

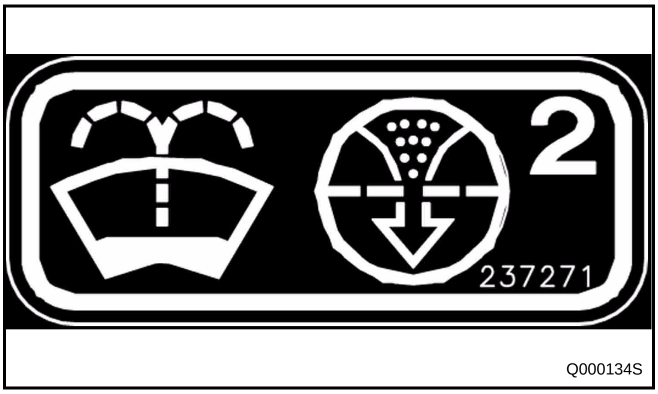


FIG. 51

**FIG. 52:**

9. Primary Fresh Air Filter.

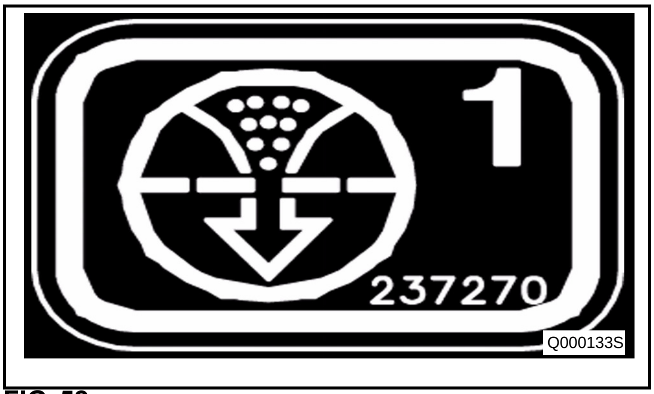


FIG. 52

**FIG. 53:**

10. Warning - Radar Hazard, do not look into the radar.

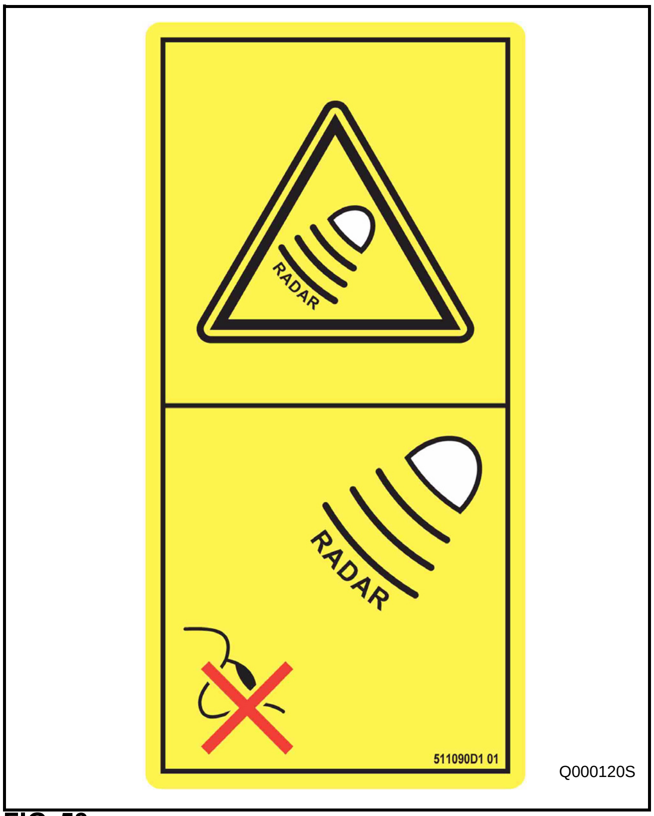


FIG. 53

**FIG. 54:**

11. Warning - Tire Pressure - Read Operator’s Manual.

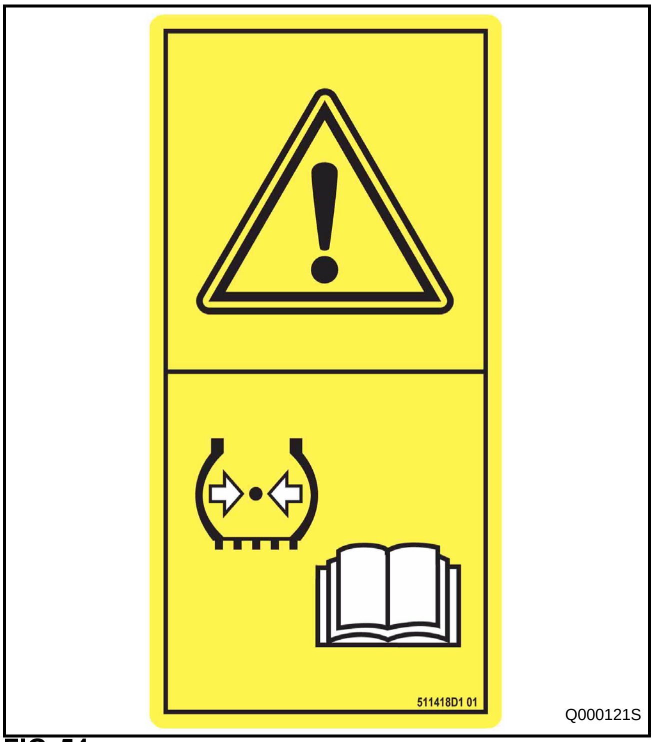


FIG. 54

**FIG. 55:**

12. Danger - Explosion Hazard - Disconnect Battery.

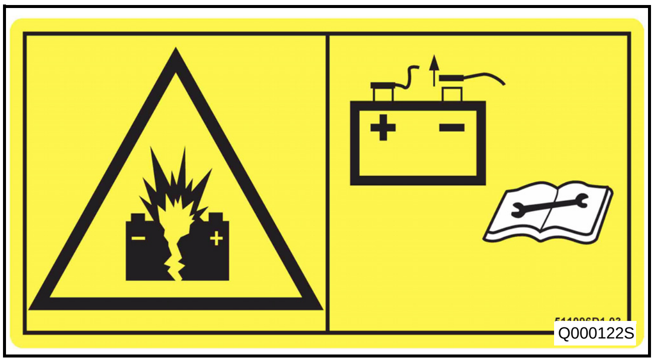


FIG. 55

**FIG. 56:**

13. Warning - Remove Key Before Maintenance - Rotating Blades.

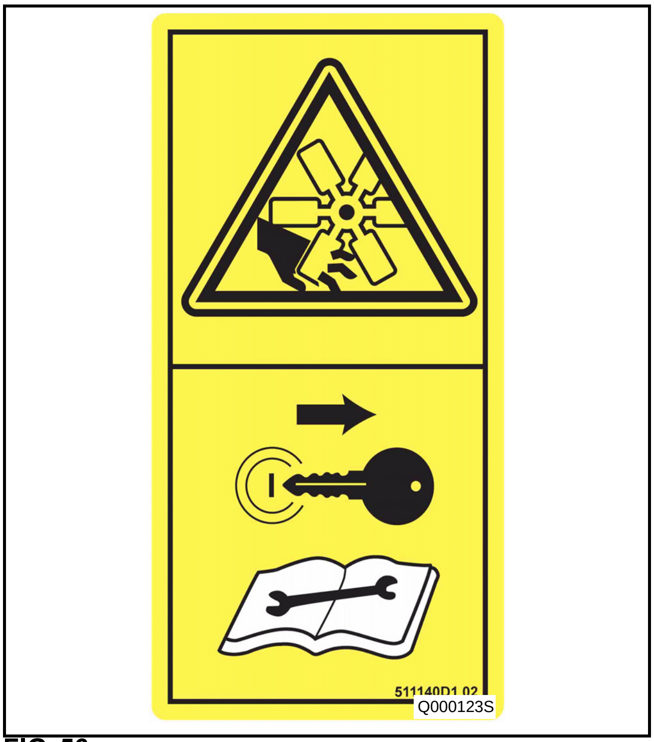


FIG. 56

**FIG. 57:**

14. Hazard - Hot surface, Exhaust.


**FIG. 57**

**FIG. 58:**

15. Warning - Remove Key Before Maintenance.


**FIG. 58**

**FIG. 59:**

16. Hazard - Hot FLuid, Burn Hazard. Remove Key, Read Manual, Cooldown Before Opening Radiator Pressure Cap.

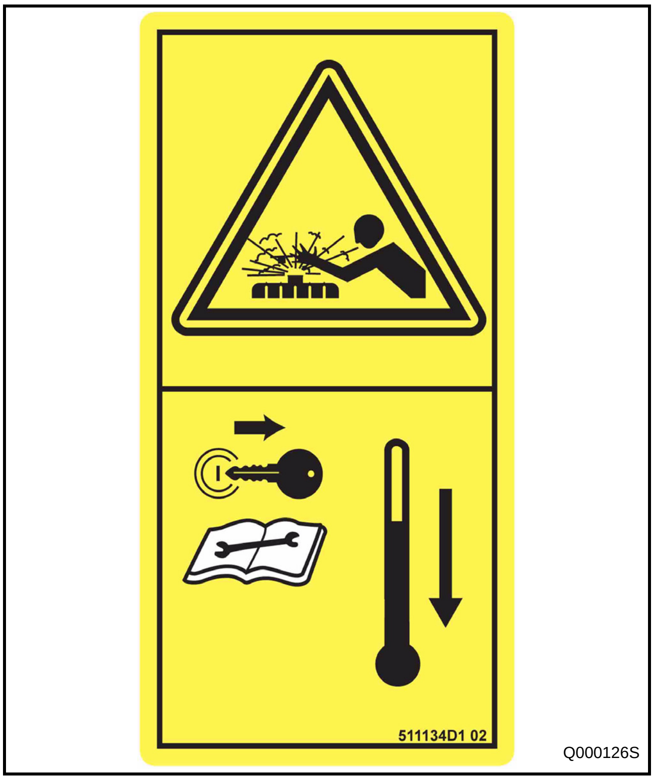


**FIG. 59**

**FIG. 60:**

17. Prohibition No Waterhose.


FIG. 60

**FIG. 61:**

18. Use Only Specified Diesel, See Engine Operators Manual

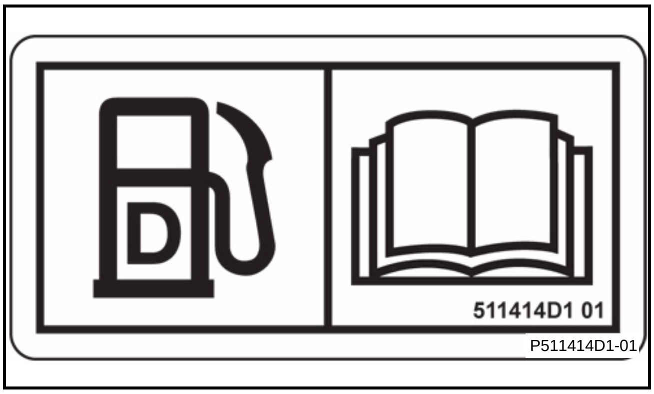


FIG. 61

**FIG. 62:**

19. Retorque Wheel Bolts With 720 Nm.

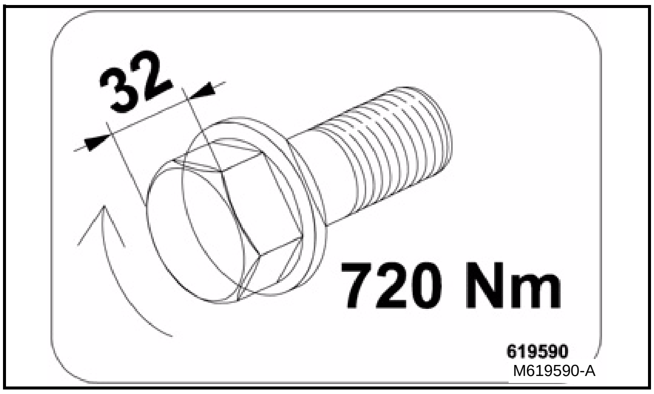


FIG. 62

**FIG. 63:**

20. Handwash Tank.


FIG. 63

**FIG. 64:**

21. Fuse Panel. See Also Chapter Lubrication and Maintenance.

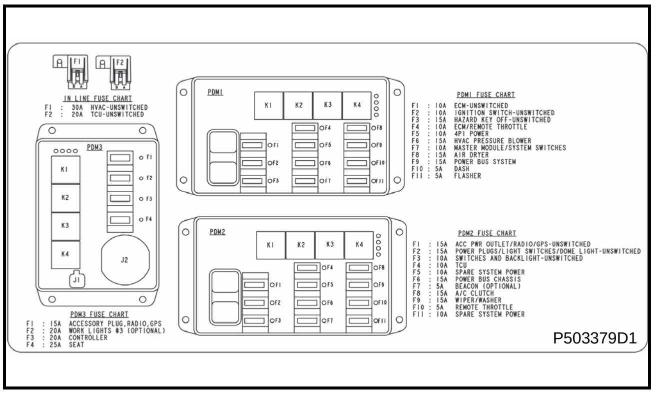


**FIG. 64**

**FIG. 65:**

22. Relay panel. See Also Chapter Lubrication and Maintenance.

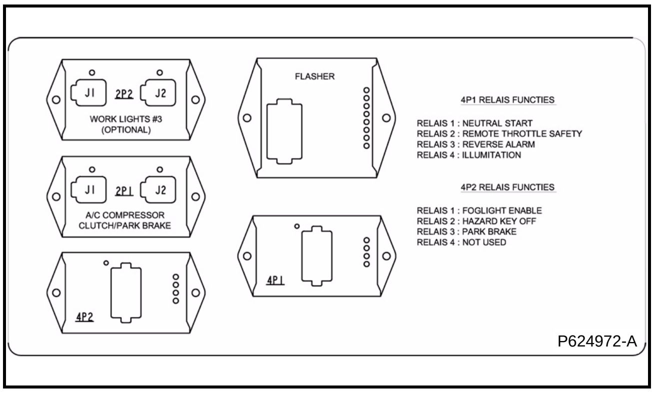


**FIG. 65**

## SAFETY AND SERVICE DECAL LOCATIONS CABINE

**WARNING: Carefully read and understand all safety signs on your vehicle. Failure to read and understand all safety signs may result in personal injury or death. Always be aware of a safety hazard. Make sure new equipment components and repair parts include the current safety signs.**


FIG. 66

**FIG. 67:**

23. Fresh Air Filter Cabine.

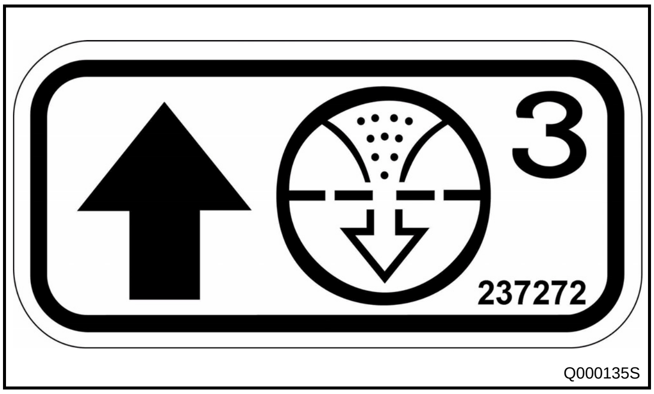


**FIG. 67**

**FIG. 68:**

24. Emergency EXIT.


**FIG. 68**

**FIG. 69:**

25. Danger - Electrocution Hazard

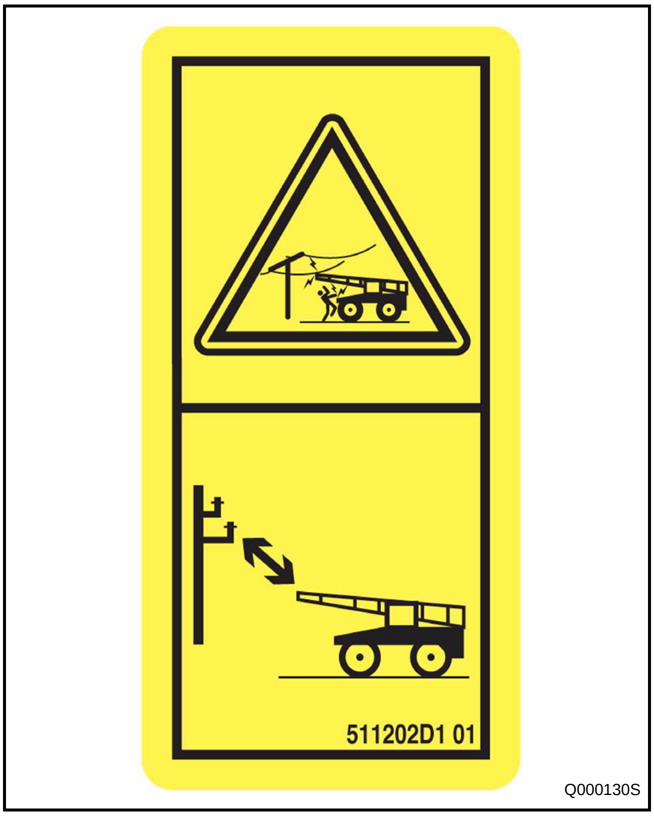


**FIG. 69**

**FIG. 70:**

26. Warning - Wear Seat belt and hold on to steering wheel if machine tips over.


FIG. 70

**FIG. 71:**

27. Warning - Fall hazard.

**FIG. 71:**


FIG. 71

**Pressure (bar and psi) - Load per tyre in kg**

| Tire size | Speed km/h | 2,0 bar 29 psi | 2,4 bar 35 psi | 2,6 bar 38 psi | 2,7 bar 39 psi | 2,8 bar 40 psi | 3,0 bar 43 psi | 3,2 bar 46 psi | 3,5 bar 51 psi |
|---|---|---|---|---|---|---|---|---|---|
| Michelin | | | | | | | | | |
| 1000/50 R25 172 A8 / 166D TL | 10 | 9000 | 9450 | 9680 | 9760 | | | | |
| MEGAXBIB T1 | 30 | 6420 | 6740 | 6450 | 6950 | | | | |
| | 40 | 6000 | 6300 | 6450 | 6500 | | | | |
| | Cyc | 9010 | 10200 | 10450 | 10540 | | | | |
| Michelin | | | | | | | | | |
| 1050/50 R 32 178 A8 TL MEGAXBIB T2 | 10 | 9810 | 10630 | 11040 | 11250 | | 12000 | 12400 | 13000 |
| | 30 | 7600 | 8030 | 8200 | 8300 | | 8600 | 8820 | 9150 |
| | 40 | 7100 | 7500 | 7700 | 7800 | | 8100 | 8300 | 8600 |
| | Cyc | 10900 | 11960 | 12490 | 12750 | | 13500 | 14050 | 14875 |
| Michelin | | | | | | | | | |
| 1050/50 R 32 178 A8 TL MEGAXBIB M28 | 10 | 9810 | 10630 | 11040 | 11250 | | 12000 | 12400 | 13000 |
| | 30 | 7600 | 8030 | 8200 | 8300 | | 8600 | 8820 | 9150 |
| | 40 | 7100 | 7500 | 7700 | 7800 | | 8100 | 8300 | 8600 |
| | Cyc | 10900 | 11960 | 12490 | 12750 | | 13500 | 14050 | 14875 |
| | | | | | | | | | |
| Firestone | 5 | 7740 | 8850 | 9230 | | 9480 | | | |
| 73 X 43.00 - 25 16 PR TL | 10 | 6470 | 7390 | 7700 | | 7920 | | | |
| | 20 | 5490 | 6270 | 6540 | | 6720 | | | |
| | 50 | 4900 | 5600 | 5840 | | 6000 | | | |
| Firestone | | | | | | | | | |
| 73 X 44.00 - 32 16 PR TL | 10 | 8967 | 10270 | 10665 | | 10905 | | | |
| | 15 | 7495 | 8580 | 8910 | | 9110 | | | |
| | 30 | 6360 | 7280 | 7560 | | 7730 | | | |
| | 50 | 5675 | 6500 | 6750 | | 6900 | | | 620590-C |

P620590-C

**FIG. 72**

28. Tire Pressure Chart. See Also Chapter Lubricatoin And Maintenance.

# GENERAL

## SERVICE MANUAL

This service manual has been prepared with the latest service information available at publication time. Read service manual carefully before performing any service on machine.

Right-hand and left-hand, as used in manual, are determined by facing the direction machine travels when in use.

Photos, illustrations and data used in manual were current at time of printing, but due to possible production changes, each machine can vary. Manufacturer reserves the right to redesign and change machine as necessary without notification.

**WARNING: Some photographs in manual show machine with shields removed for a better view of subject matter. Never operate machine with any shields removed.**

### Divisions And Page Numbers

Service manual is separated into divisions. Refer to Master Table of Contents.

Each division has an identifying part number with an alpha revision level indicator. Each division has a Table of Contents and an Index.

Each page is identified with division part number and revision level. Pages are in simple numeric order within each division.

### Units Of Measurement

Measurements are given in metric units followed by U.S. equivalent. Hardware sizes are given in millimeters for metric and inches for U.S. hardware.

## REPLACEMENT PARTS

To receive prompt efficient service, always remember to have:

- Correct part description and part number
- Model and serial number of machine

## SERIAL NUMBER IDENTIFICATION PLATE

Write the Serial Numbers in the spaces below. Use these numbers when referring to the Terra Gator. The Serial Number Identification Plate is located inside the cab on the storage compartment panel.

### Serial Number Plate Machine

**FIG. 1:** Serial Number Identification Plate, dealer sales machine. (Used by machine from MY2010.)

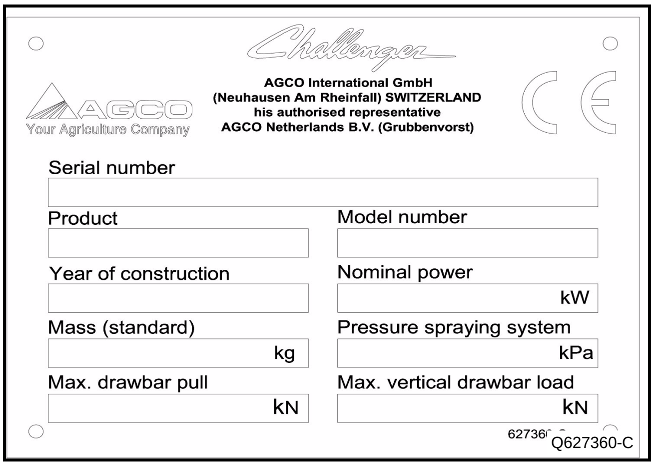


**FIG. 1**

**FIG. 2:** Serial Number Identification Plate, direct sales machine. (Used by machine from MY2010.)

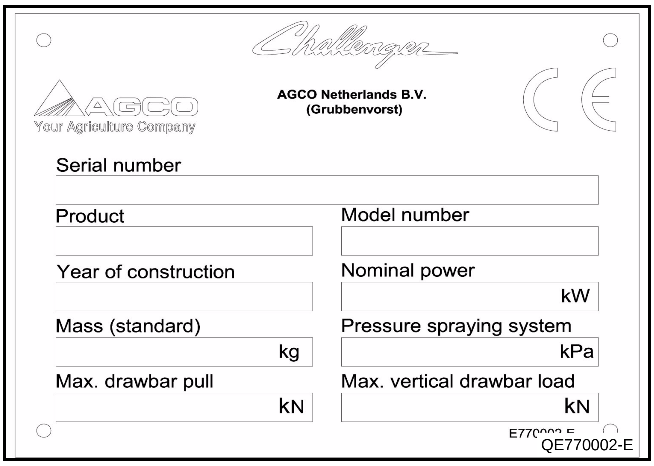


**FIG. 2**

**FIG. 3:** Serial Number Identification Plate. (Used by machine till MY2010)

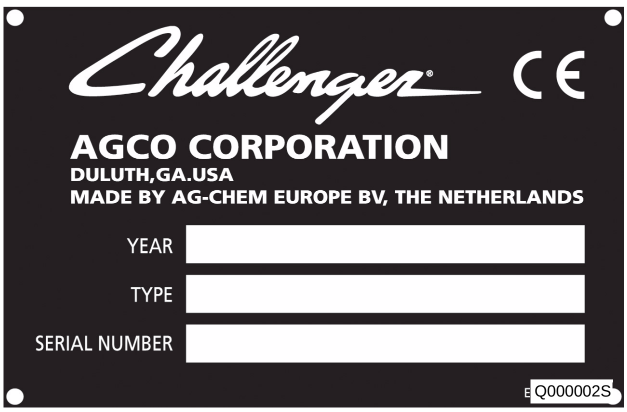


**FIG. 3**

## Engine Serial Number And Informatie Plate

**FIG. 4:** The Engine Serial Number Plate is located on the upper right side of the engine block.

ENGINE MODEL

______________________________________

SERIAL NUMBER

______________________________________

ARRANGEMENT NUMBER

______________________________________

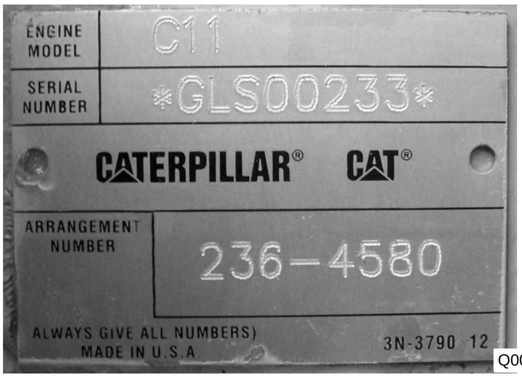


**FIG. 4**

**FIG. 5:** (1) Serial Number Location

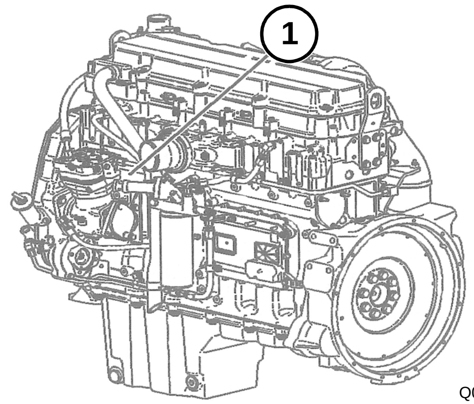


**FIG. 5**

## Transmission Serial Number

**FIG. 6:** Plate is located on rear of transmission.

Transmission Serial Number: ____________________

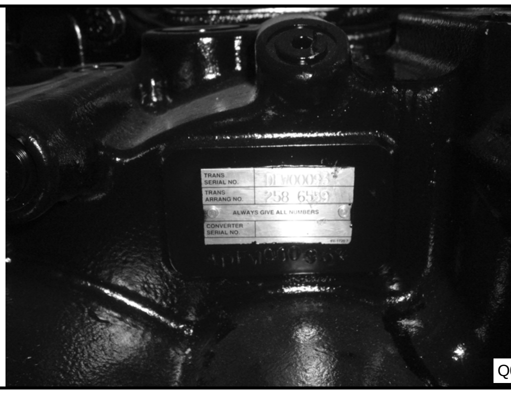


**FIG. 6**

## Cab Serial Number

**FIG. 7:** Plate is located inside cab, below rear window, behind operator's seat.

Cab Serial Number: ______________________________


FIG. 7

## Operator's Seat Serial Number

**FIG. 8:** Tag (1) is located on right rear of operator's seat.

Seat Serial Number: _____________________________


FIG. 8

## Axles

**FIG. 9:** Tag is located in the front on the top of the axle.

Model: ______________________________

Serial: ______________________________


FIG. 9

## MAINTENANCE INTRODUCTION

*IMPORTANT: Perform Maintenance procedures at regularly scheduled intervals. Failure to perform regularly scheduled maintenance will result in damage to the Terra Gator components or engine. The maintenance schedule is a recommended guide for correct maintenance of the Terra Gator.*

*DO NOT change the schedule unless you increase the frequency of service when operating the Terra Gator in very hot, cold, dusty or corrosive conditions.*

Use the hourmeter as a guide for maintenance intervals.

The maintenance intervals can be shown in both operating hours and time.

Example: 10 Hours or Every Day. Use the interval (operating hours or time) that comes first.

## MAINTENANCE SCHEDULE

| Service Item | Initial 250 Hours | Daily | 50 Hours | 100 Hours | 250 Hours | 500 Hours | 1000 Hours/ Annual |
|---|---|---|---|---|---|---|---|
| 1. Check Air Pressure - Tires | | x | | | | | |
| 2. Check All Decals | | x | | | | | |
| 3. Remove Water from Air Reservoirs | | x | | | | | |
| 4. Check Coolant | | x | | | | | |
| 5. Check Fuel Water Separator | | x | | | | | |
| 6. Check Engine Oil | | x | | | | | |
| 7. Check Battery Cables - Battery | | x | | | | | |
| 8. Check Hydraulic Oil | | x | | | | | |
| 9. Check Transmission Oil | | x | | | | | |
| 10. Check Hand Rinse Tank | | x | | | | | |
| 11. Grease Articulation Bearings (Hinge) Joint Pivot Bearings - Upper & Lower | | x | | | | | |
| 12. Check Air Cleaner Indicator | | x | | | | | |
| 13. Check Wheel Bolts | | x | | | | | |
| 14. Lubricate the Dog Walk Rotating Bearing | | x | | | | | |
| 15. Grease Steering Cylinders (2) Bases & Rod Ends (2x) | | x | | | | | |
| 16. Grease Steering Cylinders Dog Walk (2) Bases & Rod Ends (2x) | | x | | | | | |
| 17. Grease Dog Walk Locking Pin | | x | | | | | |
| 18. Check Play Dog Walk Tunnel | | x | | | | | |
| 19. Grease Cross Bearings from Drive Shaft Articulation and Drive Shaft to Rear Axle | | | x | | | | |
| 20. Clean Battery Cables | | | x | | | | |
| 21. Check Hydraulic Hoses and Lines | | | x | | | | |

| Service Item | Initial 250 Hours | Daily | 50 Hours | 100 Hours | 250 Hours | 500 Hours | 1000 Hours/ Annual |
|---|---|---|---|---|---|---|---|
| 22. Check Air Hoses | | | x | | | | |
| 23. Check Engine Belts and Tensioner | | | x | | | | |
| 24. Check Rotating Bearing | | | x | | | | |
| 25. Remove Plug Bottom of Fuel Tank Remove Sediment | | | | x | | | |
| 26. Check Cab Mounts | | | | x | | | |
| 27. Clean Heat Exchangers | | | | x | | | |
| 28. Check level Axle Oil | | | | x | | | |
| 29. Grease Drive Shaft Hanger Bearing | x | | | | x | | |
| 30. Replace Engine Oil and Filter | x | | | | x | | |
| 31. Clean or Replace Cab Air Filters | | | | | x | | |
| 32. Check Service Brake System Operation | x | | | | x | | |
| 33. Replace Fuel Filters | x | | | | x | | |
| 34. Tighten Wheel Bolts | | | note 1 | | x | | |
| 35. Retorque Axle Bolts | x | | | | | x | |
| 36. Replace Air Dryer Filter | | | | | | x | |
| 37. Retorque Articulation Pin Bolts and Steering Cylinder Bolts | x | | | | | x | |
| 38. Lubricate back seat adjusters and Armrest Mechanism | | | | | | x | |
| 39. Calibrate Transmission | x | | | | | | x |
| 40. Replace Axle Oil | x | | | | | | x |
| 41. Replace Transmission Oil and Filter | x | | | | | | x |
| 42. Replace Interne Oil Filter Gearbox | | | | | | | x |
| 43. Replace Air Cleaner Elements | | | | | | | x |
| 44. Replace Cab Air Filter | | | | | | | x |
| 45. Flush and Replace Coolant | | | | | | | note 2 |
| 46. Replace Hydraulic Filter | x | | | | | | x |
| 47. Replace Hydraulic Oil | x | | | | | | x |
| 48. Clean Axle Breather | x | | | | x | | x |
| 49. Check Drive Shaft Hanger Bearings | | | | | | | x |
| 50. Check Cross Bearings of Drive Shafts | | | | | | | x |
| 51. Replace Fuel In-line Strainer | x | | | | | | |

*NOTE: 1. For wheel bolt tightening in the break in period see the introduction section and wheel tightening in the section of the operators manual.*

*NOTE: 2. See engine manual to check which interval on prefer to which kind of coolant.*

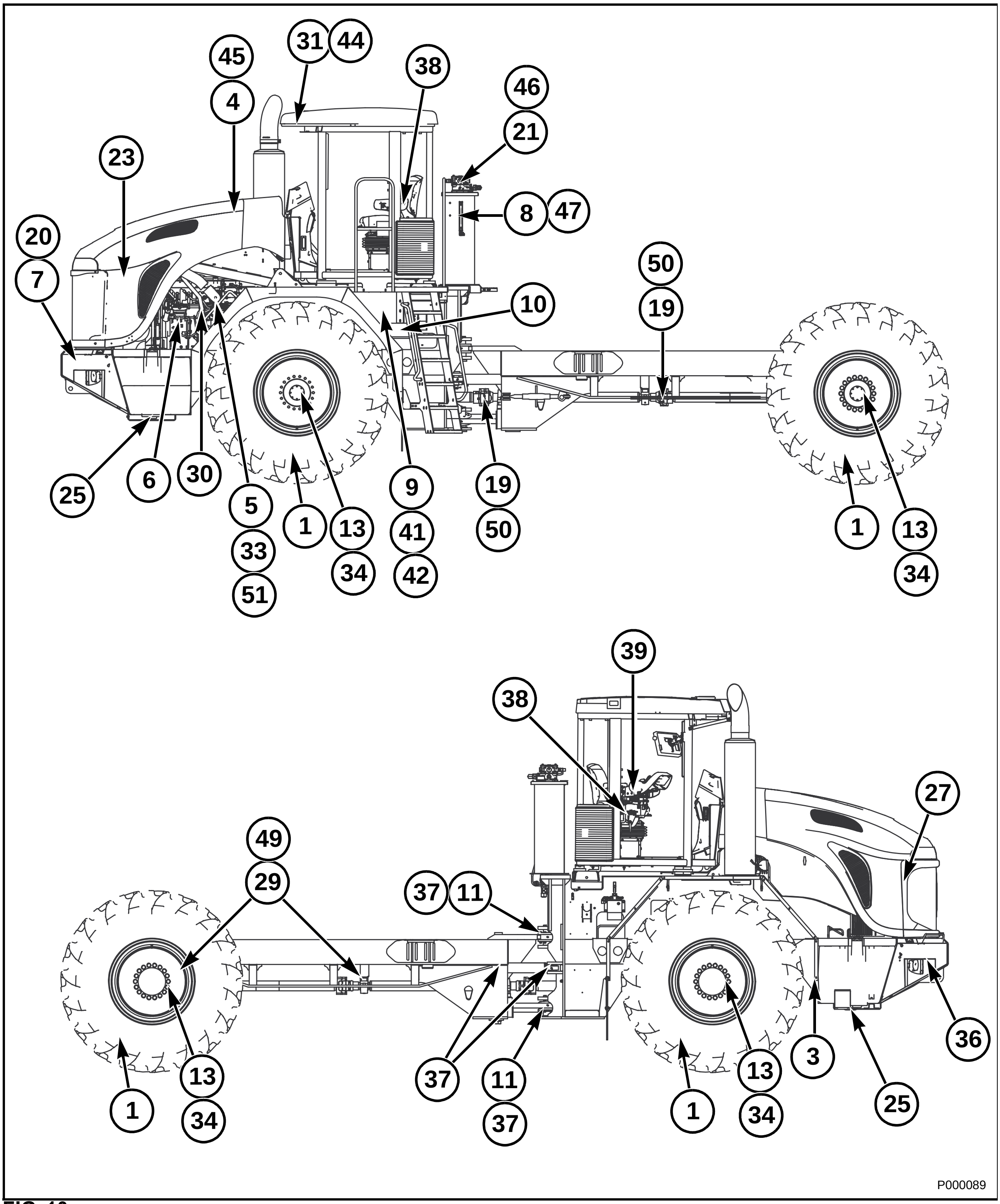
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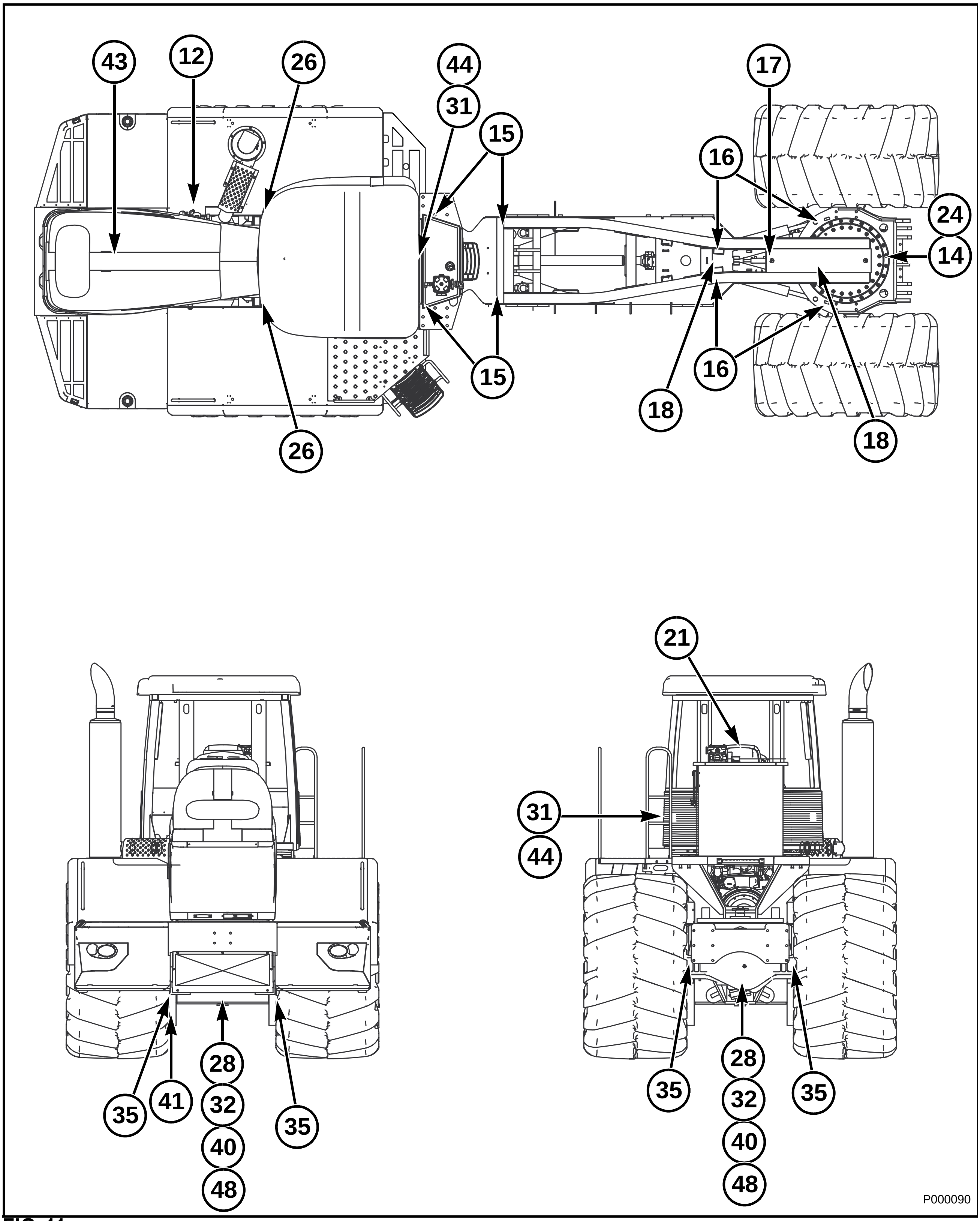
FIG. 10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P000090

FIG. 11

## Tighten Wheel Bolts

**FIG. 12:** Wheel Bolt Tightening Sequence.

1. Check the axle flange and the rear mounting surface of the wheel foreign material, burs or grease.
2. Install the wheel on the axle. Make sure the wheel holes are centered over the threaded holes on the axle flange.
3. Put a small amount of multi-purpose grease on the FIRST FOUR THREADS on the bolts. Install the bolts and washers with your hand. Tighten the bolts.
4. Torque the bolts in 3 steps:
    1. Tighten up to 300 Nm (221lbf.-ft);
    2. Tighten up to 550 Nm (405 lbf.-ft);
    3. Torgue to 720 Nm (531 lbf.-ft), torque twice.

Use the sequence shown in the Wheel Bolt Tightening Sequence illustration. A lug wrench kit is optional and can be provided in the compartment on the left front of the vehicle.

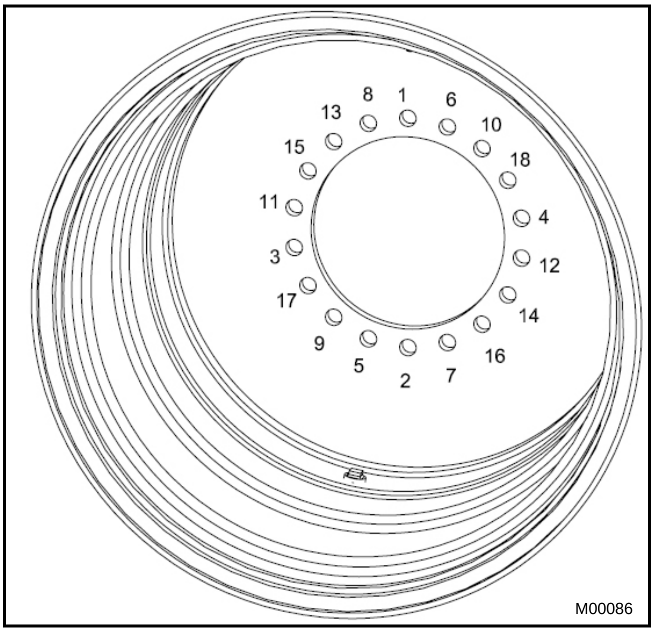



**FIG. 12**

## Retorque Axle Bolts

**FIG. 13:** Check the axle mounting bolts every 500 hours for the correct torque.

Loosen the bolts 1/4 turn, then thighten the bolts to a torque of 515 Nm (380 lbf.-ft).

1. Axle mouting bolts.

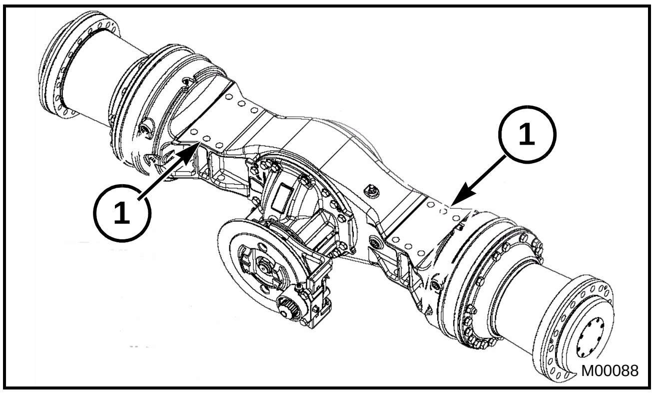



**FIG. 13**

## Retorque Articulation Pin Bolts and Steering Cylinder Bolts

**WARNING: Before performing maintenance in the area of the Articulation Joint the following procedure MUST be followed (See Safety Section)**

**1. Steer the vehicle into the straight ahead position.**

**2. Move the Articulation Lock Turnbuckle from the Storage Position to the Transport / Maintenance Position.**

### Articulation Pin Bolts

**FIG. 14:** Retorque the bolts (3) of the articulation joint pins every 500 hours of operation with 1300 Nm (960 lbf.-ft).

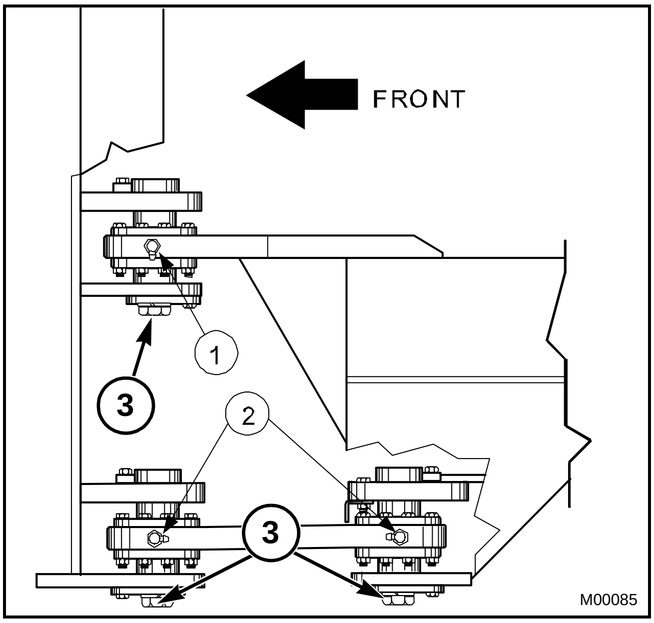



**FIG. 14**

### Steering Cylinder Bolts

**FIG. 15:** Retorque the steering cylinders bolts (1) every 500 hours of operation with 815 Nm (600 lbf.-ft).

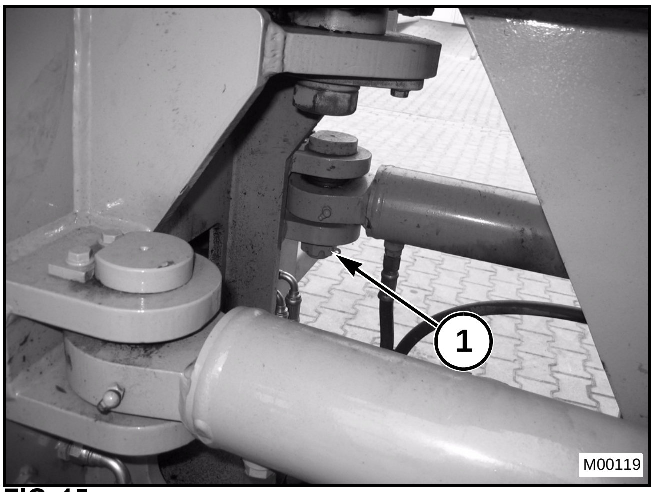



**FIG. 15**

## LUBRICANTS AND FLUIDS

*IMPORTANT: Capacities listed are APPROXIMATE. CHECK fluid levels after filling.*

| IDENTIFICATION | INITIAL FILL | RECOMMENDED | CAPACITY |
|---|---|---|---|
| AXLE DIFFERENTIALS | Hypoid Gear Oil SAE 80W90, API Class GL-5 | | 46 L (12,2 Gall) |
| HYDRAULIC SYSTEM | ISO VG 46 | ISO VG 46 | 200 L (52,8 Gall) |
| TRANSMISSION | AGCO 821XL or Equivalent Specification, J20C Transmission and Hydraulic oil | 10W30 API class SF/CC | 56,7 L (15 Gall) |
| ENGINE COOLANT | 50/50 Water and Ethylene Glycol w/o stop leak additive w/SCA | | 35 L (9,2 Gall) |
| ENGINE OIL | SAE 15W-40 API Class CF-4 Motor Oil | SAE 15W-40 API Class CF-4 Motor Oil | 40 L (10,6 Gall) |
| GREASE FITTINGS | Hi Temperature Moly-Lithium Base Grease NLGI #2 | | As Required |

# DIMENSIONS

## VEHICLE DIMENSIONS

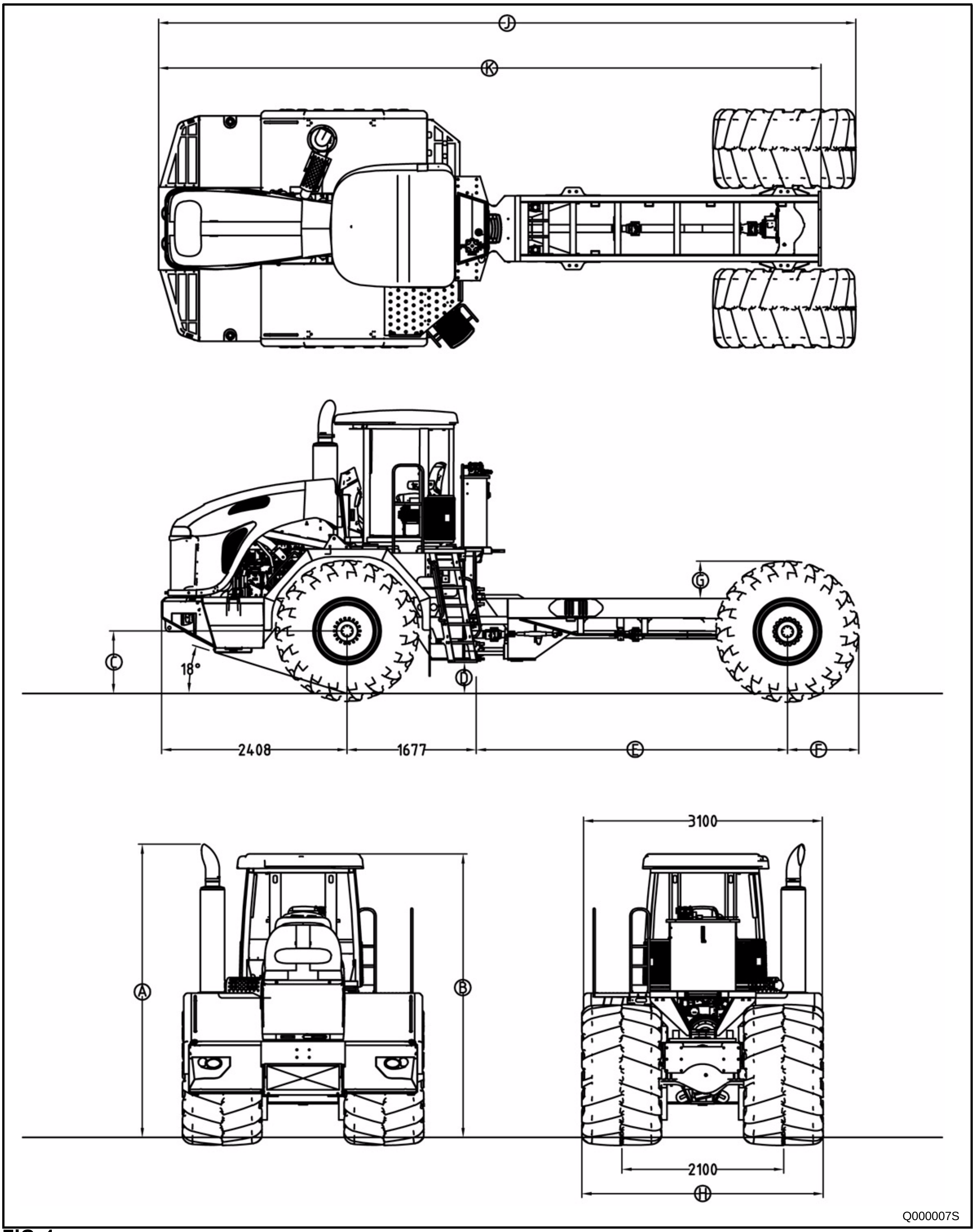



**FIG. 1**

*NOTE: Specifications subject to change without notice.*

| | | TerraGator 3244 Standard | | | TerraGator 3244 Long Wheel Base (LWB) | | | TerraGator 3244 Short Wheel Base (SWB) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dim | Description | SDT* | M-M28** | Fire*** | SDT* | M-M28** | Fire*** | SDT* | M-M28** | Fire*** |
| A | Exhaust pipe height | 3860 | 3889 | 3862 | 3860 | 3889 | 3862 | 3860 | 3889 | 3862 |
| B | Cab roof height | 3732 | 3761 | 3734 | 3732 | 3761 | 3734 | 3732 | 3761 | 3734 |
| C | Axle height | 824 | 853 | 826 | 824 | 853 | 826 | 824 | 853 | 826 |
| D | Free height | 411 | 440 | 413 | 411 | 440 | 413 | 411 | 440 | 413 |
| E | Articulation point to centre axle | 4040 | 4040 | 4040 | 4040 | 4040 | 4040 | 3530 | 3530 | 3530 |
| F | Rear axle to rear | 929 | 951 | 940 | 929 | 951 | 940 | 929 | 951 | 940 |
| G | Chassis height - wheel height | 493 | 522 | 495 | 493 | 522 | 495 | 493 | 522 | 495 |
| H | Width | 3155 | 3138 | 3197 | 3155 | 3138 | 3197 | 3155 | 3138 | 3197 |
| J | Total length | 9054 | 9076 | 9065 | 9054 | 9076 | 9065 | 8544 | 8566 | 8555 |
| K | Chassis length | 8600 | 8600 | 8600 | 8777 | 8777 | 8777 | 8270 | 8270 | 8270 |

* SDT = Standard Tire

** M-M28 = Michelin M28

*** Fire = Firestone

## TURNING RADIUS

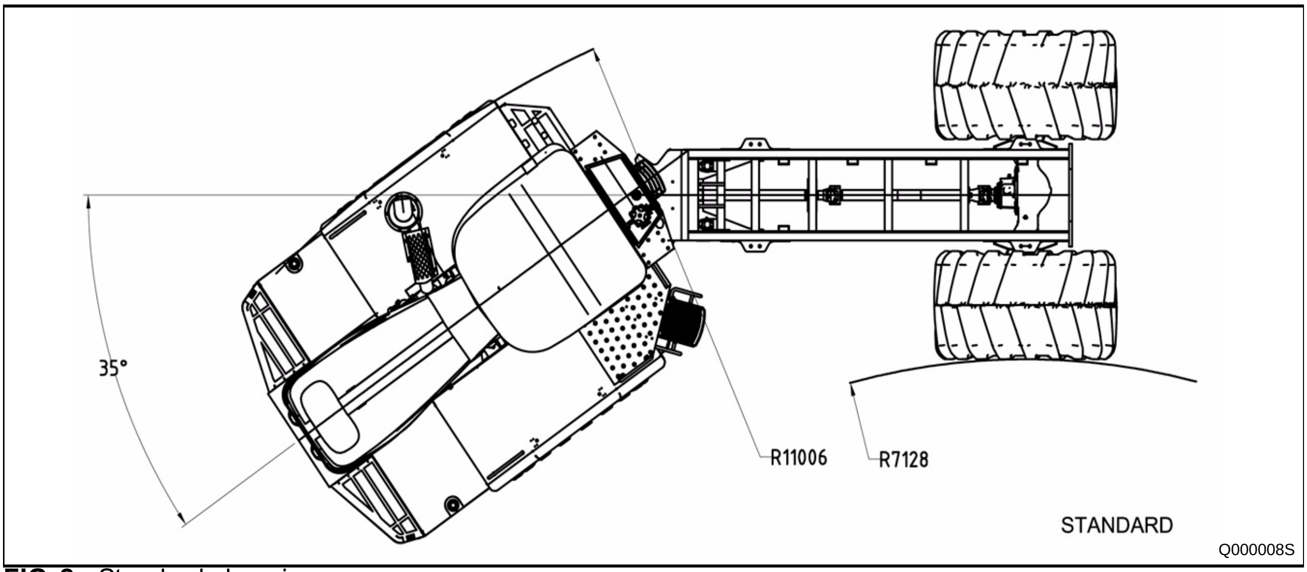



**FIG. 2:** Standard chassis

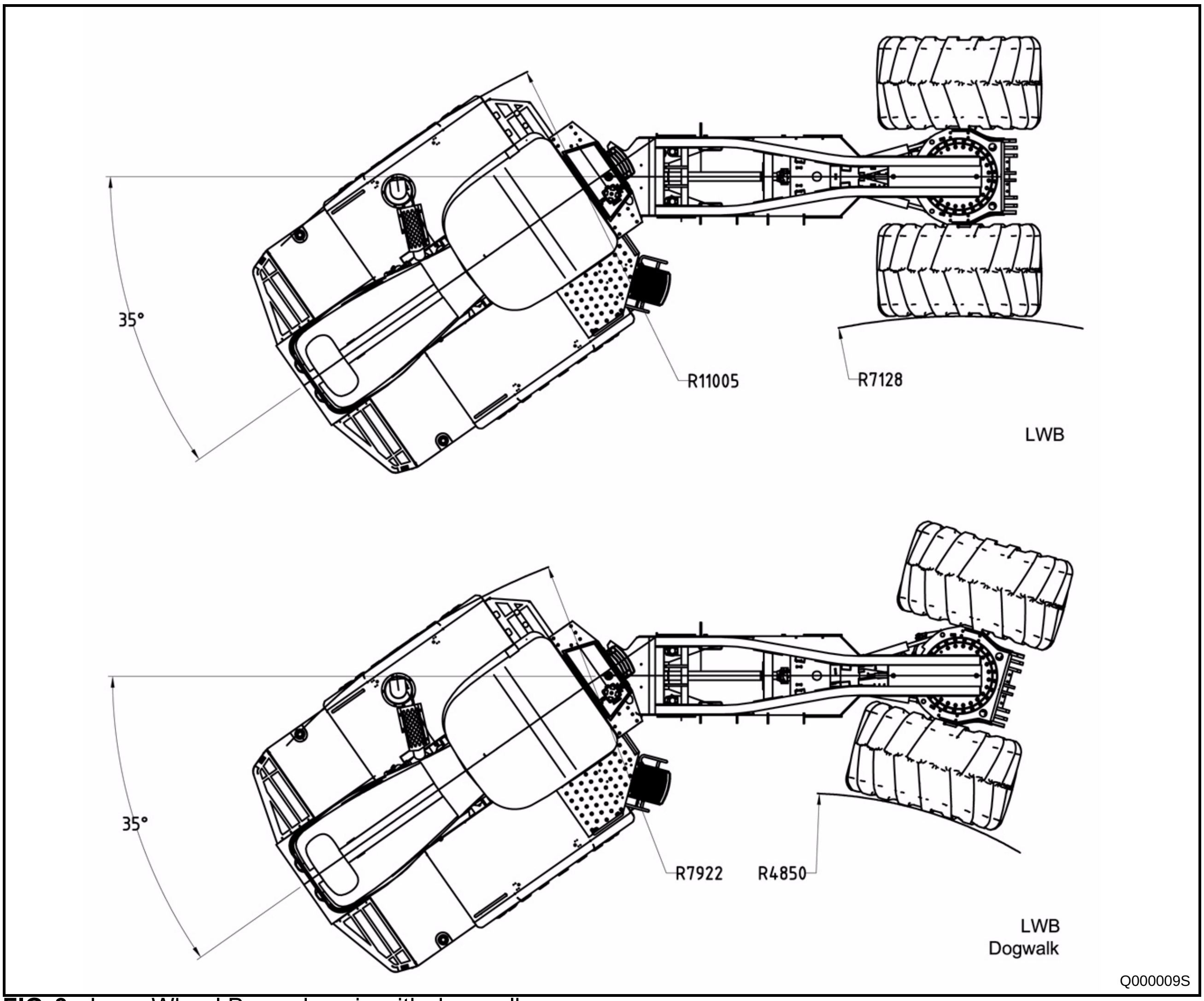



**FIG. 3:** Long Wheel Base chassis with dog walk

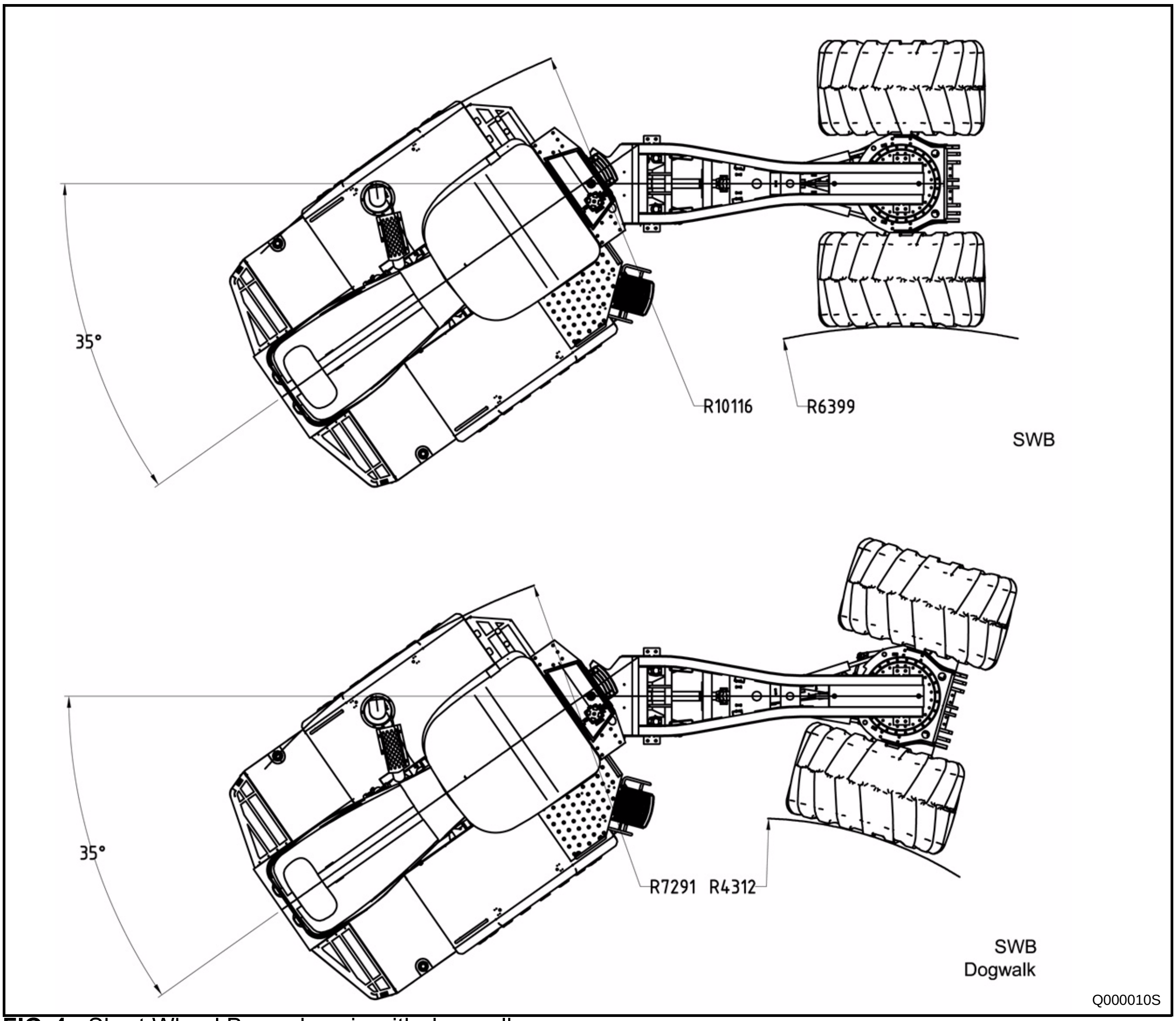



**FIG. 4:** Short Wheel Base chassis with dog walk

# TORQUE SPECIFICATIONS

## TORQUE SPECIFICATIONS

**WARNING: Mismatched or incorrect fasteners can result in damage, malfunction or personal injury. Take care to avoid mixing metric dimensioned fasteners and inch dimensioned fasteners.**

Exceptions to these torques are given in the Service Manual, if necessary.

Prior to installation of any hardware, ensure that components are in near new condition. Bolts and threads must not be worn or damaged. Threads must not have burrs or nicks. Hardware must be free of rust and corrosion. Clean hardware with a non-corrosive cleaner.

Do not lubricate fastener threads except with rust preventive. Rust preventive should be applied by supplier of component for purposes of shipping and storage. Other applications for lubricating components may also be specified in Service Manual.

## CONSTANT TORQUE HOSE CLAMPS

Hoses will heat set due to extreme temperature changes. Heat setting can cause hose clamps to loosen. The constant torque hose clamp prevents this.

**FIG. 1:** Constant torque hose clamps are installed correctly under the following conditions:

- Screw tip (1) extends 6.35 mm (.25 inch) (A) beyond housing.
- Belleville washers are collapsed nearly flat after screw (2) is tightened to a torque of 11 Nm (8.1 lb/ft).

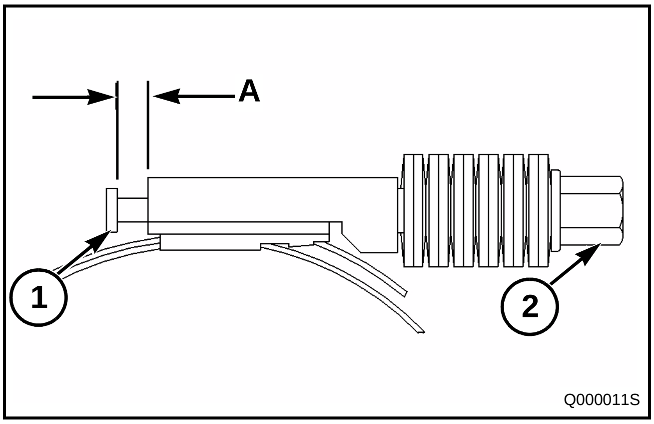



**FIG. 1**

## FASTENER INFORMATION

### Metric Fasteners

#### Assembly Torque for Metric Fasteners

| Standard | | | High | | Low | |
|---|---|---|---|---|---|---|
| Thread Size | Torque lbf ft | Torque Nm | Torque lbf ft | Torque Nm | Torque lbf ft | Torque Nm |
| M6 x 1 | 9 ± 1 | 12 ± 3 | 10 ± 1 | 13 ± 3 | 4 ±0.5 | 6 ± 1 |
| M8 x 1.25 | 21 ± 2 | 28 ± 7 | 22 ± 2 | 30 ± 7 | 11 ± 1 | 15 ± 3 |
| M10 x 1.5 | 41 ± 4 | 55 ± 10 | 44 ± 4 | 60 ± 12 | 22 ± 2 | 30 ± 7 |
| M12 x 1.75 | 75 ± 8 | 100 ± 20 | 80 ± 8 | 105 ± 20 | 35 ± 4 | 50 ± 10 |
| M14 x 2 | 120 ± 12 | 160 ± 30 | 130 ± 10 | 175 ± 30 | 60 ± 5 | 80 ± 15 |
| M16 x 2 | 175 ± 15 | 240 ± 40 | 200 ± 20 | 270 ± 40 | 90 ± 10 | 125 ± 20 |
| M20 x 2.5 | 340 ± 35 | 460 ± 60 | 390 ± 40 | 530 ± 70 | 185 ± 20 | 250 ± 40 |
| M24 x 3 | 590 ± 60 | 800 ± 100 | 665 ± 65 | 900 ± 100 | 315 ± 30 | 425 ± 50 |
| M30 x 3.5 | 1180 ± 120 | 1600 ± 200 | 1330 ± 130 | 1800 ± 200 | 625 ± 60 | 850 ± 100 |
| M36 x 4 | 2000 ± 200 | 2700 ± 300 | 2285 ± 230 | 3100 ± 350 | 1100 ± 110 | 1500 ± 200 |

| Standard Taperlock Studs | | |
|---|---|---|
| Thread Size | Torque lbf ft | Torque Nm |
| M6 | 6 | 8 |
| M8 | 13 | 17 |
| M10 | 26 | 35 |
| M12 | 48 | 65 |
| M16 | 80 | 110 |
| M20 | 125 | 170 |
| M24 | 300 | 400 |
| M30 | 550 | 750 |
| M36 | 880 | 1200 |

## SAE Fasteners

### Assembly Torque for SAE Fasteners

| Standard | | | High | | Low | |
|---|---|---|---|---|---|---|
| Thread Size | Torque lbf ft | Torque Nm | Torque lbf ft | Torque Nm | Torque lbf ft | Torque Nm |
| 1/4 - 20 | 9 ± 1 | 12 ± 3 | 10 ± 1 | 13 ± 3 | 4 ±0.5 | 6 ± 1 |
| 5/16 - 18 | 18 ± 2 | 25 ± 6 | 20 ± 2 | 28 ± 7 | 10 ± 1 | 13 ± 3 |
| 3/8 - 16 | 35 ± 4 | 47 ± 9 | 40 ± 4 | 50 ± 10 | 18 ± 2 | 25 ± 6 |
| 7/16 - 14 | 50 ± 5 | 70 ±15 | 60 ± 6 | 80 ± 15 | 30 ± 3 | 40 ± 8 |
| 1/2 - 13 | 75 ± 8 | 105 ± 20 | 90 ± 9 | 120 ± 20 | 45 ± 5 | 60 ± 12 |
| 9/16 - 12 | 120 ± 10 | 160 ± 30 | 130 ± 13 | 175 ± 30 | 60 ± 5 | 85 ± 15 |
| 5/8 - 11 | 160 ± 15 | 215 ± 40 | 175 ± 15 | 240 ± 40 | 85 ± 10 | 115 ± 20 |
| 3/4 - 10 | 275 ± 30 | 370 ± 50 | 320 ± 30 | 430 ± 60 | 150 ± 15 | 200 ± 40 |
| 7/8 - 9 | 460 ± 50 | 620 ± 80 | 520 ± 50 | 700 ± 90 | 240 ± 25 | 325 ± 40 |
| 1 - 8 | 660 ± 70 | 900 ± 100 | 775 ± 75 | 1050 ± 150 | 370 ± 35 | 500 ± 65 |
| 1 1/8 - 7 | 960 ± 100 | 1300 ± 150 | 1070 ± 105 | 1450 ± 150 | 515 ± 50 | 700 ± 90 |
| 1 1/4 - 7 | 1320 ± 130 | 1800 ± 200 | 1550 ± 155 | 2100 ± 250 | 975 ± 95 | 1000 ± 125 |
| 1 3/8 - 6 | 1780 ± 180 | 2400 ± 300 | 1990 ± 200 | 2700 ± 300 | 1315 ± 130 | 1000 ± 150 |
| 1 1/2 - 5 | 2280 ± 230 | 3100 ± 350 | 2650 ± 265 | 3600 ± 400 | 1680 ± 165 | 1700 ± 200 |

| Standard Taperlock Studs | | |
|---|---|---|
| Thread Size | Torque lbf ft | Torque Nm |
| 1/4 | 6 | 8 |
| 5/16 | 13 | 17 |
| 3/8 | 26 | 35 |
| 7/16 | 33 | 45 |
| 1/2 | 48 | 65 |
| 5/8 | 80 | 110 |
| 3/4 | 125 | 170 |
| 7/8 | 190 | 260 |
| 1 | 300 | 400 |
| 1 1/8 | 390 | 525 |
| 1 1/4 | 550 | 750 |
| 1 3/8 | 700 | 950 |
| 1 1/2 | 880 | 1200 |

### Unified Inch Bolt and Cap Screw Values

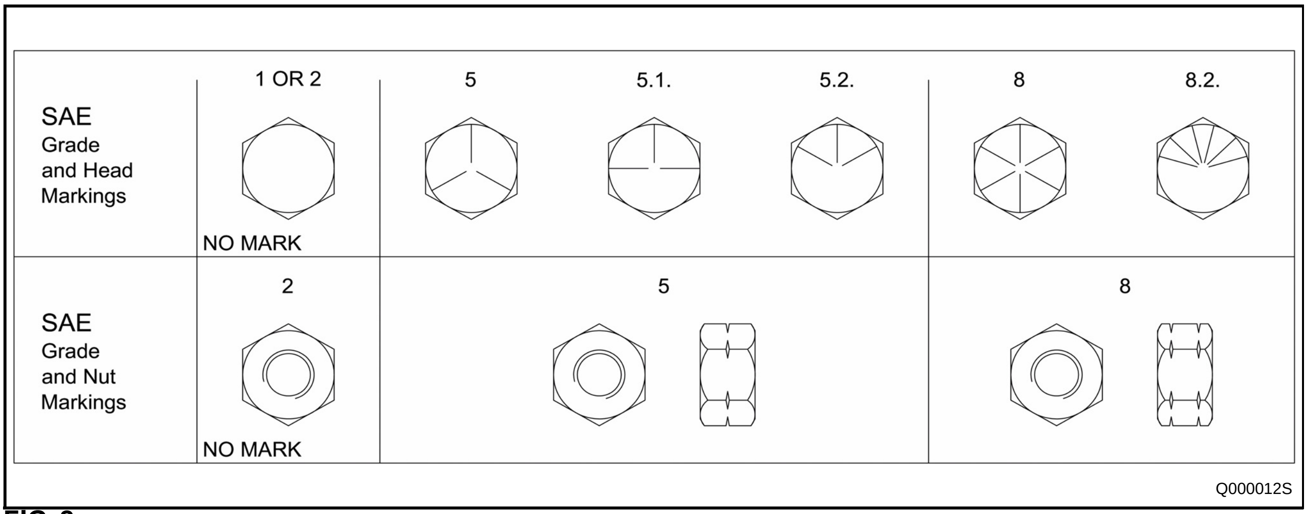



**FIG. 2**
Unified Bolt and Cap Screw Values Chart

| Size | Grade 1 | | | | Grade 2 | | | | Grade 5, 5.1, or 5.2 | | | | Grade 8 or 8.2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lubricated | | Dry | | Lubricated | | Dry | | Lubricated | | Dry | | Lubricated | | Dry | |
| | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft |
| 1/4 | 3.7 | 2.8 | 4.7 | 3.5 | 6 | 4.5 | 7.5 | 5.5 | 9.5 | 7 | 12 | 9 | 13.5 | 10 | 17 | 12.5 |
| 5/16 | 7.7 | 5.5 | 10 | 7 | 12 | 9 | 15 | 11 | 20 | 15 | 25 | 18 | 28 | 21 | 35 | 26 |
| 3/8 | 14 | 10 | 17 | 13 | 22 | 16 | 27 | 20 | 35 | 26 | 44 | 33 | 50 | 36 | 63 | 46 |
| 7/16 | 22 | 16 | 28 | 20 | 35 | 26 | 44 | 32 | 55 | 41 | 70 | 52 | 80 | 58 | 100 | 75 |
| 1/2 | 33 | 25 | 42 | 31 | 53 | 39 | 67 | 50 | 85 | 63 | 110 | 80 | 120 | 90 | 150 | 115 |
| 9/16 | 48 | 36 | 60 | 45 | 75 | 56 | 95 | 70 | 125 | 90 | 155 | 115 | 175 | 130 | 225 | 160 |
| 5/8 | 67 | 50 | 85 | 62 | 105 | 78 | 135 | 100 | 170 | 125 | 215 | 160 | 240 | 175 | 300 | 225 |
| 3/4 | 120 | 87 | 150 | 110 | 190 | 140 | 240 | 175 | 300 | 225 | 375 | 280 | 425 | 310 | 550 | 400 |
| 7/8 | 190 | 140 | 240 | 175 | 190 | 140 | 240 | 175 | 490 | 360 | 625 | 450 | 700 | 500 | 875 | 650 |
| 1 | 290 | 210 | 360 | 270 | 290 | 210 | 360 | 270 | 725 | 540 | 925 | 675 | 1050 | 750 | 1300 | 975 |
| 1-1/8 | 400 | 300 | 510 | 375 | 400 | 300 | 510 | 375 | 900 | 675 | 1150 | 850 | 1450 | 1075 | 1850 | 1350 |
| 1-1/4 | 570 | 425 | 725 | 530 | 570 | 425 | 725 | 530 | 1300 | 950 | 1650 | 1200 | 2050 | 1500 | 2600 | 1950 |
| 1-3/8 | 750 | 550 | 950 | 700 | 750 | 550 | 950 | 700 | 1700 | 1250 | 2150 | 1550 | 2700 | 2000 | 3400 | 2550 |
| 1-1/2 | 1000 | 725 | 1250 | 925 | 990 | 725 | 1250 | 930 | 2250 | 1650 | 2850 | 2100 | 3600 | 2650 | 4550 | 3350 |

*NOTE: "Lubricared" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.*

*NOTE: Grade 2 applies for hex cap screws (not hex bolts) up to 152 mm (6-inch) long. Grade 1 applies for hexcap screws over over 152 mm (6-inch) long, and for all other types of bolts and screws of any length.*

## Metric Bolt and Cap Screw Values

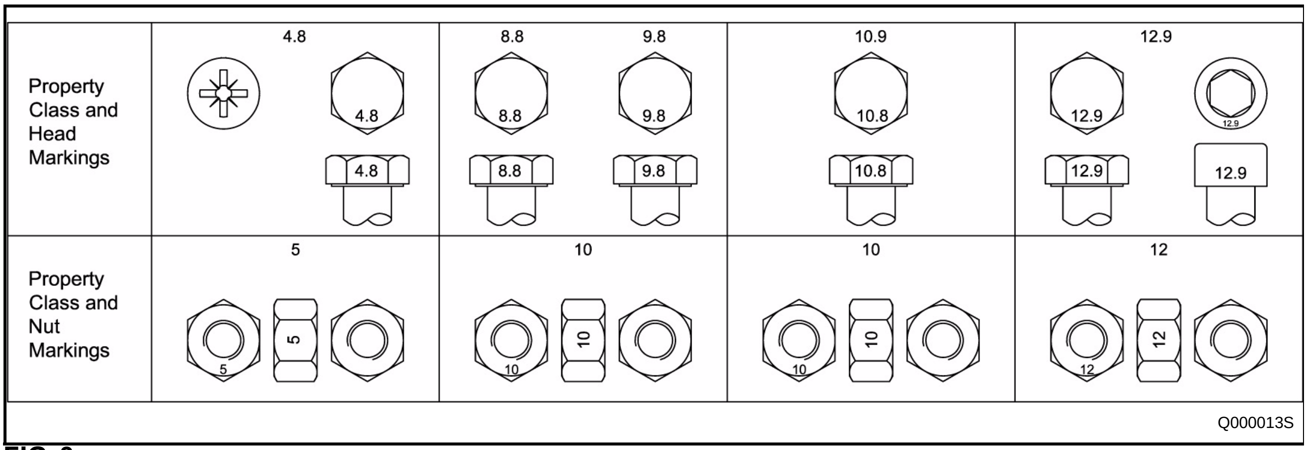



**FIG. 3**
Metric Bolt and Cap Screw Values

| Size | Grade 4.8 | | | | Grade 8.8 or 9.8 | | | | Grade 10.9 | | | | Grade 12.9 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lubricated | | Dry | | Lubricated | | Dry | | Lubricated | | Dry | | Lubricated | | Dry | |
| | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft | Nm | lb-ft |
| M6 | 4.8 | 3.5 | 6 | 4.5 | 9 | 6.5 | 11 | 8.5 | 13 | 9.5 | 17 | 12 | 15 | 11.5 | 19 | 14.5 |
| M8 | 12 | 8.5 | 15 | 11 | 22 | 16 | 28 | 20 | 32 | 24 | 40 | 30 | 37 | 28 | 47 | 35 |
| M10 | 23 | 17 | 29 | 21 | 43 | 32 | 55 | 40 | 63 | 47 | 80 | 60 | 75 | 55 | 95 | 70 |
| M12 | 40 | 29 | 50 | 37 | 75 | 55 | 95 | 70 | 110 | 80 | 140 | 105 | 130 | 95 | 165 | 120 |
| M14 | 63 | 47 | 80 | 60 | 120 | 88 | 150 | 110 | 175 | 130 | 225 | 165 | 205 | 150 | 260 | 190 |
| M16 | 100 | 73 | 125 | 92 | 190 | 140 | 240 | 175 | 275 | 200 | 350 | 255 | 320 | 240 | 400 | 300 |
| M18 | 135 | 100 | 175 | 125 | 260 | 195 | 330 | 250 | 375 | 275 | 475 | 350 | 440 | 325 | 560 | 410 |
| M20 | 190 | 140 | 240 | 180 | 375 | 275 | 475 | 350 | 530 | 400 | 675 | 500 | 625 | 460 | 800 | 580 |
| M22 | 260 | 190 | 330 | 250 | 510 | 375 | 650 | 475 | 725 | 540 | 925 | 675 | 850 | 625 | 1075 | 800 |
| M24 | 330 | 250 | 425 | 310 | 650 | 475 | 825 | 600 | 925 | 675 | 1150 | 850 | 1075 | 800 | 1350 | 1000 |
| M27 | 490 | 360 | 625 | 450 | 950 | 700 | 1200 | 875 | 1350 | 1000 | 1700 | 1250 | 1600 | 1150 | 2000 | 1500 |
| M30 | 675 | 490 | 850 | 625 | 1300 | 950 | 1650 | 1200 | 1850 | 1350 | 2300 | 1700 | 2150 | 1600 | 2700 | 2000 |
| M33 | 900 | 675 | 1150 | 850 | 1750 | 1300 | 2200 | 1650 | 2500 | 1850 | 3150 | 2350 | 2900 | 2150 | 3700 | 2750 |
| M36 | 1150 | 850 | 1450 | 1075 | 2250 | 1650 | 2850 | 2100 | 3200 | 2350 | 4050 | 3000 | 3750 | 2750 | 4750 | 3500 |

*NOTE: "Lubricared" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.*

## 4-Bolt Split Flange

**FIG. 4:** Ensure sealing surfaces are free of burrs, nicks, scratches or any foreign particles. Lubricate O-ring. Position flanges and half clamps. Place lock washers on bolts and bolt through half clamps. Hand tighten bolts. Torque bolts in diagonal sequence in small increments to torque level listed for correct flange series.

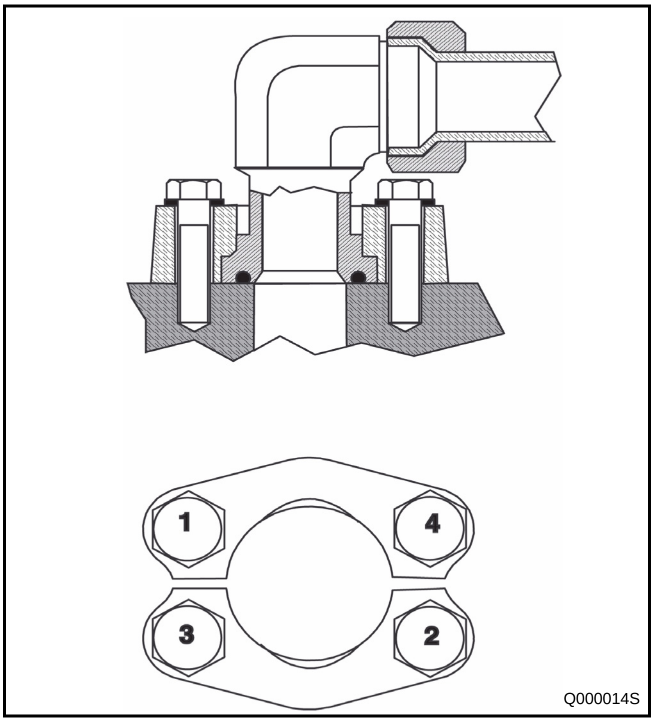



FIG. 4

| 3000 PSI | | | | |
|---|---|---|---|---|
| Dash Size | Flange Size | Bolt Size | Torque | |
| | | | lbs. In. | ft. lbs. |
| 12 | 3/4 | 3/8 - 16 | 300 ± 50 | 25 ± 4.5 |
| 16 | 1 | 3/8 - 16 | 375 ± 50 | 31 ± 4.5 |
| 20 | 1¼ | 7/16 - 14 | 488 ± 62 | 41 ± 5 |
| 24 | 1½ | 1/2 - 13 | 625 ± 75 | 52 ± 6 |
| 32 | 2 | 1/2 - 13 | 725 ± 75 | 60 ± 6 |

| 6000 PSI | | | | |
|---|---|---|---|---|
| Dash Size | Flange Size | Bolt Size | Torque | |
| | | | lbs. in. | ft. lbs. |
| 12 | 3/4 | 3/8 - 16 | 300 ± 50 | 30 ± 4.5 |
| 16 | 1 | 7/16 - 14 | 375 ± 50 | 46 ± 4.5 |
| 20 | 1¼ | 1/2 - 13 | 825 ± 75 | 69 ± 6 |
| 24 | 1½ | 5/8 - 11 | 1500 ± 100 | 125 ± 8 |

## TIGHTENING STRAIGHT THREAD FITTINGS

Straight thread hydraulic fittings require precise tightening. Overtightening of hydraulic fittings ruin sealing surfaces and require replacement of damaged parts.

Proper initial tightening depends on mating parts to be connected. Proceed as follows:

An adapter fitting (37° flare) connected to a double flare tube assembly. Fitting must be tightened finger tight and wrenched 1/2 turn (for single flare, 1/4 turn).

An adapter fitting (37° flare) connected to a hose. Fitting must be tightened finger tight and wrenched 1/4 turn.

An O-ring adapter fitting connected to a solid port. Fitting must be tightened so backup washer contacts face of boss after fitting has been properly positioned.

To retighten after initial tightening, as in service work, both tube and hose connections should be tightened finger tight and wrenched 1/4 turn. O-ring fittings should be tightened as for initial assembly.

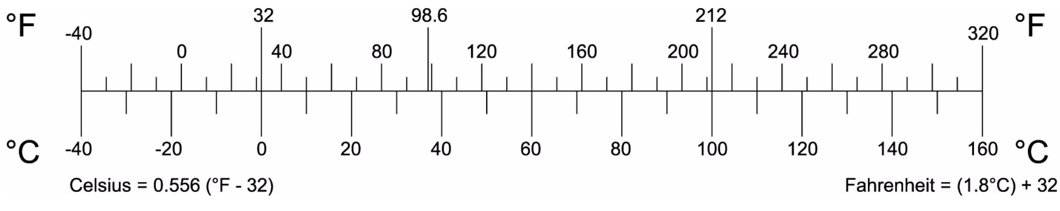
JIC SWIVEL NUTS (37° SEAT). Following values are maximum recommended torque values for JIC (37° seat) swivel nuts either swaged or brazed type. Swivel nuts will normally withstand this torque for a minimum of 15 repeated assemblies.

Torque required to seal swivel female fittings or hose couplings to a male connector depends on many variables such as fluid medium, pressure, surface finish, etc. The following values are intended only as a guide for maximum values the fittings may be subjected to.

| DASH SIZE | TUBE O. D. (REF.) | TORQUE MAX | | |
|---|---|---|---|---|
| | | Nm | lbf in | lbf ft |
| -4 | 1/4 | 12 | 110 | 9 |
| -5 | 5/16 | 20 | 180 | 15 |
| -6 | 3/8 | 27 | 240 | 20 |
| -8 | 1/2 | 40 | 360 | 30 |
| -10 | 5/8 | 54 | 480 | 40 |
| -12 | 3/4 | 95 | 840 | 70 |
| -14 | 7/8 | 110 | 980 | 80 |
| -16 | 1 | 120 | 1080 | 90 |
| -20 | 1 1/4 | 160 | 1440 | 120 |
| -24 | 1 1/2 | 180 | 1575 | 130 |
| -32 | 2 | 400 | 3600 | 300 |
| -40 | 2 1/2 | 540 | 4800 | 400 |
| -48 | 3 | 680 | 6000 | 500 |

## CONVERSION INFORMATION

| | MULTIPLY: | | BY: | | To Get MULTIPLY | | BY: | | To Get: |
|---|---|---|---|---|---|---|---|---|---|
| LINEAR | inches | x | 25,4 | = | millimeters (mm) | x | 0,03937 | = | inches |
| | feet | x | 0,3048 | = | meters (m) | x | 3,281 | = | feet |
| | yards | x | 0,9144 | = | meters (m) | x | 1,0936 | = | yards |
| | miles | x | 1,6093 | = | kilometers (km) | x | 0,6214 | = | miles |
| | inches | x | 2,54 | = | centimeters | x | 0,3937 | = | inches |
| | microinches | x | 0,0254 | = | micrometers (µm) | x | 39,37 | = | microinches |
| AREA | inches² | x | 645,16 | = | millimeters² (mm²) | x | 0,00155 | = | inches² |
| | inches² | x | 6,5516 | = | centimeters² (cm²) | x | 0,155 | = | inches² |
| | feet² | x | 0,0929 | = | meters² (m²) | x | 10,764 | = | feet² |
| | yards² | x | 0,8361 | = | meters (m²) | x | 1,196 | = | yards² |
| | acres | x | 0,4047 | = | hectometers² (hm²) | x | 2,471 | = | acres |
| VOLUME | inches3 | x | 16387 | = | millimeters$^3$ (mm$^3$) | x | 0,000061 | = | inches$^3$ |
| | inches3 | x | 16,387 | = | centimeters$^3$ (cm$^3$) | x | 0,06102 | = | inches$^3$ |
| | inches3 | x | 0,01639 | = | liters | x | 61,024 | = | inches$^3$ |
| | quarts | x | 0,94635 | = | liters | x | 1,0567 | = | quarts |
| | gallons | x | 3,7854 | = | liters | x | 0,2642 | = | gallons |
| | feet3 | x | 28,317 | = | liters | x | 0,03531 | = | feet$^3$ |
| | feet3 | x | 0,02832 | = | meters$^3$ (m$^3$) | x | 35,315 | = | feet$^3$ |
| | fluid oz. | x | 29,57 | = | milliliters (ml) | x | 0,03381 | = | fluid oz. |
| | yards3 | x | 0,7646 | = | meters$^3$ (m$^3$) | x | 1,3080 | = | yards$^3$ |
| | teaspoons | x | 4,929 | = | millilters (ml) | x | 0,2029 | = | teaspoons |
| | cups | x | 0,2366 | = | liters | x | 4,227 | = | cups |
| | bushels | x | 35,239 | = | liters | x | 0,02838 | = | bushels |
| | bushels | x | 0,03524 | = | meters$^3$ (m$^3$) | x | 28,378 | = | bushels |
| MASS | ounces (av) | x | 28,35 | = | grams (g) | x | 0,03527 | = | ounces (av) |
| | pounds (av) | x | 0,4536 | = | kilograms (kg) | x | 2,2046 | = | pounds (av) |
| | tons (2000 lbs) | x | 907,18 | = | kilograms (kg) | x | 0,001102 | = | tons (2000 lbs) |
| | tons (2000lbs) | x | 0,90718 | = | metric tons (t) | x | 1,1023 | = | tons (2000 lbs) |
| | tons (long) (2240 lbs) | x | 1016,05 | = | kilograms (kg) | x | 0,000984 | = | tons (long) (2240 lbs) |
| FORCE | ounces - f (av) | x | 0,278 | = | newtons (N) | x | 3,597 | = | ounces - f (av) |
| | pounds - f (av) | x | 0,4536 | = | newtons (N) | x | 0,2248 | = | pounds |
| | kilograms - f | x | 9,807 | = | newtons (N) | x | 0,10197 | = | kilograms - f |
| PRESSURE OR STRESS | pounds/sq. in. | x | 6,895 | = | kilopascals (kPa) | x | 0,145 | = | pounds/sq. in. |
| | pounds/sq. in. | x | 0,0689 | = | bar | x | 14,503 | = | pounds/sq. in. |
| POWER | horsepower | x | 0,746 | = | kilowatts (kW) | x | 1,34 | = | horsepower |
| | ft - lbf/min | x | 0,0226 | = | watts (W) | x | 44,25 | = | ft - lbf/min |

| | MULTIPLY: | | BY: | | To Get MULTIPLY | | BY: | | To Get: |
|---|---|---|---|---|---|---|---|---|---|
| TORQUE | pounds - inches | x | 0,11298 | = | newtons-meter (Nm) | x | 8,851 | = | pounds - inches |
| | pound - feet | x | 1,3558 | = | newton-meter (Nm) | x | 0,7376 | = | pound-feet |
| VELOCITY | miles/hour | x | 1,6093 | = | kilometers/hours (km/h) | x | 0,6214 | = | miles/hour |
| | feet/sec. | x | 0,3048 | = | meters/sec. (m/s) | x | 3,281 | = | feet/sec. |
| | kilometers/hr. | x | 0,27778 | = | meters/sec. (m/s) | x | 3,600 | = | kilometers/hr. |
| | miles/hours | x | 0,4470 | = | meters/sec. (m/s) | x | 2,237 | = | miles/hour |
| TEMPERATURE |   | | | | | | | | |

**NOTES**

# JACK UP THE MACHINE

This chapter only discript how to Jack up the Terra Gator. How to split the Terra Gator, see chapter Chassis.

## FRONT CHASSIS

**DANGER: When the machine needs to jacked up. Be extremely careful. If the machine falls of the jack, death or serious injury can result.**

**DANGER: When the machine is jacked up, always place a support. Place the machine on the supports, and remove the jack underneath the machine. A jack can loose the force and the machine will fall. Death or serious injury and damage to the machine will result.**

**WARNING: Use proper supports. Be sure the supports can carry the weight of the chassis. Otherwise serious injury, death and damage to the machine can result.**

**The weight of the front chassis is 9470 kg (20878 lb).**


**FIG. 1**

**WARNING: When the front chassis is disconnect of the rear chassis, the centre of gravity is in front of the axle. If the chassis falls of the jacks/supports, the chassis will tip over to the front.**

# Jack Up The Machine

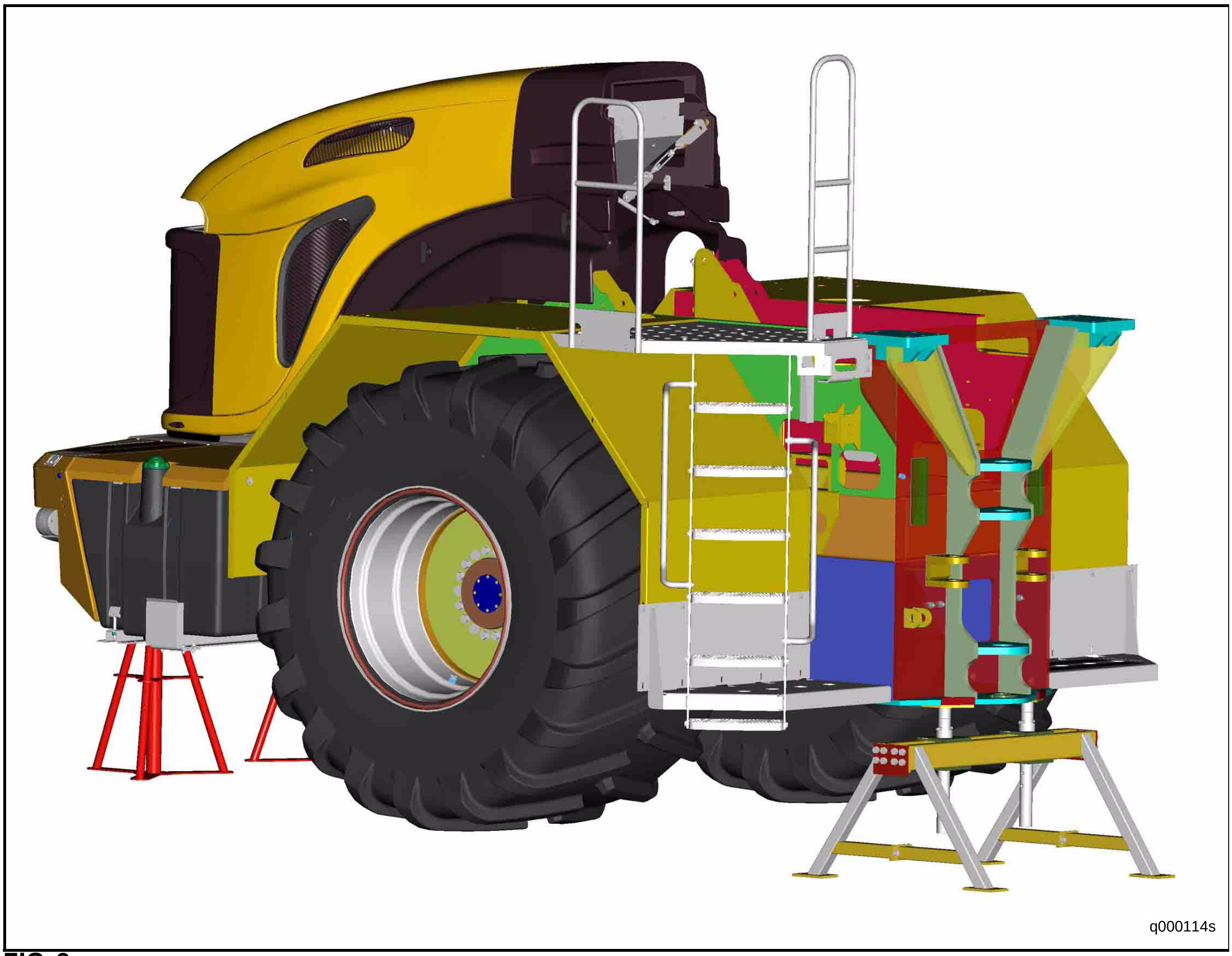



**FIG. 2**

**WARNING: Use proper supports. Be sure the supports can carry the weight of the chassis. Otherwise serious injury, death and damage to the machine can result.**

**The weight of the front chassis is 9470 kg (20878 lb).**

**WARNING: When the parking brake is released the vehicle does not have any park brake function. You must block the wheels to prevent the vehicle from moving. Serious personal inury or death and damge to components can result.**

## REAR CHASSIS

**DANGER: When the machine needs to jacked up. Be extremely careful. If the machine falls of the jack, death or serious injury can result.**

**DANGER: When the machine is jacked up, always place a support. Place the machine on the supports, and remove the jack underneath the machine. A jack can loose the force and the machine will fall. Death or serious injury and damage to the machine will result.**

**WARNING: Use proper supports. Be sure the supports can carry the weight of the chassis. Otherwise serious injury, death and damage to the machine can result.**

**The weight of the rear chassis is 3880 kg (8554 lb). This weight is without system.**

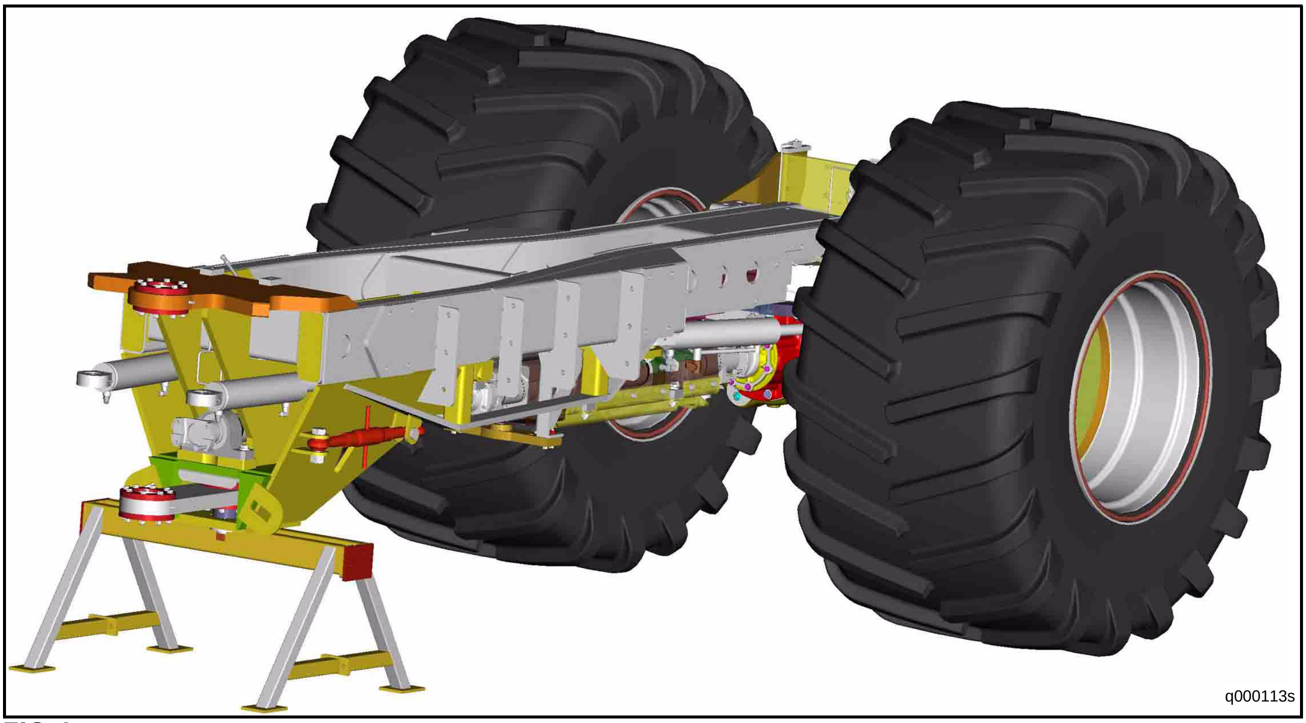



**FIG. 3**

**WARNING: When the rear chassis is disconnect of the front chassis, the centre of gravity is in front of the axle. If the chassis falls of the jacks/supports, the chassis will tip over to the front.**

**WARNING: When the parking brake is released the vehicle does not have any park brake function. You must block the wheels to prevent the vehicle from moving. Serious personal inury or death and damge to components can result.**

*IMPORTANT: If the rear chassis contains a hitch. Remove the application machine which is in the hitch, before disassembly the pivot. Otherwise the centre gravity point can be behind the axle and the rear will tip backwards.*

# Jack Up The Machine

## Dog Walk Chassis

The follow figures shows how to jack up the rear side of the rear chassis.

**DANGER: When the machine needs to jacked up. Be extremely careful. If the machine falls of the jack, death or serious injury can result.**

**DANGER: When the machine is jacked up, always place a support. Place the machine on the supports, and remove the jack underneath the machine. A jack can loose the force and the machine will fall. Death or serious injury and damage to the machine will result.**

**WARNING: Use proper supports. Be sure the supports can carry the weight of the chassis. Otherwise serious injury, death and damage to the machine can result.**

**The weight of the rear chassis is 3880 kg (8554 lb). This weight is without system.**

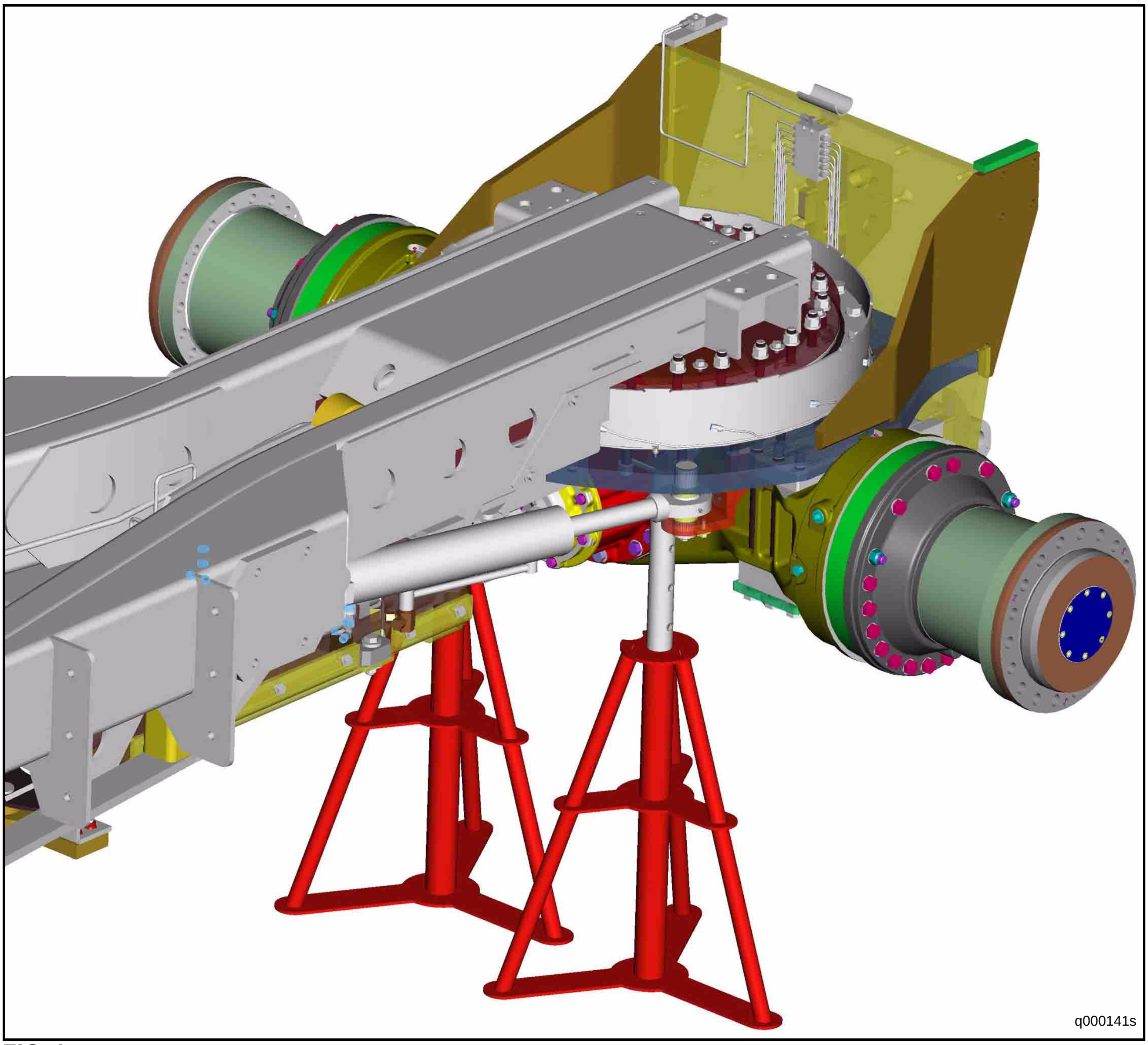



**FIG. 4**

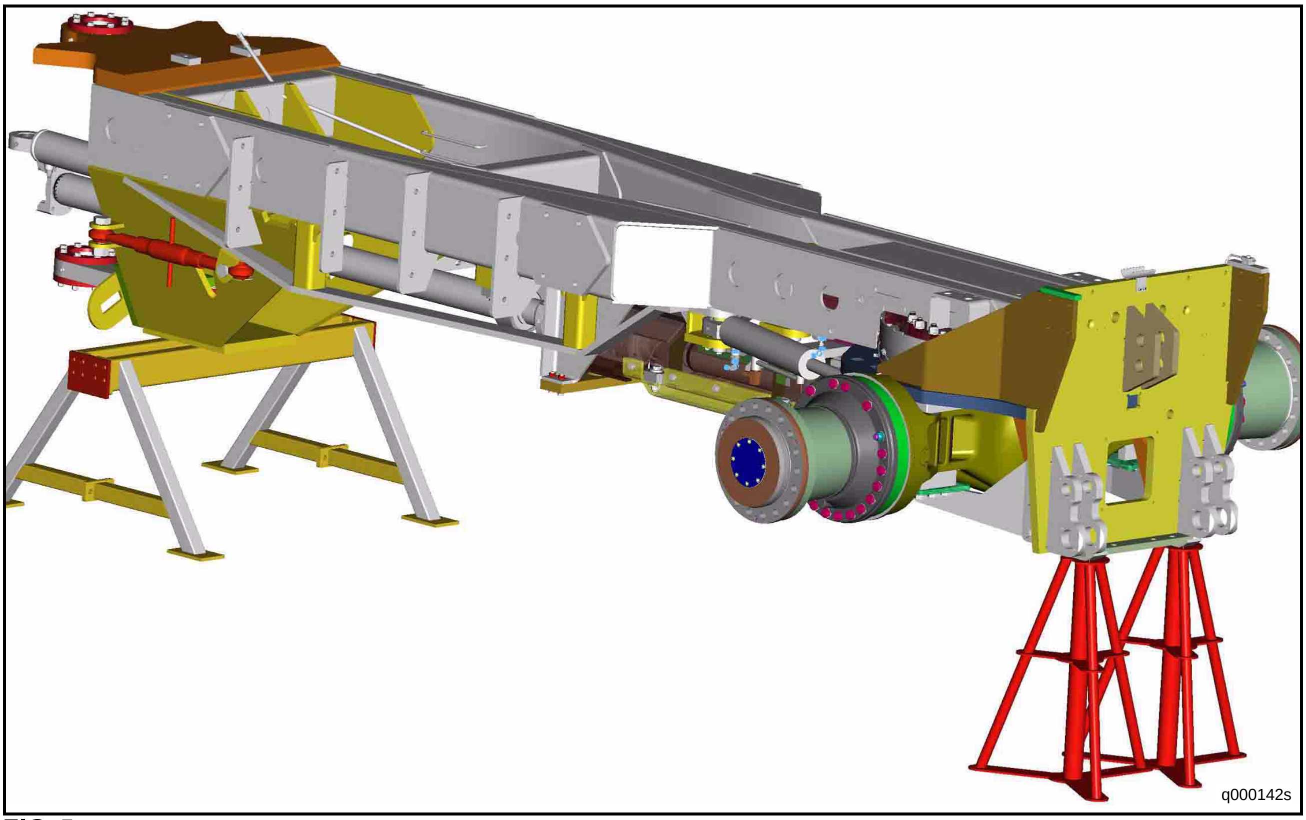



FIG. 5

# Jack Up The Machine

## Straight Chassis

The follow figures shows how to jack up the rear side of the rear chassis.

**DANGER: When the machine needs to jacked up. Be extremely careful. If the machine falls of the jack, death or serious injury can result.**

**DANGER: When the machine is jacked up, always place a support. Place the machine on the supports, and remove the jack underneath the machine. A jack can loose the force and the machine will fall. Death or serious injury and damage to the machine will result.**

**WARNING: Use proper supports. Be sure the supports can carry the weight of the chassis. Otherwise serious injury, death and damage to the machine can result.**

**The weight of the rear chassis is 3880 kg (8554 lb). This weight is without system.**

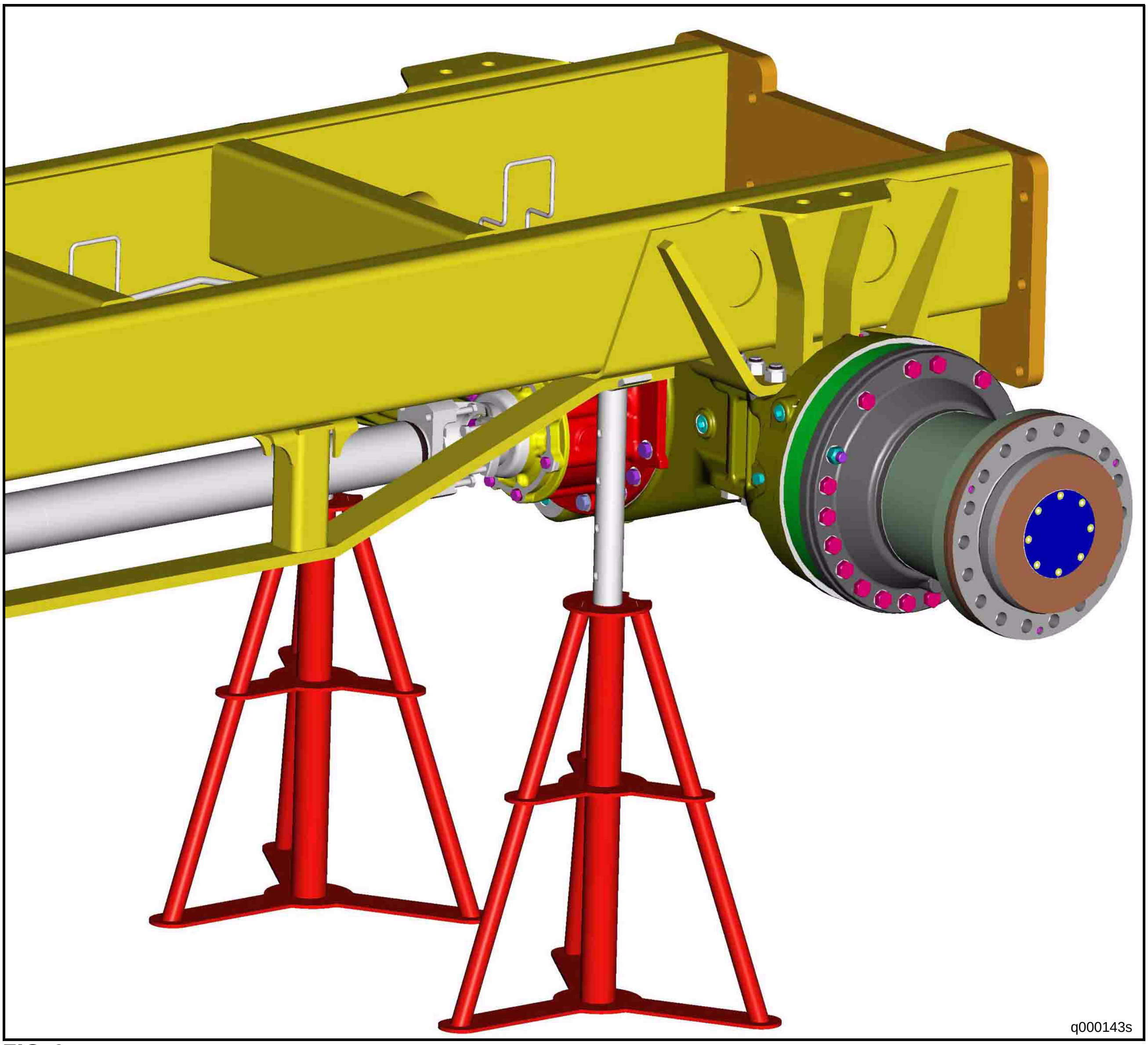



**FIG. 6**

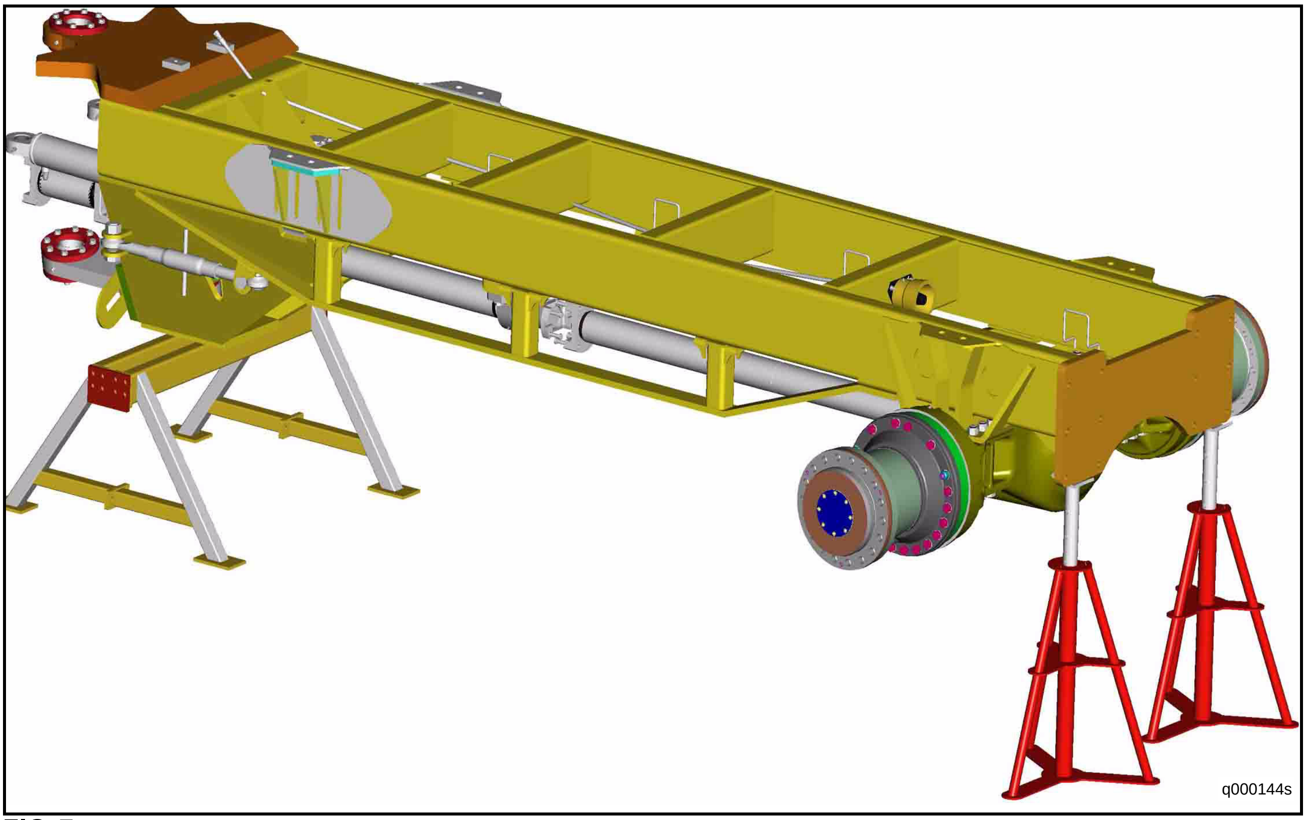



FIG. 7

NOTES

# TOOLING LIST

## TOOLING LIST

### Hoses

| Partnumber | Description | Information |
|---|---|---|
| E210002 | 200 mm (7.9 inch) | Both sides Mini Mesh (Female threaded) |
| E210003 | 300 mm (11.8 inch) | Both sides Mini Mesh (Female threaded) |
| E210004 | 450 mm (17.7 inch) | Both sides Mini Mesh (Female threaded) |
| E210006 | 600 mm (23.6 inch) | Both sides Mini Mesh (Female threaded) |
| E210010 | 1000 mm (39.4 inch) | Both sides Mini Mesh (Female threaded) |
| E210010 | 1500 mm (59 inch) | Both sides Mini Mesh (Female threaded) |
| E210020 | 2000 mm (78.7 inch) | Both sides Mini Mesh (Female threaded) |
| E210030 | 3000 mm (118 inch) | Both sides Mini Mesh (Female threaded) |
| E210040 | 4000 mm (157.5 inch) | Both sides Mini Mesh (Female threaded) |
| E210050 | 5000 mm (196.8 inch) | Both sides Mini Mesh (Female threaded) |
| E210060 | 6000 mm (236.2 inch) | Both sides Mini Mesh (Female threaded) |

**FIG. 1:** Hose with both sides Mini Mesh connection.

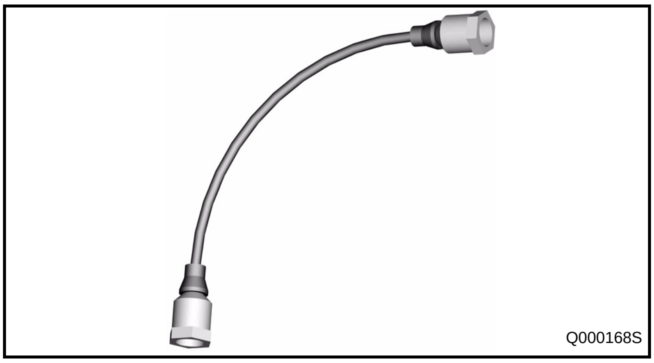



**FIG. 1**

### Pressure Gauge

| Partnumber | Discription | Information |
|---|---|---|
| E211016 | 16 bar (232 PSI) | 1/4 BPS (Male threaded) |
| E211060 | 60 bar (870 PSI) | 1/4 BPS (Male threaded) |
| E211250 | 250 bar (3626 PSI) | 1/4 BPS (Male threaded) |

**FIG. 2:** Pressure Gauge.


**FIG. 2**

## Fitting

| Partnumber | Description | Information |
|---|---|---|
| E210105 | Mini Mesh -> 7/16 UNF | Both sides Male threaded |
| E210102 | Mini Mesh -> 1/4 BSP | Both sides Male threaded |
| E210107 | Mini Mesh -> Pressure Gauge 1/4 BSP | Mini Mesh, Male threaded<br>1/4 BSP, Female threaded |

**FIG. 3:** Mini Mesh -> 7/16 UNF.


**FIG. 3**

**FIG. 4:** Mini Mesh ->1/4 BSP.

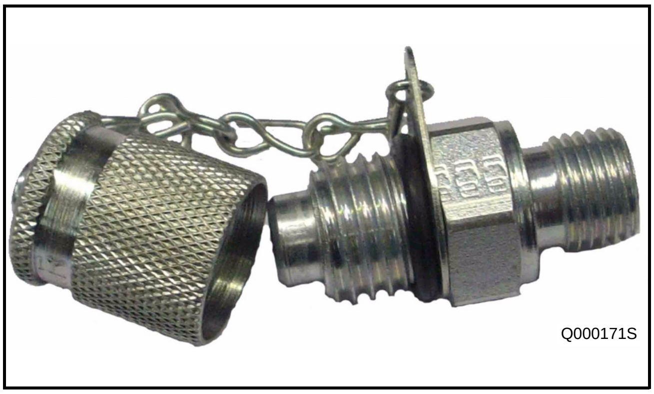



**FIG. 4**

**FIG. 5:** Mini Mesh -> Pressure Gauge 1/4 BSP.

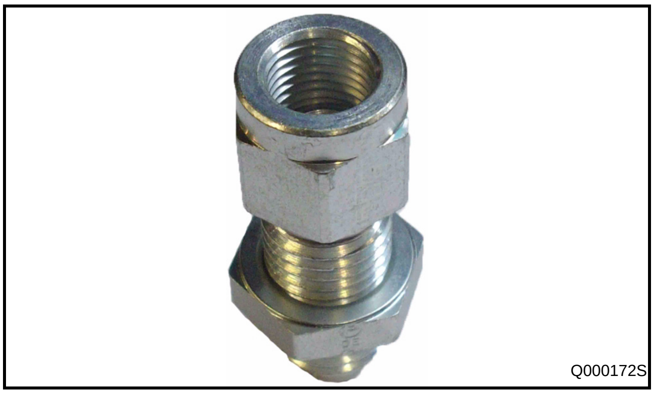



**FIG. 5**

## Quick Connect Couplers

| Partnumber | Description | Information |
|---|---|---|
| 681359 | Testpoint 7/16 UNF DF (male) | 7/16 UNF, Female threaded |
| 833317 | Testpoint 1/4 UNF DF (female) | 1/4 UNF, Female threaded |

**FIG. 6:** Testpoint 7/16 UNF DF (male).

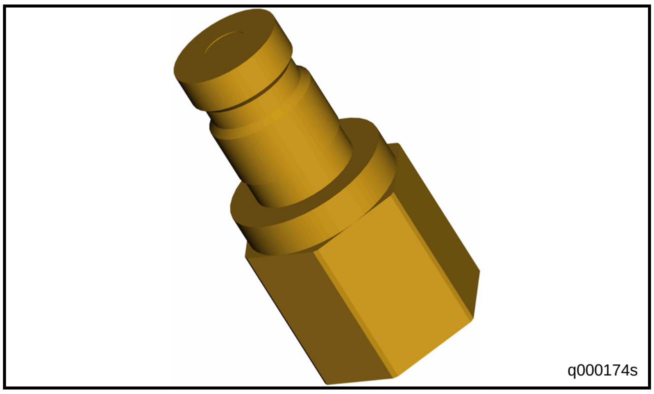



**FIG. 6**

**FIG. 7:** Testpoint 1/4 NPT DF (female).


**FIG. 7**

NOTES

# INDEX

**NOTES**

# Challenger®

## Terra Gator 3244
## Chassis

# SERVICE MANUAL
## 627333-A

# 02 - Engine

## Contents

**NOTES**

# INTRODUCTION

## INTRODUCTION

The machine utilizes a diesel engine manufactured by CAT for AGCO.

Many of the components are mounted and operate directly with the CAT engine. This section describes troubleshooting, error codes and the proper procedures to remove and install components.

If an internal engine problem arises that warrents engine, please contact your AGCO-dealer or the engine service center.

## SPECIFICATIONS AND STANDARDS CONCERNING FUEL, OIL AND COOLANT

The engines fitted on the machine series comply with standards concerning emissions imposed by the authorities. (EU97/68/EC and 2007 US EPA and California Regulations for Large Non Road Compression Ignition Engines)

The quality of the fluids used in these engines, as well as the servicing schedule, must be respected in order to keep pollution emission levels low and to maintain the machine's performance throughout its life.

### Fuel Quality

The fuel must comply with standard DIN EN 590 and with the following specifications:

Density at 15 °C (59 °F): 0,82 to 0,84 kg/dm

Viscosity at 40 °C (104 °F): 2 to 4,5 mm/sec

Cetane index: min 51

Sulphur content: max 0,005p-%

Water content: max 200mg/kg

### Oil Quality

The oil used must comply with API CI-4 standard.

### Coolant Quality

The coolant used must comply with the ASTM d 3306 standard. It must consist of pure water and ethylene/propylene glycol type antifreeze in the following proportions:

- 40-60% water
- 40-60% antifreeze

The ideal ratio is 50% water to 50% antifreeze.

## CAT C11 DIESEL

### Specification

Specification CAT C11 Diesel with Turbo Intercooler.

- 6 Cylinder, 11.1 liter engine with direct injection;
- Injection order: 1-5-3-6-2-4;
- Max injection pressure of 2070 bar (30 000 PSI);
- Oil pressure 3,8 bar (54 PSI);
- Oil capacity of 40 L (10,6 gallon);
- Oil type, SAE 15W40 API Class CF-4
- Valve clearance of;

  Inlet 0,38 mm (± 0,08 mm)

  Exhaust 0.64 mm (± 0,08 mm)

### Engine Oil Type

| Lubricant Viscosities for Ambient Temperatures | | |
|---|---|---|
| | Ambient Temperature | |
| Viscosity Grade | Minimum | Maximum |
| SAE 0W-20 | -40°C (-40°F) | 10°C (50°F) |
| SAE 0W-30 | -40°C (-40°F) | 30°C (86°F) |
| SAE 0W-40 | -40°C (-40°F) | 40°C (104°F) |
| SAE 5W-30 | -30°C (-22°F) | 30°C (86°F) |
| SAE 5W-40 | -30°C (-22°F) | 50°C (122°F) |
| SAE 10W-30 | -18°C (-0°F) | 40°C (104°F) |
| SAE 10W-40 | -18°C (-0°F) | 50°C (122°F) |
| SAE 15W-40 | -9.5°C (-15°F) | 50°C (122°F) |

Generally, use the highest oil viscosity that is available to met the requirement for the temperature at start-up.

If ambient temperature conditions at engine start-up require the use of multigrade SAE 0W oil, SAE 0W-40 viscosity grade is generally preferred over SAE 0W-20 or SAE 0W-30.

*NOTE: SAE 10W-30 is the preferred viscosity grade for the engine when the ambient temperature is above -18°C (0°F) and below 40°C (104°F).*

*NOTE: Supplemental heat is recommended for cold-soaked starts below the minimum ambient temperature. Supplemental heat may be required for cold-soaked starts that are above the minimum temperature that is stated, depending on the parasitic load and other factors. Cold-soaked starts occur when the engine has not been operated for a period of time and when the cooler ambient temperatures allow the oil to become more viscous.*

## LIFTING AND STORAGE

### Lifting

**FIG. 1:** Never band the eyebolts and the brackets. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 °.

When it is necessary to remove a compnent at an angle, only use a link bracket that is properly rated for the weight.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting the fixtures in order to obtain proper balance and safety.

To remove the engine ONLY, use the lifting eyes that are on the engine.

Lifting eyes are designed and installed for the specific engine arrangement. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your engine service center for information regarding fixtures for proper engine lifting.

The weight of the engine is approximately 1250 Kg (2760 lb).

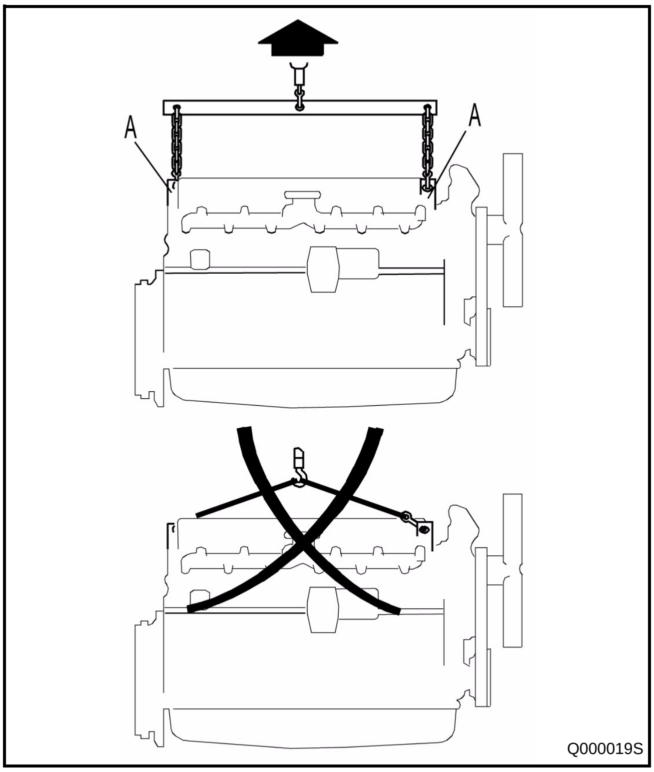



**FIG. 1**

### Storage

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface. Rust on the cylinder liner surface will cause increased engine wear and a reduction in engine service life.

To help prevent which excessive engine wear, use the following guidelines how are described in the engine manual.

## ENGINE SERVICE MANUAL

CAT only granted service manual of the engine which match with the serial number of the engine.

# ENGINE COMPONENTS

## ENGINE COMPONENT LOCATIONS

### Left Side

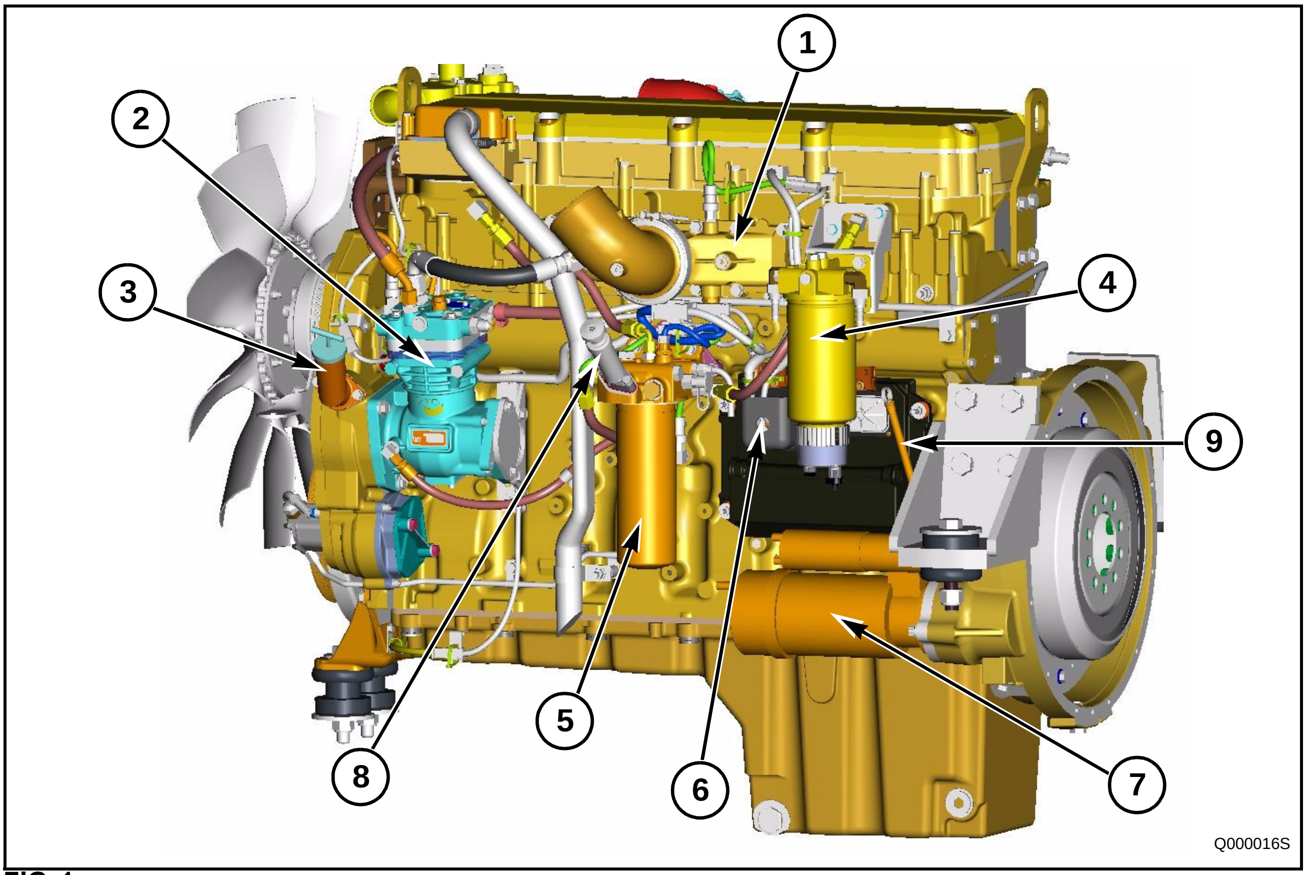



**FIG. 1**

1. Air Inlet;
2. Compressor;
3. Oil Fill Point;
4. Primary Fuel Filter;
5. Secondary Fuel Filter;
6. ECU;
7. Starter Motor;
8. Fuel Prime Pump;
9. Dipstick.

# Engine Components

## Right Side

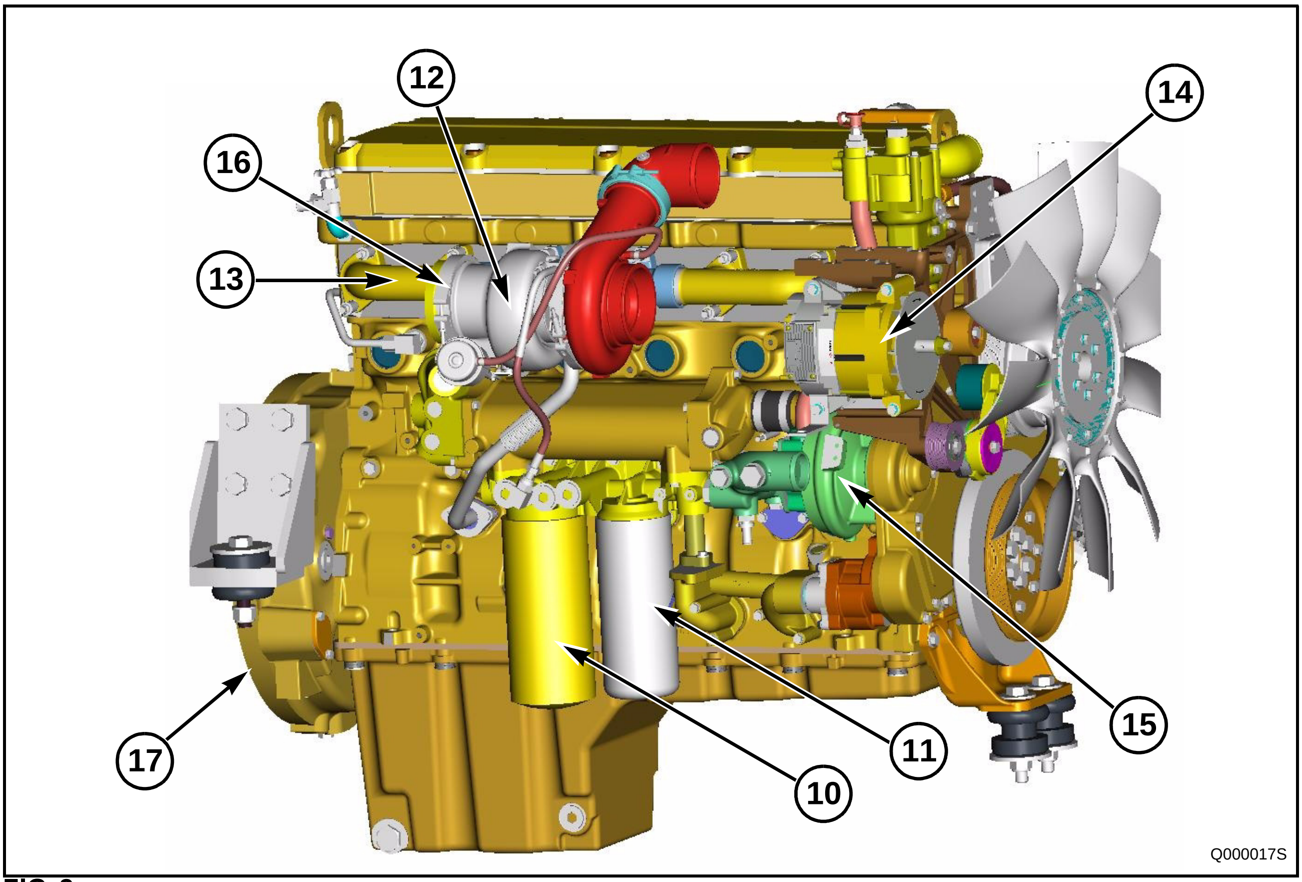



**FIG. 2**

10. Oil Filter;
11. Oil Fiter Bypass;
12. Turbo Charger;
13. Exhaust Manifold;
14. Dynamo Fix Plate;
15. Cool Water Pump;
16. Exhaust Pipe Connection;
17. Output Power to Transmission.

## SENSOR

### Sensor Overview

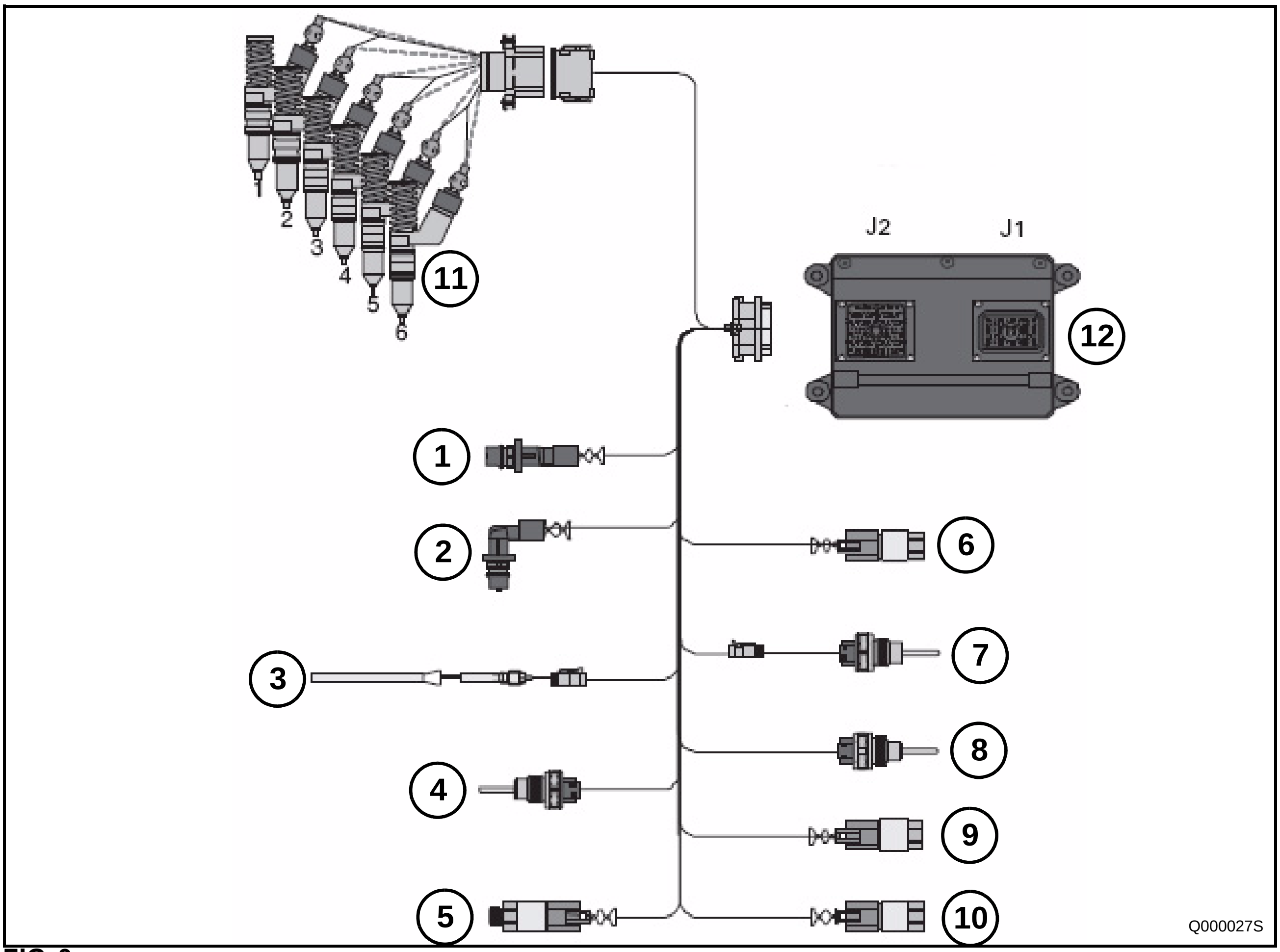



**FIG. 3**

Senors on the engine

1. Crankshaft Speed/Timing;
2. Camshaft Speed/Timing;
3. Timing CAL probe;
4. Fuel Temperature Sensor;
5. Atmospheric Temperature Pressure;
6. Intake Manifold (boost) Pressure;
7. Intake Manifold Air Pressure;
8. Coolant Temperature;
9. Fuel Pressure Sensor;
10. Oil Pressure;
11. Injectors;
12. ECU.

## Replacement Senors

**WARNING: Ensure that the engine can not be started while this maintenance is being performed.**

**Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.**

**WARNING: Personal injury can result from fluid pressure and hot oil.**

**Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.**

**Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.**

Don’t use extreme forces when disconnecting or removing a sensor.

## Sensor Location

**FIG. 4:**

1. Crankshaft Speed/Timing Sensor;

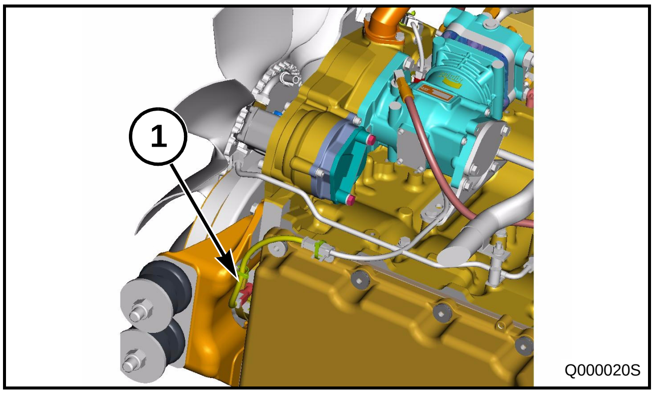



FIG. 4

**FIG. 5:**

2. Camshaft Speed/Timing Sensor;

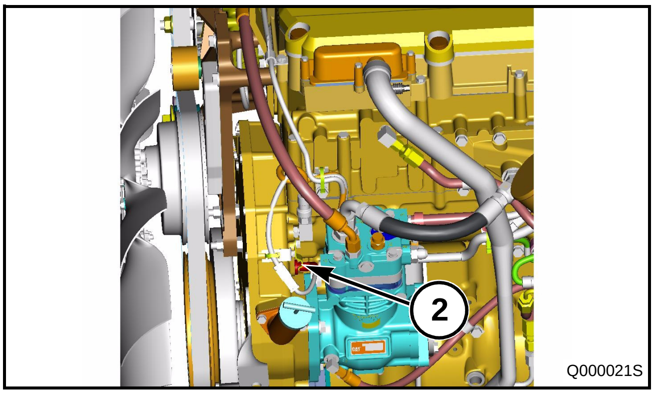



FIG. 5

**FIG. 6:**

3. Timing Cal probe, Adapter, Cable;

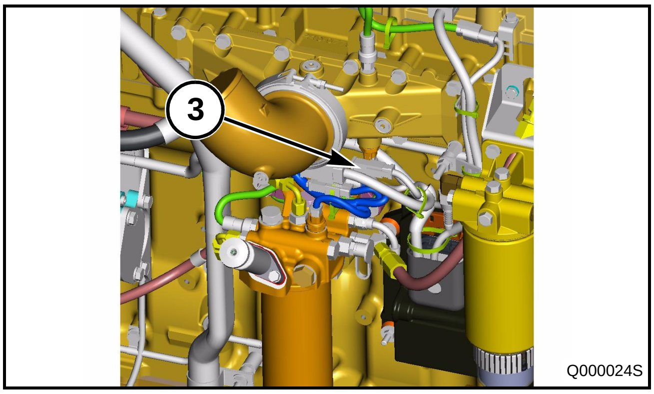



FIG. 6

**FIG. 7:**

4. Fuel Temperature Sensor

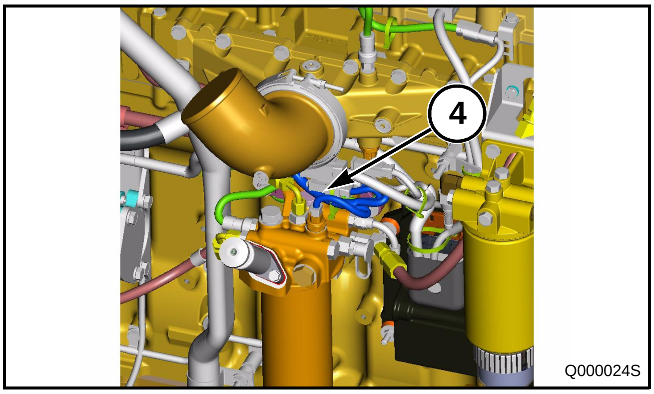



FIG. 7

**FIG. 8:**

5. Atmospheric Pressure;

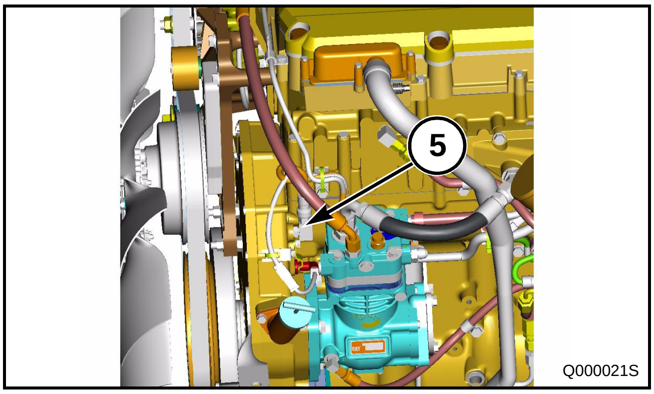



FIG. 8

**FIG. 9:**

6. Intake Manifold (boost) Pressure;

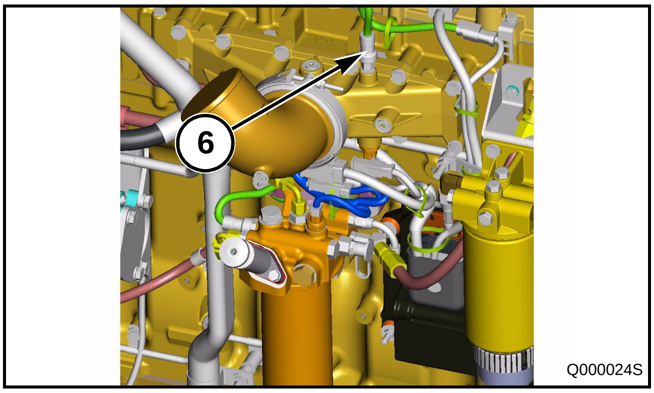



FIG. 9

**FIG. 10:**

7. Intake Manifold Air Temperature;

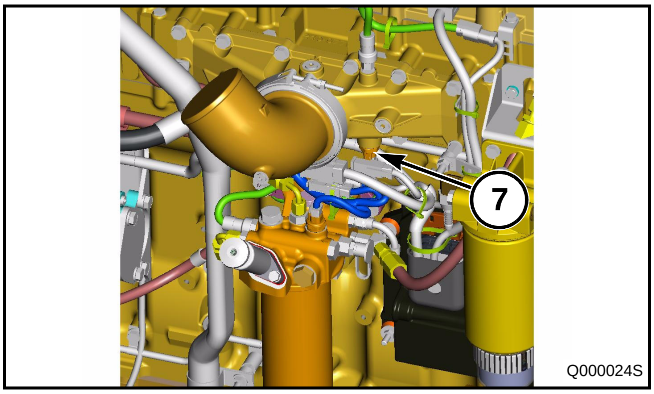



FIG. 10

**FIG. 11:**

8. Coolant Temperature;

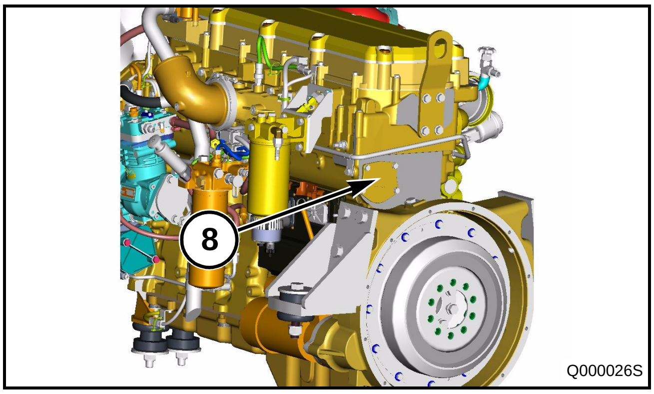



FIG. 11

**FIG. 12:**

9. Fuel Pressure;

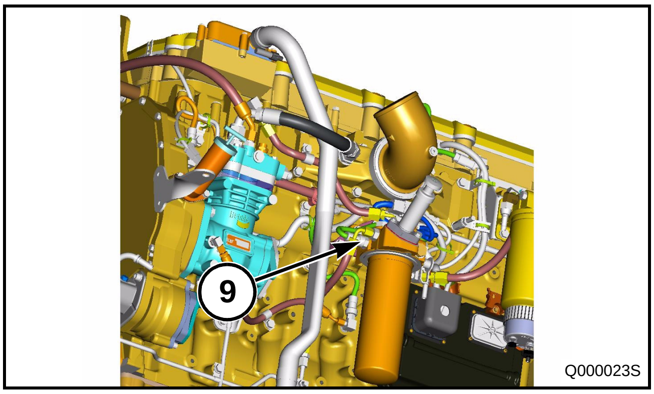



FIG. 12

**FIG. 13:**

10. Oil Pressure;

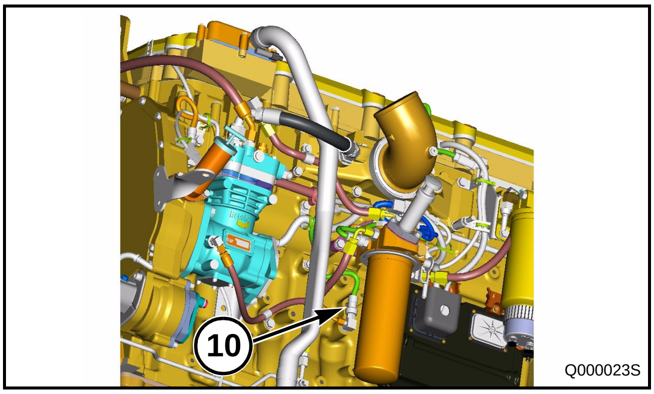



FIG. 13

**FIG. 14:**

11. Injectors;

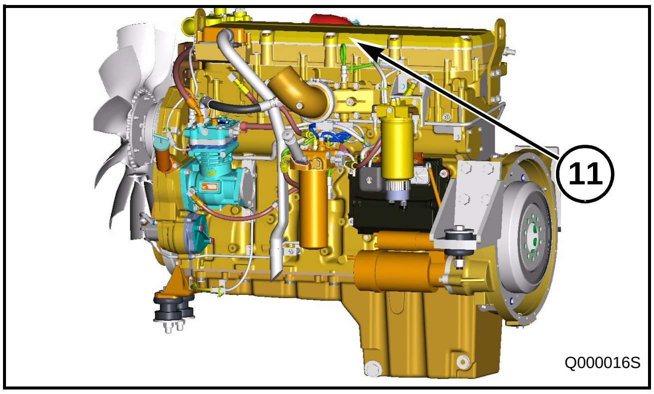



FIG. 14

**FIG. 15:**

12. ECU.

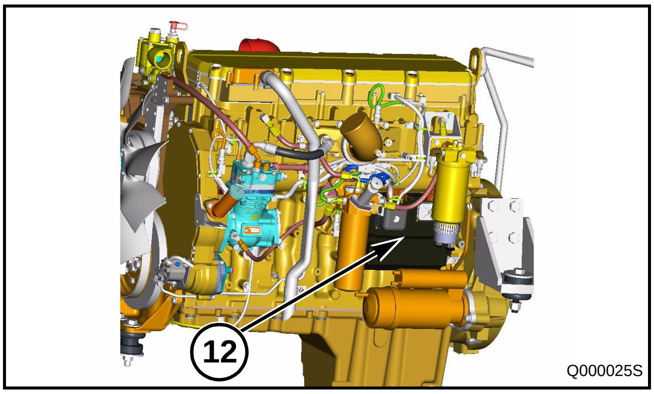



FIG. 15

## COOLING

**WARNING: The cooling system operates under pressure which is controlled by the radiator pressure cap. Removing the cap while the system is hot may allow the escape of hot coolant and steam, causing serious burns. Before you remove the radiator cap allow the system to cool. Use a thick cloth and turn the radiator cap slowly to the first stops to allow pressure to escape before fully removing the cap. Avoid contact with coolant.**

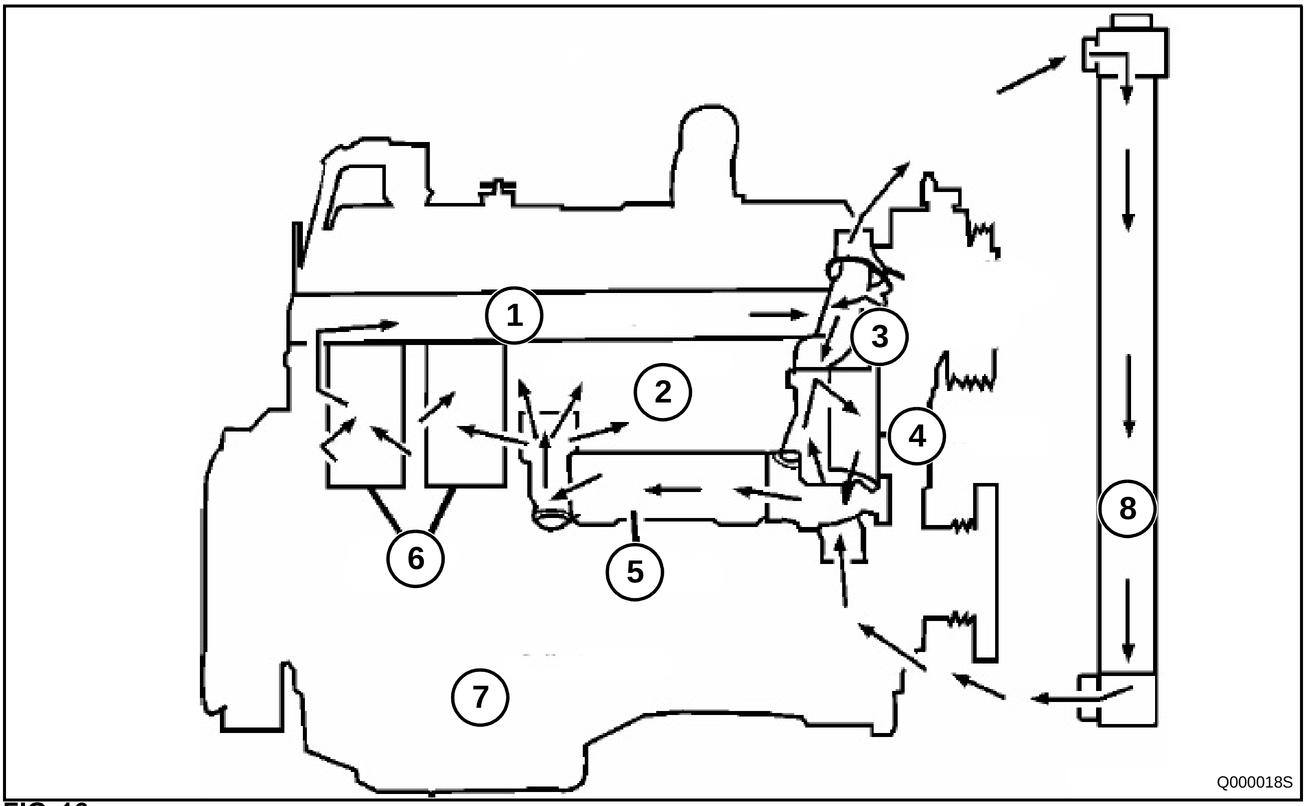



**FIG. 16**

1. Cylinder Head;
2. Coolant Bypass;
3. Coolant Temprature Regulator Housing;
4. Water Pump;
5. Oil Cooler;
6. Cylinder Liners;
7. Cylinder Block;
8. Radiator.

# ENGINE MAINTENANCE

## ENGINE VALVE LASH INSPECT / ADJUST

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines is recommended at the first scheduled oil change. The adjustment is necessary due to the initial wear of the valve train components and to the seating of the valve train components.

This maintenance is recommended by Caterpillar as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

*NOTE: Only qualified service personnel should perform this maintenance. Refer to the engine Service Manual or your engine service center for the complete valve lash adjustment procedure.*

*NOTE: Operation of Caterpillar engines with improper valve adjustment can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.*

**WARNING: Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.**

**Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.**

Ensure that the engine is stopped before measuring the valve lash. To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

The following components should be inspected and adjusted when the valves are inspected and adjusted.

- Valve actuators
- Injectors;
- Compression brakes.

Refer to the engine service manual for more information.

## Valve Lash Check

An adjustment is not necessary if the measurement of the valve lash is in the rang shown in table below

| | Inlet Valves | Exhaust Valves |
|---|---|---|
| Valve Lash (stopped Engine) | 0,38 ± 0,08 mm (0,015 ± 0,003 inch) | 0,64 ± 0,08 mm (0,025 ± 0,003 inch) |
| TC Compression Stroke | 1-2-4 | 1-3-5 |
| TC Exhaust Stroke | 3-5-6 | 2-4-6 |
| Firing Order | 1-5-3-6-2-4 | |

*NOTE: TC Exhaust stroke is 360° from Compression stroke.*

*NOTE: The no. 1 cylinder is at the front of the engine (see picture below).*

**FIG. 1:** Cylinder and valve location

a. Exhaust Valves;

b. Inlet Valves.

If the measurement is not within this range, an adjustment is necessary. Refer to the chapter “Valve Lash Adjustment” for the proper procedure.

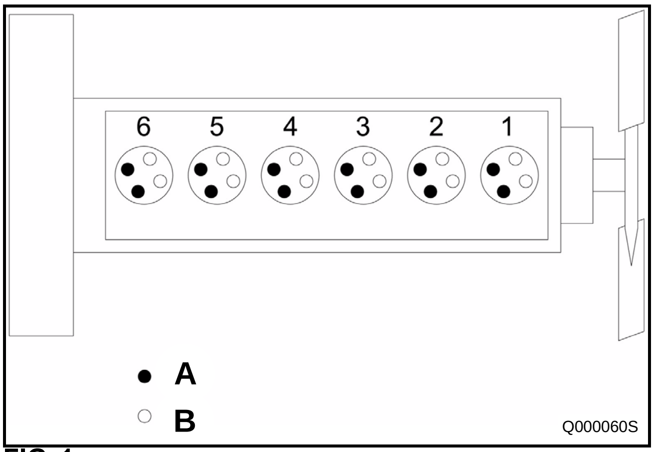



**FIG. 1**

## Valve Lash Adjustment

Use the following procedure to adjust the valve lash.

1. Ensure that the No. 1 pistion is at the TDC (Top Dead Center) position on the compression stroke;

*NOTE: To get No. 1 pistion in top center position. Turn engine in the direction it runs untill all valves from pistion 1 are closed. Until TDC (Top Dead Center) is reached.*

When the No. 1 pistion is at TDC. Install the timing bolt in the flywheel.

| TC Exhaust Stroke | Inlet Valves | Exhaust Valves |
|---|---|---|
| Valve Lash | 0.38 ± 0.08 mm (0.015 ± 0.003 inch) | 0.64 ± 0.08 mm (0.025 ± 0.003 inch) |
| Cylinders | 1-2-4 | 1-3-5 |

2. Adjust the valve lash according to the table above;

   a. Lightly tap the rocker arm with a soft mallet. This will ensure that the lifter roller seats against the camshafts base circle;

   b. Loosen the adjustment locknut;

c. Place the appropriate feeler gauge between rocker arm and the valve bridge. Then, turn the adjustemnt screw in a clockwise direction. Slide the feeler gauge between the rocker arm and the valve bridge. Continue turning the adjustment screw until a slight drag is felt on the feeler gauge. Remove the feeler gauge;

d. Tighten the adjustment locknut to a torque of 30 ± 7 Nm (22 ± 5 lb ft). Do not allow the adjustment screw to turn while you are tightening the adjustment. Recheck the valve lash after tightening the adjustment locknut.

3. Remove the timing bolt and turn the flywheel by 360° in the direction of engine rotation. This will put the No. 6 piston at the top center position on the compression stroke. Install the timing bolt in the flywheel;

| **TC Exhaust Stroke** | **Inlet Valves** | **Exhaust Valves** |
|---|---|---|
| Valve Lash | 0,38 ± 0,08 mm (0,015 ± 0,003 inch) | 0,64 ± 0,08 mm (0,025 ± 0,003 inch) |
| Cylinders | 3-5-6 | 2-4-6 |

4. Adjust the valve lash according to table above;

a. Lightly tap the rocker arm with a soft mallet. This will ensure that the lifter roller seats against the camshaft's base circle;

b. Loosen the adjustment locknut;

c. Place the appropriate feeler gauge between rocker arm and the valve bridge. Then, turn the adjustment screw in a clockwise direction. Slide the feeler gauge between the rocker arm and the valve bridge. Continue turning the adjustment screw until a slight drag is felt on the feeler gauge. Remove the feeler gauge;

d. Tighten the adjustment locknut to a torque of 30 ± 7 Nm (22 ± 5 lb ft). Do not allow the adjustment screw to turn while you are tightening the adjustment locknut. Recheck the valve lash after tightening the adjustment locknut.

5. Remove the timing bolt from the flywheel after all adjustment to the valve lash has been made. Reinstall the timing cover.

*NOTE: The valve lash must be adjusted before adjusting the compression brake, if equipped.*

## ENGINE REMOVAL AND INSTALLATION

To make access to the engine, remove the bonnet with frame complete. Before remove the bonnet and frame check the adjustment of the bonnet, frame and cooler. During the installation of the bonnet and frame, adjust the bonnet, frame and cooler the same as it where before removal.

**WARNING: Hot engine components can cause injury from burns. Before performing maintenance on engine, allow engine and components to cool.**

**WARNING: Remove all air pressure from tanks before disconnecting any air hoses. Pressurized air can cause serious personal injury.**

**WARNING: Never open coolant system when fluid is hot. Hot fluid can cause serious personal injury.**

**WARNING: Personal injury can result from contact with refrigerant.**

**Contact with refrigerant can cause frostbite. Keep face and hands away to help prevent injury.**

**Protective goggles must always be worn when refrigerant lines are opened even if the gauges indicated the system is empty of refrigerant.**

**Always use precaution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, release it slowly in a well ventilated area.**

**Do not smoke when servicing air conditioners or wherever refrigerant gas may be present.**

**Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air condition refrigerant gas, can cause bodily harm of death.**

**Use a certified recovery and recycling cart to properly remove the refrigerant from the air conditioning system.**

*NOTE: Put identification marks on all hoses, hose assemblies, wires, and tube assemblies for installation purposes. Any engine openings such as turbo charger, intake manifold ports and coolant ports should be plugged or capped while their respective tubes, hoses and any other connections are removed. Plugging prevents fluid loss and helps keep contaminants from entering the system.*

*NOTE: Cleanliness is an important factor. Thoroughly clean exterior of components prior to disassembly to prevent dirt from entering internal mechanisms. Precision components can be damaged by contaminants or dirt. Perform disassembly procedures on a clean work surface. Keep components covered and protected at all times.*

*NOTE: Care must be taken to ensure fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.*

*Dispose of all fluids according to local regulations and mandates.*

*NOTE: Only a certified technician with certified equipment is allowed to service the air conditioning system.*

*NOTE: Whenever the air conditioning system is opened, replace the air conditioning Receiver / Dryer. See air conditioning Receiver / Dryer removal and installation section.*

# INDEX

NOTES

# Challenger®

## Terra Gator 3244
## Chassis

# SERVICE MANUAL
## 627333-A

# 03 - Powertrain

## Contents

# Contents

# TRANSMISSION SERVICE MANUAL

## TRANSMISSION SERVICE INFORMATION

Information for the Caterpillar transmission used in this machine must be procured through an authorized Caterpillar transmission distributor.

### Oil Type

| Identification | Initial Fill | Recommended | Capacity |
|---|---|---|---|
| Transmission | AGCO 821 XL or Equivalent Specification, J20C Transmission and Hydraulic oil | 10W30 API class SF/CC | 56,7 L (15 Gall) |

### Check Oil level

Check the oil level only when the oil is warm. See below for the correct procedure for checking the oil level

**WARNING: Hot oil and components can cause personal injury.**

**Do not allow hot oil or components to contact skin.**

*NOTE: Perform this procedure on a smooth horizontal surface for the most accurate reading.*

1. Allow the engine to run for a period of two minutes at LOW IDLE position with the transmission in the park position;
2. Ensure that the oil level is between the ADD and FULL marks of dipstick;

**FIG. 1:** Transmission oil filler cap (1), transmission dipstick (2).

3. If necessary, add transmission oil;
    a. Remove transmission oil filler cap;
    b. Add the correct type of transmission oil;
    c. Clean transmission oil filler cap. Install transmission oil filler cap.
4. Stop the engine;
5. Visually inspect the transmission for leaks. Check for leaks under the transmission and around the drain plug.

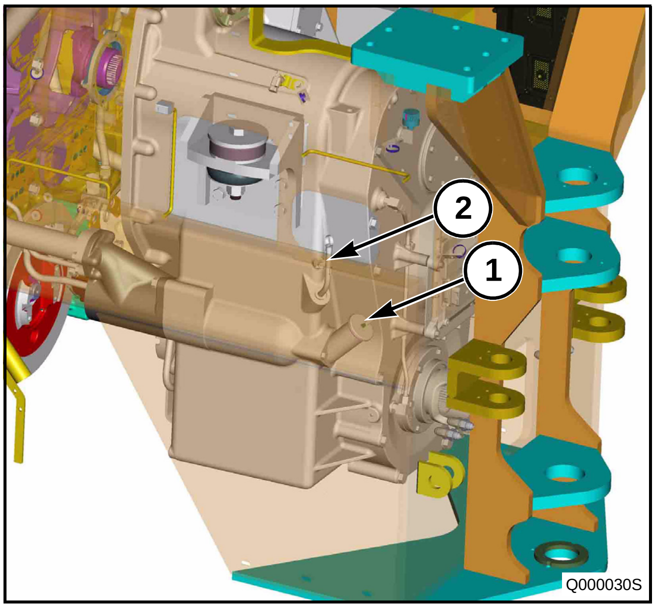


**FIG. 1**

NOTES

# TRANSMISSION AND SOLENOIDS

## THEORY OF OPERATION

The transmission is a 16-speed forward and 3-speed reverse powershift transmission with electronically controlled hydraulic power assisted shifting. A TCU (Transmission Control Unit) sends 12 volt power to electric coils on the front of the transmission to change gear ratios. There are a total of nine clutches, which engage in different combinations of two determining the speed of the output shaft.

The transmission is coupled to the engine through a rubber damper to absorb some of the shock between the engine, the transmission and the propschaft.

The electronic control allows the TCU to monitor various functions such as throttle position, input speed, output speed, temperature and thus control shifting as well as display error codes.

A charge pump mounted at the left top of the transmission provides the hydraulic flow for the transmission. There is an auxiliary output drive on the back of the charge pump that can be used to drive various hydraulic pumps for the various systems mounted to the chassis. There is a second auxiliary drive on the top right side of the transmission for systems requiring another hydraulic pump.

## TRANSMISSION COMPONENTS

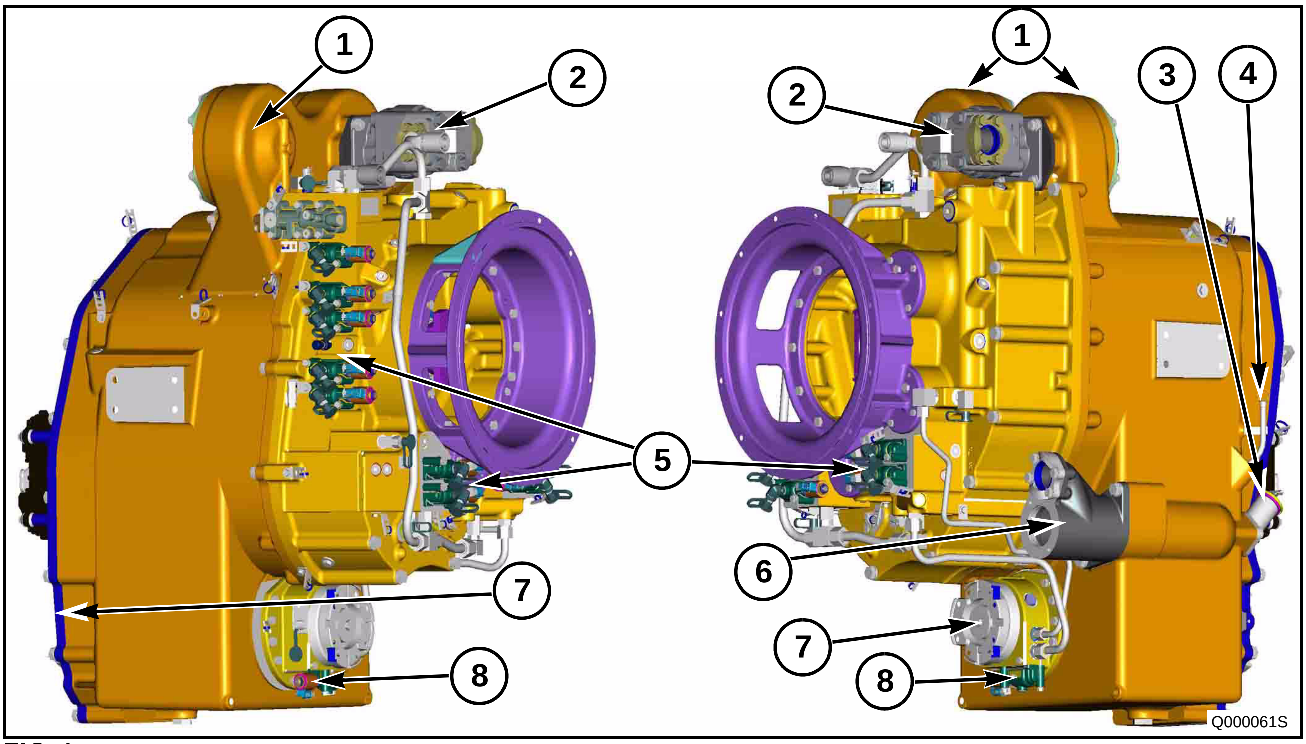



**FIG. 1**

Location  transmission componenten

1. PTO;
2. Charge Pump;
3. Fill Tube;
4. Dipstick;
5. Solenoids;
6. Screen Filter;
7. Output Shaft;
8. 4WD Valve.

## TRANSMISSION OIL CHANGE PROCEDURE

Start the machine and run it until the transmission oil temperature warms. This is necessary to allow the oil to flow freely during the draining procedure.

Place the machine on a hard, level surface and set the parking brake. Remove the key and block the wheels.

**FIG. 2:** Remove the drain plug (1) (spanner 1½”) at the underside of the transmission and drain the 56,7 L (15 Gall) of transmission fluid into an appropriate container.

*IMPORTANT: It is extremely important to work in a clean environment when working with hydraulic systems.*

*NOTE: There are multiple drain plugs located on the transmission. Only one plug needs to be removed to drain the transmission oil.*

*NOTE: Be prepared to collect and contain all fluids in an approved container. Transmission capacity 56,7 L (15 Gall).*

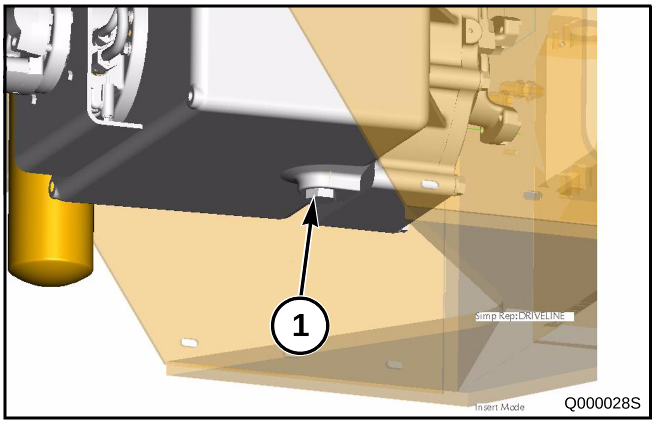



FIG. 2

**FIG. 3:** The transmission filter (1) is located to the front and to the right of the transmission. Loosen and remove the transmission filter.

Drain the filter into an appropriate container.

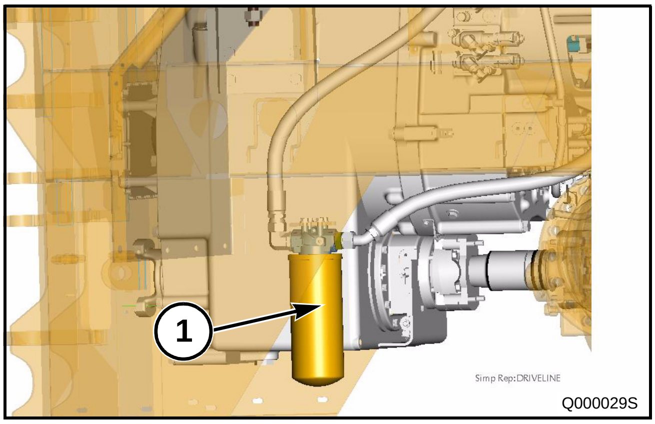



FIG. 3

**FIG. 4:** The screen filter (1) is located at the left. Loosen the cover of the filter housing. Clean the filter with pressurized air.

**WARNING: Wear safety goggles when work with pressurized air. Small part with a blowing away can come in your eyes. Serious injury can result.**

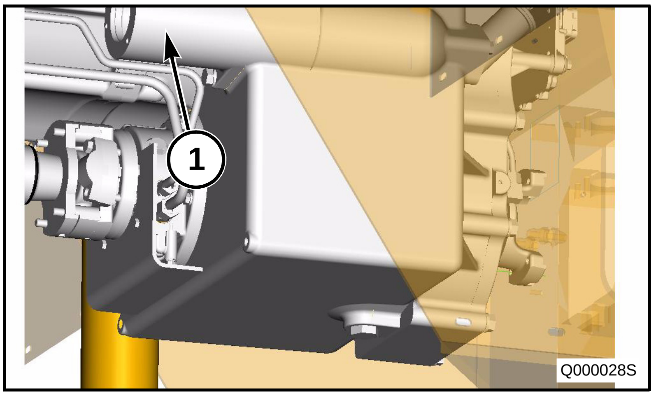



FIG. 4

**FIG. 5:** Reinstall the drain plug (1) (spanner 1½”) once all oil has been drained from the transmission.

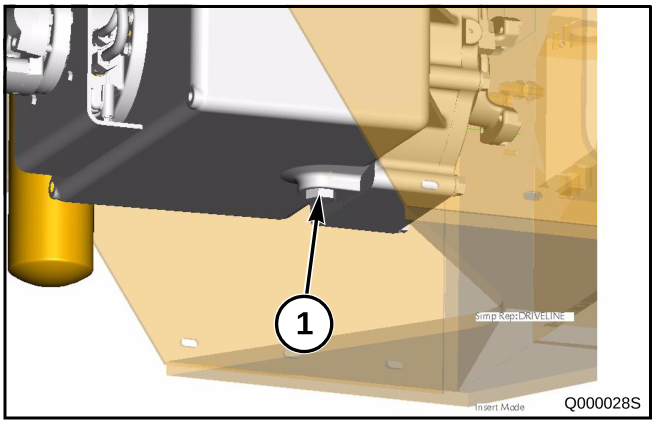



FIG. 5

**FIG. 6:** Apply a light coating of oil to the o-ring on the transmission filter. This will aid to create a tight seal.

Fill the transmissoin filter with AGCO 821XL (J20C) or equivalents.

Install the transmission filter (1) by hand. When the filer seal contacts the filter base, tighten the filter element by an additional turn of 270 degrees. Rotation marks are spaced at 90-degrees intervals. Use these rotation marks as a guide for proper tightening.

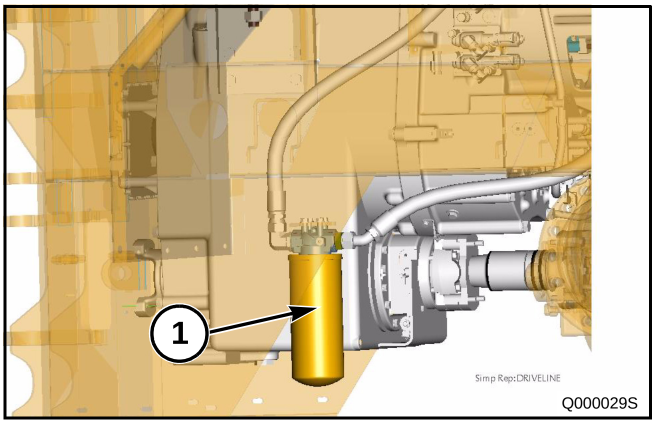



FIG. 6

**FIG. 7:** Refill the transmission with AGCO 821XL (J20C) or equivalents through the transmission fill tube (1). Check the level of oil with the dip stick (2), with a running engine

. The transmission will hold approximately 56,7 L (15 gal).

*IMPORTANT: Do not overfill the transmission. Overheating of the transmission will occur, resulting in possible damage to the transmission.*

Recalibrate the transmission and check for the proper oil level.

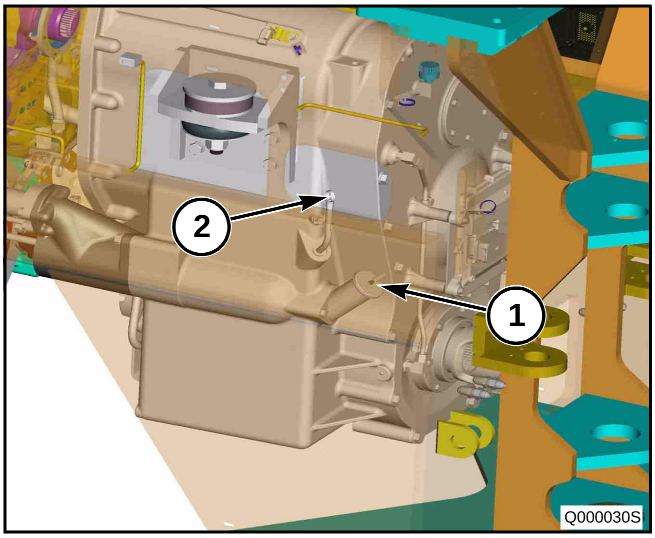



FIG. 7

## TRANSMISSION CALIBRATION

*IMPORTANT: Calibrate the transmission every 1000 hours of operation or annually. Also calibrate the transmission if shifting problems appear.*

### Calibration

*IMPORTANT: Before starting calibration procedure, park machine in area open on all sides of machine. Do not park in front of a building, vehicle or group of people when performing this procedure. Never leave operator station during calibration.*

In order to start calibration the transmission oil temp must be within 60°C to 65°C (140°F to 150°F), the park brake must be on and the RPM's must be set at 2100 or above.

**FIG. 8:**

Calibration can be entered by pressing all three buttons on the display at the same time for 3 seconds. First there will appear a radar calibration menu. Exit this menu by pressing "ESC", then the transmission calibration menu will come up to confirm that the operator wishes to start. To start calibration, select "YES". To exit back to normal operation select "NO".

Once calibration has been started the display will show the current status of calibration. If calibration cannot be completed a reason will be displayed, and the display will revert back to normal operation. If calibration is successful the display will show a completed status and resume normal operation.

**FIG. 8**

### Calibration Process

During the calibration the TCU will activate one by one all the solenoids. The TCU adjust the length of stroke of the solenoids to the point the clutch will be engaged. Every solenoid can have a different stroke length.

If the length of stroke is not correct, shifting will be very tough. This will decrease the lifetime of the transmission.

## SYSTEM OPERATION SECTION

### Hydraulic System

The transmission hydraulic system provides a modulated flow of pressurized oil to the transmission. The transmission contains nine transmission clutches. The nine clutches are controlled by the nine corresponding modulating valves (transmission). The transmission provides the operator with 16 forward and 3 reverse gears.

The modulating valves (transmission) provide the following control functions:

- Proportional control of pressure;
- Controls oil flow to clutch.

## Transmission System

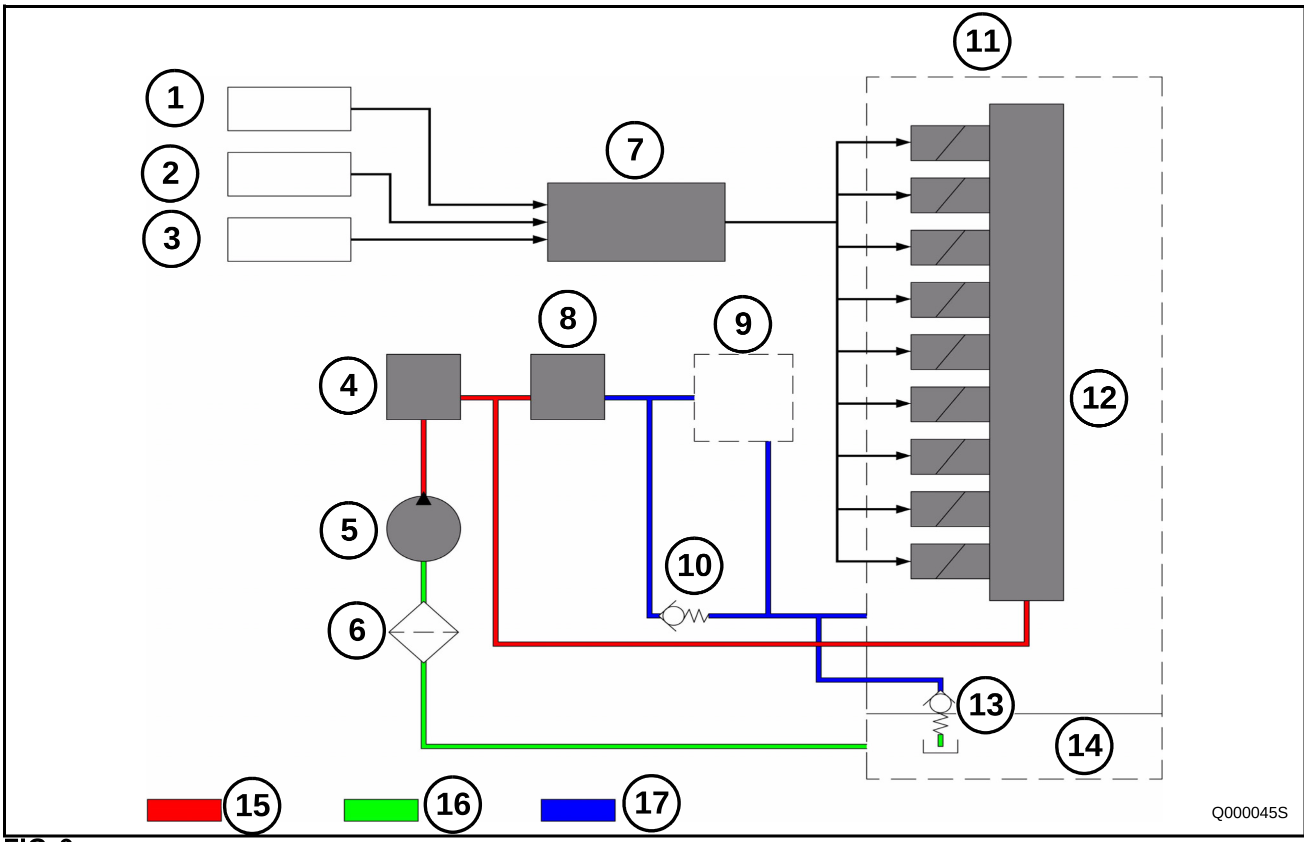



FIG. 9

1. Inching Pedal;
2. Shift Lever;
3. Auto Switch;
4. Filter;
5. Charge Pump;
6. Suction Filter;
7. Transmission ECM;
8. Main Relief Valve;
9. Oil Cooler;
10. Cooler Bypass;
11. Transmission;
12. Modulating Valves;
13. Lube Relief Valve;
14. Sump;
15. Charge Pressure;
16. Sump;
17. Lube Pressure.

The operator can intiate a hydraulic function by using one of the following controls:

- Inching Pedal (1);
- Shift Lever (2);
- Auto Shift Switch (3).

Oil from sump (14) is drawn through suction filter (6) by the charge pump (5). Suction filter (6) is rated at 200 micron. Hydraulic oil filter (4) filters the oil from charge pump (5).

Filtered oil is supplied to following valves:

- Modulating valves (transmission) (11);
- Relief valve (8).

When the modulating valves are energized, oil flows to the transmission clutches. When the modulating valves are de-energized, oil flows from the valve to the sump.

The relief valve (charge pressure) regulates the pressure in the transmission hydraulic system to a maximum pressure of 2100 kPa (305 psi).

Excess oil flows from relief valve (8) (charge pressure) to hydraulic oil cooler (9). Cooler bypass valve (10) will open if a pressure of 520 kPa (75 psi) is felt at the input side of the hydraulic oil cooler. Normally, the cooler bypass valve will remain closed unless there is a restriction in the hydraulic oil cooler or if the oil is very cold.

Oil from transmission oil cooler (9) flows to the transmission for lubrication of the clutches. The transmission lubrication relief (13) regulates the oil pressure for lubrication to 275 kPa (40 psi).

## Electrical System

The transmission electrical system provides controls for the transmission hydraulic system. The transmission electrical system includes switches, sensors, and control levers. The input signals are processed by the transmission electronic control module (ECM) which then energizes the appropriate solenoid.

The transmission electrical system contains the following components:

- Transmission ECM;
- Control inputs;
- Solenoids.

The transmission hydraulic system provides a modulated flow of pressurized oil to the transmission. The transmission contains nine transmission clutches are controlled by the nine corresponding modulating valves (transmission). The transmission provides the operator with 16 forward and 3 reverse gears.

## Transmission Electrical Control System

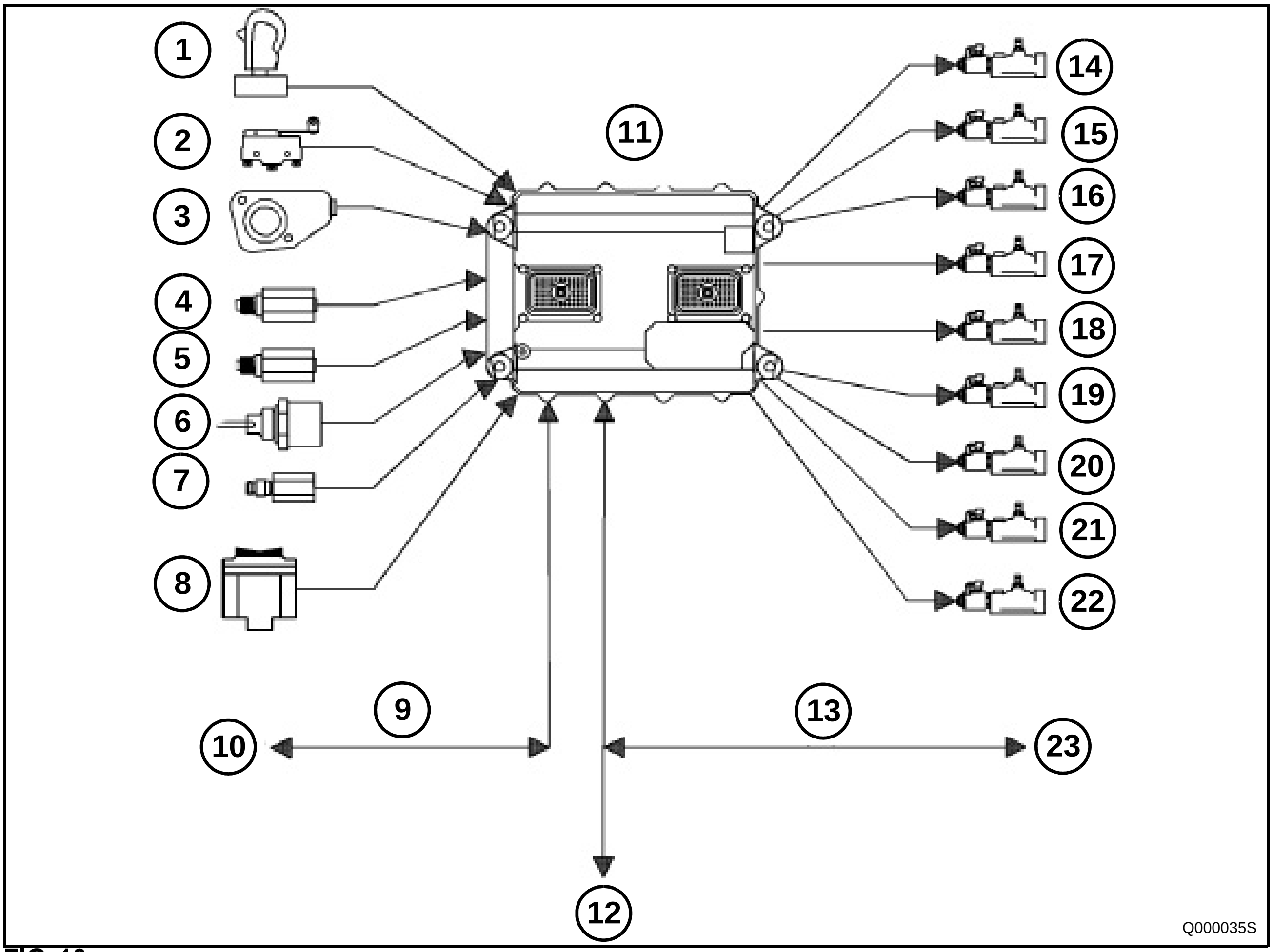



**FIG. 10**

1. Shift Lever Position Sensor;
2. Inching Pedal Switch;
3. Inching Pedal Position Sensor;
4. Input Speed Sensor;
5. Output Speed Sensors;
6. Hydraulic Oil Temperature Sensor;
7. Charge Pressure Sensor;
8. Auto Shift Switch;
9. CAT Data Link;
10. Service Connector;
11. Transmission ECM;
12. Dash Panel Display;
13. CAN Date Link;
14. Modulating Valve;
15. Modulating Valve;
16. Modulating Valve;
17. Modulating Valve;
18. Modulating Valve;
19. Modulating Valve;
20. Modulating Valve;
21. Modulating Valve;
22. Modulating Valve;
23. Service Connector.

CAT date link (13) is a serial communication bus that is used in order to communicate with the following components:

- Engine ECM;
- Transmission ECM;
- Dash Panel Cluster;
- Other OEM electronic modules

Shift lever (3) sends a PWM signal to transmission ECM (11). Transmission ECM (11) processes the signal in order to determine the position of the lever.

Speed sensors (5), temperature sensor (6), and pressure sensor (7) send signals to transmission ECM (11). The transmission ECM uses the signals order to monitor the conditions of the transmission.

## MODULATING VALVE

**FIG. 11:** Nine modulating valves (1) are located on the left side of the transmission and on the front of the transmission.

Each modulating valve has a designated letter, as shown. The letters have been cast into the transmission case. The designated letters are used to correlate the modulating valve to the corresponding transmission clutch.

An inspection hatch is located behind the right front wheel. Through this inspection hatch there is an easy access to the modulating valves. To reach the inspection hatch the right front wheel has to be removed.

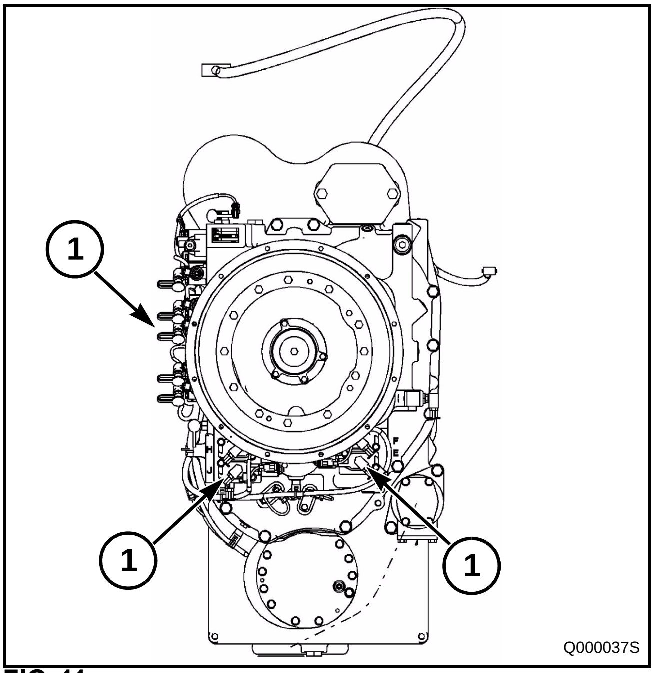



FIG. 11

**FIG. 12:**

**WARNING: Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this of injury.**

**Always use a board or cardboard when checking for a leak.**

**WARNING: Personal injury can result form hydraulic oil pressure and hot oil.**

**Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.**

**Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.**

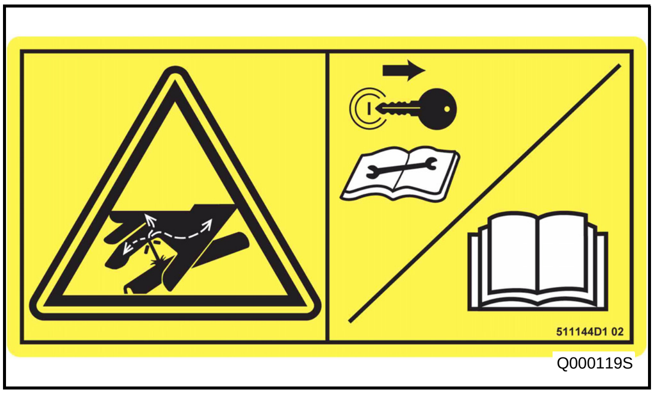



FIG. 12

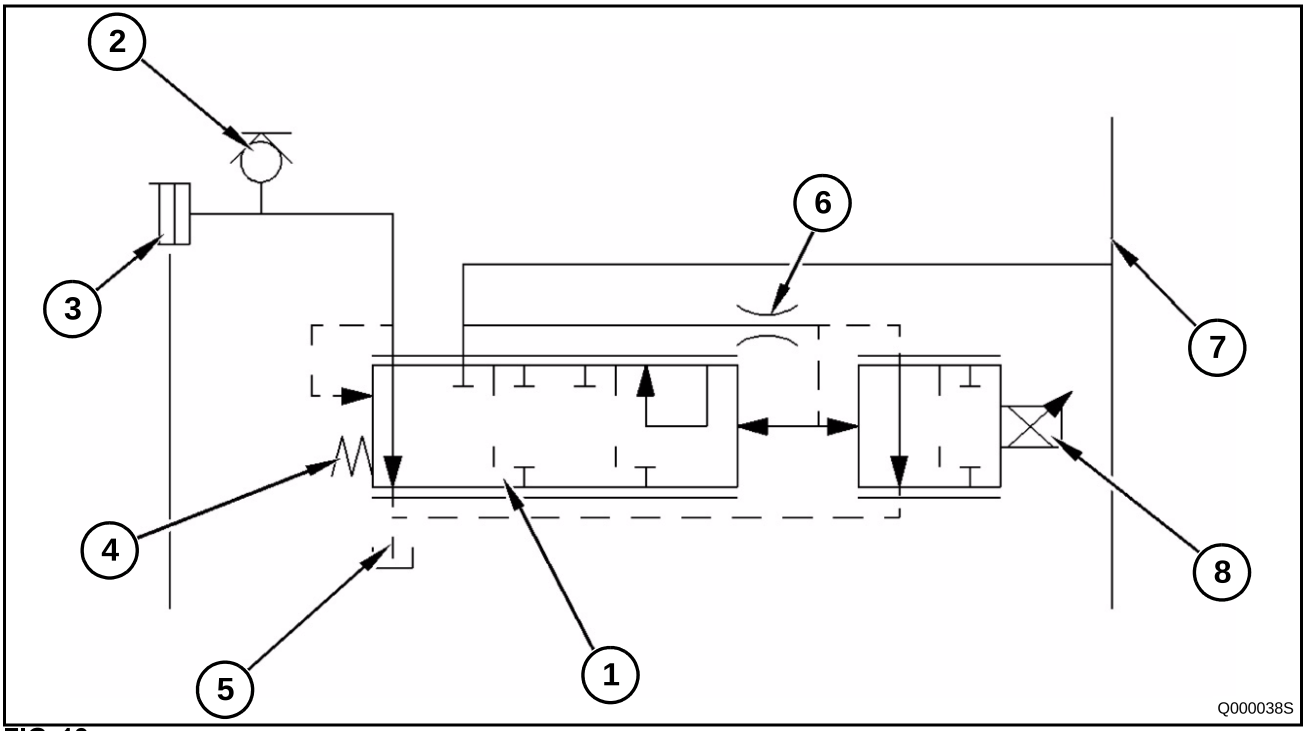



**FIG. 13**
Schematic of modulating valve (transmission)

1. Modulating Valve (Transmission);
2. Test Port;
3. Transmission Clutch;
4. Spring;
5. Line to Sump;
6. Spool Orifice;
7. Charge Pressure Oil;
8. Solenoid.

Modulating valve (1) is controlled by transmission electronic control module (ECM). The modulating valve is used by the transmission ECM to directly modulate the oil pressure that is sent to each of the nine individual transmission clutches.

When the operator selects a direction or when the operator selects a speed, the transmission ECM sends a pulse width modulated signals in order to vary the current to solenoid (8).

The distance that is travelled by the solenoid plunger is proportional to the electrical current that is sent to the solenoid. The position of the solenoid plunger controls the oil pressure the is sent to transmission clutch (3).

When the transmission ECM sends the maximum programmed current to the modulating valve, the pressure in the transmission clutch will be at the maximum desired pressure. When no current is sent to the modulating valve, the oil pressure in the transmission clutch will be zero.

## Install/Remove Solenoids

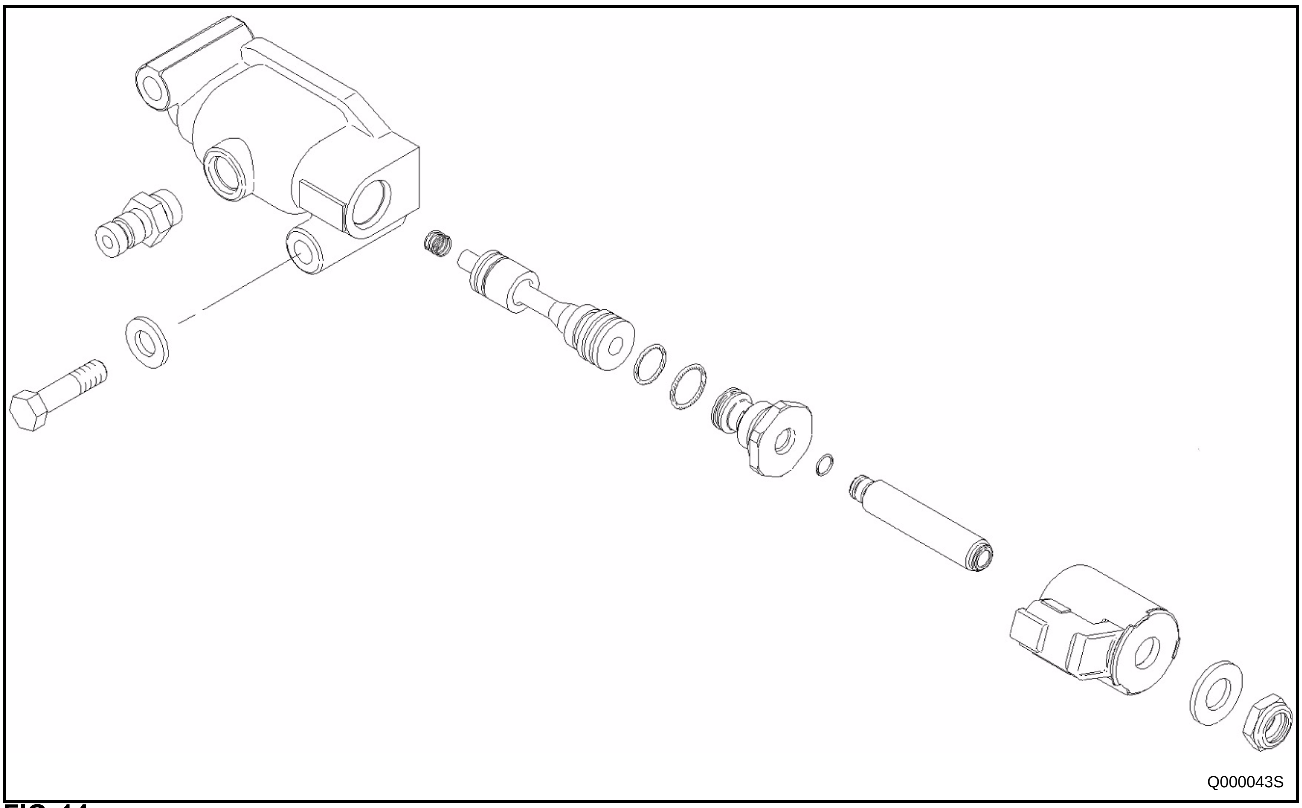



**FIG. 14**
Modulating Valve

Install Solenoids:

- Always use new O-rings;
- Lubricate the O-rings before installing;
- Replace if needed a new valve.

Remove Solenoids:

- Remove the electric connector;
- Unscrew the two bolts on the solenoid;

## Valve Port

**FIG. 15:** Bottom View of Modulating Valve

1. To Transmission Clutch;
2. Charge Pressure Oil;
3. To Transmission Clutch.

The figure shows the bottom view of the modulating valve. The bottom view shows the porting for the inlet and outlet flow of hydraulic oil.

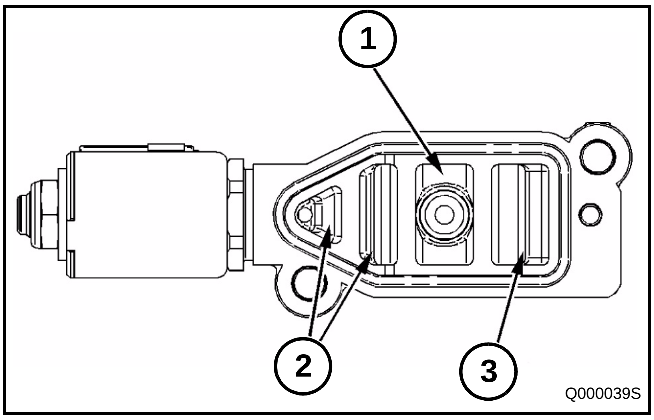



**FIG. 15**

## Valve Operation

There are three basic stages of the controlled operation of the modulating valve:

- No Signal Current;
- Partial Signal Current;
- Maximum Signal Current.

The operation of the modulating valve is not a simple on/off cycle. The transmission ECM varies the strength of the signal current through a programmed cycle in order to control the movement of the proportional solenoid valve spool.

### No Signal Current (Clutch Disengaged)

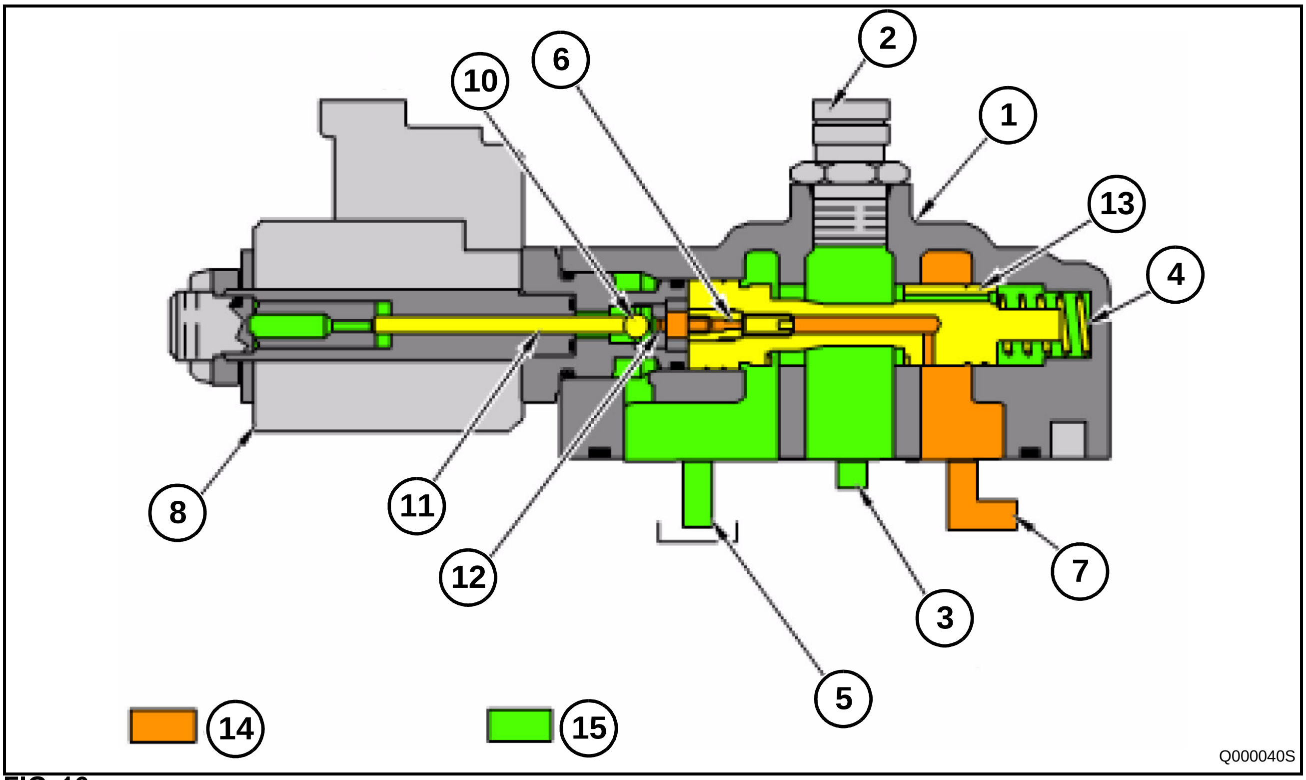



**FIG. 16**
Modulating Valve

1. Modulating Valve;
2. Test Port;
3. To Transmission Clutch;
4. Spring;
5. Line to Sump;
6. Spool Orifice;
7. Charge Pressure Oil;
8. To Transmission Clutch;
9. Solenoid;
10. Ball;
11. Valve Spool;
12. Drain Orifice;
13. Pin;
14. Charge Pressure;
15. Sump.

The transmission ECM controls the rate of oil flow through modulating valve (1) by changing the strength of the signal current to solenoid (9). When signal current is not being sent to the solenoid, the solenoid will be de-energized.

**Oil Flow in a De-energized Valve**

Spring (1) holds the valve spool to the left in the valve body.

The valve spool opens the passage between transmission clutch (3) and the sump.

The valve spool blocks the passage between the transmission clutch and the charge pressure oil. Consequently, pressurized oil flow is blocked to the transmission clutch.

Charge pressure oil (7) flows from the charge pump into the valve body and around valve spool (11).

The oil flows through the drilled passage that is in the valve spool and into spool orifice (6). The spool orifice in on the left side of the valve spool. The oil then flows onto drain orifice (12).

Because there is no force on pin (13), in order to hold ball (10) against the drain orifice, the oil flows through the valve spool. The oil flows through the drain orifice, around the ball and to sump (5).

Oil from the transmission clutch will drain into the sump. As a result, the transmission clutch in not engaged.

**Partial Signal Current (Modulation)**

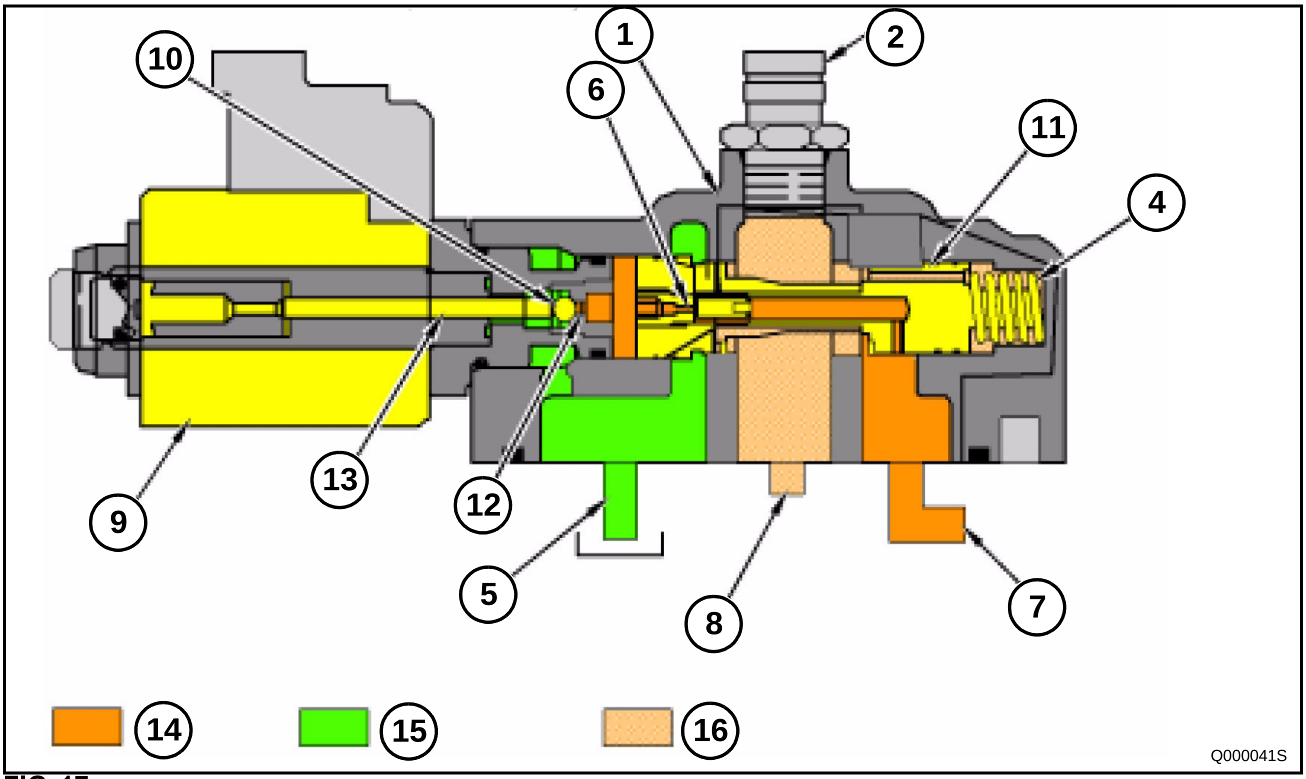



**FIG. 17**

Modulating Valve

1. Modulating Valve;
2. Test Port;
3. Clutch;
4. Spring;
5. Line to Sump;
6. Spool Orifice;
7. Charge Pressure Oil;
8. To Transmission Clutch;
9. Solenoid;
10. Ball;
11. Valve Spool;
12. Drain Orifice;
13. Pin;
14. Charge Pressure;
15. Sump;
16. 1st Charge Pressure Reduction.

The transmission ECM controls the signal current in order to modulate the flow of oil through modulating valve (1). When solenoid (9) receives less than maximum programmed signal current, the flow is modulated.

### Oil Flow in Valve with less than Maximum Signal Current

The engagement of transmission clutch (3) begins when the transmission ECM initially sends signal current in order to energize the solenoid.

The signal current creates a magnetic field around pin (13) which will cause the pin to move to the right against ball (10).

The force against the ball will be in proportion to the strength of the signal current from the transmission ECM.

The position of the ball against drain orifice (12) restrict the oil flow to sump (5). This partial restriction causes the pressure at the left end of valve spool (11) to increase.

The oil pressure moves the valve spool to the right against spring (4). The movement of the valve spool starts to open a passage on the right end of the valve spool. As a result, charge pressure oil (7) will start to fill the transmission clutch. Oil also begins to fill the chamber for the spring on the right end of the valve spool.

In the initial stage for filling the transmission clutch with oil, the transmission ECM sends a high pulse of current in order to quickly move the valve spool.

During this short period of time, the clutch piston will move in order to remove the clearances that are between the clutch discs and the plates. This will minimize the amount of time that is needed to fill the clutch.

The transmission ECM will then reduce the signal current which also reduce the pressure setting of the modulating valve. The change in signal current reduces the flow of oil to the transmission clutch.

When the plates and the discs start to touch each other, this is called the touch-up point. Once the touch-up point is obtained, the transmission ECM begins a controlled increase of the signal current in order to start the modulation cycle.

The increase in the signal current causes the ball and pin to further restrict the flow of oil through the drain orifice and to the sump. This causes a controlled movement of the valve spool to the right.

This movement of the valve spool allows the pressure to transmission clutch (3) to increase.

The modulating valve uses the variable signal current from the transmission ECM to vary the pressure output of the valve.

The sequence of partial engagement is called desired slippage. The clutches must slip a specific amount in order to provide smooth shifting. The desired slippage is controlled by the application program that is stored in the transmission ECM.

**Maximum Signal Current (Clutch Fully Engaged)**

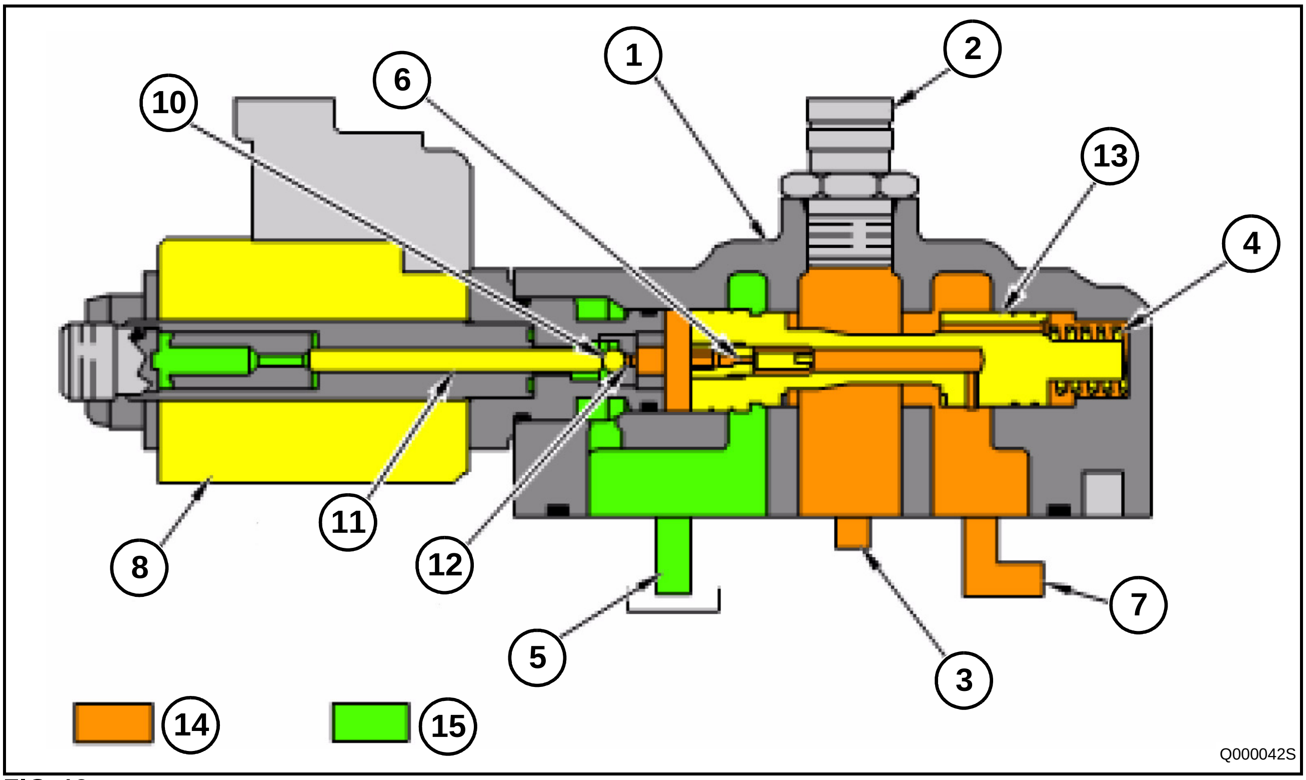



FIG. 18

Modulating Valve

1. Modulating Valve;
2. Test Port;
3. Clutch;
4. Spring;
5. Line to Sump;
6. Spool Orifice;
7. Charge Pressure Oil;
8. To Transmission Clutch;
9. Solenoid;
10. Ball;
11. Valve Spool;
12. Drain Orifice;
13. Pin;
14. Charge Pressure;
15. Sump;

When the modulation cycle stops, the transmission ECM will send the maximum specified signal current in order to fully engage the transmission.

The constant signal current pushes pin (11) firmly against ball (10) in modulating valve (1).

The force against the ball reduces the amount of oil flow through drain orifice (12). This restriction causes an increase in pressure on the left side of valve spool (13).

The valve spool moves to the right to allow the charge oil to fully engage the transmission clutch.

In a short period of time, maximum pressure is felt at both ends of the valve spool. This pressure and the additional force that is produced by spring (4) causes the valve spool to move to the left until the forces on the right end and the left end of the valve spool are balanced.

The movement of the valve spool to the left balanced position reduces the flow of oil to the engaged transmission clutch. The transmission ECM sends a constant maximum specified signal current to solenoid (8) in order to maintain the desired clutch pressure.

## TRANSMISSION CLUTCH ENGAGEMENT

Side view of transmission

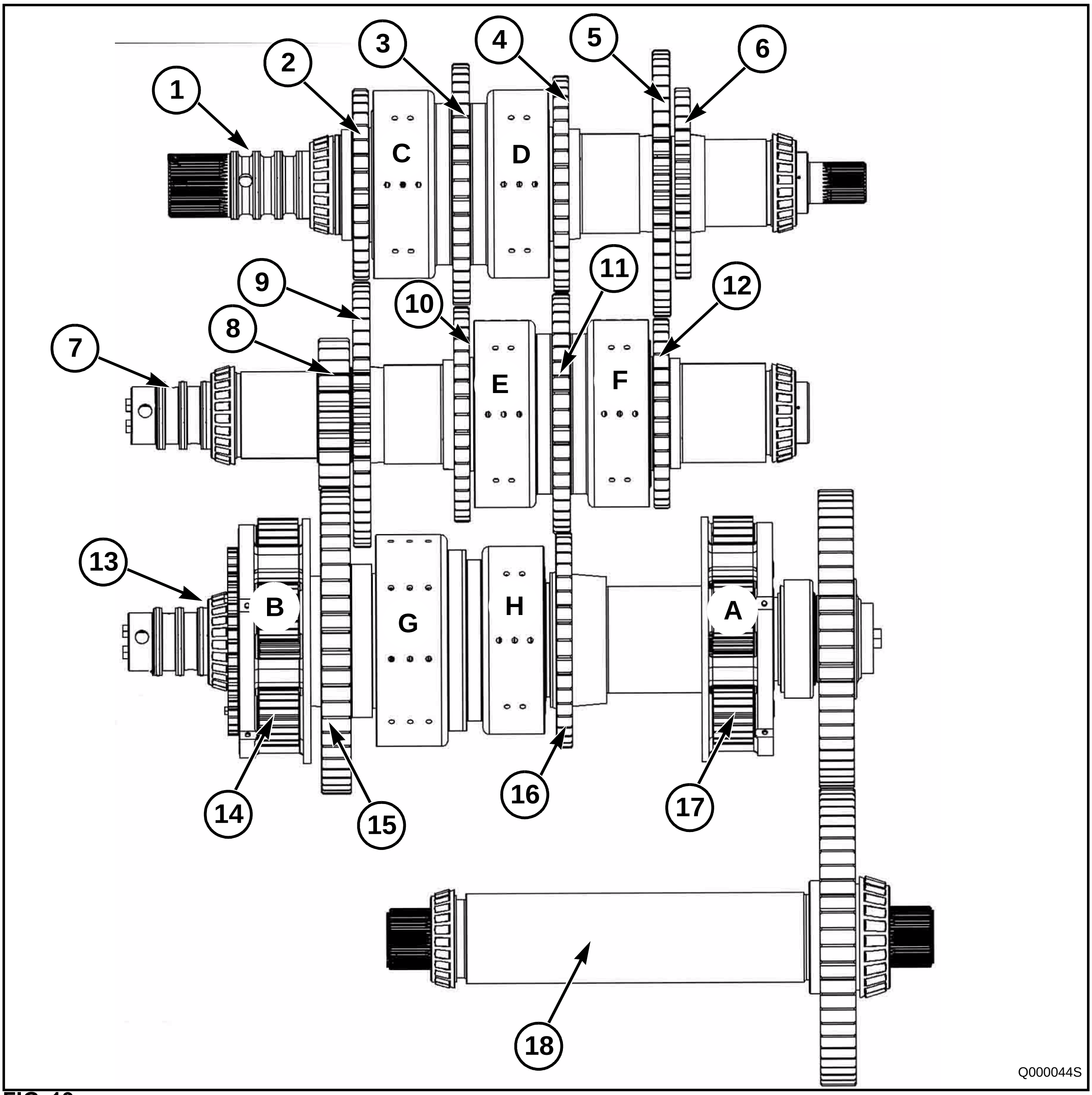



**FIG. 19**

1. Input Shaft
2. Gear;
3. Gear;
4. Gear;
5. Gear;
6. Gear;
7. Intermediate Shaft;
8. Gear;
9. Gear;
10. Gear;
11. Gear;
12. Gear;
13. Output Shaft;
14. Planetary Carrier;
15. Gear;
16. Gear;
17. Planetary Carries
18. Transfer Gear shaft;

A - B. Planetary Carries

C - H. Clutch Pack

Front view Transmission

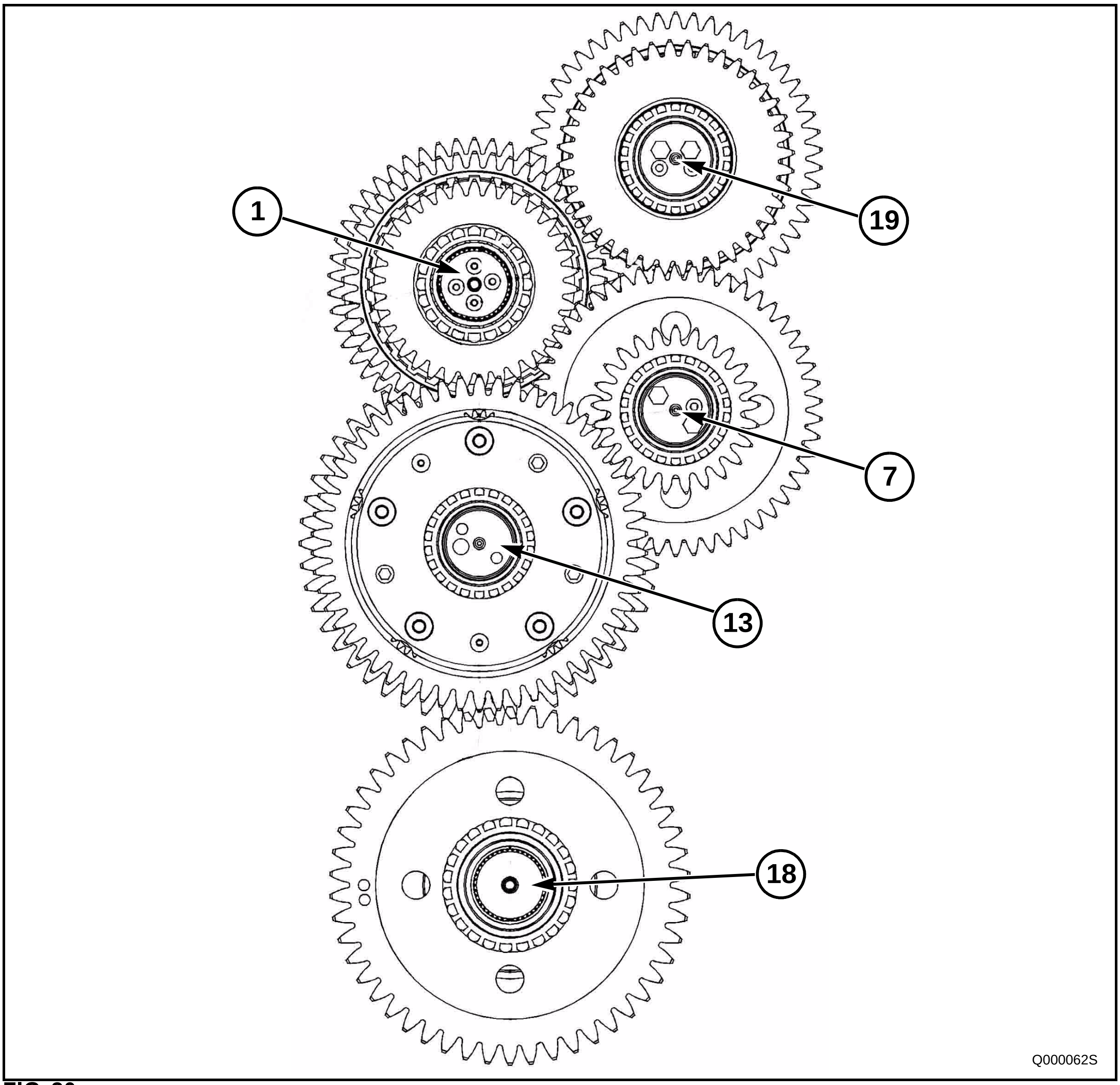



**FIG. 20**

1. Input Shaft;
7. Intermediate Shaft;
13. Ouput Shaft;
18. Transfer Shaft;
19. Reverse Shaft

Power flow for reverse gears only involves the clutches on the shaft:

- Reverse Shaft (19);
- Output Shaft (13).

The different solenoids resembles the different clutches. When a combination of solenoids is engaged, the specific gear will be set.

Each gear has its own combination of solenoids. No more than two clutches are engaged at the time. Also, no more than one clutch is engaged at the time on any shaft. The different combinations of solenoids is regulated by the TCU.

For the reverse gear, input shaft (1) is used only to transfer power flow through gear (10). For reverse gears, intermediate shaft (7) is used only to transfer power flow through gears (8), (11) and (15). This gear are permanently splinted to the shafts. The gears will always rotate with the shaft.

| Transmission Clutch Engagement Engine RPM at 2100 | | | | | |
|---|---|---|---|---|---|
| **Gear** | **Reverse Shaft** | **Input Shaft** | **Intermediate Shaft** | **Output Shaft** | **Reduction** |
| Third Gear (Reverse) | A | - | - | H | 3.857 |
| Second Gear (Reverse) | A | - | - | B | 4.343 |
| First Gear (Reverse) | A | - | - | G | 10.553 |
| Neutral | - | - | - | J | - |
| First Gear | - | C | - | G | 8.442 |
| Second Gear | - | D | - | G | 6.648 |
| Third Gear | - | - | E | G | 5.253 |
| Fourth Gear | - | - | F | G | 4.137 |
| Fifth Gear | - | C | - | B | 3.747 |
| Sixth Gear | - | C | - | H | 3.086 |
| Seventh Gear | - | D | - | B | 2.736 |
| Eighth Gear | - | D | - | H | 2.430 |
| Ninth Gear | - | - | E | B | 2.162 |
| Tenth Gear | - | - | E | H | 1.920 |
| Eleventh Gear | - | - | F | B | 1.702 |
| Twelfth Gear | - | - | F | H | 1.512 |
| Thirteenth Gear | - | C | - | J | 1.270 |
| Foureenth Gear | - | D | - | J | 1.000 |
| Fifteenth Gear | - | - | E | J | 0.790 |
| Sixteenth Gear | - | - | F | J | 0.622 |

# TESTING AND ADJUSTING

## RELIEF VALVE

**FIG. 1:**

**WARNING: Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this of injury.**

**Always use a board or cardboard when checking for a leak.**

**WARNING: Personal injury can result form hydraulic oil pressure and hot oil.**

**Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.**

**Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.**

*IMPORTANT: Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.*

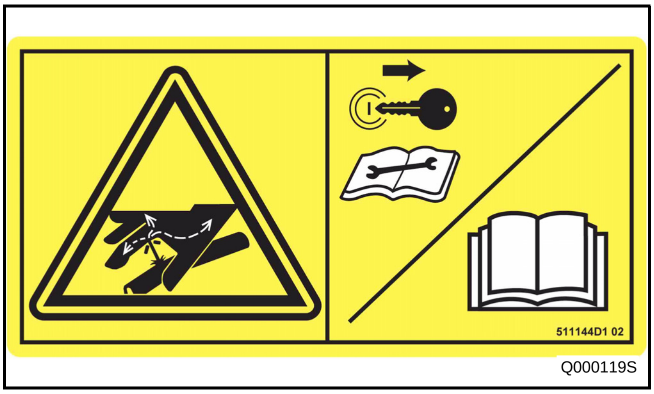



**FIG. 1**

## Introduction

The transmission hydraulic control relief valve regulates the pressure of the oil that is used to control the transmission system and the oil that is used for the torque converter.

## Required Tools

**FIG. 2:** The tool to check the oil pressure contains a:

- Pressure Gauge, to read the pressure;
- Fitting, to connect the pressure gauge to the hose;
- Quick Connect Coupler, to connect the pressure gauge to the transmission.
- Hose, to allow make a distance between pressure gauge and the measure point.

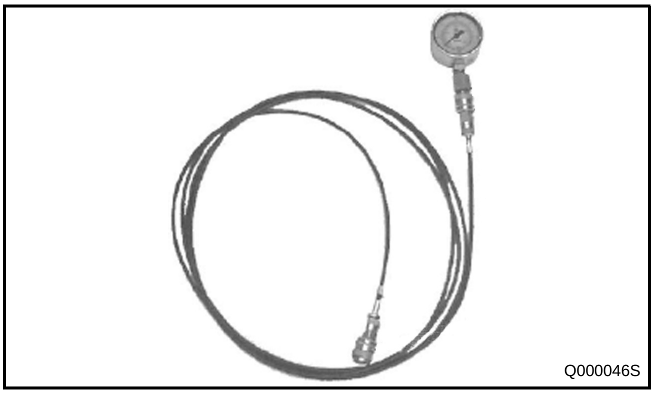



**FIG. 2**

## Testing Procedure

**FIG. 3:** Test port for the transmission hydraulic control.

The relief pressure for the transmission hydraulic control system can be measured at pressure tap (1) on the transmission hydraulic control relief valve.

1. Install tooling (A) on pressure tap (1);
2. Start the engine. Warm the oil until the oil reaches 60°C (140°F);
3. Operate the engine at high idle. Observe the pressure gauge. The relief pressure for the transmission hydraulic control must be within 2100 kPa (305 psi);
4. If the pressure is at the specified level, go to 5. If the pressure is not at the specified level, go to “Adjusting Procedure”;
5. Shut off the engine. Remove tooling (A) from pressure tap (1).

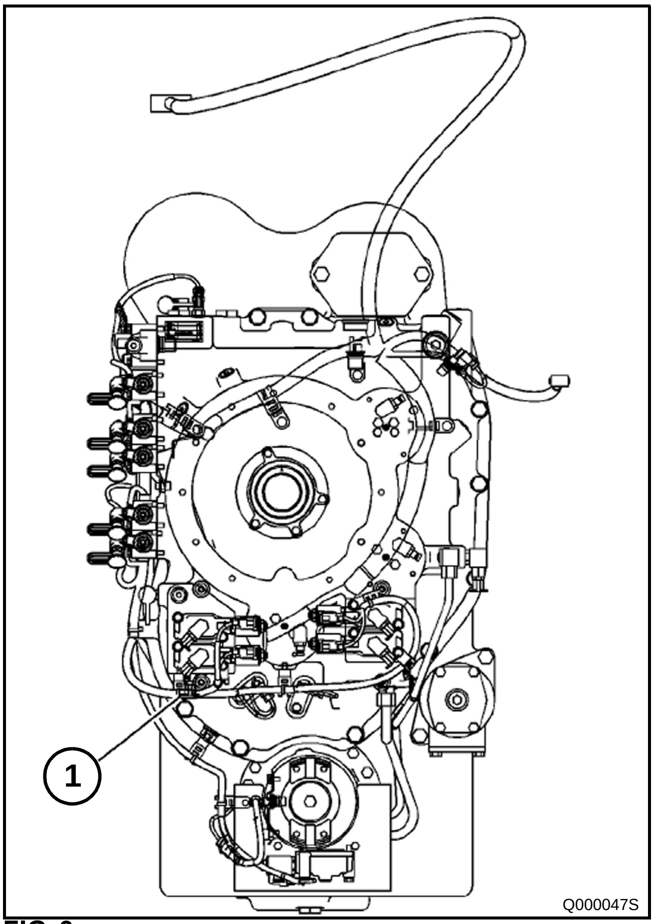



**FIG. 3**

## Adjusting Procedure

**FIG. 4:** Transmission hydraulic valve

The transmission hydraulic control relief valve can be adjusted by increasing or by decreasing the spring load (2).

1. Remove cap (3) from the end of the transmission hydraulic control relief valve;
2. Turn adjustment screw (4) in the appropriate direction;
3. Recheck the pressure at pressure tap (11). Tighten locknut (5) and replace cover (3).

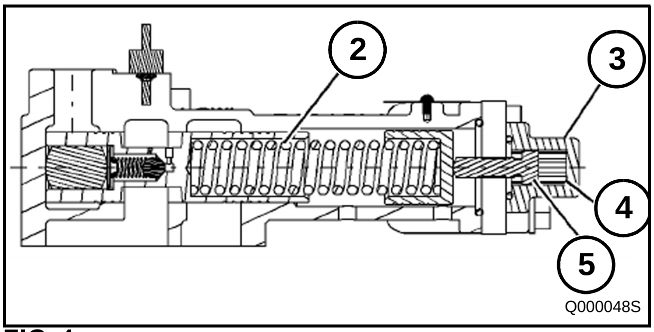



**FIG. 4**

## PRESSURE FOR TRANSMISSION LUBRICATION

**FIG. 5:**

**WARNING: Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this of injury.**

**Always use a board or cardboard when checking for a leak.**

**WARNING: Personal injury can result form hydraulic oil pressure and hot oil.**

**Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.**

**Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.**

*IMPORTANT: Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.*

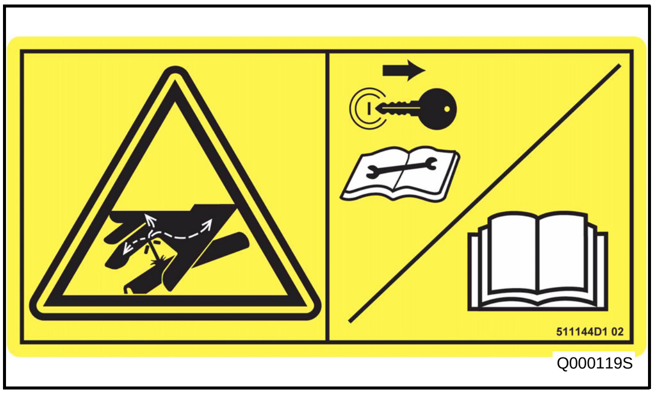



**FIG. 5**

### Introduction

This test will show the following conditions of the conditions exist:

- Oil pressure to the transmission lubrication circuit is good.
- The transmission lubrication relief valve is closed.

### Required Tools

**FIG. 6:** The tool to check the oil pressure contains a:

- Pressure Gauge, to read the pressure;
- Fitting, to connect the pressure gauge to the hose;
- Quick Connect Coupler, to connect the pressure gauge to the transmission.
- Hose, to allow make a distance between pressure gauge and the measure point.

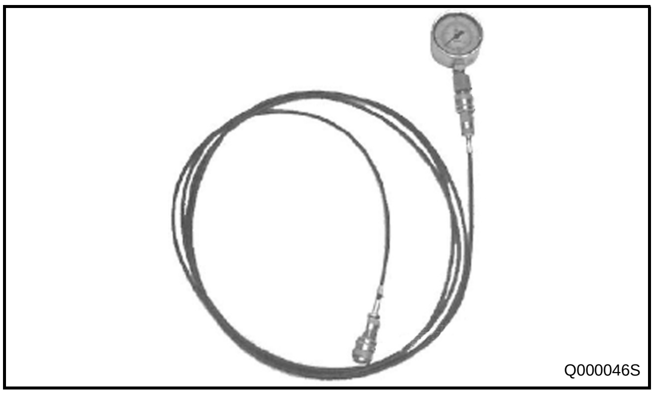



**FIG. 6**

## Test Procedure

**FIG. 7:** Pressure tap location for lubrication test.

Pressure gauges are used in the following test procedure.

1. Attach a coupler to the transmission lubrication pressure tap (1). If necessary, connect the pressure hose. Install a pressure gauge 400 kPa (58 psi) to the fitting.
2. Start the engine and warm the oil up to 60°C (140°F).
3. Run the engine at LOW idle rpm with the transmission control lever in the neutral position. The pressure on the gauge must be a minimum of 4 kPa (0.5 psi).
4. Run the engine at HIGH idle rpm with the transmission control lever in the neutral position. The pressure on the gauge must be 179 ± 27 kPa (26 ± 4 psi).
5. When the test is complete, stop the engine and remove the test equipment.

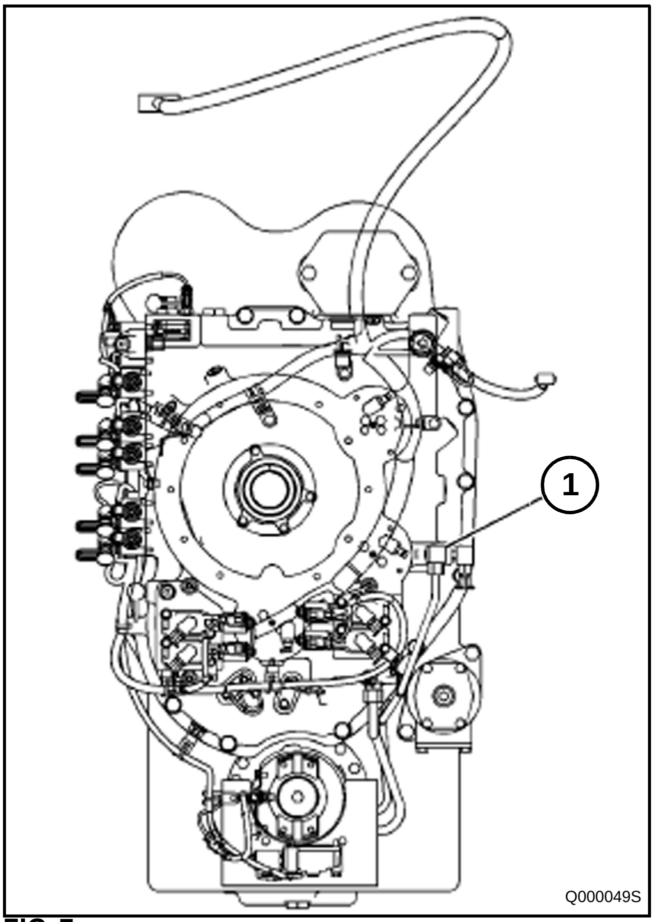



**FIG. 7**

## MODULATING VALVE

**FIG. 8:**

**WARNING: Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this of injury.**

**Always use a board or cardboard when checking for a leak.**

**WARNING: Personal injury can result form hydraulic oil pressure and hot oil.**

**Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.**

**Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.**

*IMPORTANT: Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.*

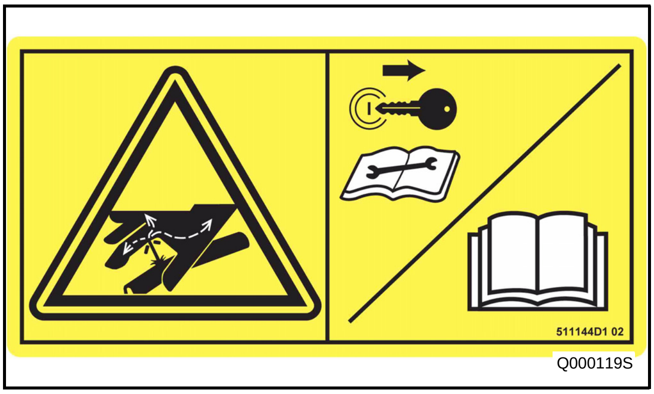



**FIG. 8**

### Introduction

The following test procedure will check the pressure of the charge oil that is being delivered from a modulating valve (transmission) to a transmission clutch. There are niin individual modulating valves that control the nine transmission cltuches. The modulating valves (transmission) are modulated. The modulation of these valves can be adjusted.

### Required Tools

**FIG. 9:** The tool to check the oil pressure contains a:

- Pressure Gauge, to read the pressure;
- Fitting, to connect the pressure gauge to the hose;
- Quick Connect Coupler, to connet the pressure gauge to the transmission.
- Hose, to allow make a distance between pressure gauge and the measure point.

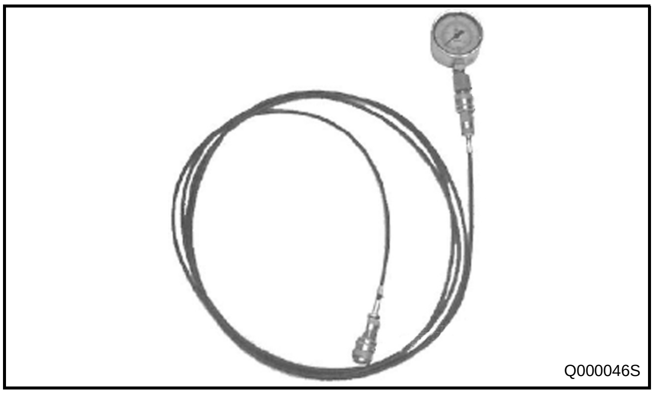



**FIG. 9**

## Test Procedure

**FIG. 10:** Transmission clutches

Pressure gauges are used in the following test procedure.

The designated letters are used to correlate a modulating valve to the corresponding transmission clutch, as shown.

1. Input Shaft;
2. Intermediate Shaft;
3. Output Shaft;
4. Transfer Gear shaft;
5. Reverse Shaft.

a. Clutch pack;
b. Planetary Carrier;
c. Clutch pack;
d. Clutch pack;
e. Clutch pack;
f. Clutch pack;
g. Planetary Carrier;
h. Clutch pack;
i. Clutch pack.

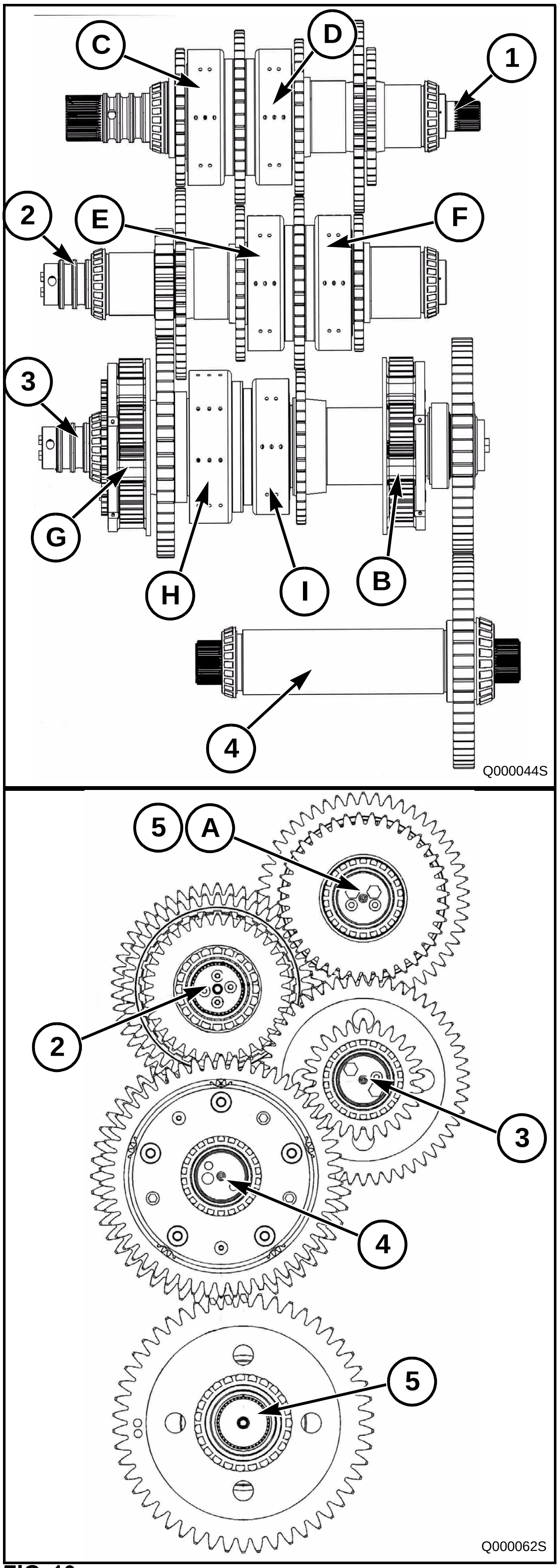



**FIG. 10**

**FIG. 11:** Modulating Valves

Each modulating valve has a designated letter, as shown. The letters have been cast into the transmission housing.

Log the clutch pressures in the table on the next page. There are always two clutches that are engaged for each gear selection. Neutral position only uses one clutch. See the table in order to determine the clutches that are engaged for gear selection.

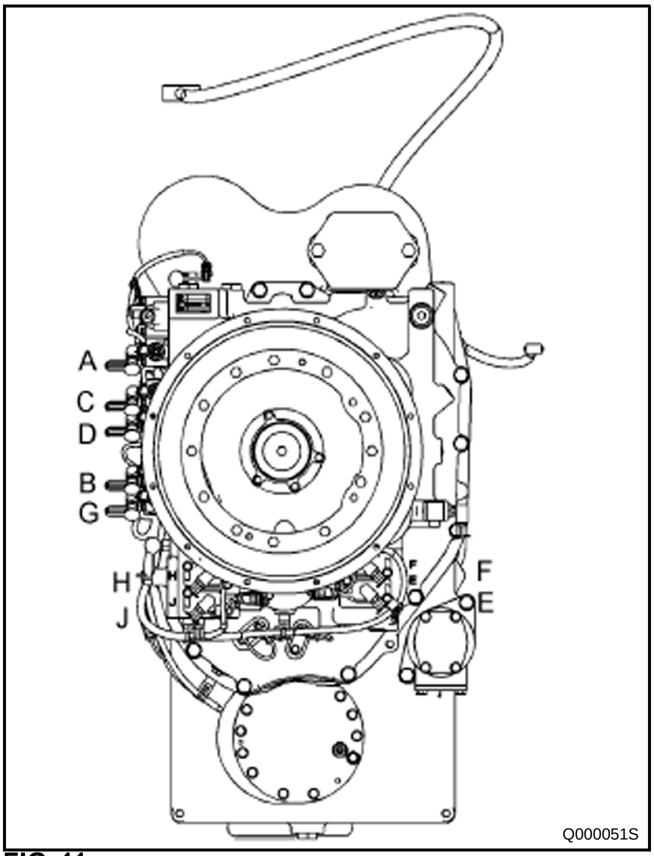



**FIG. 11**

| Checklist for Transmission Clutch Pressures | | | | |
|---|---|---|---|---|
| **Gear** | **Clutch or Valve** | **Pressure Measurement** | **Clutch or Valve** | **Pressure Measurement** |
| Third gear (reverse) | A | | H | |
| Second gear (reverse) | A | | B | |
| First gear (reverse) | A | | G | |
| Neutral | J | | - | |
| First gear | C | | G | |
| Second gear | D | | G | |
| Third gear | E | | G | |
| Fourth gear | F | | G | |
| Fifth gear | C | | B | |
| Sixth gear | C | | H | |
| Seventh gear | D | | B | |
| Eighth gear | D | | H | |
| Ninth gear | E | | B | |
| Tenth gear | E | | H | |
| Eleventh gear | F | | B | |
| Twelfth gear | F | | H | |
| Thirteenth gear | C | | J | |
| Foureenth gear | D | | J | |
| Fifteenth gear | E | | J | |
| Sixteenth gear | F | | J | |

1. Make sure that the transmission control lever is in the park brake position.
2. Warm the oil to a minimum temperature of 60°C (140°F).

*NOTE: Third gear that uses clutches E and G is shown in the following test:*

3. Connect one end of tooling (A) to the test port on valve E. Connect one end of a second tooling (A) to the test port on valve G.
4. Operate the transmission in third gear at high idle.
5. Observe the pressure that is being delivered to transmission clutches E and G. Use the table above (or a copy of that table) to write down the measurement.
6. Stop the engine.
7. Repeat steps 3 through 6 for the remaining reverse gears and forward gears. Use the table in order to determined the combination of modulating valves that are being engaged for each gear.
8. Compare the pressure measurements from all of the transmission clutches. The pressure measurement should be within 2100 ± 35 kPa (305 ± 5 psi).
9. Remove tooling (A).
10. Stop the engine.
11. If the pressure is not within the specified limits, check the pressure that is being delivered by the relief valve (charge pressure).

## HYDRAULIC OIL COOLER

**FIG. 12:**

**WARNING: Escaping fluid under pressure, even a pinhole size leak, can penetrate body tissue, causing serious injury, and possible death. If fluid is injected into your skin, it must be treated immediately by a doctor familiar with this of injury.**

**Always use a board or cardboard when checking for a leak.**

**WARNING: Personal injury can result form hydraulic oil pressure and hot oil.**

**Hydraulic oil pressure can remain in the hydraulic system after the engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on the hydraulic system.**

**Make sure all of the attachments have been lowered, oil is cool before removing any components or lines. Remove the oil filler cap only when the engine is stopped, and the filler cap is cool enough to touch with your bare hand.**

*IMPORTANT: Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.*

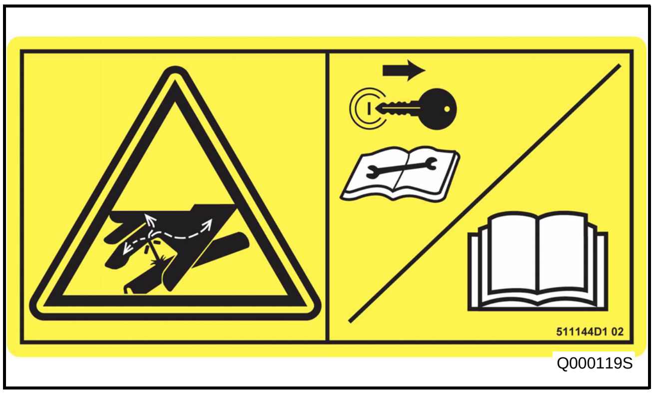



**FIG. 12**

### Introduction

The following test procedure will check the pressure of the oil that returns the hydraulic oil cooler.

### Required Tools

**FIG. 13:** The tool to check the oil pressure contains a:

- Pressure Gauge, to read the pressure;
- Fitting, to connect the pressure gauge to the hose;
- Quick Connect Coupler, to connet the pressure gauge to the transmission.
- Hose As, to allow make a distance between pressure gauge and the measure point.

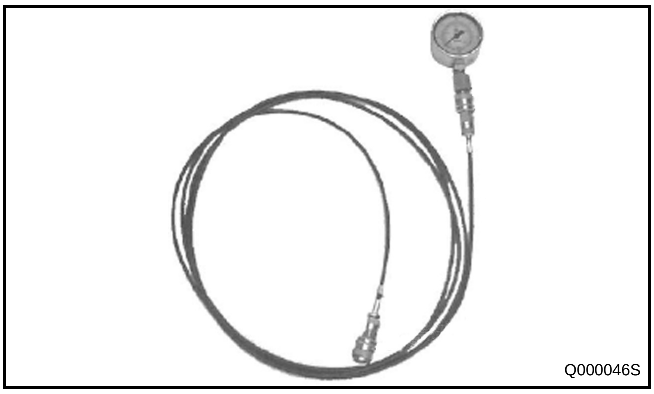



**FIG. 13**

## Test Procedure

**FIG. 14:** Pressure tap location for the hydraulic cooler return oil.

1. Warm the oil to a minimum temperature of 60°C (140°F).
2. Connect tooling (A) to test port (1).
3. Start the engine. Run the engine at high idle.
4. Make sure that the temperature of the hydraulic oil is at least 60°C (140°F). Record the pressure of the hydraulic oil that is coming from the hydraulic oil cooler. The pressure of the oil that is returning from the hydraulic oil cooler should be 520 kPa (75 psi).
5. Remove tooling (A) from test port (1).
6. Stop engine.

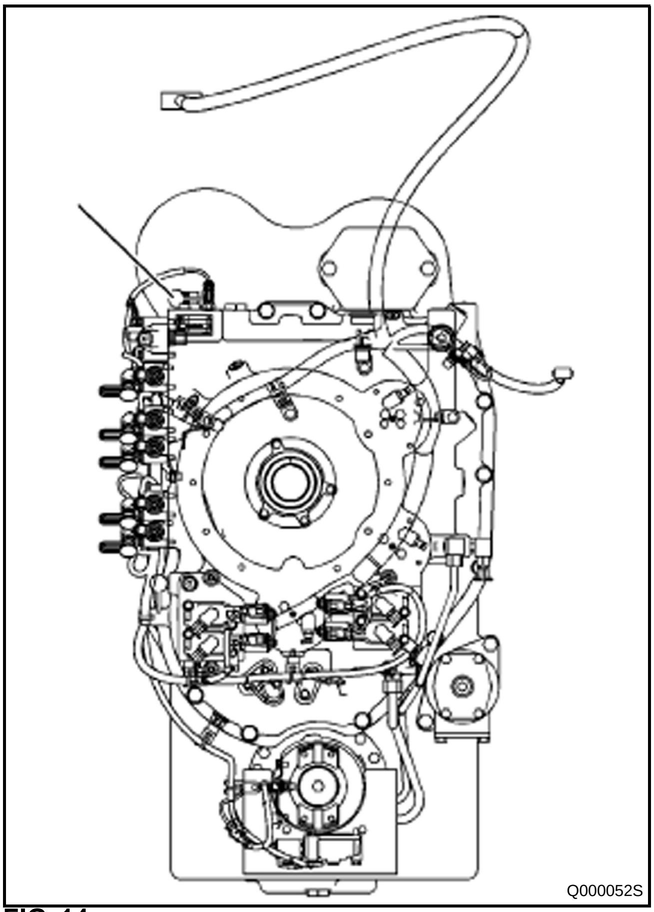



**FIG. 14**

# TRANSMISSION TROUBLESHOOTING

## GENERAL TROUBLESHOOTING INFORMATION

When you are attempting to define a problem with the transmission, it is necessary to perform the procedures that are contained in this section.

If a problem is encountered with the planetary transmission, recalibrate the transmission prior to proceeding with investigations.

A visual inspection of the system must be carried out in order to eliminate many of the less complex problems.

Upon completion of a visual inspection, if the cause of the problem has not been diagnosed, carry out operational checks of the system.

If both visual inspection and operational checks have been carried out and there is still no clear indication of the cause of the problem. Then it will be necessary to refer to the troubleshooting procedures and the test procedures that are contained in the engine service manual.

Troubleshooting a system such as the transmission is a complex operation. Refer to the various troubleshooting sections in this manual for specific routines for troubleshooting.

This list of possible problems and possible corrections will only, provide an indication of the location of a problem and the repairs that are required. It is important to remember that a problem is not necessarily caused by a single part, but by the relation of one part to a number of other parts. This information cannot provide all the possible problems and corrections. It is necessary for service personnel to define the problem. Any repairs may then be carried out.

## TROUBLESHOOTING

When a error is active for more than 3 seconds, it will automatically appear as a code in the transmission display. Error code will disappear when the error is not active anymore. The error code will be stored in the ECU and in the TCU

When errors are shown, first check for visible malfunctions. For example, broken or loosen connectors or incorrect battery voltage.

When you cannot find the problem, find the error code in the display and search the explanation in this manual or in the recommend manual.

Complete explanation overview of the functions and troubleshooting of the gearbox can be found the CAT manuals.

### Visual Inspection

Perform a visual inspection at the beginning of troubleshooting a problem. Perform the inspection while the engine is turned off. Put the transmission control in the NEUTRAL position and engage the park brake.

**FIG. 1:**

**WARNING: Never check for leaks in the hydraulic system with your hands. Hydraulic fluids under pressure can cause cuts, burns, eye injuries or skin irritations. Therefore never use your hands for finding leaks in lines, always use a piece of cardboard.**

1. Check for leaks.

   Inspect all oil, hoses and connections for damage or for leaks.

*NOTE: If oil can leak out of a fitting or a connection, air can leak into the system. Air in the system can be as bad as a low amount of oil.*

2. Check the electrical system.

   Inspect the harnesses, the electrical connectors and the fuse(s) for the ECM. Refer to electrical schematic.

   With the engine start switch and the battery disconnect switch in the OFF position. Check the 20 ampere fuse for the Electronic Control Module. If the fuse is open, replace the fuse.

   Inspect the electrical harnesses for damaged wires or for broken wires. Disconnect each connector and look for pins and socket that have been bent, broken or removed. Look for any foreign material inside the connectors. The connectors must be tightened with normal force. The connectors must be disconnected with the same amount of force.

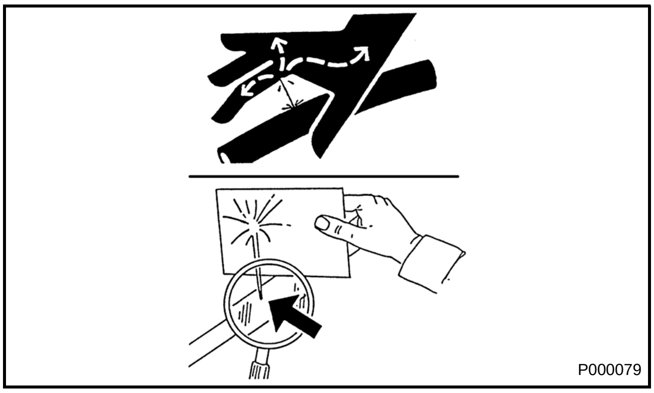



**FIG. 1**

## Operational Checks

Operate the transmission in each direction and in speeds. Check that the transmission is operating correctly in all functions. If the transmission is not operating correctly refer to the troubleshooting information that is contained in the Engine service manual. Use in the Engine service manual the troubleshooting information in order to investigate the problem.

The checks for troubleshooting that are included in this manual are designed to guide service personnel in a correct troubleshooting procedure. The checks and procedures are set sequence in order to find problems and causes quickly.

The checks for troubleshooting should be carried out in order. Do not proceed to the next check until the current check has been carried out fully. If the correct result for the check is found, go directly to the next check.

Take note of all warnings and notices in these checks. You must read the warnings and the notices before you start a check. before carrying out a procedure, it is important to read the procedure thoroughly.

The checks that follow can be used to find many of the problems that may occur during the operation of the machine. The checks that follow can also give an indication of the system that has the problem.

## ERROR CODES

*NOTE: For the complete explanation of the error code, see the troubleshooting manual of the transmission (TA 19 KENR 6678).*

*NOTE: For the complete troubleshooting maunal (TA 19 KENR 6678) see end of this chapter.*

### Error Codes 100 - 699

| Codes | Description | Possible Cause |
|---|---|---|
| 117-2 | Parking brake pressure switch inputs incorrect. | The signal circuit for sensor has failed. |
| 126-16 | Transmission filter plugged. | Filter not renewed on time. |
| 127-1 | Low transmission oil pressure warning. | Leakage on transmission. |
| 127-3 | Transmission oil pressure open circuited short to positive terminal of the battery. | The signal for the sensor is open.<br>The signal circuit for the sensor is shorted to the + battery circuit.<br>The sensor has failed.<br>The power circuit or the ground circuit has failed.<br>The ECM has failed. This is unlikely |
| 127-4 | Transmission oil pressure sensor short to ground. | The signal circuit for the sensor is shorted to ground.<br>The sensor has failed.<br>The ECM has failed. This is unlikely |
| 161-2 | Transmission input speed sensor signal erratic. | The sensor has failed.<br>Intermittent connections or poor connections.<br>Mechanical devices are loose.<br>The ECM has failed. This is unlikely. |
| 177-0 | High transmission oil temperature shutdown. | To lowe oil level. |
| 177-3 | Transmission oil temperature sensor open circuit/short to positive terminal of the battery. | The transmission oil temperature is too high.<br>The signal circuit for the sensor is open.<br>The signal circuit for the sensor is shorted to a higher voltage.<br>The sensor has failed.<br>The power circuit or the ground circuit has failed.<br>The ECM has failed. This is unlikely. |
| 191-12 | Transmission output speed sensor #1 bad component. | Sensor or cable failure. |
| 191-16 | Transmission over speed. | |
| 525-0 | Transmission lever position sensor signal out of range high. | The sensor has failed.<br>The signal circuit of the sensor is shorted to the + battery circuit.<br>The sensor needs to be calibrated/<br>The ECM has failed. This is unlikely. |

| Codes | Description | Possible Cause |
|---|---|---|
| 525-1 | Transmission lever position sensor signal out of range low. | The position sensor has failed. |
| | | The signal circuit of the sensor is shorted to the ground |
| | | The sensor needs to be calibrated. |
| | | The ECM has failed. This in unlikely. |
| 525-8 | Transmission lever position sensor signal abnormal. | The sensor has failed. |
| | | Intermittent connections or poor connections. |
| | | Mechanical devices are loose. |
| | | The ECM has failed. This is unlikely |
| 625-9 | Engine not cummunicating with transmission ECM on CAT Date Link. | Poor electrical connection at a machine harness connector. |
| | | The circuit for the CAT Data Link in the machine harness is shorted to ground. |
| | | The circuit for the CAT Data Link in the machine harness is shorted to the + battery. |
| | | The circuit for CAT Data Link in the machine harness in open. |
| 639-9 | J1939 data link not communicating. | Broken fuse or wire. |

## Error Codes 699 - 999

| Codes | Description | Possible Cause |
|---|---|---|
| 701-3 | Transmission clutch #9 solenoid short to positive terminal of the battery. | The solenoid has failed. |
| | | The energize circuit of the solenoid is shorted to the + battery circuit. |
| | | The ECM has failed. This unlikely. |
| 701-5 | Transmission clutch #9 solenoid open circuit. | The energize circuit of the solenoid is open. |
| | | The return circuit of the solenoid is open. |
| | | The solenoid has failed. |
| | | The ECM has failed. This is unlikely. |
| 701-6 | Transmission clutch #9 short to ground. | The energize circuit of the solenoid is shorted to ground. |
| | | The solenoid has failed. |
| | | The ECM has failed. This is unlikely |
| 702-2 | Inching pedal switch inputs incorrect. | Poteniometer broken. |
| 703-0 | Inching pedal position sensor signal out of range high. | The sensor has failed. |
| | | The signal circuit of the sensor is shorted to the + battery circuit. |
| | | The sensor needs to be calibrated. |
| | | The ECM has failed. This in unlikely. |

| Codes | Description | Possible Cause |
|---|---|---|
| 703-1 | Inching pedal position sensor signal out of range low. | The position sensor has failed.<br><br>The signal circuit of the sensor is shorted to the ground.<br><br>The sensor needs to be calibrated.<br><br>The ECM has failed. This is unlikely |
| 703-8 | Inching pedal position sensor signal abnormaal. | The sensor has failed.<br><br>Intermittent connections or poor connections.<br><br>Mechanical devices are loose.<br><br>The ECM has failed. This is unlikely. |
| 704-12 | Transmission output speed sensor #2 bad component. | Sensor failure |
| 705-2 | Headland auto shift switch-set gear switch incorrect. | An open circuit exists.<br><br>The ECM has failed. This is unlikely. |
| 706-2 | Front / All wheel drive switch. | There is an open wire of a grounded wire between 823-GN and the ECM.<br><br>There is an open wire or a grounded wire between 718-BU and the ECM.<br><br>The switch has failed.<br><br>The ECM has failed. This is unlikely. |
| 734-3 | Transmission clutch #1 solenoid short to positive terminal of the battery. | The solenoid has failed.<br><br>The energize circuit of the solenoid is shorted to the + battery circuit.<br><br>The ECM has failed. This is unlikely. |
| 734-5 | Transmission clutch #1 solenoid open circuit. | The energize circuit of the solenoid is open.<br><br>The return circuit of the solenoid is open.<br><br>The solenoid has failed.<br><br>The ECM has failed. This is unlikely. |
| 734-6 | Transmission clutch #1 solenoid short to ground. | The energize circuit of the solenoid is shorted to ground.<br><br>The solenoid has failed.<br><br>The ECM has failed. This is unlikely. |
| 735-3 | Transmission clutch #2 solenoid short to positive terminal of the battery. | The solenoid has failed.<br><br>The energize circuit of the solenoid is shorted to the + battery circuit.<br><br>The ECM has failed. This in unlikely. |
| 735-5 | Transmission clutch #2 solenoid open circuit. | The energize circuit of the solenoid is open.<br><br>The return circuit of the solenoid is open.<br><br>The solenoid has failed.<br><br>The ECM has failed. This unlikely. |

| Codes | Description | Possible Cause |
|---|---|---|
| 735-6 | Transmission clutch #2 solenoid short to ground. | The energize circuit of the solenoid is shorted to ground.<br>The solenoid has failed.<br>The ECM has failed. This in unlikely. |
| 736-3 | Transmission clutch #3 solenoid short to positive terminal of the battery. | The solenoid has failed.<br>The energize circuit of the solenoid is shorted to the + battery circuit.<br>The ECM has failed. This is unlikely. |
| 736-5 | Transmission clutch #3 solenoid open circuit. | The energize circuit of the solenoid is open.<br>the return circuit of the solenoid is open.<br>The solenoid has failed.<br>The ECM has failed. This is unlikely. |
| 736-6 | Transmission clutch #3 solenoid short to ground. | The energize circuit of the solenoid is shorted to ground.<br>The solenoid has failed.<br>The ECM has failed. This unlikely. |
| 737-3 | Transmission clutch #4 solenoid short to positive terminal of the battery. | The solenoid has failed.<br>The energize circuit of the solenoid is shorted to the + battery circuit.<br>The ECM has failed. This is unlikely. |
| 737-5 | Transmission clutch #4 solenoid open circuit. | The energize circuit of the solenoid is open.<br>The return circuit of the solenoid is open.<br>The solenoid has failed.<br>The ECM has failed. This is unlikely. |
| 737-6 | Transmission clutch #4 solenoid short to ground. | The energize circuit of the solenoid is shorted to ground.<br>The solenoid has failed.<br>The ECM has failed. This is unlikely. |
| 738-3 | Transmission clutch #5 solenoid short to positive terminal of the battery. | The solenoid has failed.<br>The energize circuit of the solenoid is shorted to the + battery circuit.<br>The ECM has failed. This is unlikely. |
| 738-5 | Transmission clutch #5 solenoid open circuit. | The energize circuit of the solenoid is open.<br>The return circuit of the solenoid is open.<br>The solenoid has failed.<br>The ECM has failed. This is unlikely. |
| 738-6 | Transmission clutch #5 solenoid short to ground. | The energize circuit of the solenoid is shorted to ground.<br>The solenoid has failed.<br>The ECM has failed. This unlikely. |

| Codes | Description | Possible Cause |
|---|---|---|
| 739-3 | Transmission clutch #6 solenoid short to positive terminal of the battery. | The solenoid has failed.<br><br>The energize circuit of the solenoid is shorted to the + battery circuit.<br><br>The ECM has failed. This is unlikely. |
| 739-5 | Transmission clutch #6 solenoid open circuit. | The energize circuit of the solenoid is open.<br><br>The return circuit of the solenoid is open.<br><br>The solenoid has failed.<br><br>The ECM has failed. This is unlikely. |
| 739-6 | Transmission clutch #6 solenoid short to ground. | The energize circuit of the solenoid is shorted to ground.<br><br>The solenoid has failed.<br><br>The ECM has failed. This is unlikely. |
| 774-2 | Up shift switch inputs incorrect. | Failure in the switch |
| 775-2 | Down shift inputs incorrect. | Failure in the switch |

## Error Codes 1000 - 2999

| Codes | Description | Possible Cause |
|---|---|---|
| 1079-0 | 5 Volt sensor power supply above normal. | The supply circuit (wire R977-OR) is shorted to the + battery circuit in the machine harness.<br><br>The ECM has failed. This in unlikely. |
| 1079-1 | 5 Volt sensor power supply below normal. | The supply circuit (wire R977-OR) is shorted to the ground circuit in the machine harness.<br><br>The ECM failed. This is unlikely. |
| 1079-3 | 5 Volt sensor power supply short to positive terminal of the battery. | +5 DCV (wire R977-OR) is shorted to the + battery circuit in the machine harness.<br><br>The ECM has failed. This is unlikely. |
| 1079-4 | 5 Volt sensor power supply short to ground. | +5 DCV (wire R977-OR) is shorted to the + battery circuit in the machine harness.<br><br>The ECM has failed. This is unlikely. |
| 1084-12 | Front wheel drive transmission output speed bad component. | Failure in the sensor. |
| 1542-0 | 10 Volt sensor power supply above normal. | The +10 VDC is shorted to the +battery circuit.<br><br>The ECM has failed. This is unlikely. |
| 1542-1 | 10 Volt sensor power supply below normal. | 10 VDC is shorted to ground between the sensor and the ECM.<br><br>The ECM has failed. This is unlikely |
| 1619-3 | Backup alarm relay short to the positive terminal of the battery. | The relay has failed.<br><br>The energize circuit of the relay is shorted to the + battery circuit.<br><br>The ECM has failed. This is unlikely. |

| Codes | Description | Possible Cause |
|---|---|---|
| 1619-5 | Backup alarm relay open circuit. | The energize circuit of the relay is open.<br>The return circuit of the relay is open.<br>The relay has failed.<br>The ECM has failed. This in unlikely. |
| 1619-6 | Backup alarm relay short to ground. | The energize circuit of the relay is shorted to ground.<br>The relay has failed.<br>The ECM has failed. This is unlikely. |
| 1666-2 | Auto/Manual shift switch incorrect. | There is an open wire or a grounded wire between F907-GN and the ECM.<br>There is an open or a grounded wire between F908-PU and the ECM.<br>The switch has failed.<br>The ECM has failed. This is unlikely. |
| 1675-3 | Starter relay short to the positive terminal of the battery. | The relay has failed.<br>The energize circuit of the relay is shorted to the + battery circuit.<br>The ECM has failed. This is unlikely. |
| 1675-5 | Starter relay open circuit. | The energize circuit of the relay is open.<br>The return circuit of the relay is open.<br>The relay has failed.<br>The ECM has failed. This is unlikely. |
| 1675-6 | Starter relay short to ground. | The energize circuit of the relay is shorted to ground.<br>The relay has failed.<br>The ECM has failed. This is unlikely. |
| 2612-3 | Front wheel drive actuator solenoid short to the positive terminal of the battery. | The solenoid has failed.<br>The energize circuit of the solenoid is shorted to the + battery circuit.<br>The ECM has failed. This is unlikely. |
| 2612-5 | Front wheel drive actuator solenoid open circuit. | The energize circuit of the solenoid is open.<br>The return circuit of the solenoid is open.<br>The solenoid has failed.<br>The ECM has failed. This is unlikely. |
| 2612-6 | Front wheel drive actuator solenoid short to ground | The energize circuit of the solenoid is shorted to ground.<br>The solenoid has failed.<br>The ECM has failed. This is unlikely. |
| 2905-3 | Transmission clutch #7 solenoid short to the positive terminal of the battery. | The solenoid has failed.<br>The energize circuit of the solenoid is shorted to the + battery circuit.<br>The ECM has failed. This is unlikely. |

| Codes | Description | Possible Cause |
|---|---|---|
| 2905-5 | Transmission clutch #7 solenoid open circuit. | The energize circuit of the solenoid is open.<br>The return circuit of the solenoid is open.<br>The solenoid has failed.<br>The ECM has failed. This unlikely. |
| 2905-6 | Transmisson clutch #7 solenoid short to ground. | The energize circuit of the solenoid is shorted to ground.<br>The solenoid has failed.<br>The ECM has failed. This is unlikely. |
| 2906-3 | Transmission clutch #8 solenoid short to positive terminal of the battery. | The solenoid has failed.<br>The energize circuit of the solenoid is shorted to the + battery circuit.<br>The ECM has failed. This is unlikely. |
| 2906-5 | Transmission clutch #8 solenoid open circuit. | The energize circuit of solenoid is open.<br>The return circuit of the solenoid is open.<br>The solenoid has failed.<br>The ECM has failed. This is unlikely. |
| 2906-6 | Transmisson clutch #8 solenoid short to ground. | The energize circuit of the solenoid is shorted to ground.<br>The solenoid has failed.<br>The ECM has failed. This is unlikely. |

# DISASSEMBLY AND ASSEMBLY

## GENERAL

Park the chassis on hard, level surface and block the wheels.

Drain transmission fluid into suitable container.

*IMPORTANT: It is extremely important to work in clean environment when working with hydraulic systems.*

*NOTE: Be prepared to collect and contain all fluids in an approved container.*

**WARNING: The transmission is extremely heavy. Care should be used while lowering the transmission with the come-along.**

## CAB TIPPING OVER

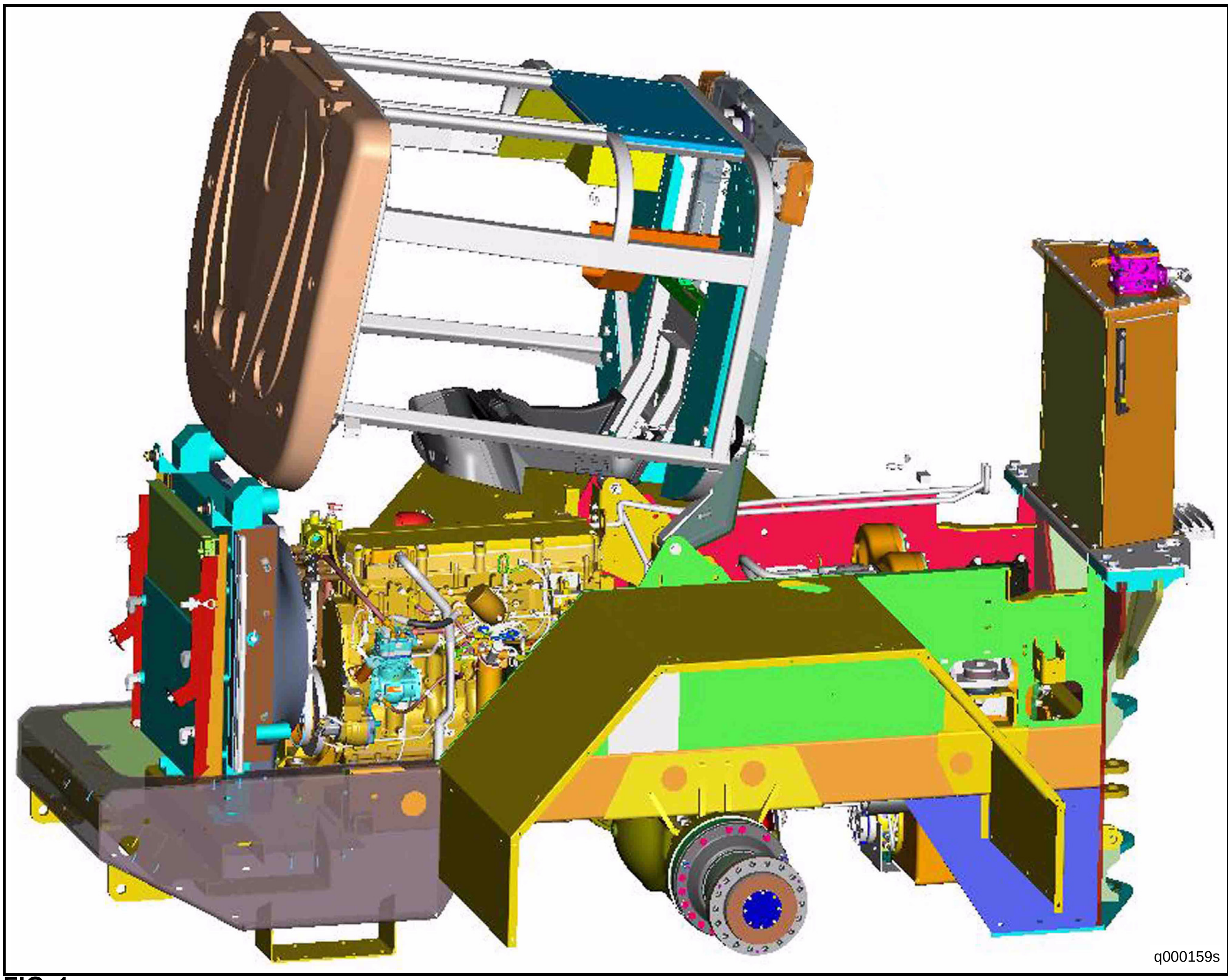



**FIG. 1**

To make complete acces to the transmission. The cab must be tiped over almost 90°.

## Tipping Over

1. Remove the side panels, complete bonnet and bonnetframe;
2. Remove the cooler supports above the engine;
3. Remove all loose objects inside the cab.

*IMPORTANT: Loose objects insde the cab can cause damage during tipping over the cab.*

4. Take the lock pin with retainer out of his locking position underneath the cab. And place the lock pin on the left platform, near the rotating point of the cabin;
5. Bend the tube of the wind washer fluid, so no fluid can come out of the reservoir.

**FIG. 2:** Cab tip over pump

6. Close the knob (1) on the handpump (CW);
7. Place pump lever (2) in the pump and pump up the cab. While pumping up the cab suspension lock (4) will be automatically opened for tipping over;

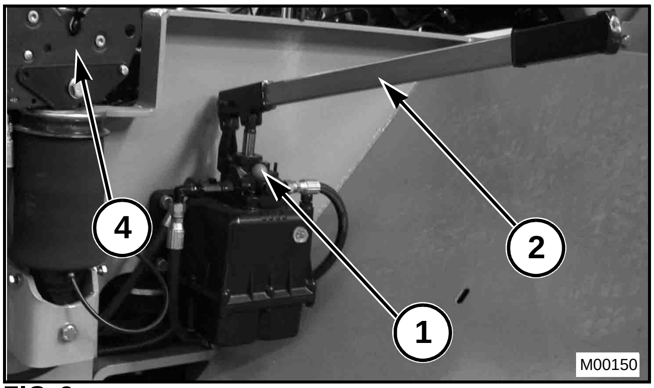



**FIG. 2**

**FIG. 3:** Lock pin with retainer (3);

8. After tipping over the cab put the lock pin with retainer immediatly in it's place;

**DANGER: When the locking pin is not in position, noboby is allowed under the cab.**

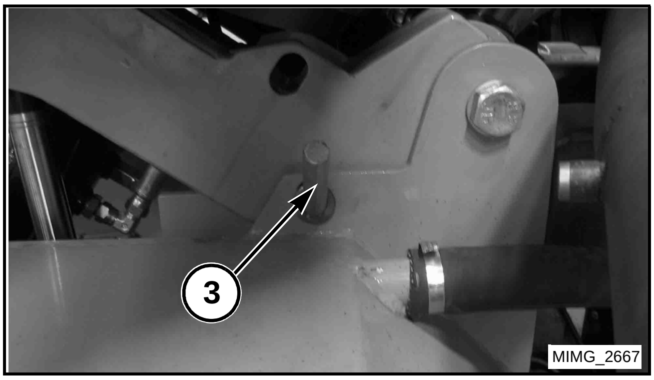



**FIG. 3**

**FIG. 4:** Wire rope underneath the cab (5).

9. Remove the wire rope at the bottom of the cab. Normally the wire rope protects the cab tipping to far and hit the bonnet;

**WARNING: Remove the wire rope only when the bonnet and bonnetframe is complety removed. Otherwise damage to the cab will result.**

10. Remove the lock pin and retainer. Place the lock pin on the left platform, near the rotating point of the cab;
11. Start pumping to tipping over the cab.

**WARNING: Be extremely carefull, when the cab past the center of gravity. It will become in a free fall. So secure the cab. when falls over by the gravity. Use a tensioner/chain hoist to control the movement of the cab.**

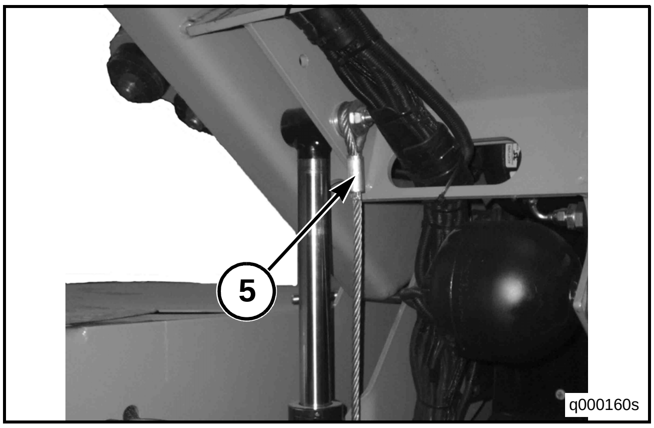



**FIG. 4**

12. Tipping over the cab untill the transmission can be removed/installated.

**WARNING: Make sure the cab does not hit anything. Otherwise damage to the cab will by result.**

*IMPORTANT: By tipping over the cab this far. The center of gravity is in front of the rotating point of the cab. So there is no support needed underneath the cab.*

## Lower the Cab

**FIG. 5:** Cab suspension and lock (4) at rear side of cab.

To lower the cab act as follows:

1. Close the knob (1) on the handpump (CCW);
2. Place pump lever (2) in the pump and pump down the cab.

**WARNING: When the cab past the center of gravity, the cab will come in a free fall.**

**When the cab is lower by its weight, close the knob (1) on the handpump (CCW).**

3. Lower or tipping over the cab so the locking pin can be installed.
4. Install the wire rope (5) underneath the cab;
5. Remove the lock pin (3) from it's locking position;

**DANGER: Make sure there's nobody under the cab.**

6. Open the knob (1) (CCW) to depressurize the system. The cab will lower by its weight;

   The rear suspesion will lock its self.

   Leave the knob (1) in the "open" position.
7. Restore the lock pin with retainer in this locking position underneath the cab;
8. Remove the pump lever (3) of the pump. Place the pump lever back to the storage compartment.
9. Install the cooler supports above the engine;
10. Install the bonnet, frame and side panels.

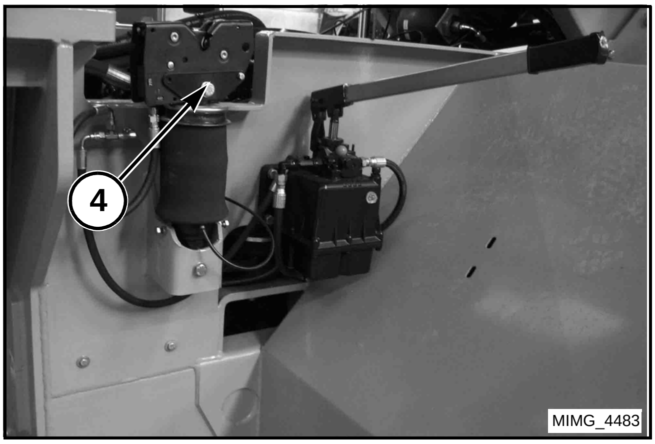



**FIG. 5**

## KENR6054

See for the complete Disassembly and Assembly manual (TA 19 KERN 6054) at the end of this chapter.

# DRIVE LINE

## DRIVE LINE REAR

**WARNING: Before performing maintenance in the area of the Articulation Joint the following procedure MUST be followed (See Safety Section)**

**1. Drive the vehicle to a hard level surface. Steer the vehicle into the straight ahead position.**

**2. Engage the park brake and turn of the engine.**

**3. Move the articulation Lock Turnbuckle form the Storage Position to the Transport / Maintenance Position**

### Straight Chassis

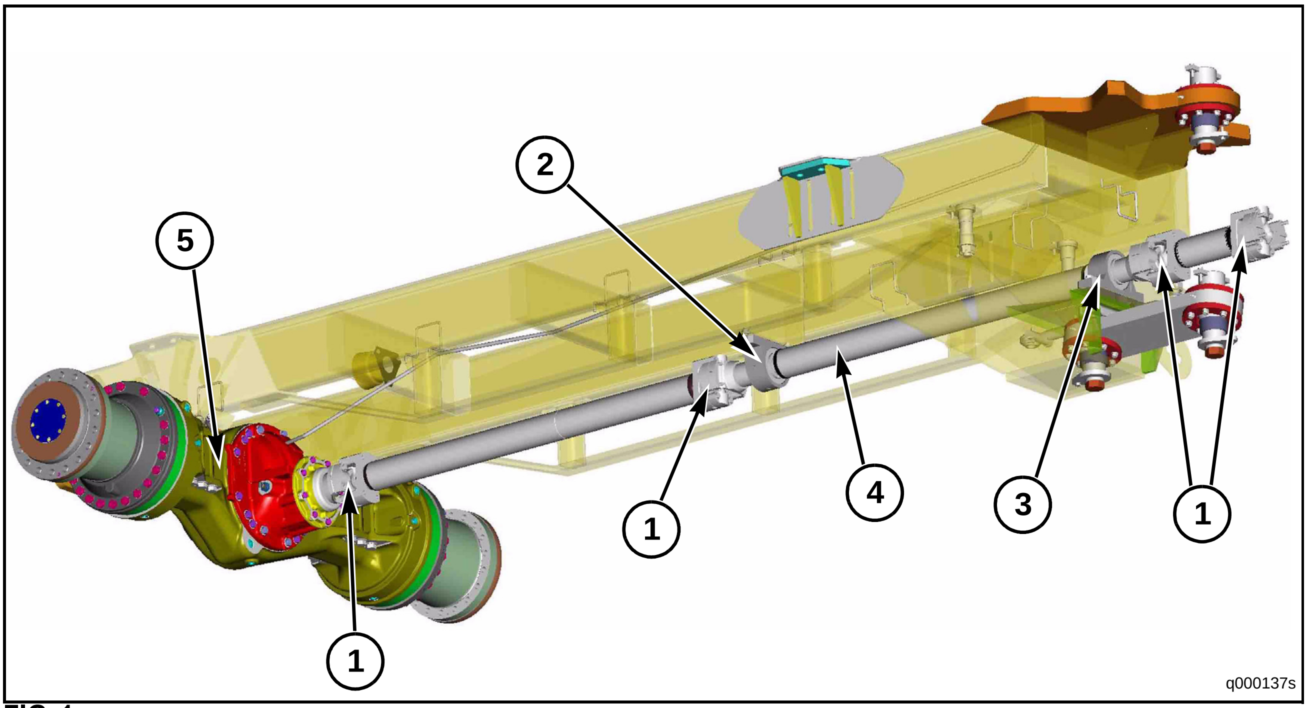



**FIG. 1**

1. Cross Bearing (4x);
2. Shaft Hanger Bearing (Loose);
3. Shaft Hanger Bearing (Fixed);
4. Drive shaft;
5. Rear Axle;

The drive line from a Terra Gator with a straight chassis is divided in three parts. One short part in the pivot point. And two longer part underneath the chassis. The drive line can make one angle, to provide the pivot steering.

Both the front and rear drive line is timed, which means the yoke on each end of the drive line is aligned parallel with the yoke on the opposite end.

## Dog Walk Chassis

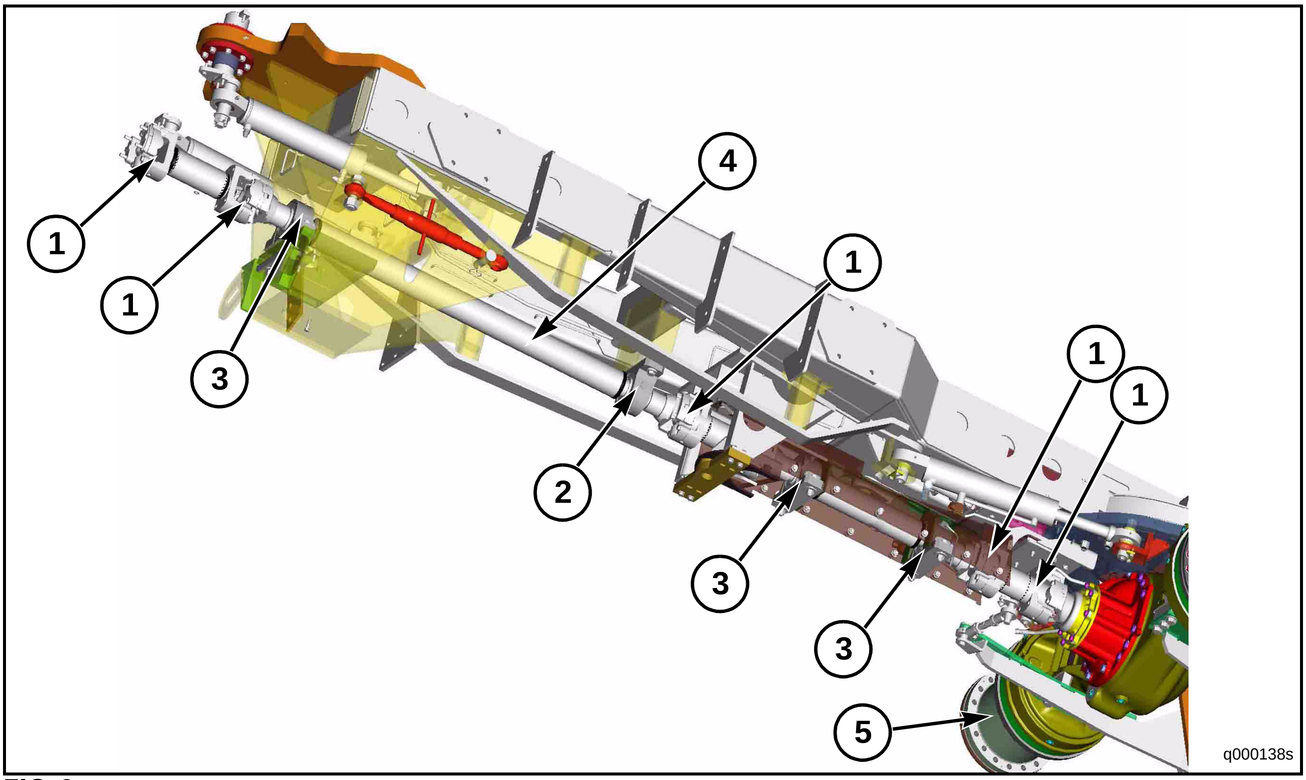



FIG. 2

1. Cross Bearing (6x);
2. Shaft Hanger Bearing (Loose);
3. Shaft Hanger Bearing (Fixed);
4. Drive shaft; Terra Gator
5. Rear Axle.

The drive line from a Terra Gator with a dog walk chassis is divided in four parts. Two short parts and two longer parts. The drive line can make two angle's. One to provide pivot steering and one provide the dog walk.

The last part of the drive line is build in a dog walk tunnel.

Both the front and rear drive line is timed, which means the yoke on each end of the drive line is aligned parallel with the yoke on the opposite end.

## Drive Shaft Hanger Bearings

The drive line of a Terra Gator with dog walk contains 4 bearings.

- 1 Sliding Bearings;
- 3 Fixed bearings.

## DRIVE LINE FRONT

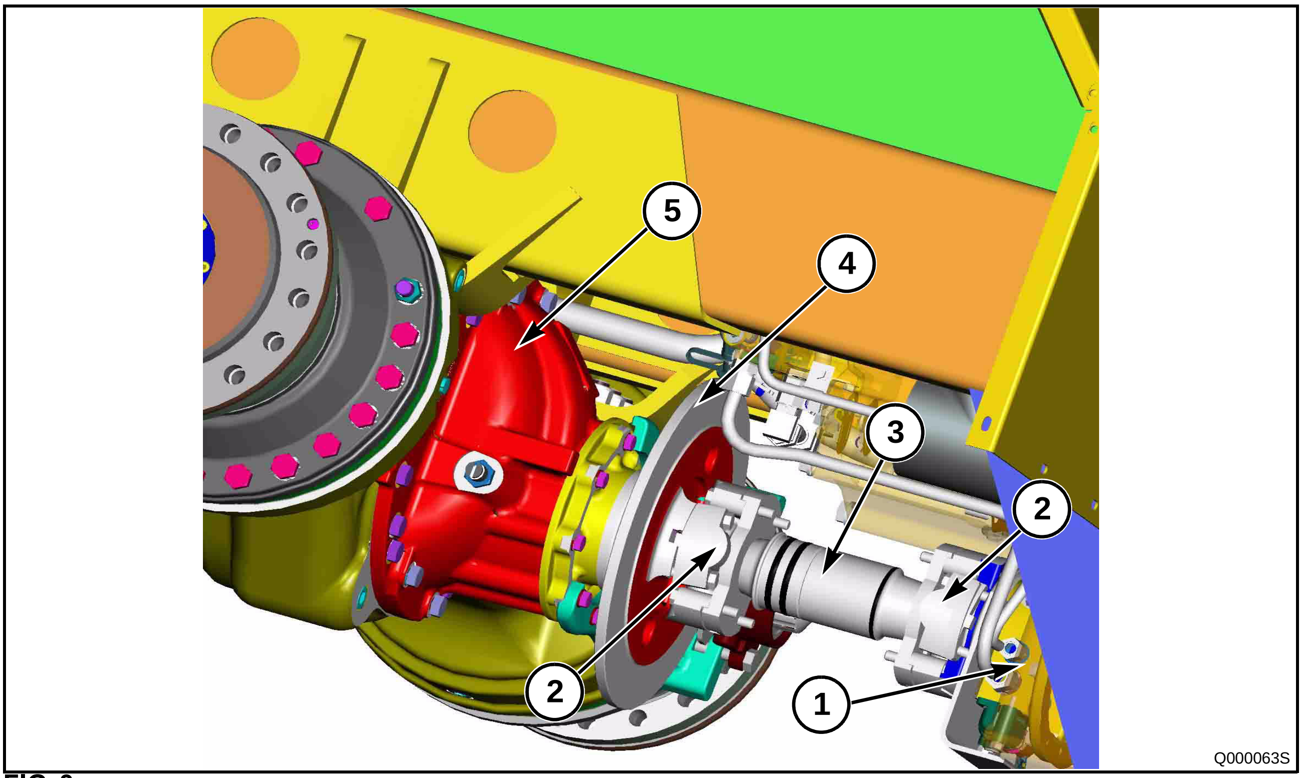



**FIG. 3**

To provide the Terra Gator of a 4-wheel drive there need to be a drive line from the transmission to the front axle.

1. Transmission;
2. Cross Bearing (2x);
3. Drive shaft;
4. Disc Park Brake;
5. Front Axle.

## HANGER BEARING

### Maintenance Hager Bearing

#### Lubrication Bearing

Grease the roller bearing every 250 hours of operation.

Do not use a high pressure automatic grease gun.

Do not over grease.

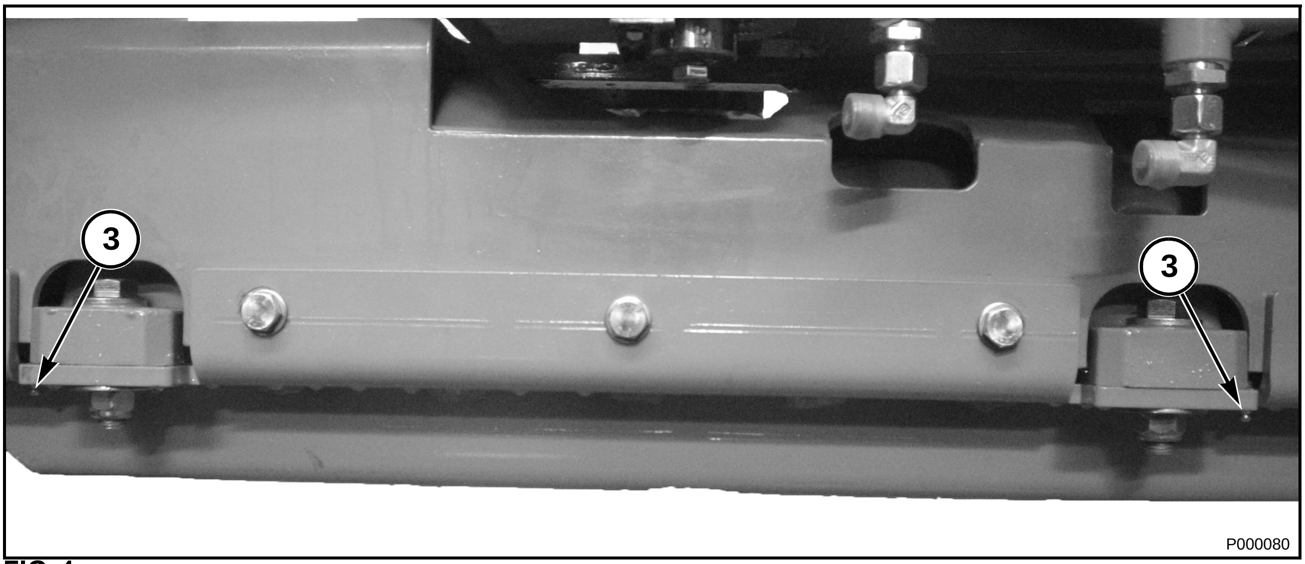



**FIG. 4**

*NOTE: Never connect to an automatic central lubrication system.*

#### Check Roller Bearings

Check the drive shaft bearing every 1000 hours of operation or annualy. Replace the bearing by play more than approximately 0,5 mm.

#### Check Cross Bearing

Check the cross bearings of the drive drive shaft every 1000 hours of operation or annualy. Replace the Cross Bearings by to much play.

## Introduction ConCentra Roller Bearing



### The deep groove ball bearing

The bearings used in SKF ConCentra ball bearing units are based on deep groove ball bearings in the 62 series. These bearings have a convex sphered outside surface. The inner ring is extended on both sides and has a multi-tapered bore (→ **fig. 2**).

The bearing is sealed on both sides with the highly-efficient SKF "Superagriseal", which is complemented by flingers to considerably enhance the sealing effect without increasing friction. It is filled with a premium lithium-calcium grease that fills between 25 and 35 % of the free space in the bearing. If necessary, the bearing unit can be relubricated via the outer ring.

### The ConCentra stepped sleeve

The ConCentra stepped sleeve, a masterpiece of locking technology, is the real innovation behind the SKF ConCentra bearing unit (→ **fig. 3**). The locking concept is based on two mating surfaces with precision-engineered inclined serrations on their contact surfaces. These mating surfaces respond to axial displacement by expanding and contracting evenly around the entire circumference of the shaft. The stepped sleeve is equipped with a mounting and a pressure ring (→ **fig. 4**).

By tightening the grub (set) screws in the mounting ring, using the hexagonal key (allen wrench) supplied with each unit, the pressure ring forces the inner ring up the inclined planes of the stepped sleeve to provide a true concentric tight fit on the shaft (→ **fig. 5**).

SKF ConCentra locking technology enables a bearing to operate with maximum reliability – improving both function and service life.

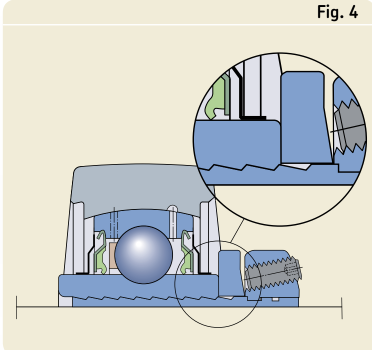
Fig. 2

Fig. 3

***Prior to installation***

*The two mating surfaces with precision-engineered serrations in the bearing bore and on the sleeve outside diameter are positioned to provide clearance around the shaft*

Fig. 4



***During installation***

*The mating surfaces are axially displaced by tightening the grub screws, which forces the bearing ring to expand and the sleeve to contract, providing a true concentric, tight friction joint with the shaft*

Fig. 5

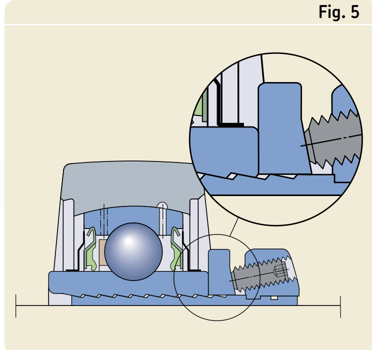


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**FIG. 5**

## Mouting Instructions

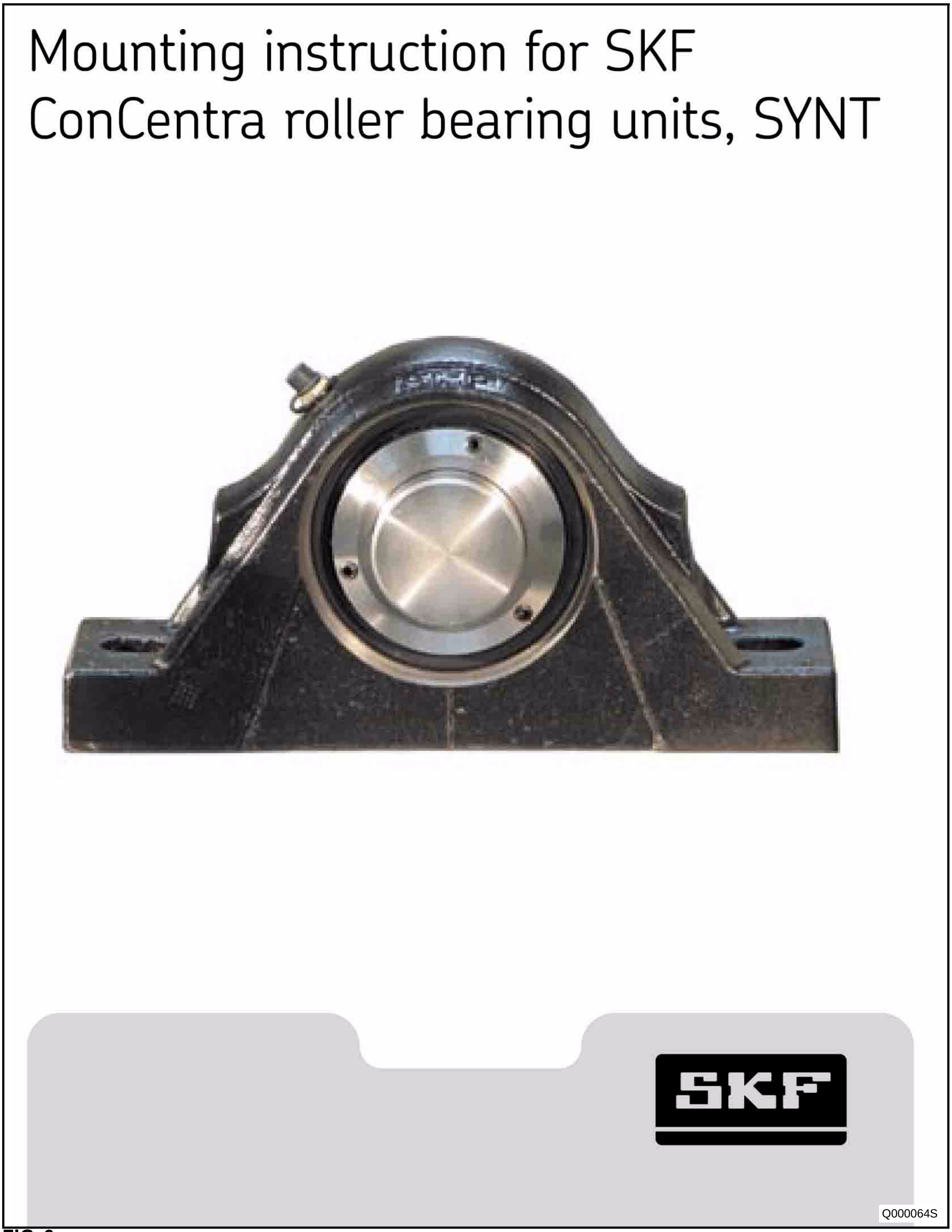

Mounting instruction for SKF ConCentra roller bearing units, SYNT



FIG. 6

EN

# Mounting SKF ConCentra roller bearing units, SYNT

Before starting installation work, the following instructions should be carefully read:

⚠ The mounting and dismounting of rolling bearings involve the handling of sometimes heavy weights, the use of tools and other devices, and in some cases the use of high pressure oil. In order to avoid accidents, injuries or damage to property please follow carefully the prescribed methods.

**CAUTION!** This is a unit assembly. No attempt should be made to disassemble the unit prior to installation. The mounting screws must under no condition be tightened unless the unit is mounted on a shaft since this may damage the unit.

## Mounting

**1.** Determine the positions of the locating and non-locating units. The locating unit should always be at the drive side.

**2.** Make sure that the base of the bearing unit and the support surface are clean and free from burrs. For the support surface a flatness tolerance within tolerance grade IT7 is recommended. Recommended max surface finish for the support surface is $R_a \leq 12{,}5$ µm.

**3.** Make sure the shaft is clean and free from burrs and check the dimensional and form accuracy of the shaft. The recommended diameter tolerance for the shaft is h9 and the cylindricity tolerance grade IT5. Recommended max surface finish for the shaft is $R_a \leq 3{,}2$ µm. Lightly oil the shaft bearing seats with low viscous oil. A small entrance chamfer on the shaft will make mounting easier.

**4.** Mount any components which are to be on the shaft between the bearing positions.

**5.** Push the bearing units on to the shaft.

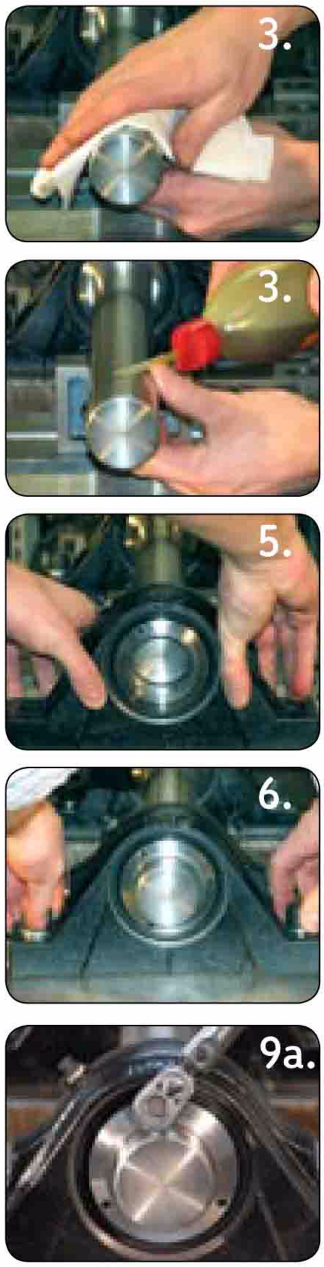
**6.** Fasten the bearing units to the support surface with the attachment bolts but do not tighten.

**7.** Adjust the position of the bearing units on the support surface if necessary.

**8.** Position the shaft axially in the bearing units.

**9.** Lock the locating bearing SYNT .. F/FTS/FTF on the shaft.

**9a.** Tighten the set screws in the mounting ring using a 3 mm bit and a torque wrench. Tighten the screws following the mounting pattern below, to finger tightness.




Q000065S

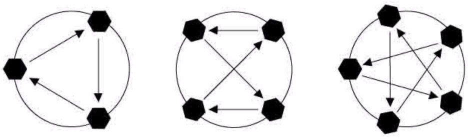
FIG. 7

## SYNT

**9b.** Tighten each set screw to 7,4 Nm following the mounting pattern.

**9c.** If the supplied hexagonal key is used tighten each screw to finger tightness following the mounting pattern below. Then mount the supplied red torque indicator on the short end of the hexagonal key and tighten the screw until the hexagonal key comes in contact with the torque indicator.

**CAUTION!** Do not use auxiliary equipment such as hammer or a pipe when tightening the screws.





**10.** Check the bearing alignment.The maximum permissible misalignment of the shaft relative to the unit is 1,5°. Fully tighten the attachment bolts of the locating bearing unit. The recommended tightening torques for bolts of strength class 8.8 are:

M12 ----- 80 Nm (59 ft.lbf.)

M16 ----- 200 Nm (148 ft.lbf.)

M20 ----- 385 Nm (284 ft.lbf.)

M24 ----- 665 Nm (484 ft.lbf.)


**11.** Find the middle of the bearing seat in the non-locating housing (SYNT .. L/LTS/LTF) by supporting the shaft and by pushing the unloaded bearing from one end position in the housing to the other while housing is fixed. If only thermal elongation of the shaft is expected it is recommended that the end position of bearing is towards the locating bearing. Be careful to only push the bearing not the housing.


**12.** Lock the non-locating bearing on the shaft as under point 9-10.

**13.** If end cover is needed, snap the ECY end cover into the end cover groove.


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**FIG. 8**

## Dismounting

**1.** Clean the bearing position and all the internal hexagons of the grub screws.

**2.** Remove any rust or damage over which the bearing unit is to be withdrawn.

**3.** Loosen the attachment bolts.

**4.** Remove the attachment bolts.

**5.** Support the shaft with its components.

**6.** Loosen the grub screws in the mounting side ring 3 or 4 turns.

**7.** Face the mounting ring side and pull the unit holding the housing base until it releases from shaft.

**8.** If needed use a rubber hammer and hit the backside of housing until it releases from shaft.

**9.** Withdraw the unit from the shaft.

**10.** If the application permits, it is recommended to remove all the attachment bolts and to lift out the complete arrangement of shaft with SKF ConCentra units and other components. Then proceed as described under point 6 to 9.

## Lubrication

SKF ConCentra roller bearing units are delivered filled with SKF grease. The quantity of grease corresponds to a completely filled bearing and 30 - 50 % of the free space in the housing. If relubrication is needed use LGEP 2 grease or equivalent.

## Label

The designation of the unit is shown on a label covered by a transparent protective film. If the unit is repainted, the label can be revealed by removing this protective film.

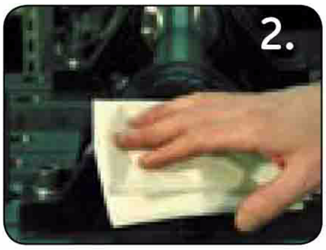






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**FIG. 9**

## Adjustment Dog Walk Tunnel

To adjust the dog walk tunnel follow the next instruction.

*IMPORTANT: The life time of the bearings will increase when the dog walk tunnel is proper installed and not grease more than specification.*

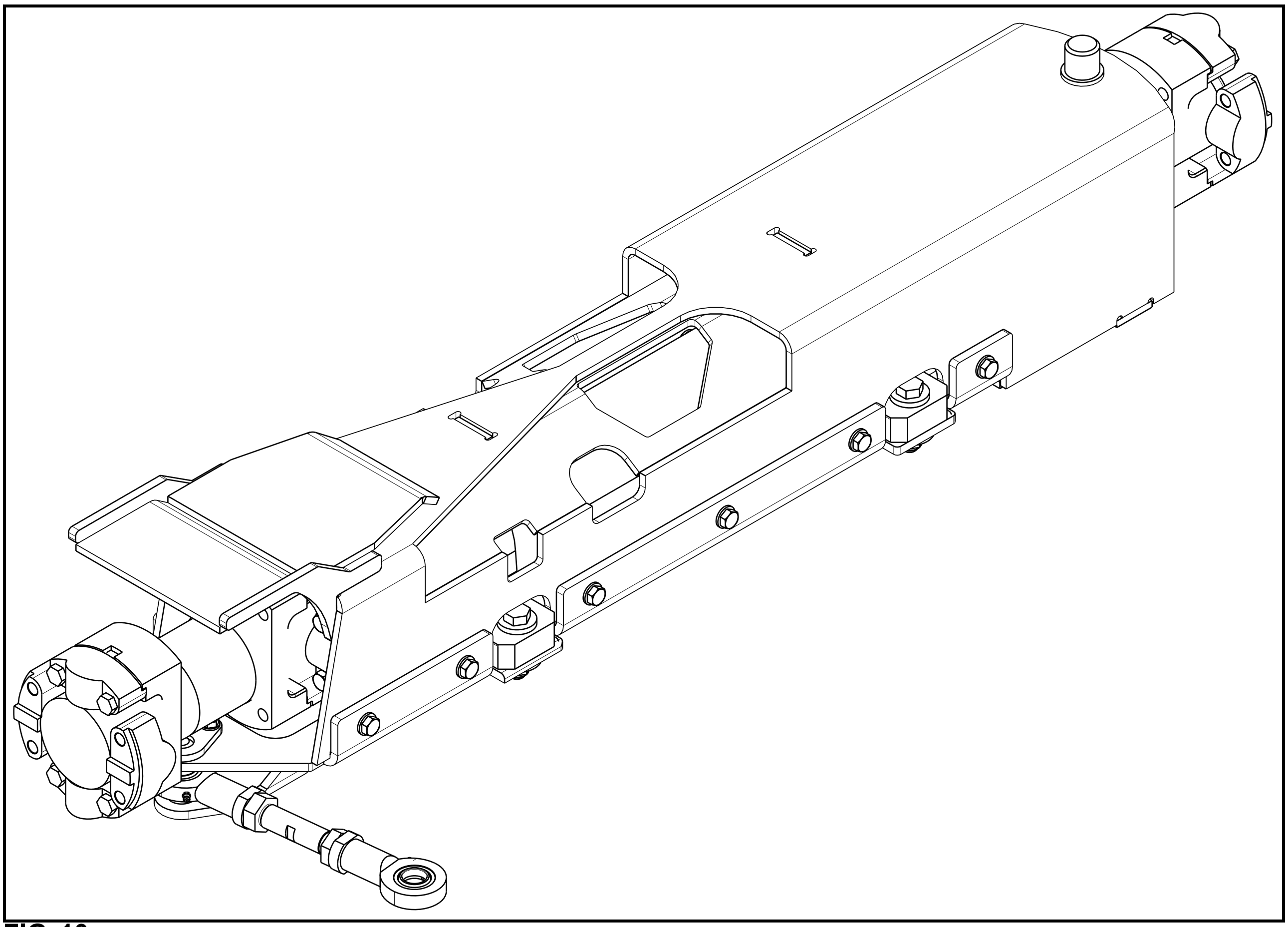

**FIG. 10**

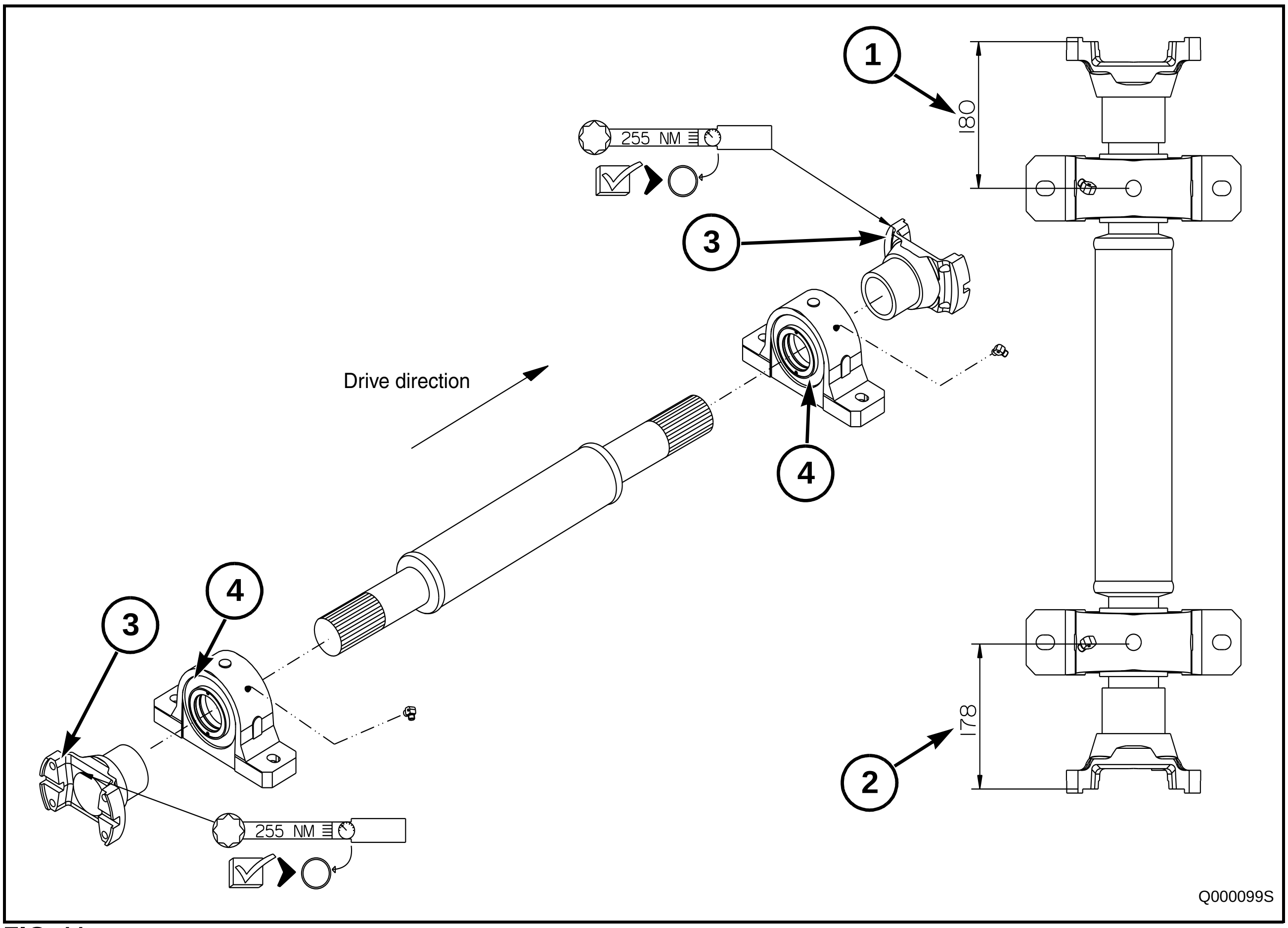


**FIG. 11**

1. Measure from the face of the axle (180 mm);
2. Measure from the face of the axle (178 mm);
3. Torque the bolts of the cross bearing with 255 Nm;

   Use a ring spanner.
4. Torque the bolts of the roller bearing with the special wrench with 7,5 Nm. See “Mounting instruction for SKF ConCentra roller bearing units, SYNT” in the front of this chapter;

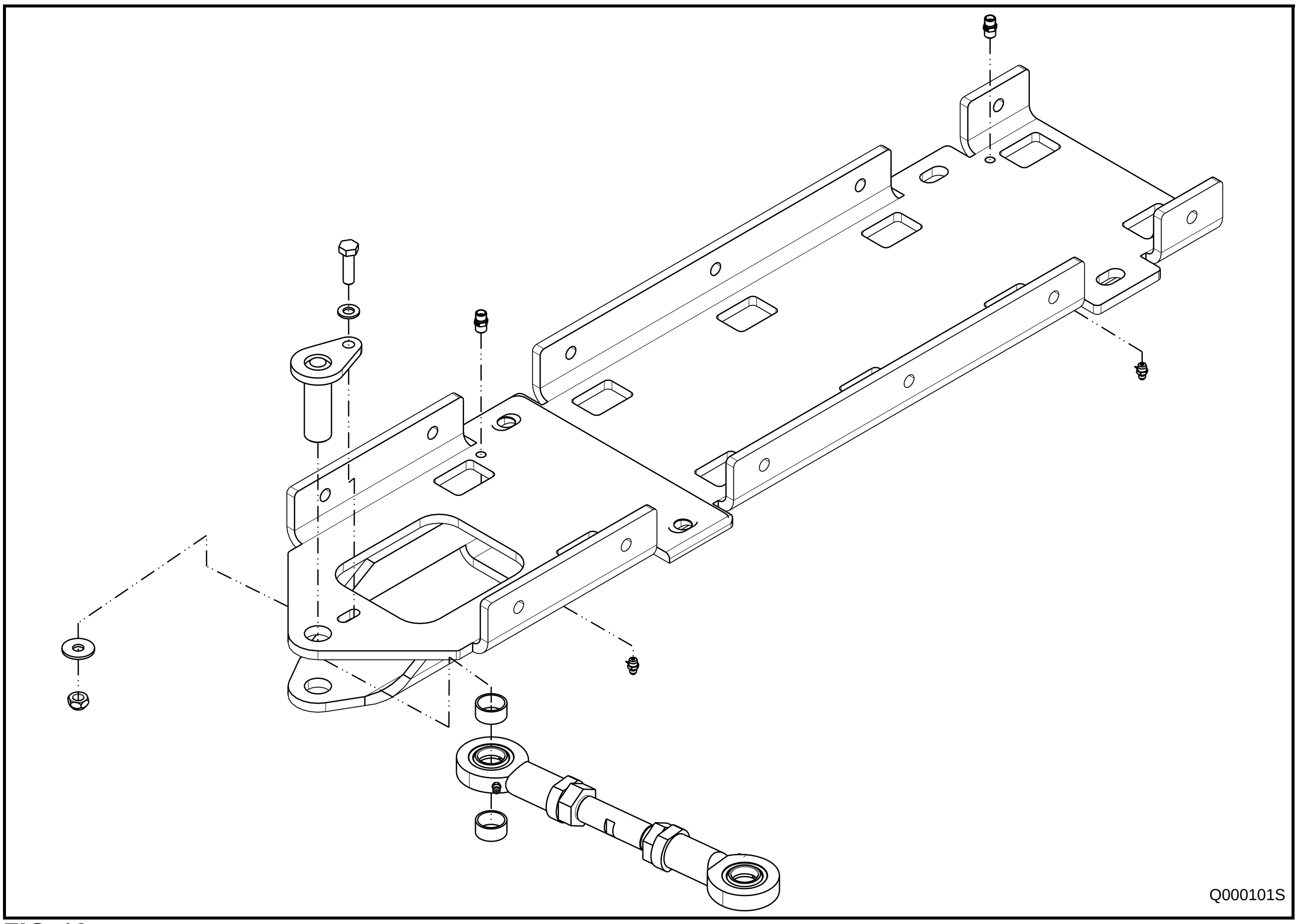


**FIG. 12**

Mount the parts to the bottom of the Dog Walk Tunnel.

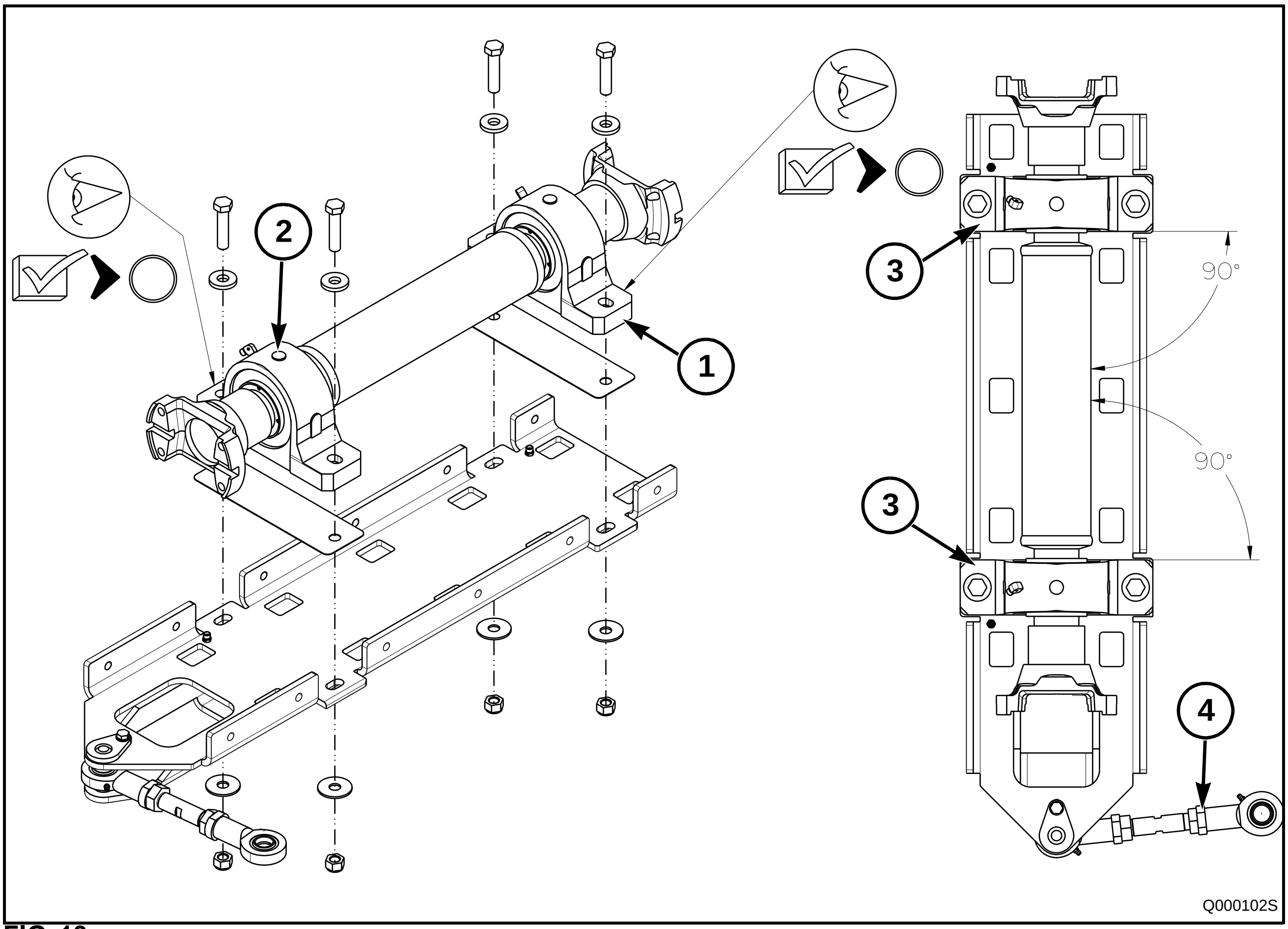


**FIG. 13**

1. Fixed Bearing;
2. Sliding Bearing;
3. Position of the bearing is very important. A good aligned position increase life time of the bearings.

   The bearings have to been align horizontal and vertical. The horizontal alignment can be set with the shims under the bearings
4. Adjust the bar untill the dog walk tunnel in straight underneath the Terra Gator, when the Terra Gator is not in Dog walk position.

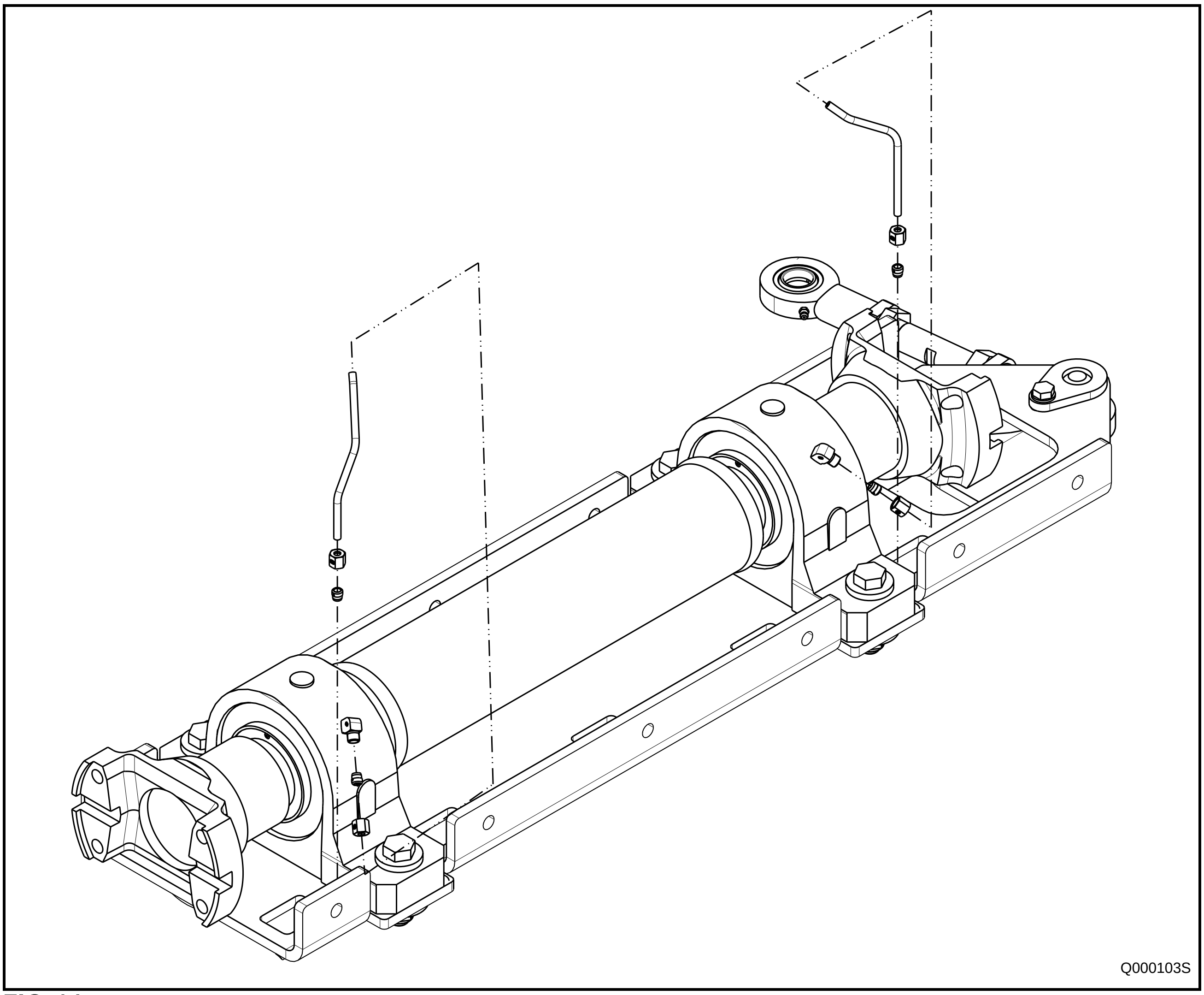


**FIG. 14**

Mount the grease line the to bearings. The Grease nipples are mount at the bottom of the Dog Walk Tunnel.

**WARNING: Never connect the bearing to the central lubrication system.**

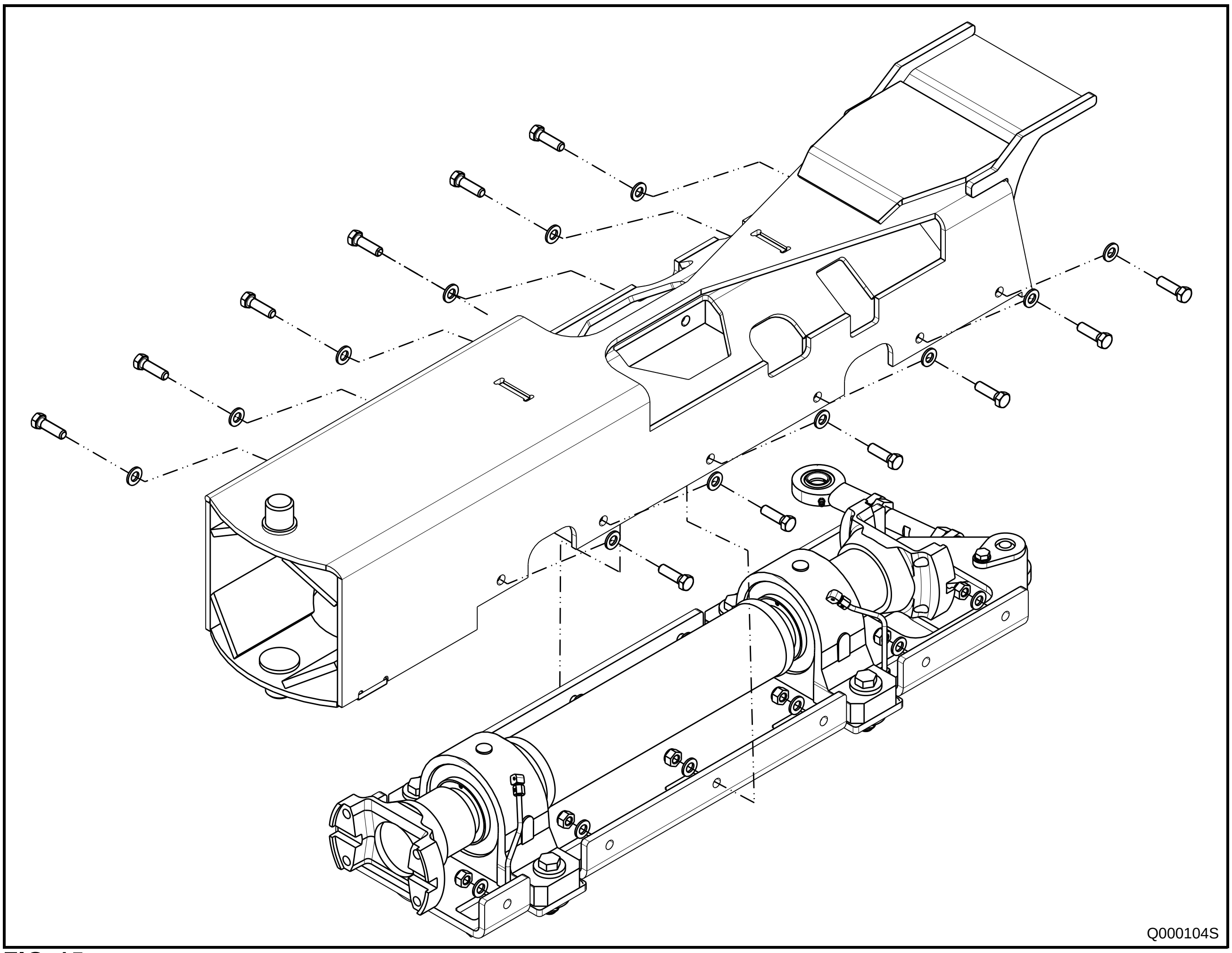


**FIG. 15**

Mount the bottom part of the Dog Walk Tunnel to the top part.

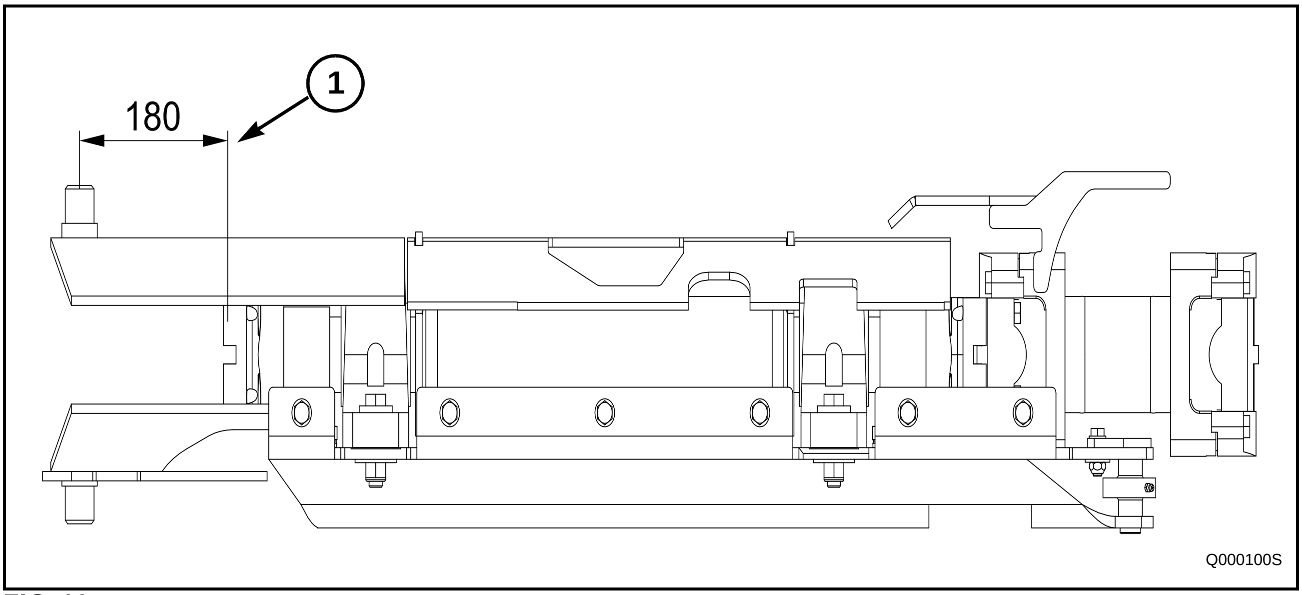


**FIG. 16**

1. Measure from the face of the axle (180 mm);

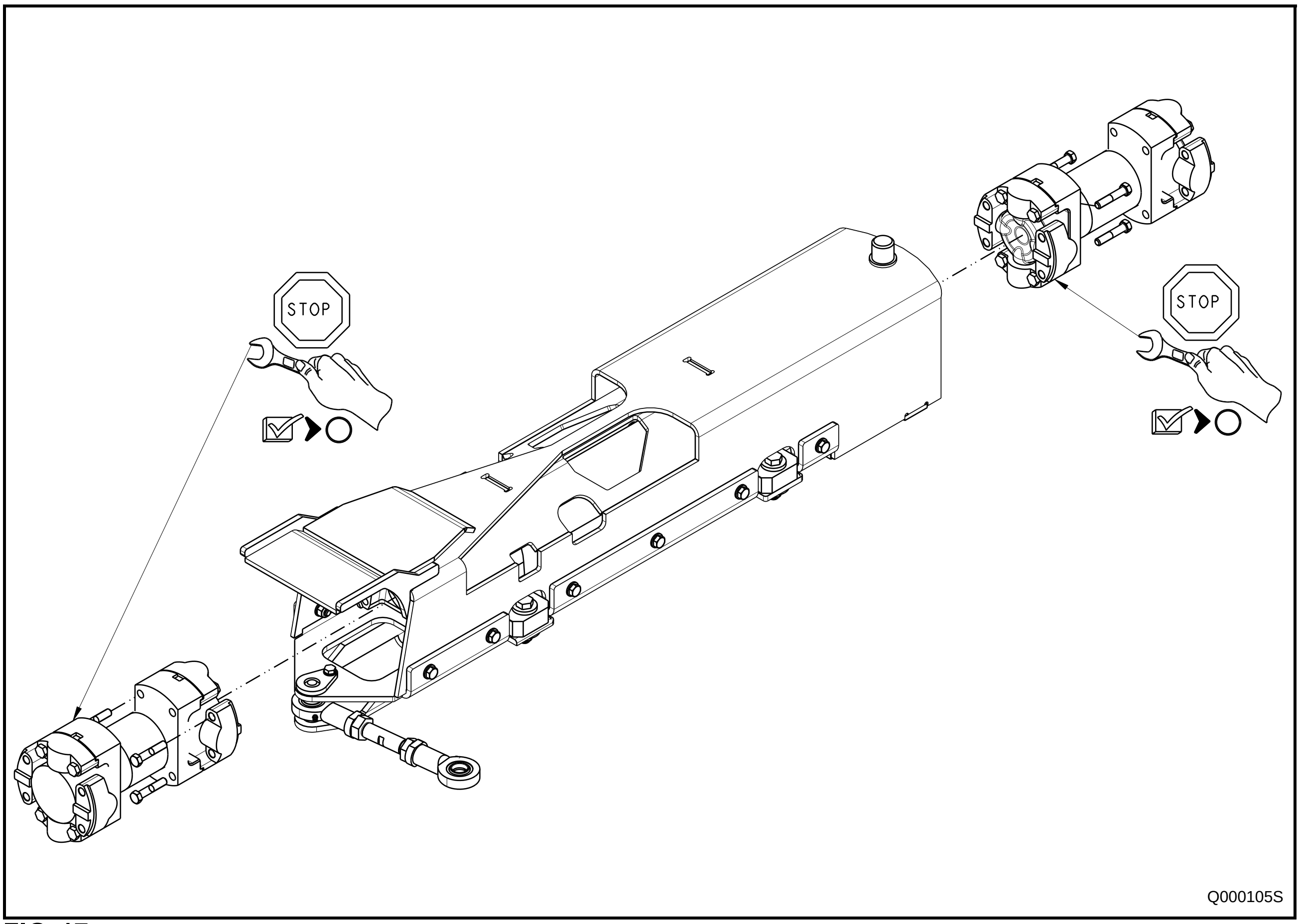


**FIG. 17**

Mount the cross bearings. Torque the bolts dry with 140 Nm (105 ft lb).

NOTES

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### T



### V

# Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

**Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.**

**Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.**

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

**⚠ WARNING**

The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

**Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.**

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.

**⚠ WARNING**

**When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.**

**Failure to heed this warning can lead to premature failures, product damage, personal injury or death.**

# Table of Contents

## Disassembly and Assembly Section



## Index Section

# Disassembly and Assembly Section

i02648750

## Relief Valve (Transmission Main) - Remove

**SMCS Code:** 5069-011-T3

### Removal Procedure

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

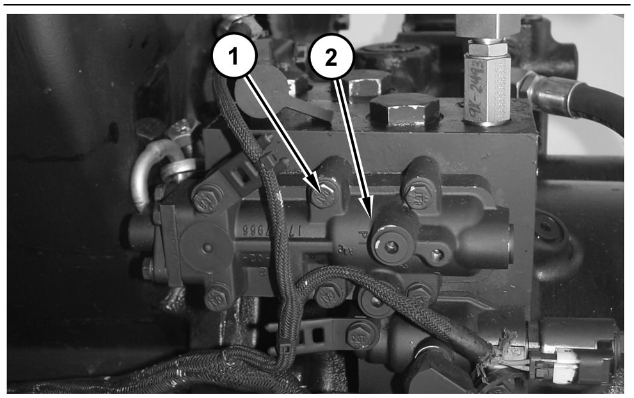


Illustration 1 g01329210

**1.** Remove bolts (1).

**2.** Remove relief valve (2).

i02536685

## Relief Valve (Transmission Main) - Disassemble

**SMCS Code:** 4059-015-T3; 5069-015-T3

### Disassembly Procedure

Table 1

| Required Tools | | | |
|---|---|---|---|
| Tool | Part Number | Part Description | Qty |
| A | 1P-1853 | Retaining Ring Pliers | 1 |

**Start By:**

**a.** Remove the relief valve. Refer to Disassembly and Assembly, “Relief Valve (Transmission Hydraulic Control) - Remove”.

**Note:** Cleanliness is an important factor. Before you begin the disassembly procedure, the exterior of the components should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism. Precision components can be damaged by contaminants or by dirt. Perform disassembly procedures on a clean work surface. Keep components covered and protected at all times.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

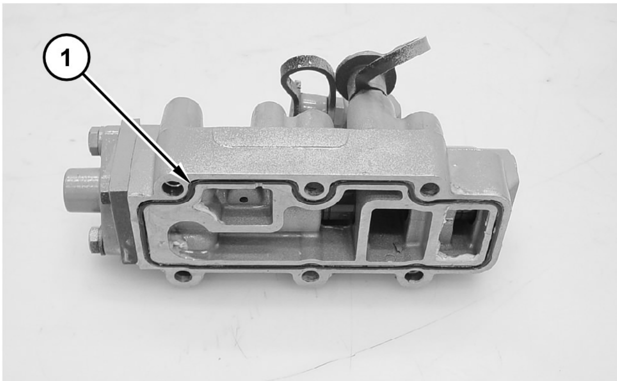


Illustration 2 g01209440

**1.** Remove O-ring seal (1).

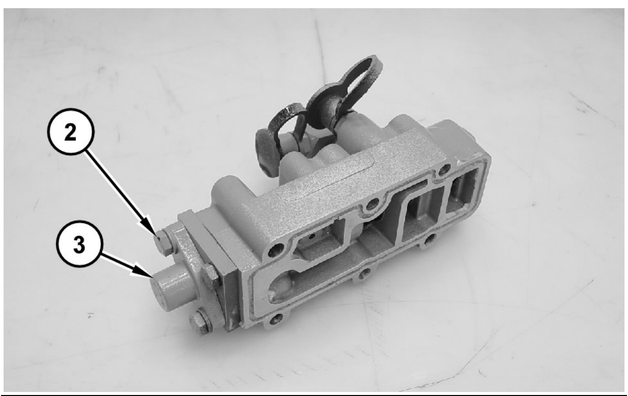


Illustration 3 g01209441

**2.** Remove bolts (2) and cover (3).

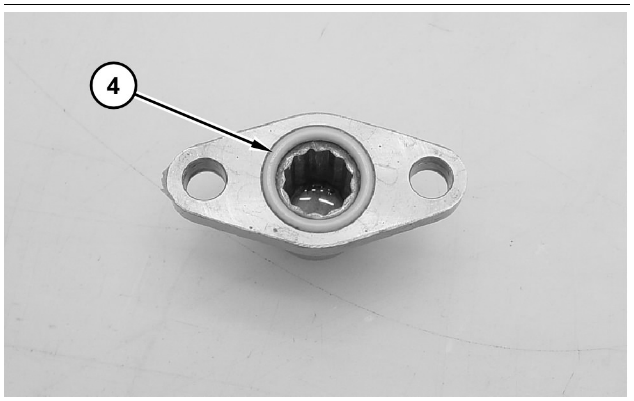


Illustration 4 g01209450

**3.** Remove O-ring seal (4).

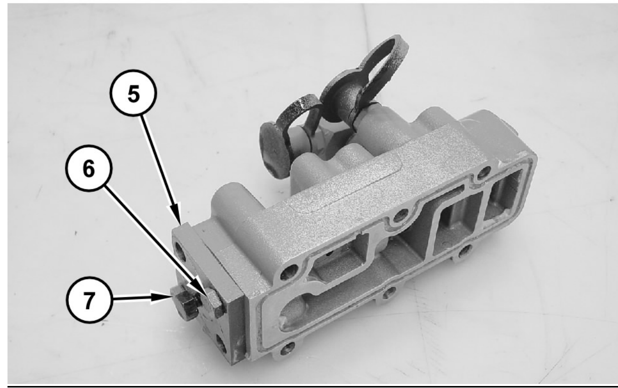


Illustration 5 g01209465

**WARNING**

**Personal injury can result from being struck by parts propelled by a released spring force.**

**Make sure to wear all necessary protective equipment.**

**Follow the recommended procedure and use all recommended tooling to release the spring force.**

**4.** Note the position of adjustment screw (7). Remove adjustment screw (7). Remove bolts (6) and cover (5).

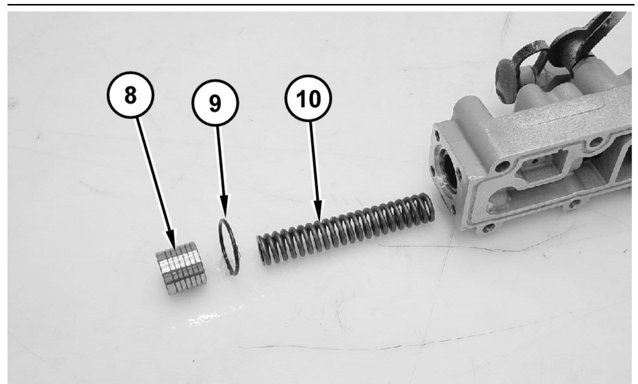


Illustration 6 g01209506

**5.** Remove load piston (8), O-ring seal (9), and spring (10).

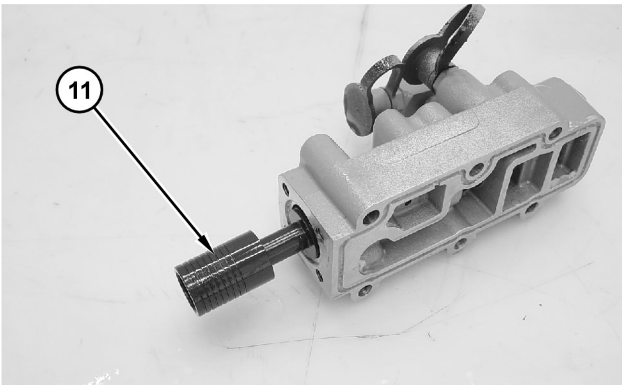


Illustration 7 g01209507

6. Remove spool assembly (11).

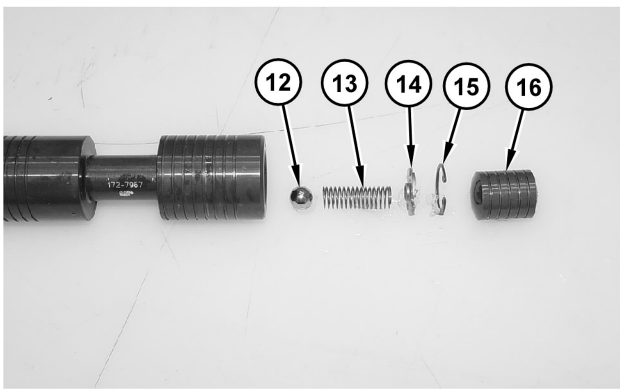


Illustration 8 g01209518

**⚠ WARNING**

**Personal injury can result from being struck by parts propelled by a released spring force.**

**Make sure to wear all necessary protective equipment.**

**Follow the recommended procedure and use all recommended tooling to release the spring force.**

7. Remove slug (16).

8. Use Tooling (A) in order to remove retaining ring (15). Remove retainer (14), spring (13), and ball (12).

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# Relief Valve (Transmission Main) - Assemble

**SMCS Code:** 5069-016-T3

## Assembly Procedure

Table 2

| Required Tools | | | |
|---|---|---|---|
| **Tool** | **Part Number** | **Part Description** | **Qty** |
| A | 1P-1853 | Retaining Ring Pliers | 1 |

**Note:** Cleanliness is an important factor. Before assembly, thoroughly clean all parts in cleaning fluid. Allow the parts to air dry. Do not use wiping cloths or rags to dry parts. Lint may be deposited on the parts which may cause trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement. Dirt and other contaminants can damage the precision component. Perform assembly procedures on a clean work surface. Keep components covered and protected at all times.

**Note:** Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

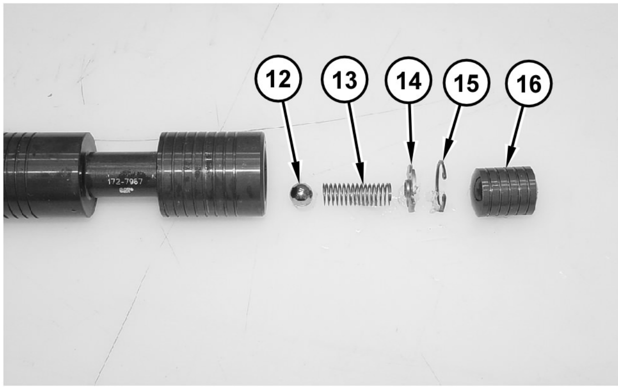


Illustration 9 g01209518

**WARNING**

**Personal injury can result from being struck by parts propelled by a released spring force.**

**Make sure to wear all necessary protective equipment.**

**Follow the recommended procedure and use all recommended tooling to release the spring force.**

1. Install ball (12), spring (13), and retainer (14). Use Tooling (A) in order to install retaining ring (15).

2. Install slug (16).

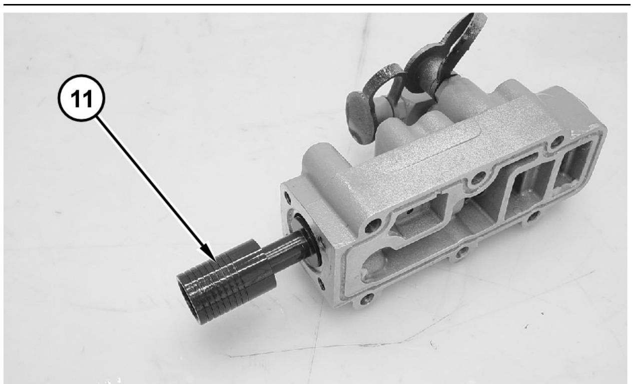


Illustration 10 g01209507

3. Install spool assembly (11).

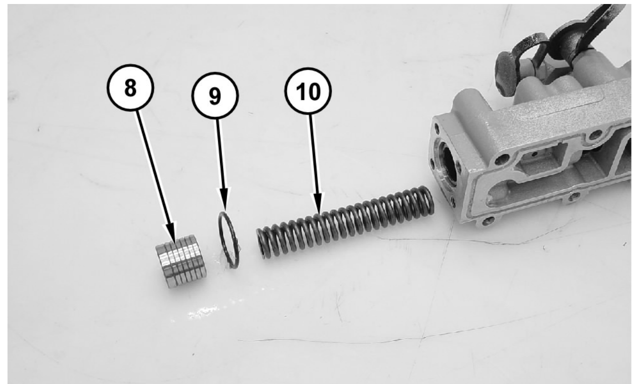


Illustration 11 g01209506

4. Install spring (10), O-ring seal (9), and load piston (8).

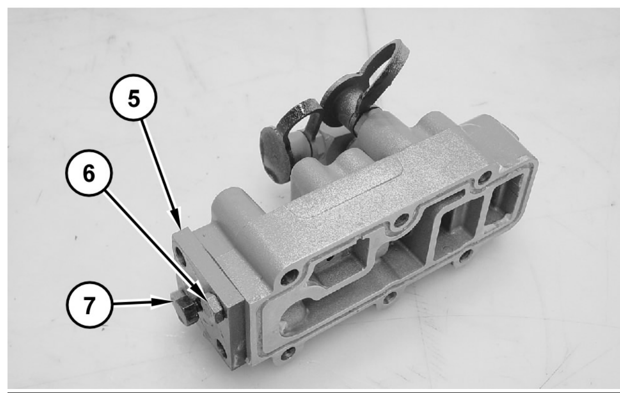


Illustration 12 g01209465

**WARNING**

**Personal injury can result from being struck by parts propelled by a released spring force.**

**Make sure to wear all necessary protective equipment.**

**Follow the recommended procedure and use all recommended tooling to release the spring force.**

5. Install adjustment screw (7) to the original location. Install cover (5) and bolts (6). Tighten bolts (6) to a torque of 28 ± 7 N·m (21 ± 5 lb ft).

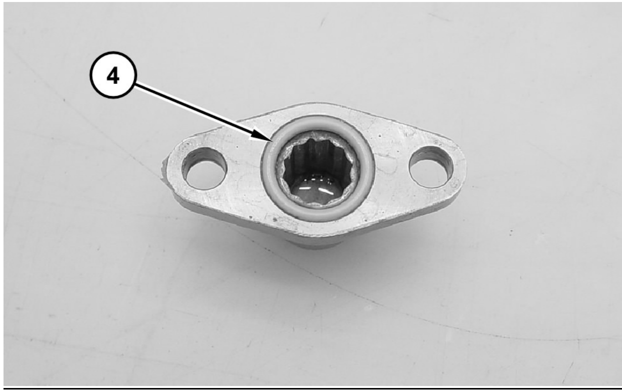


Illustration 13 g01209450

6. Install O-ring seal (4).

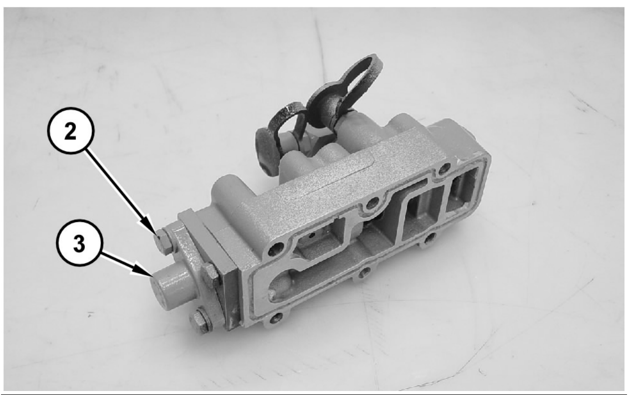


Illustration 14 g01209441

7. Install cover (3) and bolts (2). Tighten bolts (2) to a torque of 28 ± 7 N·m (21 ± 5 lb ft).

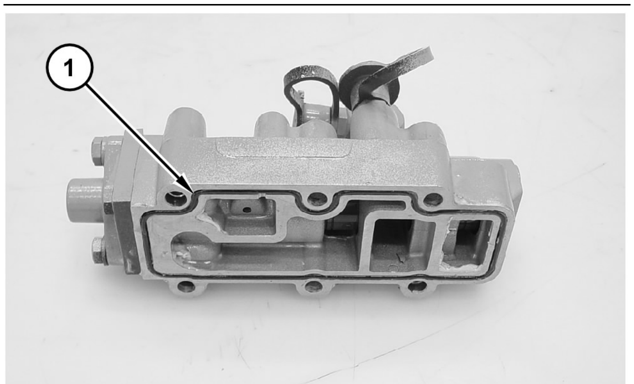


Illustration 15 g01209440

8. Install O-ring seal (1).

**End By:**

a. Install the relief valve. Refer to Disassembly and Assembly, “Relief Valve (Transmission Hydraulic Control) - Install”.

i02648785

# Relief Valve (Transmission Main) - Install

**SMCS Code:** 5069-012-T3

## Installation Procedure

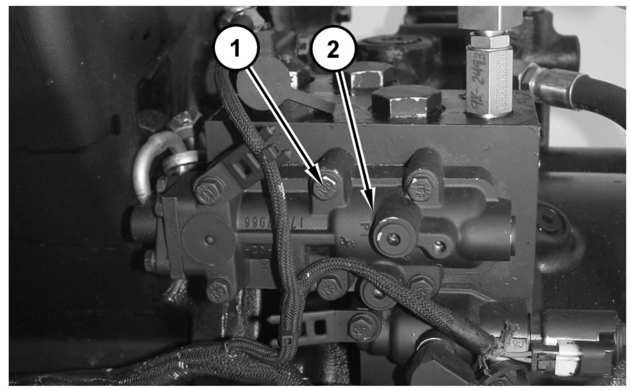


Illustration 16 g01329210

1. Install relief valve (2).

2. Install bolts (1). Tighten bolts (1) to a torque of 30 ± 4 N·m (22 ± 3 lb ft).

i02648891

# Pump Drive - Remove

**SMCS Code:** 3108-011

## Removal Procedure

Table 3

| Required Tools | | | |
|---|---|---|---|
| Tool | Part Number | Part Description | Qty |
| A | 138-7575 | Link Brackets | 4 |
| B | 1U-9202 | Lever Puller Hoist | 1 |
| C | 1P-2420 | Transmission Repair Stand | 1 |
| D | 154-6181 | Forcing Screws | 2 |
| E | 1P-0510 | Driver Gp | 1 |
| | 8B-7551 | Bearing Puller Gp | 1 |
| | 126-7181 | Sliding Plates | 4 |
| | 6V-3010 | Puller Gp | 1 |

**Start By:**

**a.** Remove the input speed sensor. Refer to Disassembly and Assembly, “Speed Sensor (Transmission) - Remove”.

**Note:** The top pump drive gears can be removed without the removal of the case assembly. Only the removal of the idler gear requires the removal of the case assembly.

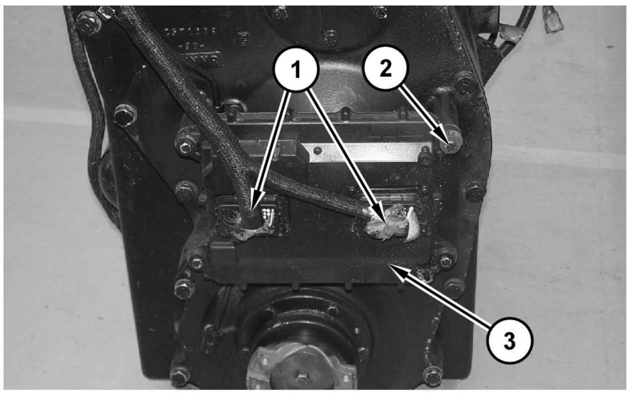


Illustration 17 g01265765

**1.** Disconnect harness assemblies (1).

**2.** Remove bolts (2) and Electronic Control Module (3).

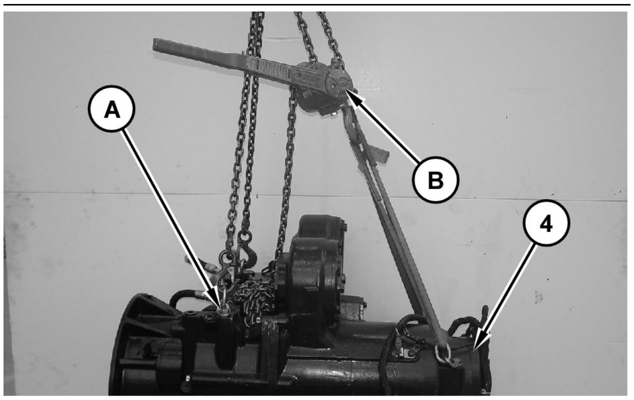


Illustration 18 g01265774

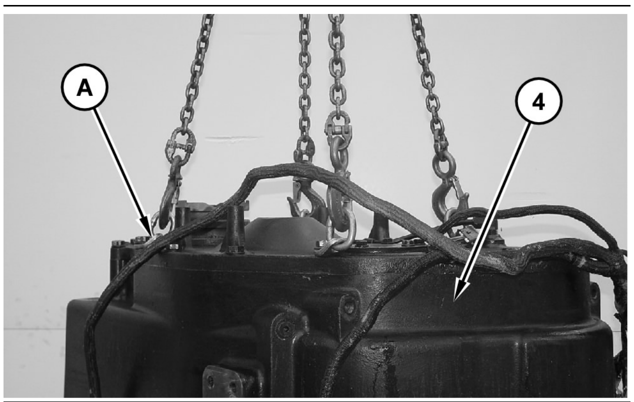


Illustration 19 g01265775

**3.** Use Tooling (A), Tooling (B), and a suitable lifting device to reposition transmission (4) onto Tooling (C). The weight of transmission (4) is approximately 1315 kg (2900 lb).

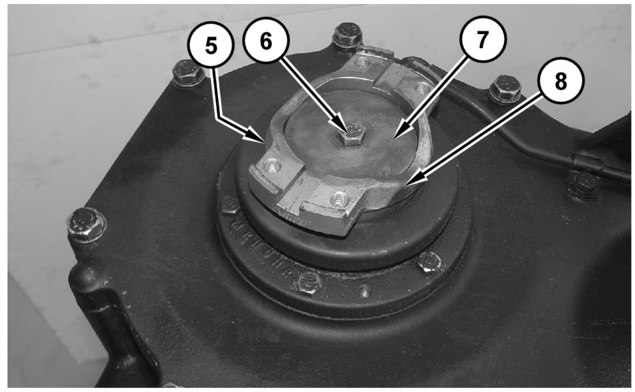


Illustration 20 g01265795

**4.** Remove bolt (6), retainer (7), and yoke (8). Remove O-ring seal (5).

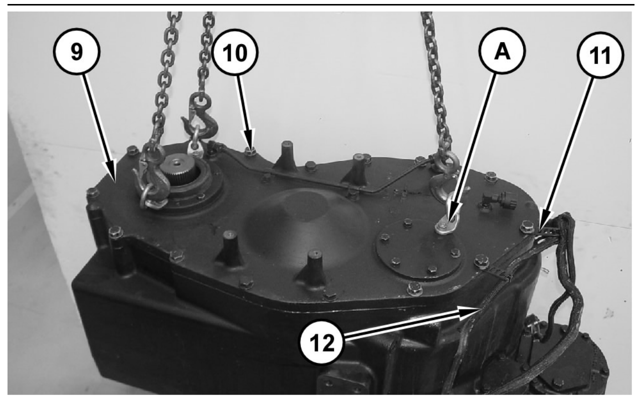


Illustration 21 g01265805

**5.** Attach Tooling (A) and a suitable lifting device to cover assembly (9). The weight of cover assembly (9) is approximately 60 kg (130 lb).

**6.** Remove bolts (10) and bracket assemblies (11).

**7.** Reposition harness assembly (12).

**8.** Remove cover assembly (9).

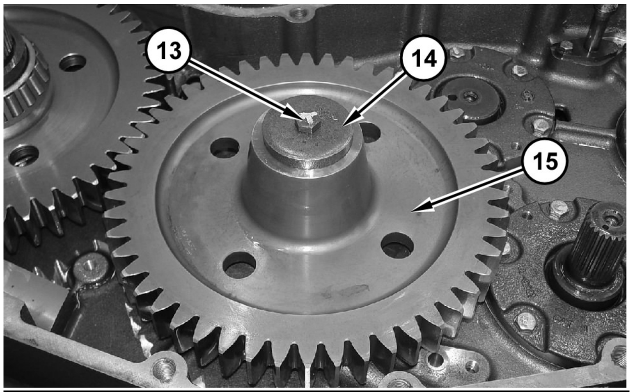


Illustration 22 g01265829

**9.** Remove bolt (13) and retainer (14). Use two people in order to remove gear (15). The weight of gear (15) is approximately 23 kg (50 lb).

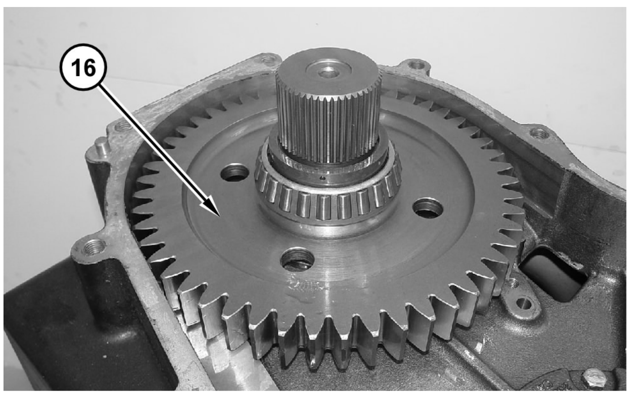


Illustration 23 g01265831

**10.** Use two people in order to remove gear assembly (16). The weight of gear assembly (16) is approximately 32 kg (70 lb).

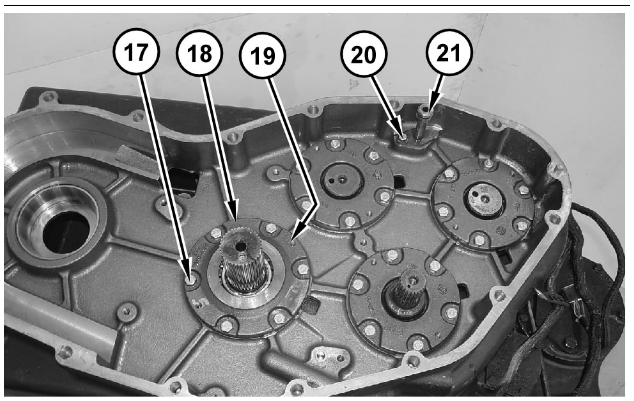


Illustration 24 g01265863

**11.** Remove bolts (17). Remove retainer (18) and shims (19).

**12.** Repeat Step 11 for the other retainers.

**13.** Remove bolt (20). Remove tube assembly (21).

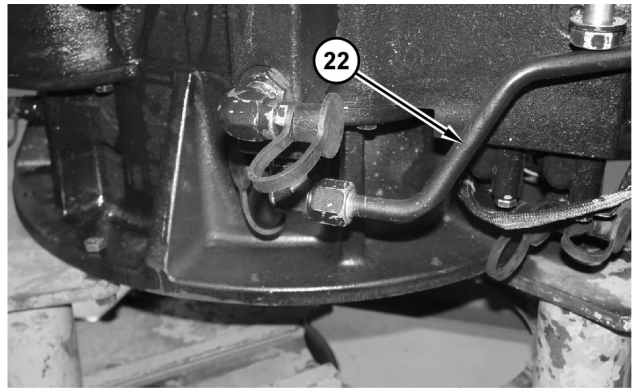


Illustration 25 g01265880

**14.** Remove tube assembly (22).

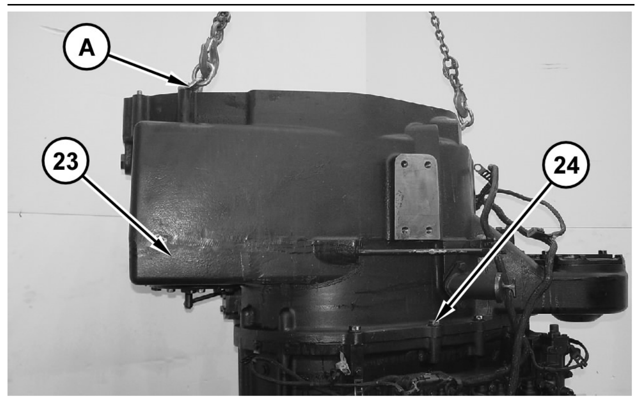


Illustration 26 g01265881

**15.** Attach Tooling (A) and a suitable lifting device to case assembly (23). The weight of case assembly (23) is approximately 365 kg (800 lb).

**16.** Remove bolts (24).

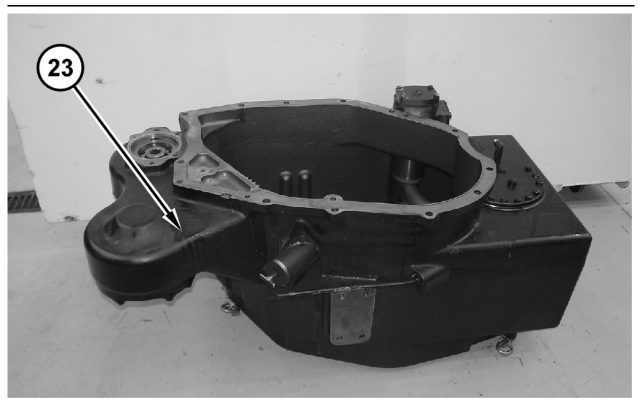


Illustration 27 g01265910

**17.** Use Tooling (A), Tooling (B), and a suitable lifting device in order to reposition case assembly (23).

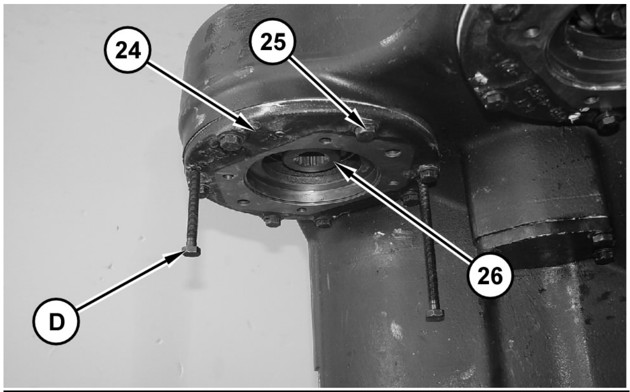


Illustration 28 g01265914

**18.** Loosen bolts (25). Use Tooling (D) in order to separate adapter (24). Remove Tooling (D).

**19.** Remove bolts (25), adapter (24), and gear (26).

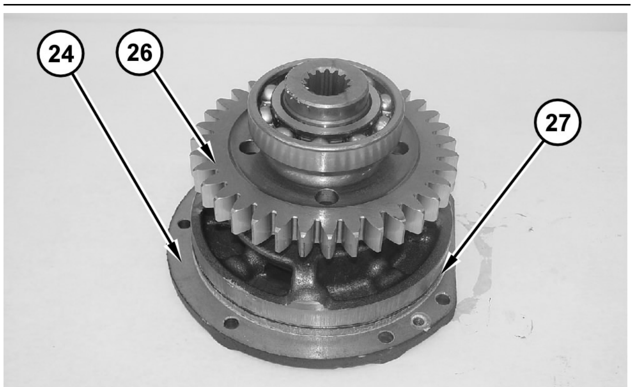


Illustration 29 g01265924

**20.** Remove O-ring seal (27) and gear (26) from adapter (24).

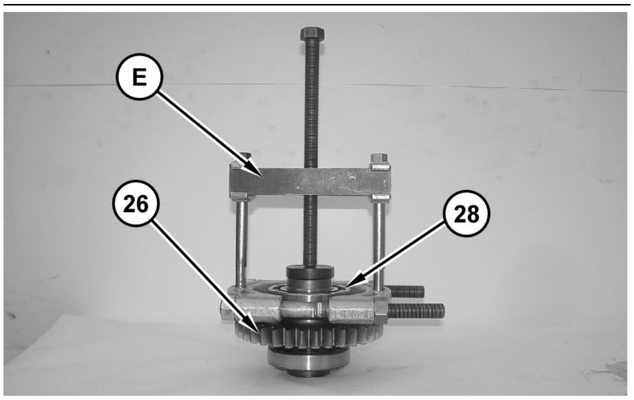


Illustration 30 g01265932

**21.** Use Tooling (E) in order to remove bearings (28) from gear (26).

**22.** Repeat Steps 18 through 21 in order to remove the remaining adapter, gear, and bearings.

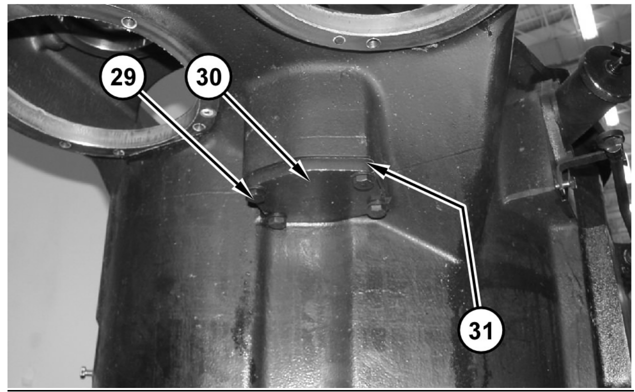


Illustration 31 g01266612

**23.** Remove bolts (29), cover (30), and O-ring seal (31).

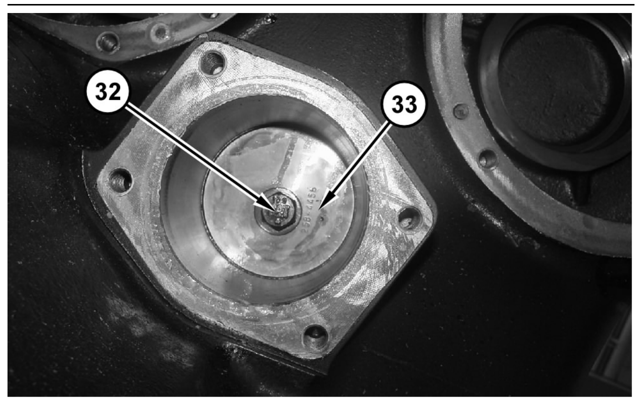


Illustration 32 g01265950

**24.** Remove bolt (32). Remove shaft (33).

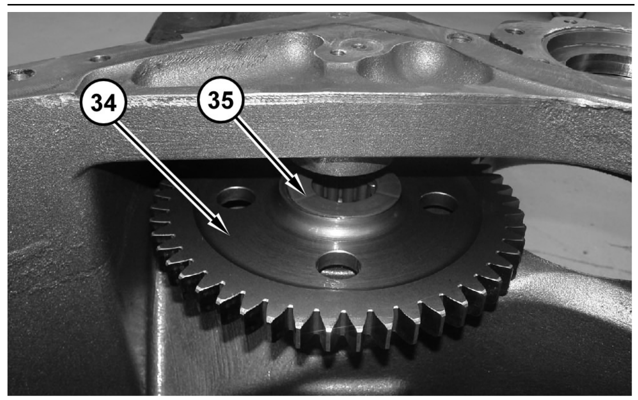


Illustration 33 g01266697

**25.** Remove gear (34). Remove thrust discs (35).

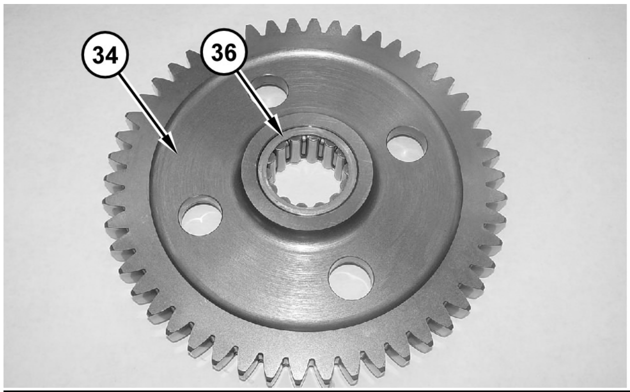


Illustration 34 g01266709

**26.** Remove bearing (36) from gear (34).

i02648905

# Pump Drive - Install

**SMCS Code:** 3108-012

## Installation Procedure

Table 4

| Required Tools | | | |
|---|---|---|---|
| Tool | Part Number | Part Description | Qty |
| A | 138-7575 | Link Brackets | 4 |
| B | 1U-9202 | Lever Puller Hoist | 1 |
| C | 1P-2420 | Transmission Repair Stand | 1 |
| F | 1U-8846 | Gasket Sealant | - |

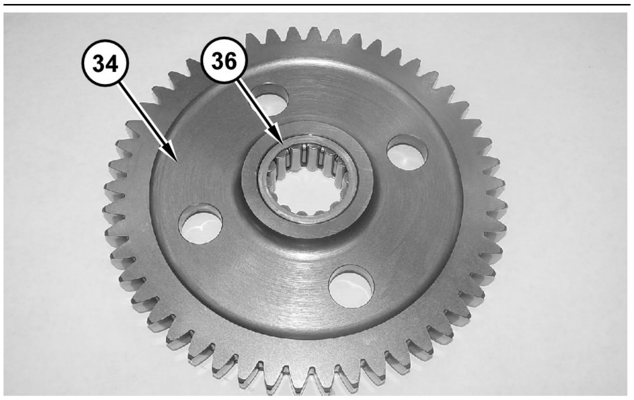


Illustration 35 g01266709

**1.** Install bearing (36) into gear (34).

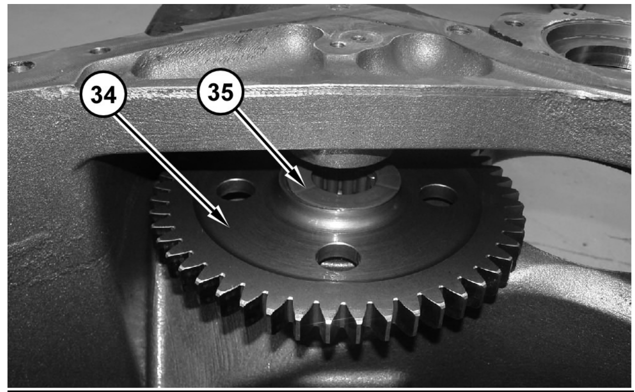


Illustration 36 g01266697

**2.** Install thrust discs (35). Install gear (34).

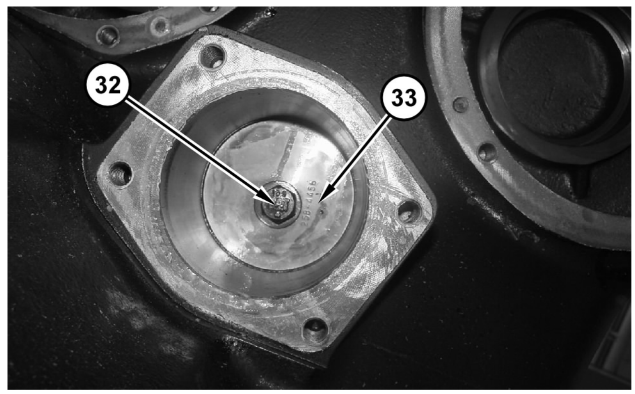


Illustration 37 g01265950

**3.** Install shaft (33). Install bolt (32).

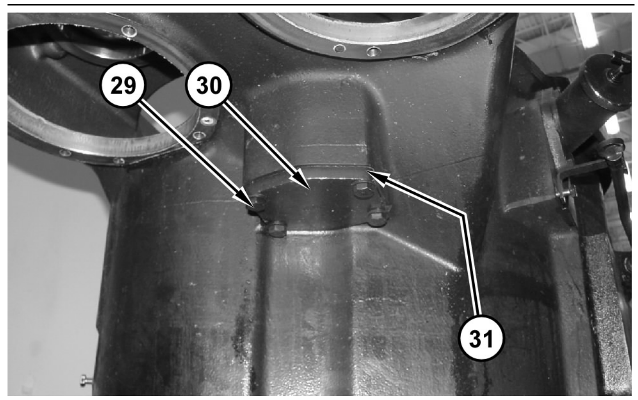


Illustration 38 g01266612

**4.** Install O-ring seal (31), cover (30), and bolts (29).

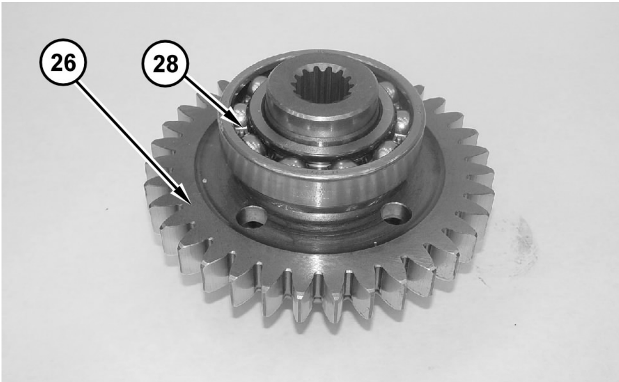


Illustration 39 g01266763

5. Raise the temperature of bearings (28). Install bearings (28) onto gear (26).

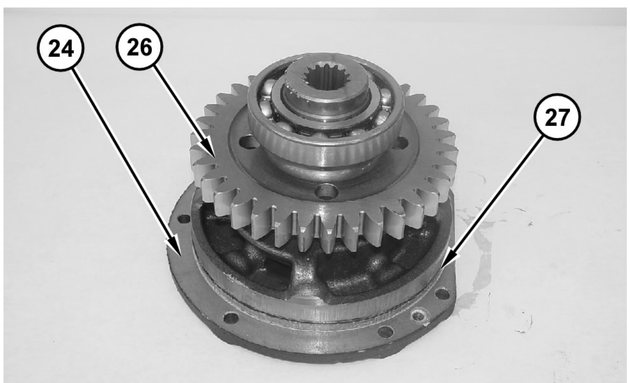


Illustration 40 g01265924

6. Install O-ring seal (27) and gear (26) onto adapter (24).

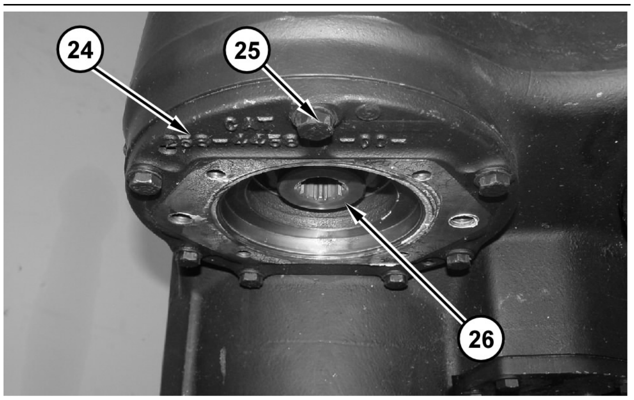


Illustration 41 g01266820

7. Install gear (26) and adapter (24). Install bolts (25).

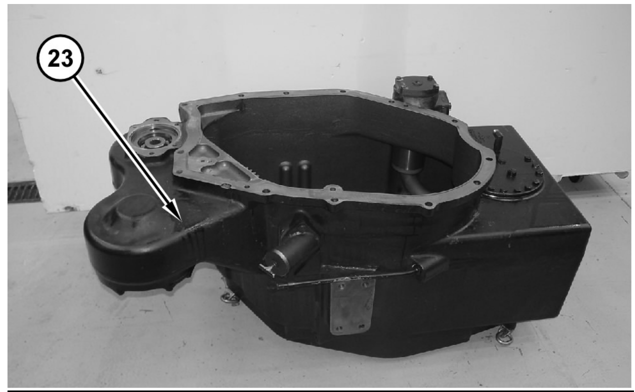


Illustration 42 g01265910

8. Use Tooling (A), Tooling (B), and a suitable lifting device in order to reposition case assembly (23). The weight of case assembly (23) is approximately 365 kg (800 lb). Apply Tooling (F) to case assembly (23). Install case assembly (23).

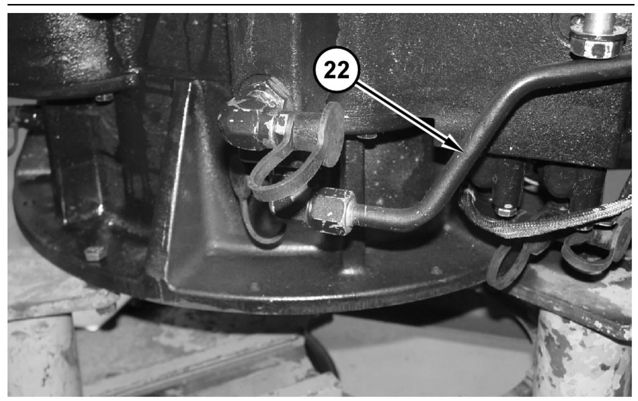


Illustration 43 g01265880

9. Install tube assembly (22).

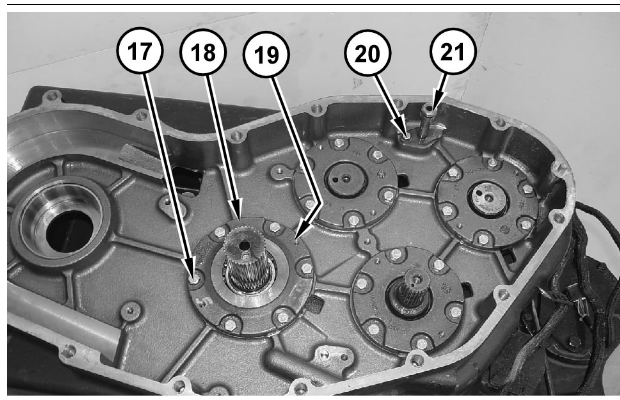


Illustration 44 g01265863

10. Install tube assembly (21). Install bolt (20).

11. Install shims (19) and retainer (18). Install bolts (17).

**Note:** If new bearings are installed, check the end play of the shaft assembly. Refer to Disassembly and Assembly, “Transmission - Assemble”.

**12.** Repeat Step 11 for the other retainers.

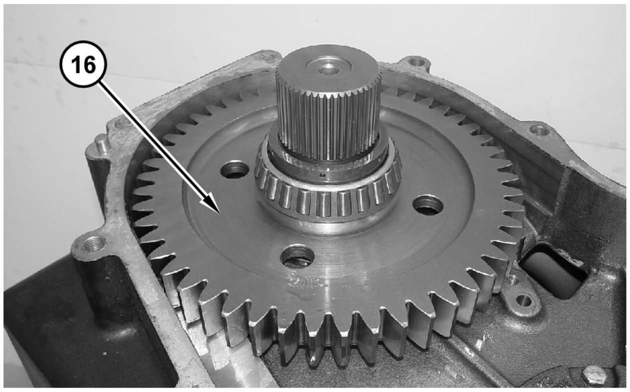


Illustration 45 g01265831

**13.** Use two people in order to install gear assembly (16). The weight of gear assembly (16) is approximately 30 kg (70 lb).

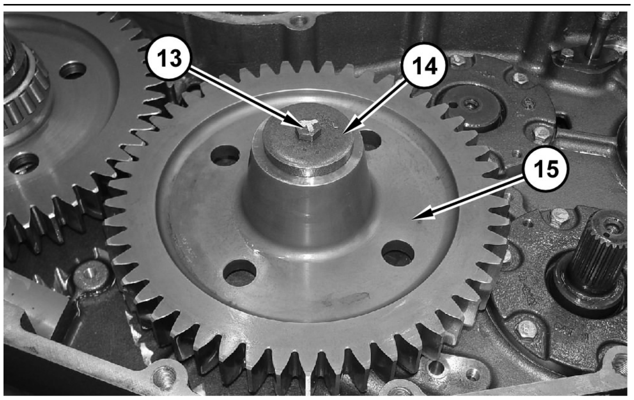


Illustration 46 g01265829

**14.** Use two people in order to install gear (15). The weight of gear (15) is approximately 23 kg (50 lb). Install retainer (14) and bolt (13).

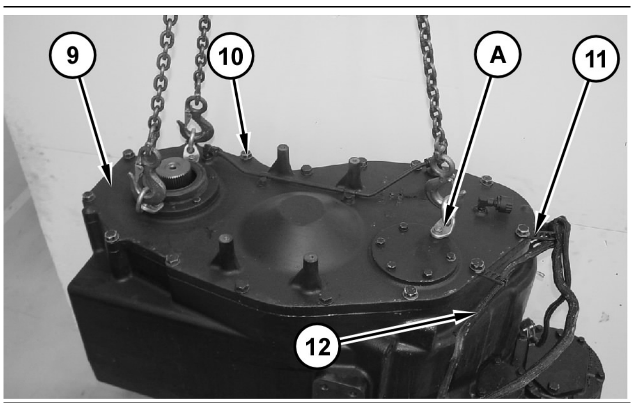


Illustration 47 g01265805

**15.** Apply Tooling (F) to cover assembly (9).

**16.** Use Tooling (A) and a suitable lifting device in order to install cover assembly (9). The weight of cover assembly (9) is approximately 60 kg (130 lb).

**17.** Check the end play of the shaft assembly. Refer to Disassembly and Assembly, “Transmission - Assemble”.

**18.** Position harness assembly (12).

**19.** Install bracket assemblies (11) and bolts (10).

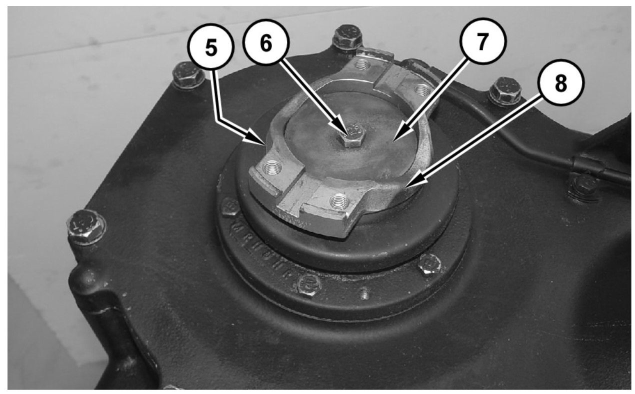


Illustration 48 g01265795

**20.** Install O-ring seal (5). Install yoke (8), retainer (7), and bolt (6).

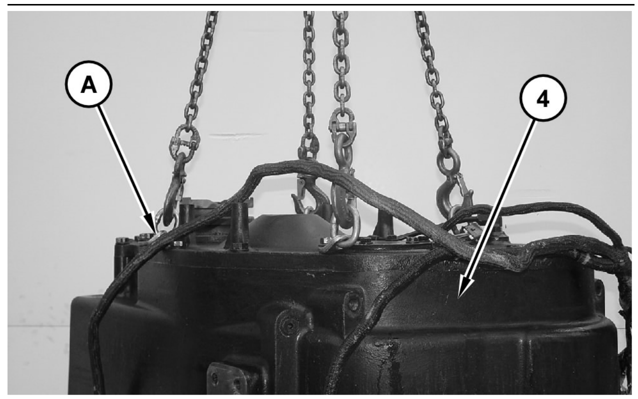


Illustration 49 g01265775

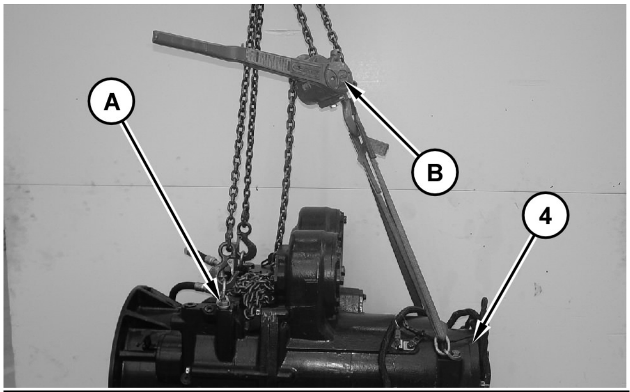


Illustration 50 g01265774

**21.** Use Tooling (A), Tooling (B), and a suitable lifting device in order to reposition transmission (4). The weight of transmission (4) is approximately 1315 kg (2900 lb).

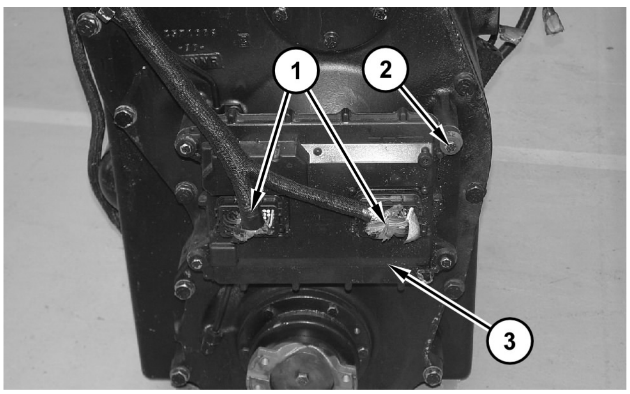


Illustration 51 g01265765

**22.** Install Electronic Control Module (3) and bolts (2).

**23.** Connect harness assemblies (1).

**End By:**

**a.** Install the input speed sensor. Refer to Disassembly and Assembly, "Speed Sensor (Transmission) - Install".

i02648921

# Transmission - Disassemble

**SMCS Code:** 3002-015; 3030-015; 3150-015; 3159-015

## Disassembly Procedure

Table 5

| Required Tools | | | |
|---|---|---|---|
| Tool | Part Number | Part Description | Qty |
| A | 138-7575 | Link Brackets | 4 |
| B | 1U-9202 | Lever Puller Hoist | 1 |
| C | 1P-2420 | Transmission Repair Stand | 1 |
| D | 154-6181 | Forcing Screws | 2 |
| E | 203-5581 | Plate | 1 |
| F | 1P-2322 | Combination Puller | 1 |
| | 8B-7560 | Step Plate | 1 |
| G | FT-2769 | Table | 1 |
| H | 5P-4758 | Retaining Ring Pliers As | 1 |
| J | 207-8153 | Shaft Retainer | 1 |

**Start By:**

**a.** Remove the input speed sensor. Refer to Disassembly and Assembly, "Speed Sensor (Transmission) - Remove".

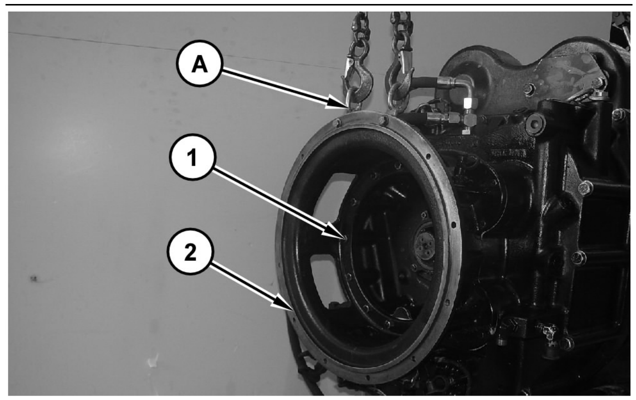


Illustration 52 g01269011

**1.** Attach Tooling (A) and a suitable lifting device to bell housing (2). The weight of bell housing (2) is approximately 35 kg (75 lb). Remove bolts (1). Remove bell housing (2) and the O-ring seals.

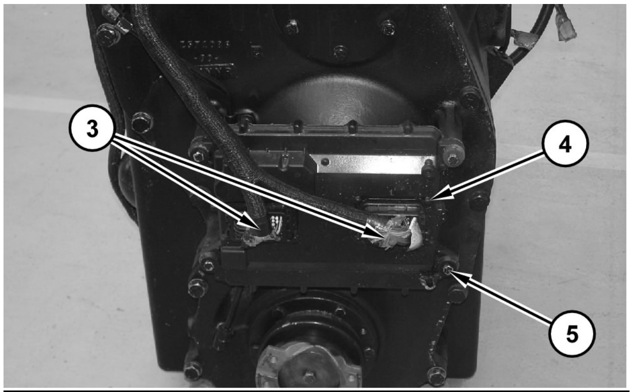


Illustration 53 g01269023

**2.** Disconnect harness assemblies (3). Remove bolts (5) and electronic control module (4).

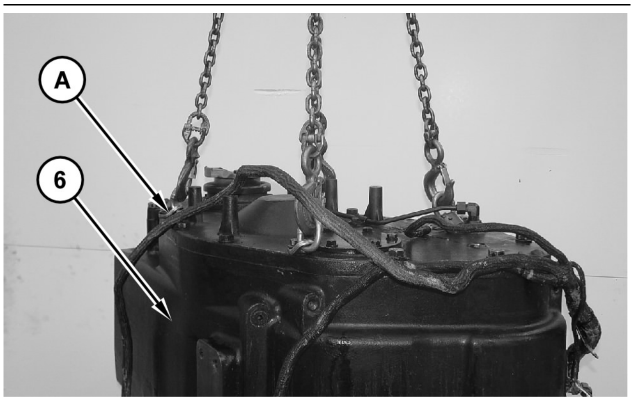


Illustration 54 g01269041

**3.** Use Tooling (A), Tooling (B), and a suitable lifting device in order to reposition transmission (6) onto Tooling (C). The weight of transmission (6) is approximately 1315 kg (2900 lb).

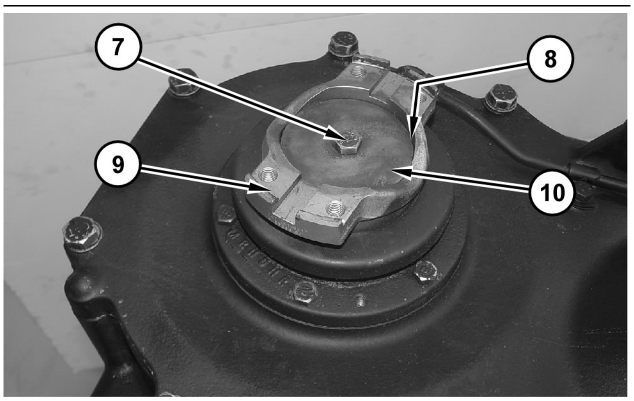


Illustration 55 g01269046

**4.** Remove bolt (7) and retainer (10). Remove yoke (9) and O-ring seal (8).

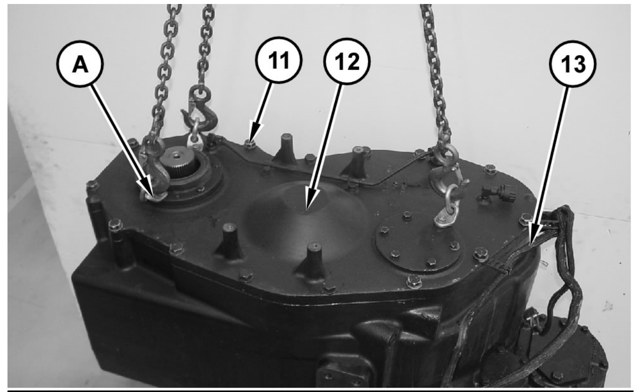


Illustration 56 g01269055

**5.** Reposition harness assembly (13). Attach Tooling (A) and a suitable lifting device to cover assembly (12). The weight of cover assembly (12) is approximately 60 kg (130 lb). Remove bolts (11) and cover assembly (12).

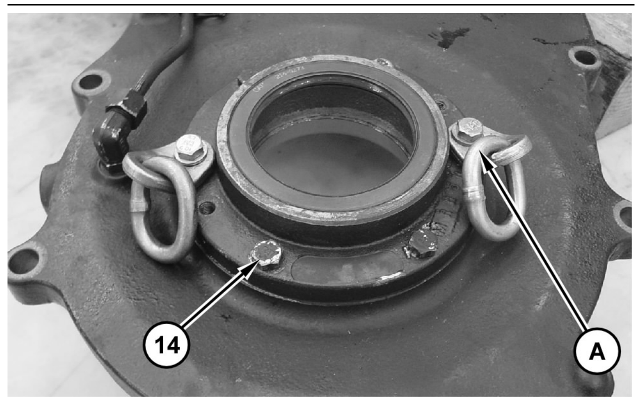


Illustration 57 g01269057

**6.** Remove bolts (14) and Tooling (A).

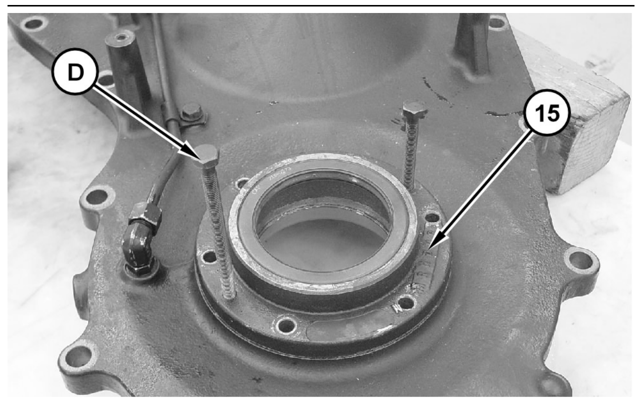


Illustration 58 g01269063

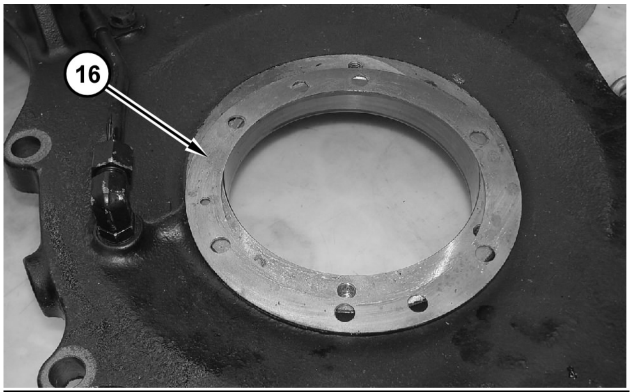


Illustration 59 g01269068

7. Use Tooling (D) in order to remove bearing cage (15). Remove shims (16).

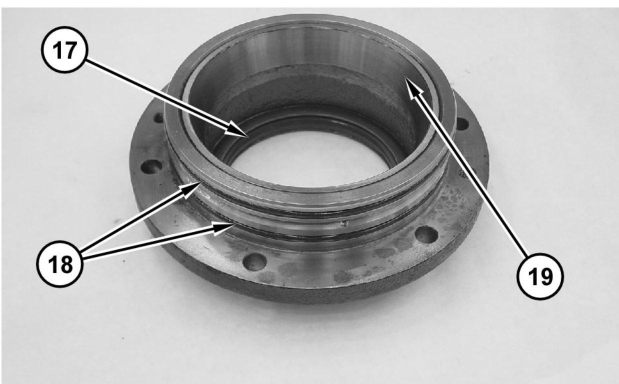


Illustration 60 g01269118

8. Remove O-ring seals (18) and lip seal (17). Remove bearing cup (19).

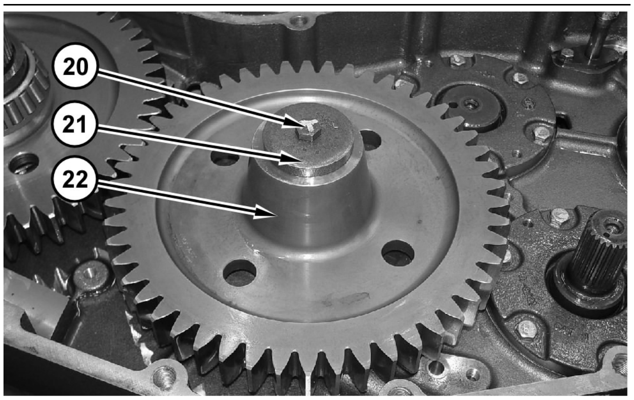


Illustration 61 g01269176

9. Remove bolt (20) and retainer (21). Use two people in order to remove gear (22). The weight of gear (22) is approximately 23 kg (50 lb).

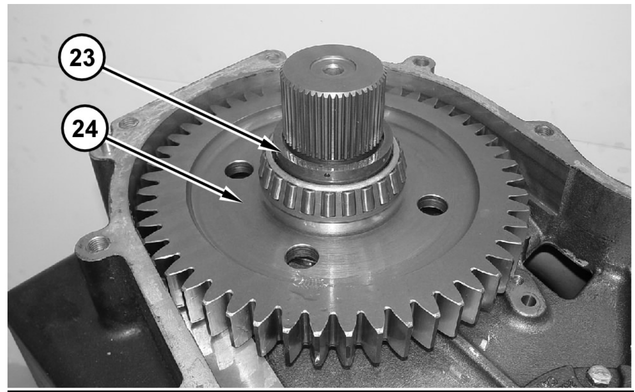


Illustration 62 g01269183

10. Remove ring (23). Use two people in order to remove gear (24). The weight of gear (24) is approximately 32 kg (70 lb).

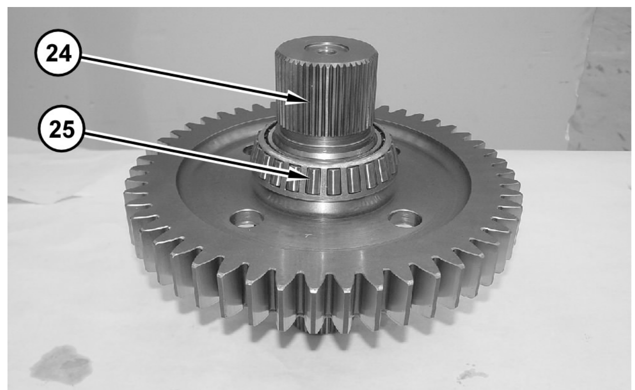


Illustration 63 g01269221

11. Remove bearing cones (25) from gear (24).

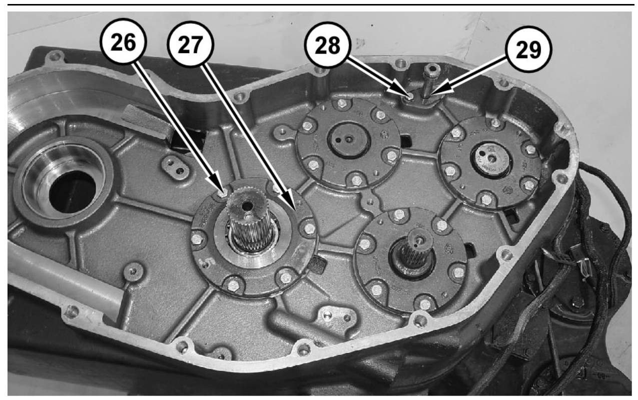


Illustration 64 g01269222

12. Remove bolt (28) and tube assembly (29).

13. Remove bolt (26) and bearing cage (27).

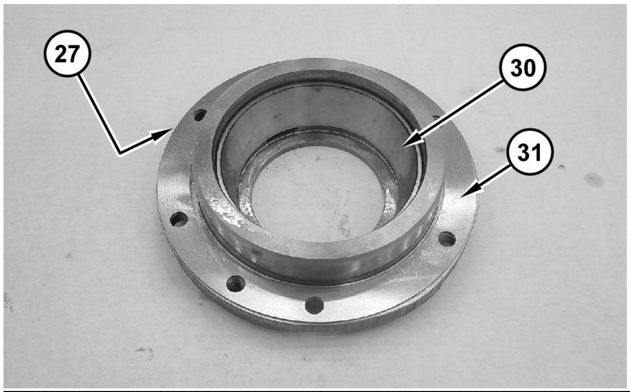


Illustration 65 g01269226

**14.** Remove shims (31). Remove bearing cup (30) from bearing cage (27).

**15.** Repeat Steps 13 and 14 for the remaining bearing cages.

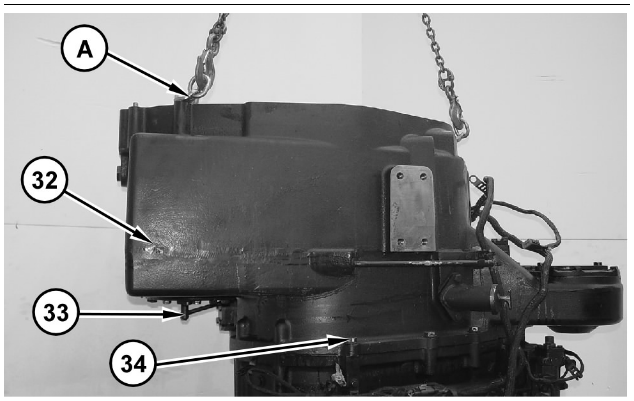


Illustration 66 g01269240

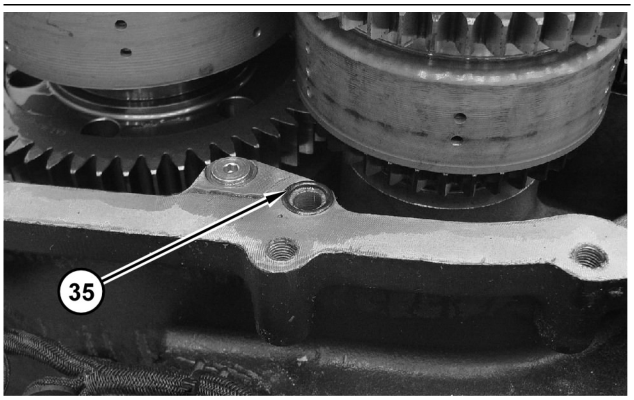


Illustration 67 g01269241

**16.** Remove tube assembly (33). Attach Tooling (A) and a suitable lifting device to case assembly (32). The weight of case assembly (32) is approximately 365 kg (800 lb). Remove bolts (34) and case assembly (32). Remove O-ring seal (35).

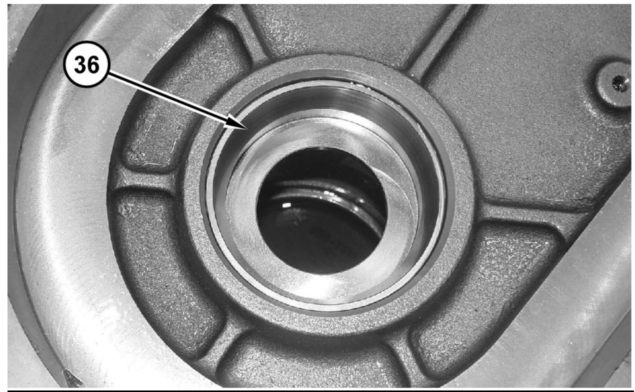


Illustration 68 g01269287

**17.** Remove bearing cup (36).

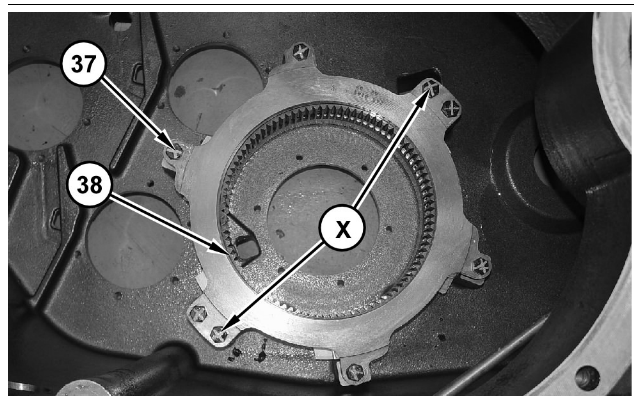


Illustration 69 g01329460

**Note:** Do not remove bolts (X).

**18.** Remove bolts (37). Use two people in order to remove clutch assembly (38). The weight of clutch assembly (38) is approximately 25 kg (55 lb).

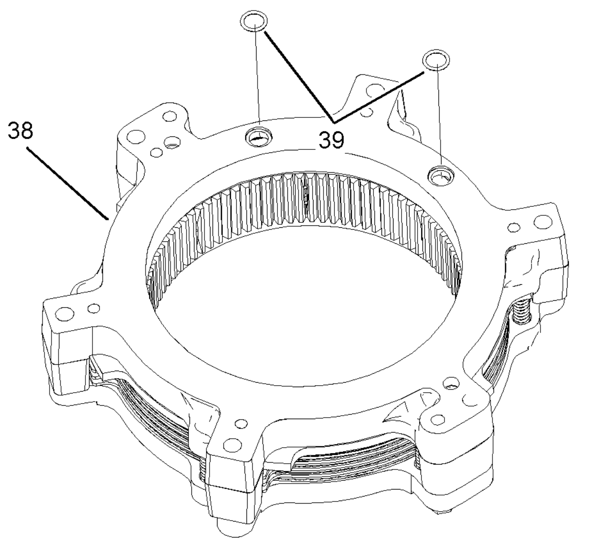


Illustration 70 g01269430

**19.** Remove O-ring seals (39) from clutch assembly (38).

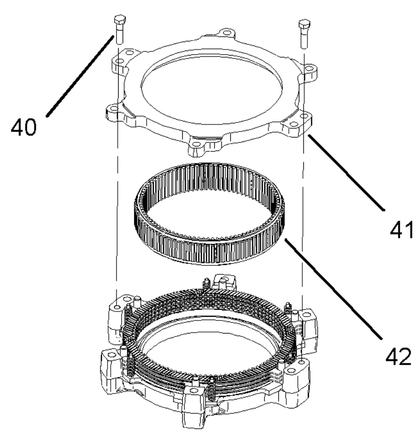


Illustration 71 g01269435

**20.** Remove bolts (40). Remove reaction plate (41) and ring gear (42).

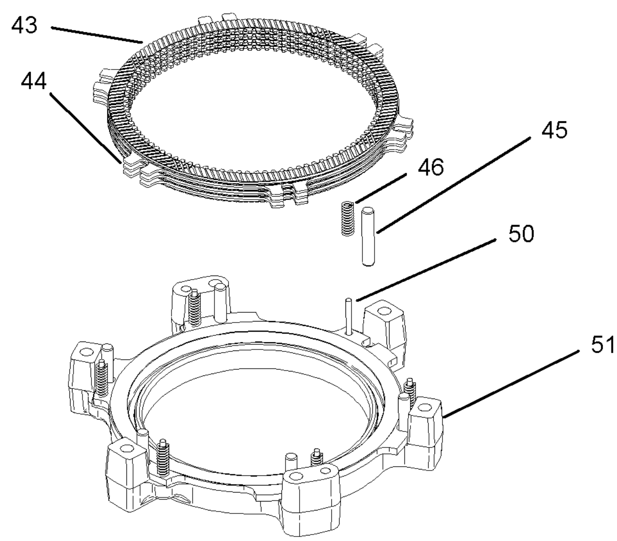


Illustration 72 g01269438

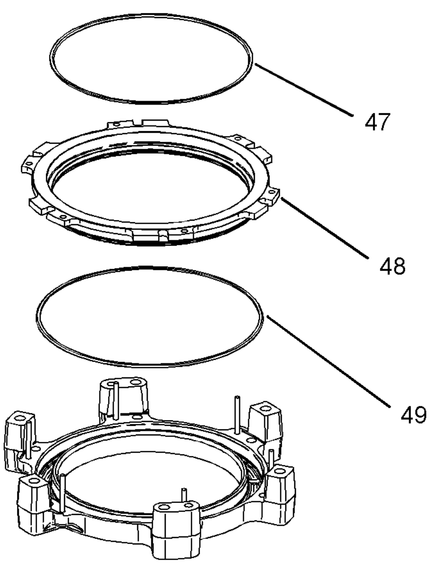


Illustration 73 g01269440

**WARNING**

**Personal injury can result from being struck by parts propelled by a released spring force.**

**Make sure to wear all necessary protective equipment.**

**Follow the recommended procedure and use all recommended tooling to release the spring force.**

**21.** Remove disc (43) and plates (44). Remove dowels (45) and springs (46). Remove dowels (50) from housing (51), if necessary.

**22.** Remove piston (48) from housing (51). Remove seals (47) and (49) from piston (48).

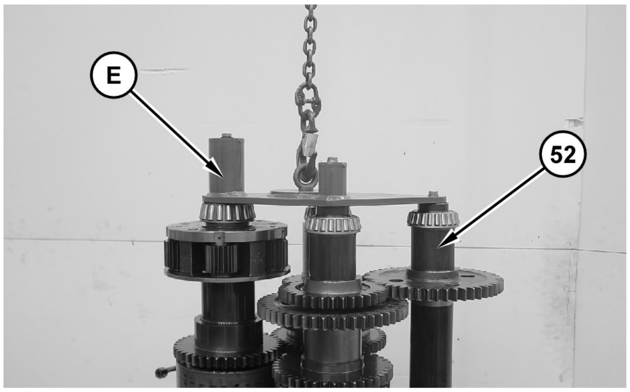


Illustration 74 g01269516

**23.** Attach Tooling (E) and a suitable lifting device to shaft assemblies (52). The weight of shaft assemblies (52) is approximately 375 kg (820 lb). Remove shaft assemblies (52).

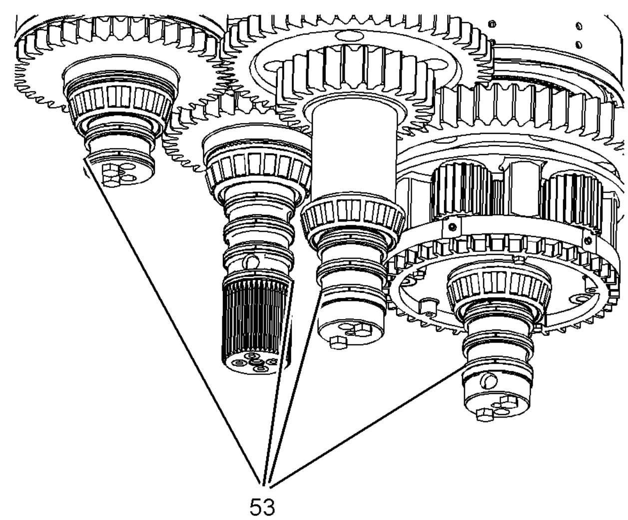


Illustration 75 g01269519

**24.** Remove ring seals (53).

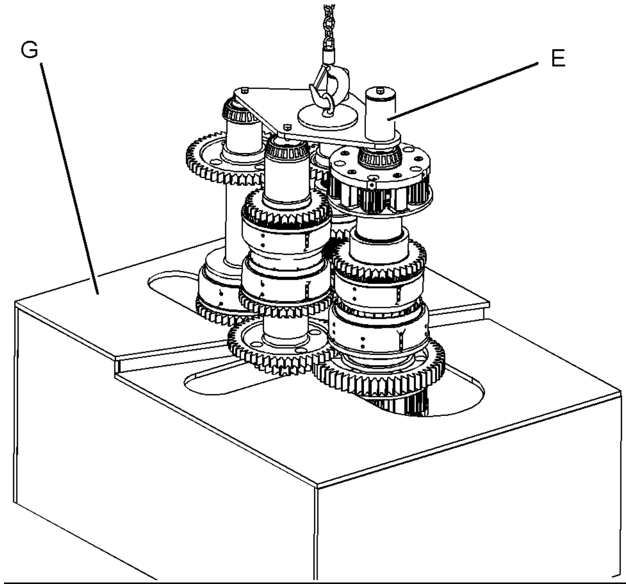


Illustration 76 g01269526

**25.** Place the shaft assemblies onto Tooling (G). Remove Tooling (E).

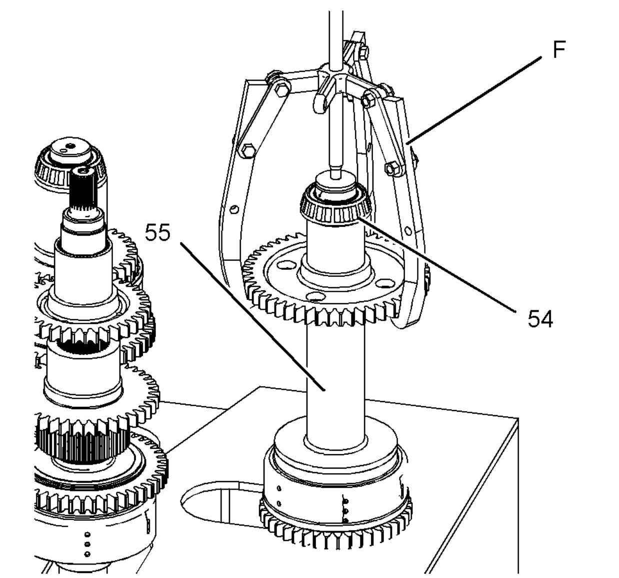


Illustration 77 g01269638

Reverse Shaft

**26.** Use Tooling (F) in order to remove bearing cone (54) from shaft assembly (55).

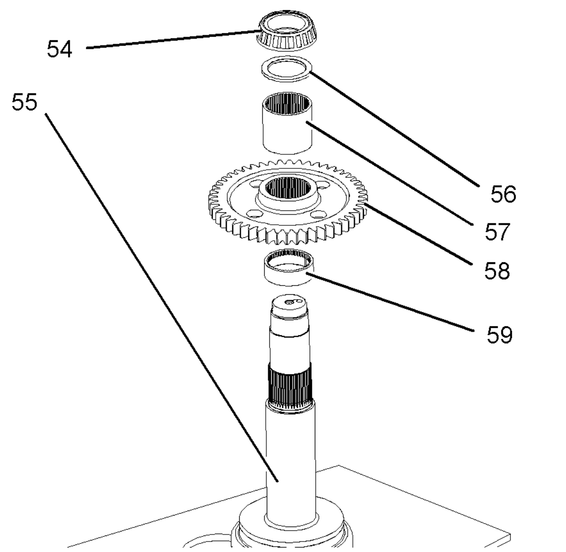


Illustration 78 g01269685

**27.** Remove bearing cone (54), spacer (56), spacer (57), gear (58), and spacer (59) from shaft assembly (55).

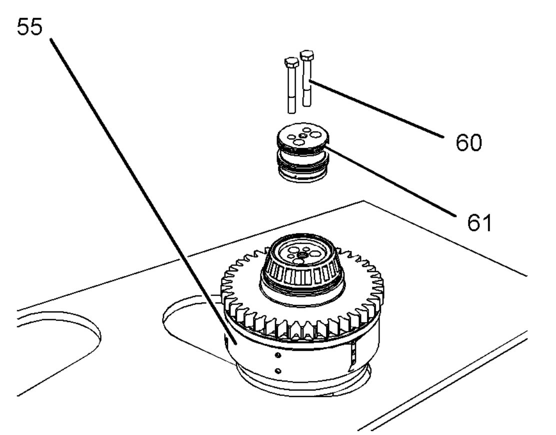


Illustration 79 g01269743

**28.** Rotate shaft assembly (55) by 180 degrees. Remove bolts (60) and remove seal carrier (61).

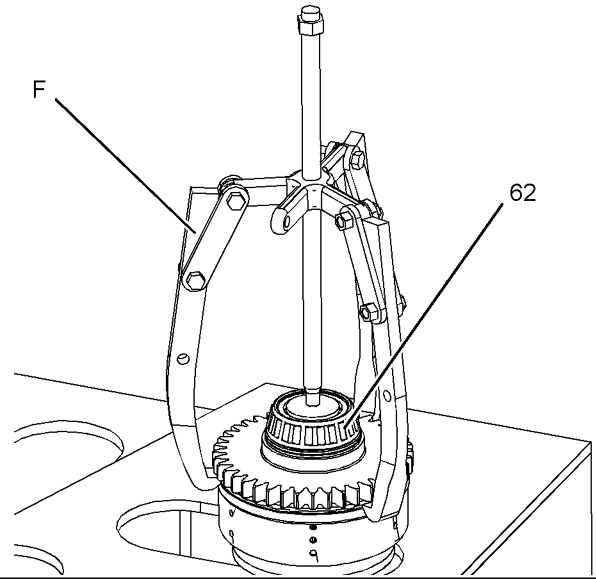


Illustration 80 g01269746

**29.** Use Tooling (F) in order to remove bearing cone (62).

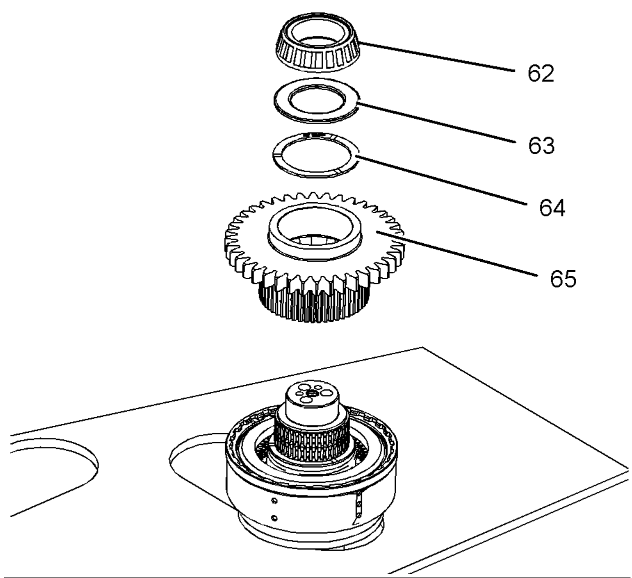


Illustration 81 g01269751

**30.** Remove bearing cone (62) and spacer (63). Remove thrust washer (64) and gear (65).

 

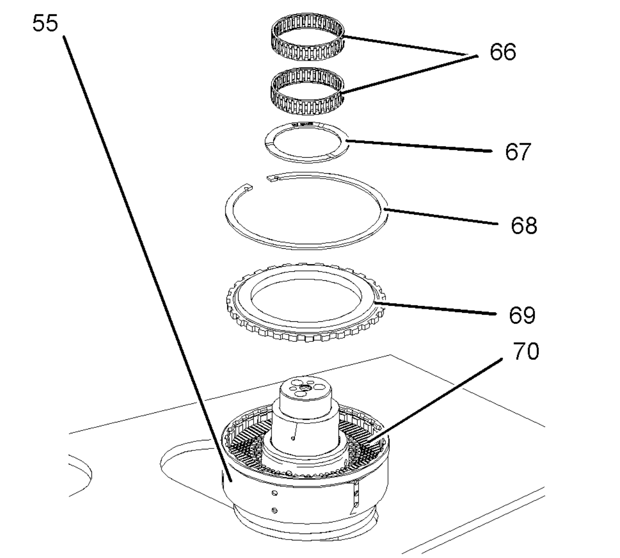


Illustration 82 g01269758

**31.** Remove bearings (66) and thrust washer (67). Use Tooling (H) in order to remove retaining ring (68). Remove clutch plate (69). Remove the friction discs and plates (70) from shaft assembly (55).

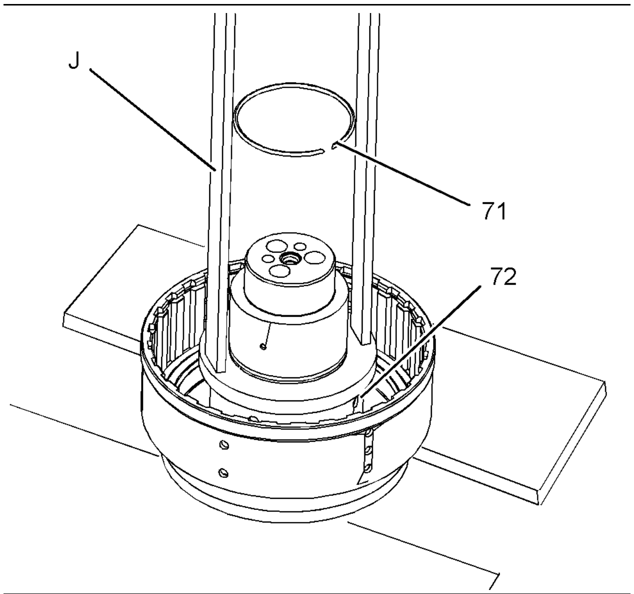


Illustration 83 g01269765

**⚠ WARNING**

**Personal injury can result from being struck by parts propelled by a released spring force.**

**Make sure to wear all necessary protective equipment.**

**Follow the recommended procedure and use all recommended tooling to release the spring force.**

**32.** Use a suitable press and Tooling (J) in order to compress spring (72). Remove retaining ring (71).

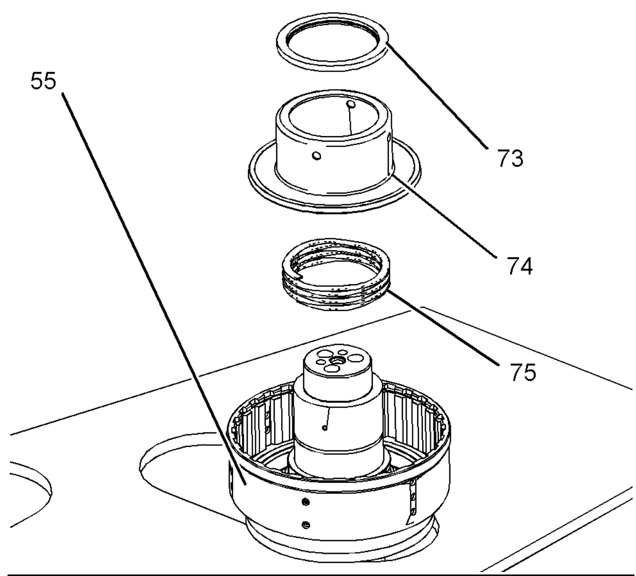


Illustration 84 g01269767

**33.** Remove spacer (73), seal assembly (74), and spring (75) from shaft assembly (55).

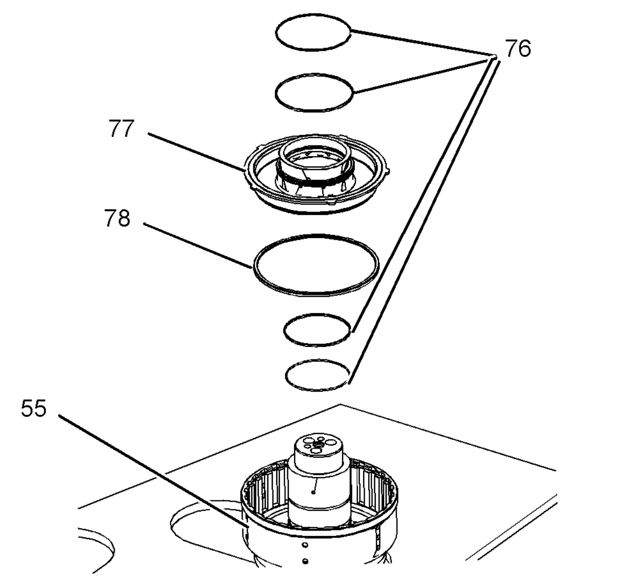


Illustration 85 g01270206

**34.** Remove piston (77) from shaft assembly (55). Remove seals (76) from piston (77). Remove seal (78) from piston (77).

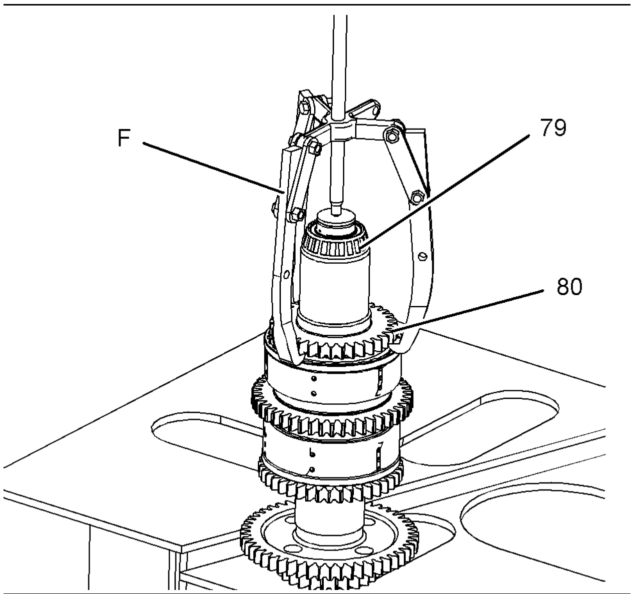


Illustration 86 g01270208

Intermediate Shaft

**35.** Use Tooling (F) in order to remove bearing cone (79) from shaft assembly (80).

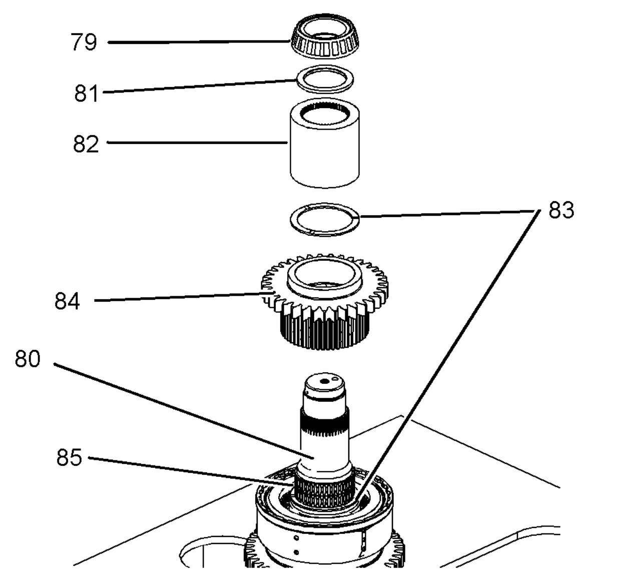


Illustration 87 g01270211

**36.** Remove bearing cone (79), spacer (81), spacer (82), thrust washer (83), and gear (84) from shaft assembly (80). Remove bearings (85) and thrust washer (83).

**Note:** The procedure for the disassembly of the clutch packs are identical.

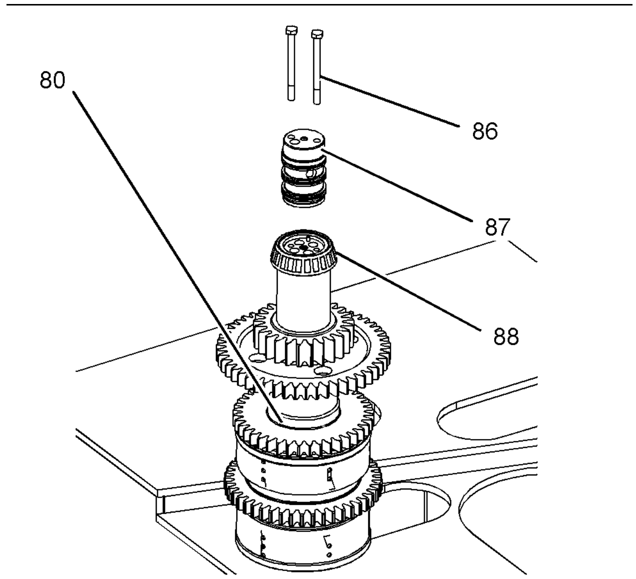


Illustration 88 g01269959

**37.** Rotate shaft assembly (80) by 180 degrees. Remove bolts (86) and seal carrier (87). Remove bearing cone (88) from shaft assembly (80).

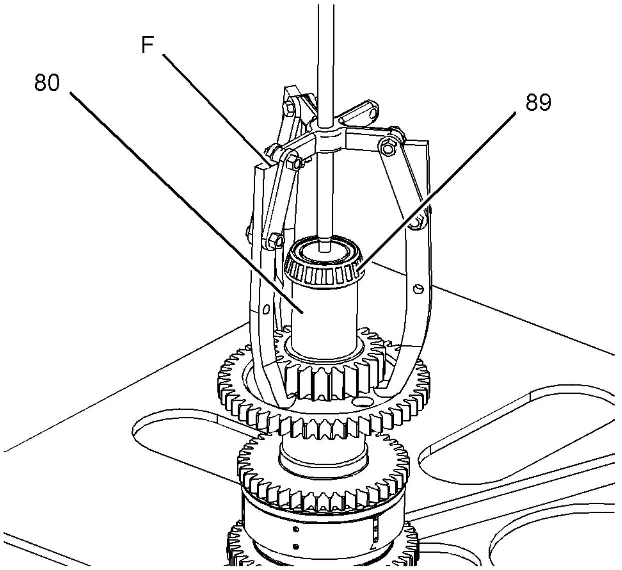


Illustration 89 g01269966

**38.** Use Tooling (F) in order to remove bearing cone (89) from shaft assembly (80).

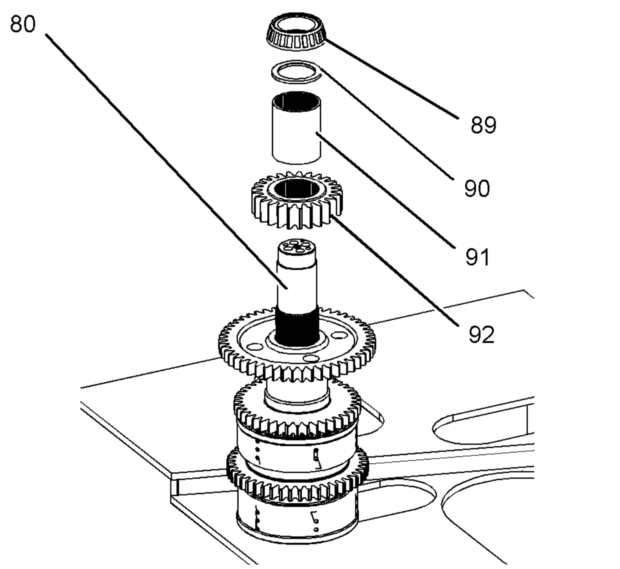


Illustration 90 g01269968

**39.** Remove bearing cone (89), spacer (90), spacer (91), and gear (92) from shaft assembly (80).

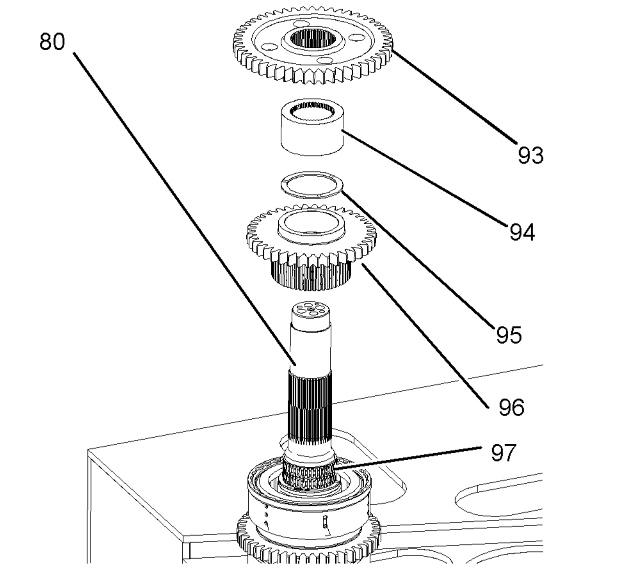


Illustration 91 g01269969

**40.** Remove gear (93), spacer (94), thrust washer (95), and gear (96). Remove bearing (97) and thrust washer (95) from shaft assembly (80).

**Note:** The procedure for the disassembly of the clutch packs are identical.

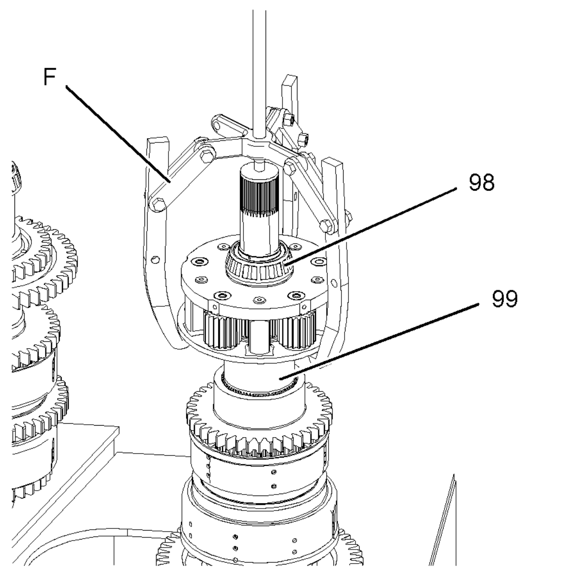


Illustration 92 g01269974

Output Shaft

**41.** Use Tooling (F) in order to remove bearing cone (98) from shaft assembly (99).

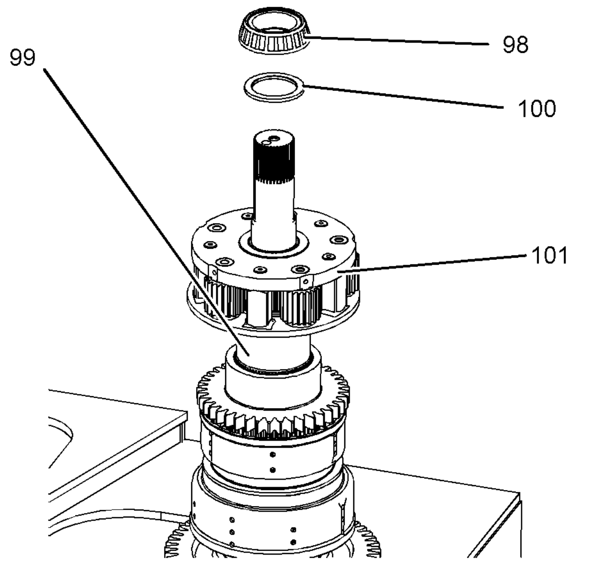


Illustration 93 g01269976

**42.** Remove bearing cone (98), spacer (100), and planetary carrier (101) from shaft assembly (99).

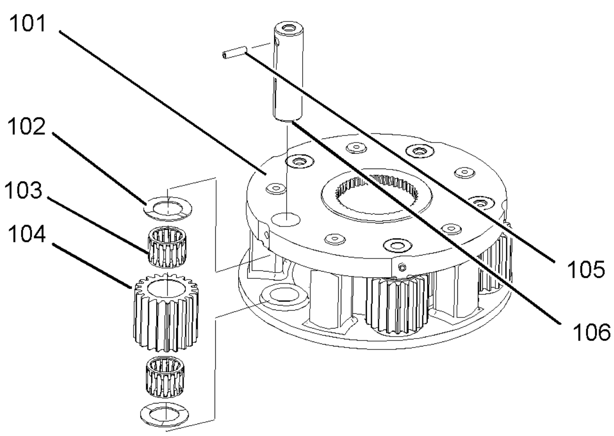


Illustration 94 g01269978

**Note:** Drive spring pin (105) into shaft (106) until shaft (106) can be removed. Do not drive spring pin (105) too far.

**43.** Drive spring pin (105) into shaft (106). Remove shaft (106), thrust discs (102), gear (104), and bearings (103) from carrier (101).

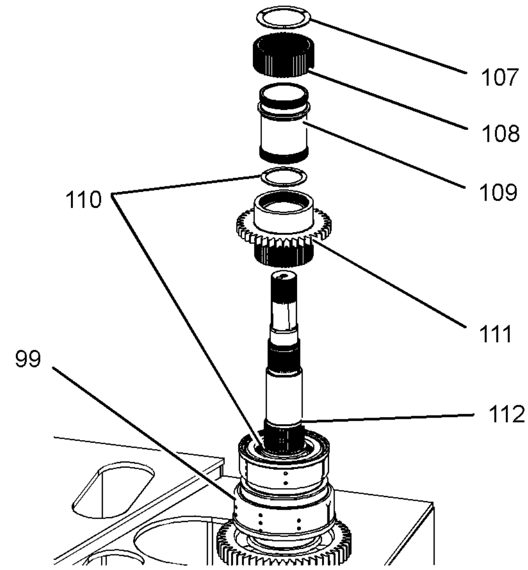


Illustration 95 g01269983

**44.** Remove thrust washer (107), sun gear (108), spacer (109), thrust washer (110), and gear (111). Remove bearings (112) and thrust washer (110) from shaft assembly (99).

**Note:** The procedure for the disassembly of the clutch packs are identical.

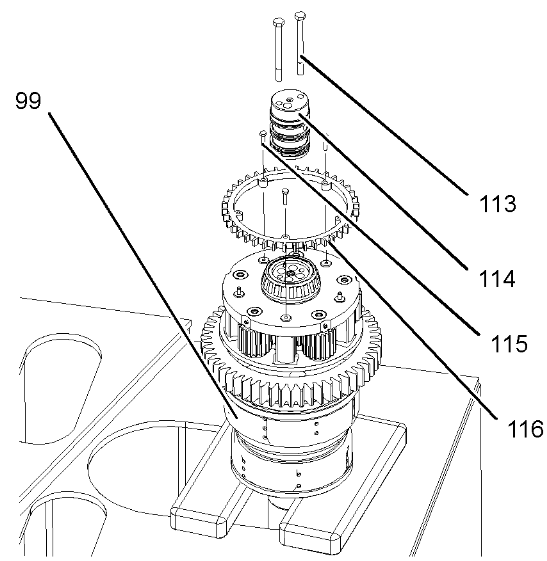


Illustration 96 g01269986

**45.** Rotate shaft assembly (99). Remove bolts (113), seal carrier (114), bolts (115), and rotor (116) from shaft assembly (99).

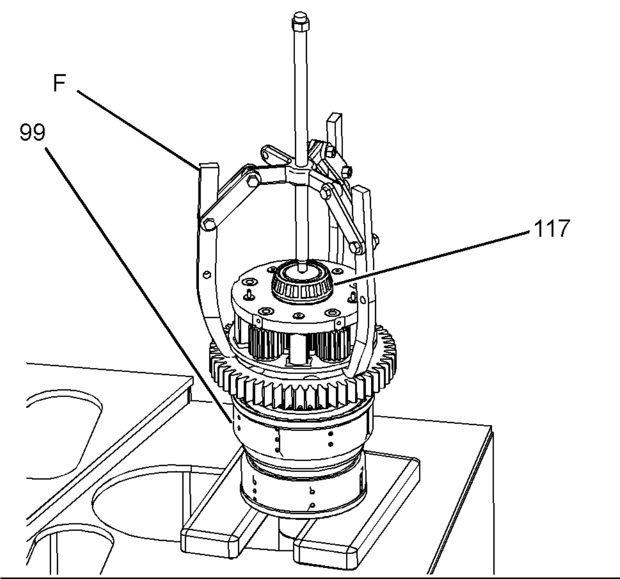


Illustration 97 g01270066

**46.** Use Tooling (F) to remove bearing cone (117) from shaft (99).

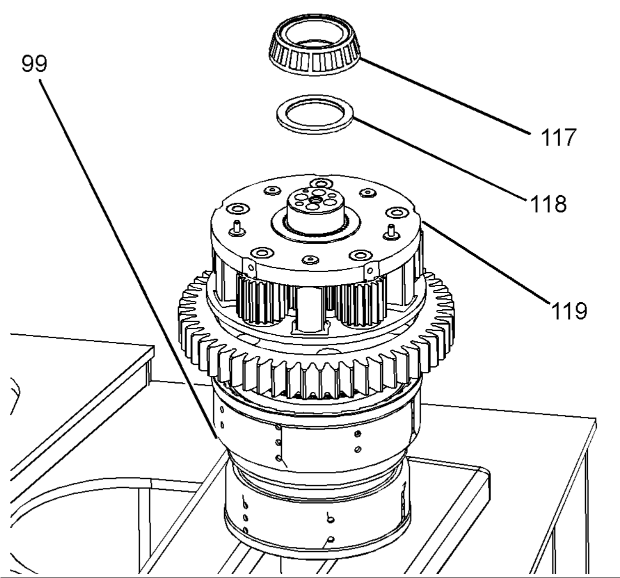


Illustration 98 g01270067

**47.** Remove bearing cone (117), spacer (118), and planetary carrier (119) from shaft assembly (99).

**Note:** The procedure for the disassembly of the planetary carriers are identical.

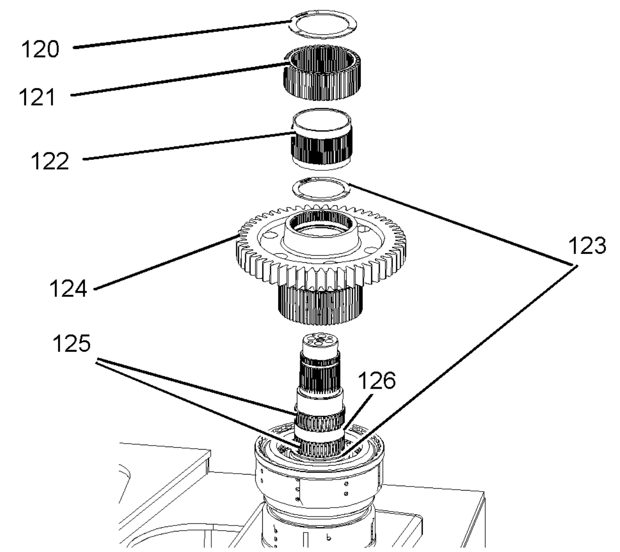


Illustration 99 g01270078

**48.** Remove thrust washer (120), sun gear (121), tube (122), thrust washers (123), and gear (124). Remove bearings (125) and spacer (126) from shaft assembly (99).

**Note:** The procedure for the disassembly of the clutch packs are identical.

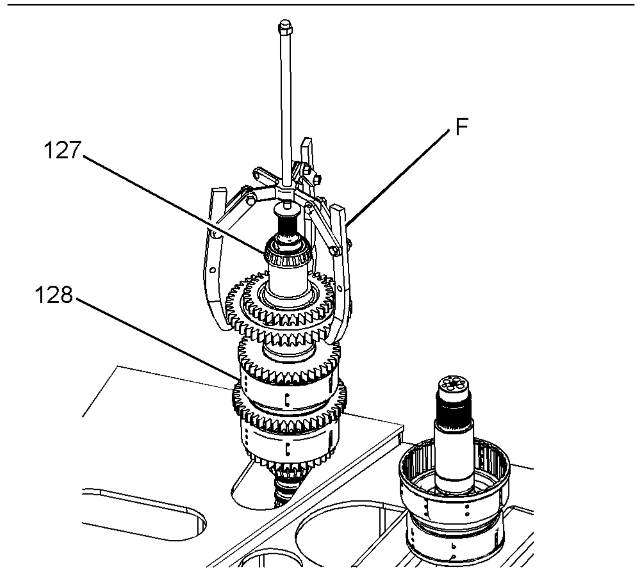


Illustration 100 g01270090

Input Shaft

**49.** Use Tooling (F) in order to remove bearing cone (127) from shaft assembly (128).

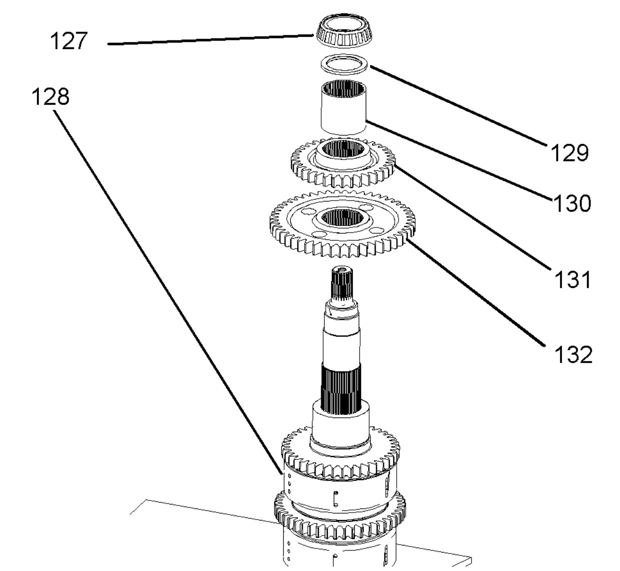


Illustration 101 g01270092

**50.** Remove bearing cone (127), spacer (129), spacer (130), gear (131), and gear (132) from shaft assembly (128).

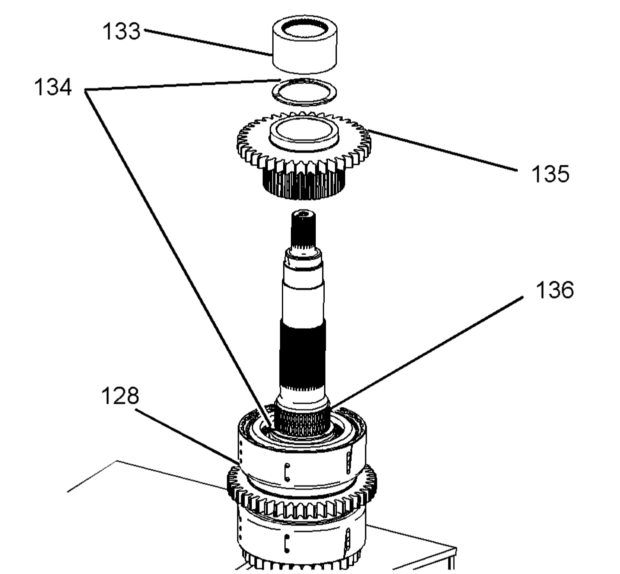


Illustration 102 g01270098

**51.** Remove spacer (133), thrust washer (134), and gear (135). Remove bearings (136) and thrust washer (134) from shaft assembly (128).

**Note:** The procedure for the disassembly of the clutch packs are identical.

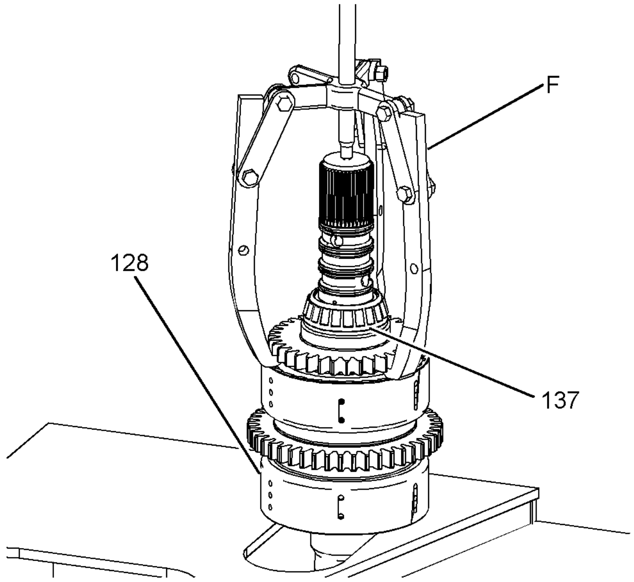


Illustration 103 g01270099

**Note:** Remove the seal rings before removal of bearing cone (137).

**52.** Rotate shaft assembly (128) by 180 degrees. Use Tooling (F) in order to remove bearing cone (137) from shaft assembly (128).

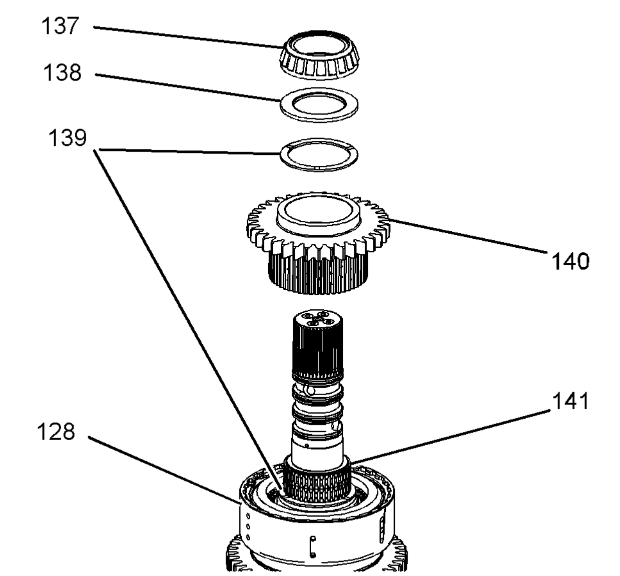


Illustration 104 g01270555

**53.** Remove bearing cone (137), spacer (138), thrust washer (139), and gear (140). Remove bearings (141) and thrust washer (139) from shaft assembly (128).

**Note:** The procedure for the disassembly of the clutch packs are identical.

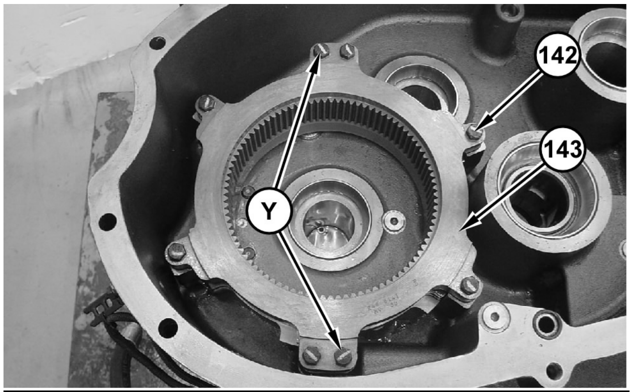


Illustration 105 g01329472

**Note:** Do not remove bolts (Y).

**54.** Remove bolts (142). Use two people in order to remove clutch assembly (143). The weight of clutch assembly (143) is approximately 25 kg (55 lb).

**55.** Refer to Steps 19 through 22 for disassembly of remaining clutch assemblies.

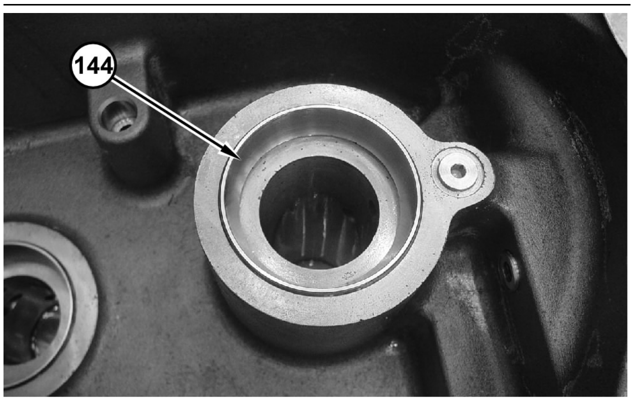


Illustration 106 g01270596

**56.** Remove bearing cups (144).

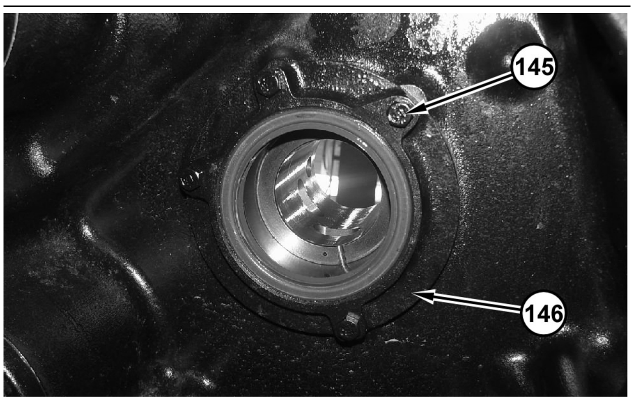


Illustration 107 g01270626

**57.** Remove bolts (145) and seal ring housing (146).

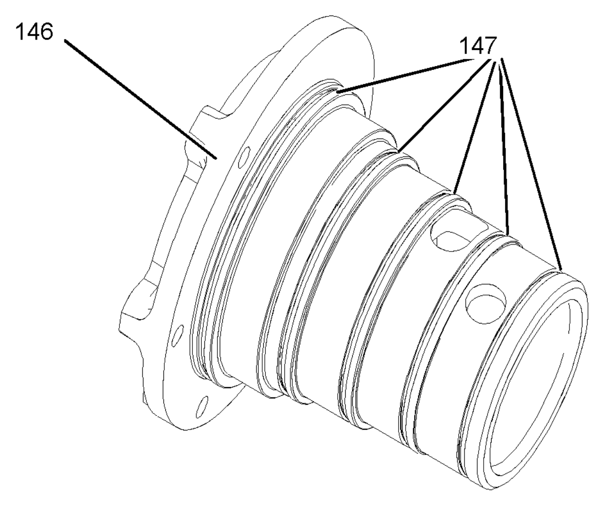


Illustration 108 g01270632

**58.** Remove O-ring seals (147) from seal ring housing (146).

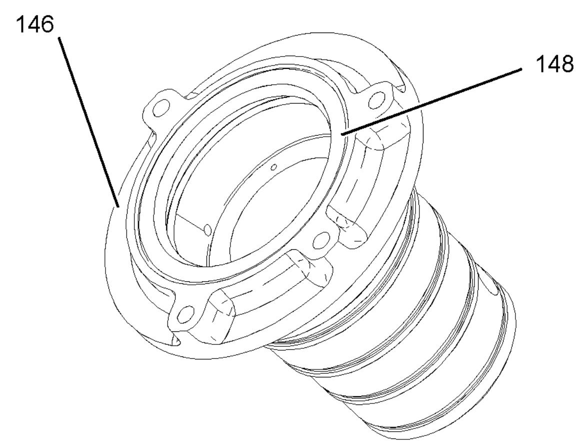


Illustration 109 g01270685

**59.** Remove lip seal (148) from seal ring housing (146).

i02649079

# Transmission - Assemble

**SMCS Code:** 3002-016; 3030-016; 3150-016; 3159-016

## Assembly Procedure

Table 6

| Required Tools | | | |
|---|---|---|---|
| Tool | Part Number | Part Description | Qty |
| A | 138-7575 | Link Brackets | 4 |
| B | 1U-9202 | Lever Puller Hoist | 1 |
| C | 1P-2420 | Transmission Repair Stand | 1 |
| D | 154-6181 | Forcing Screws | 2 |
| E | 203-5581 | Plate | 1 |
| G | FT-2769 | Table | 1 |
| H | 5P-4758 | Retaining Ring Pliers As | 1 |
| J | 207-8153 | Shaft Retainer | 1 |
| K | 8T-5096 | Dial Indicator Gp | 1 |
| L | 1U-8846 | Gasket Sealant | - |

**Note:** Cleanliness is an important factor. Before assembly, thoroughly clean all parts in cleaning fluid. Allow the parts to air dry. Do not use wiping cloths or rags to dry parts. Lint may be deposited on the parts which may cause trouble. Inspect all parts. If any parts are worn or damaged, use new parts for replacement. Dirt and other contaminants can damage the precision component. Perform assembly procedures on a clean work surface. Keep components covered and protected at all times.

**Note:** Check the O-ring seals, the gaskets, and the seals for wear or for damage. Replace the components, if necessary.

**Note:** Lubricate all seal rings and O-ring seals prior to assembly.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

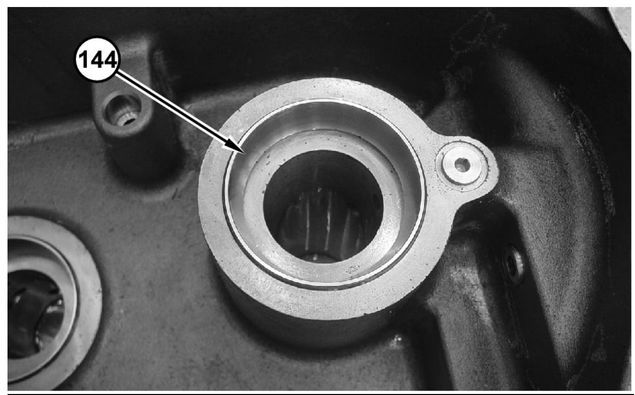


Illustration 110 g01270596

1. Lower the temperature of bearing cups (144). Install bearing cups (144).

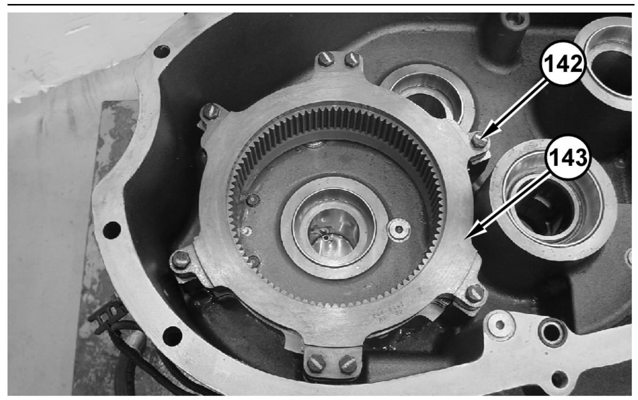


Illustration 111 g01270589

2. Refer to Steps 24 through 27 in order to assemble clutch assembly (143).

3. Use two people in order to install clutch assembly (143). The weight of clutch assembly (143) is approximately 25 kg (55 lb). Install bolts (142).

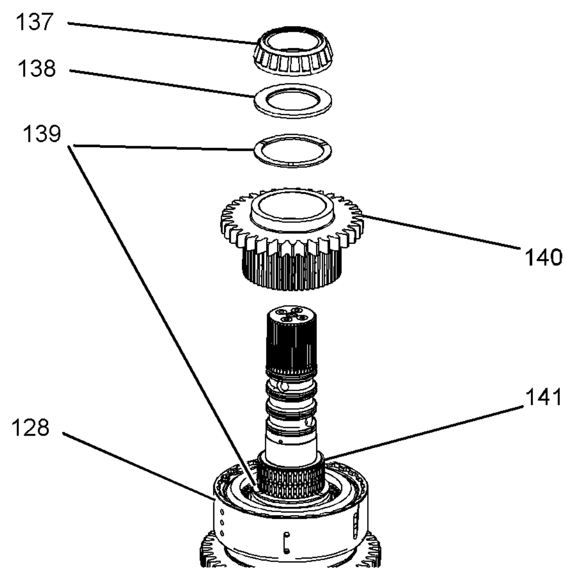


Illustration 112 g01270555

Input Shaft

4. Install bearings (141) and thrust washer (139) onto shaft assembly (128). Install gear (140), thrust washer (139), and spacer (138). Raise the temperature of bearing cone (137). Install bearing cone (137). Install the seal rings after installation of bearing cone (137).

**Note:** The procedure for the assembly of the clutch packs are identical.

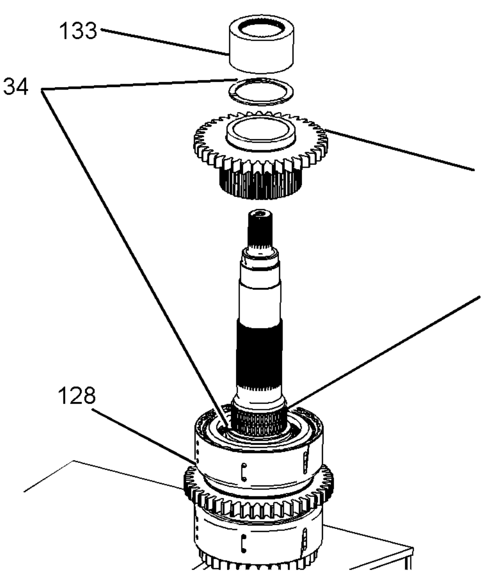


Illustration 113 g01270098

5. Install thrust washer (134) and bearings (136) onto shaft assembly (128). Install gear (135), thrust washer (134), and spacer (133).

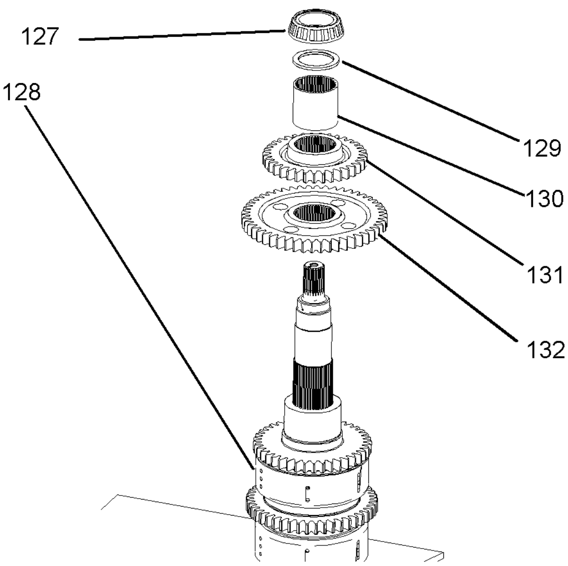


Illustration 114 g01270092

6. Install gear (132), gear (131), spacer (130), and spacer (129) onto shaft assembly (128).

7. Raise the temperature of bearing cone (127) and install bearing cone (127) onto shaft assembly (128).

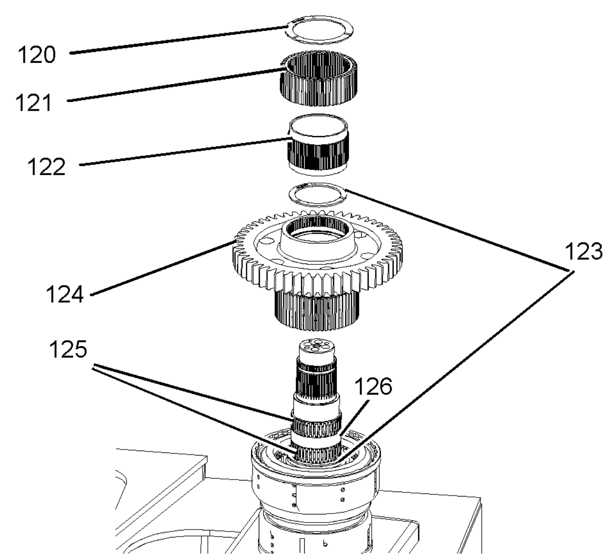


Illustration 115 g01270078

Output Shaft

8. Install spacer (126) and bearing (125) onto shaft assembly (99). Install gear (124), thrust washer (123), tube (122), sun gear (121), and thrust washer (120) onto shaft assembly (99).

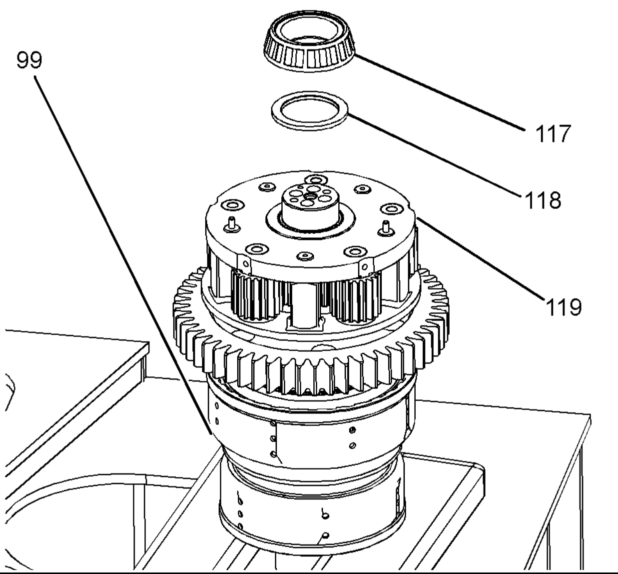


Illustration 116 g01270067

**9.** Install planetary carrier (119) and spacer (118) onto shaft assembly (99). Raise the temperature of bearing cone (117). Install bearing cone (117) onto shaft assembly (99).

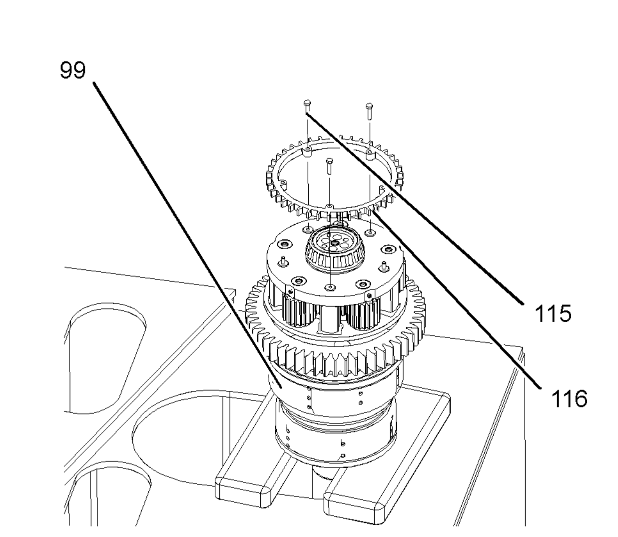


Illustration 117 g01280580

**10.** Install rotor (116) and bolts (115) onto shaft assembly (99).

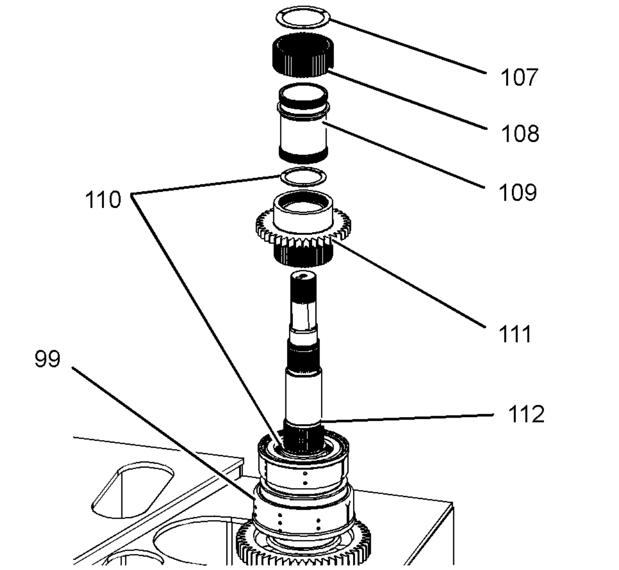


Illustration 118 g01269983

**11.** Install bearing (112) onto shaft assembly (99). Install gear (111), thrust washer (110), spacer (109), sun gear (108), and thrust washer (107) onto shaft assembly (99).

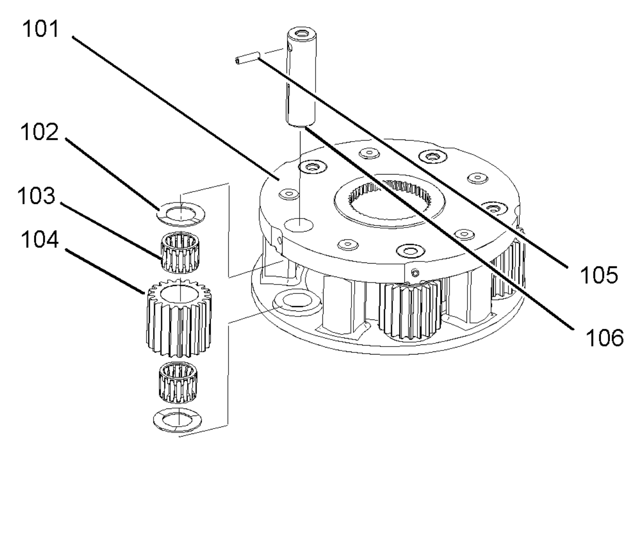


Illustration 119 g01269978

**12.** Position bearings (103), gear (104), thrust disc (102), and shaft (106) onto carrier (101). Install shaft (106). Install pin (105).

 

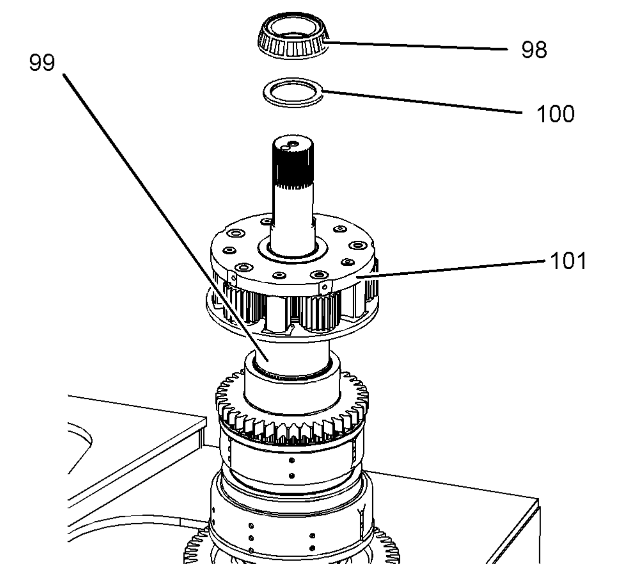


Illustration 120 g01269976

**13.** Install planetary carrier (101) and spacer (100) onto shaft assembly (99). Raise the temperature of bearing cone (98). Install bearing cone (98) onto shaft assembly (99).

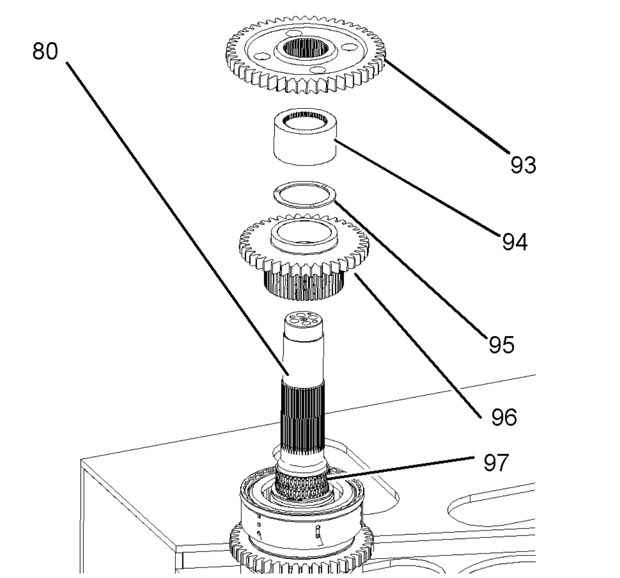


Illustration 121 g01269969

Intermediate Shaft

**14.** Install bearing (97) onto shaft assembly (80). Install gear (96), thrust washer (95), spacer (94), and gear (93) onto shaft assembly (80).

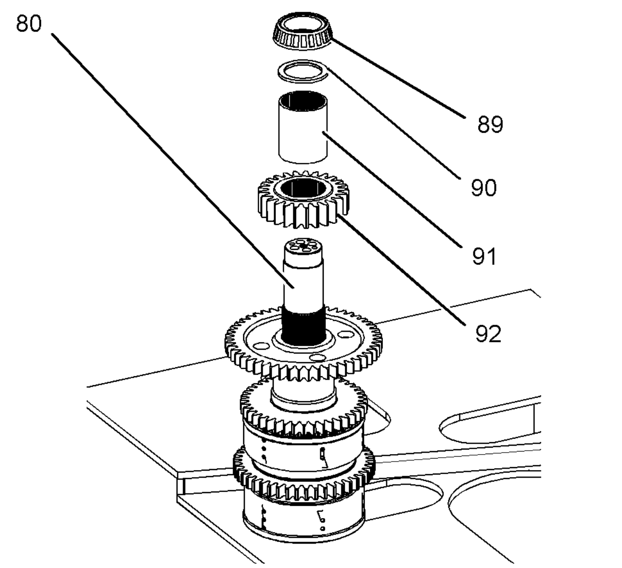


Illustration 122 g01269968

**15.** Install gear (92), spacer (91), and spacer (90) onto shaft assembly (80). Raise the temperature of bearing cone (89). Install bearing cone (89) onto shaft assembly (80).

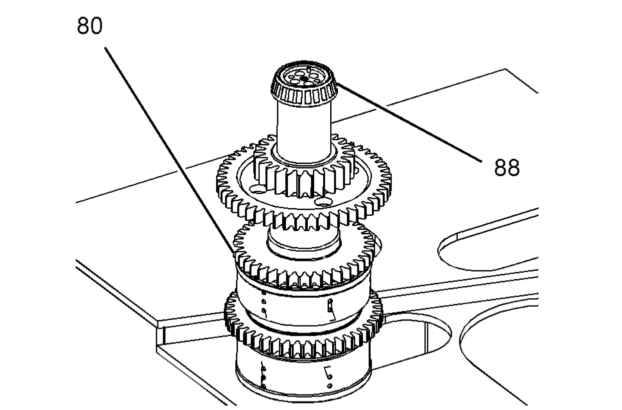


Illustration 123 g01280589

**16.** Raise the temperature of bearing cone (88). Install bearing cone (88) onto shaft assembly (80).

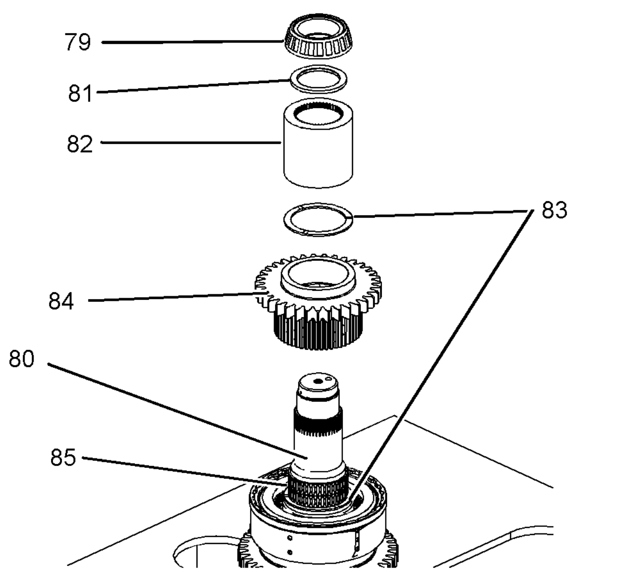


Illustration 124 g01270211

**17.** Install thrust washer (83) onto shaft assembly (80). Install bearing (85) onto shaft assembly (80). Install gear (84), thrust washer (83), spacer (82), and spacer (81) onto shaft assembly (80). Raise the temperature of bearing cone (79). Install bearing cone (79) onto shaft assembly (80).

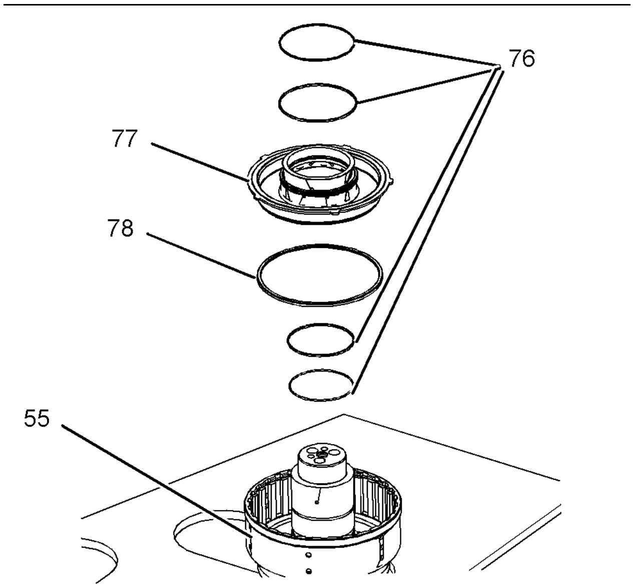


Illustration 125 g01270206

**18.** Install seal (78) onto piston (77). Install seals (76) onto piston (77). Install piston (77) onto shaft assembly (55).

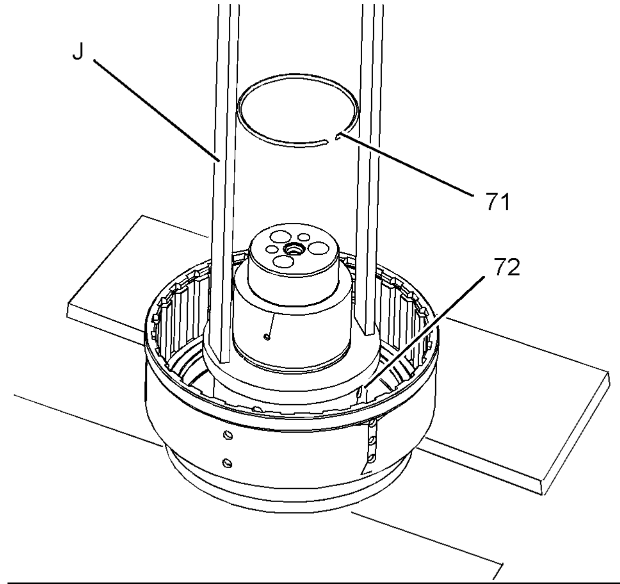


Illustration 126 g01269765

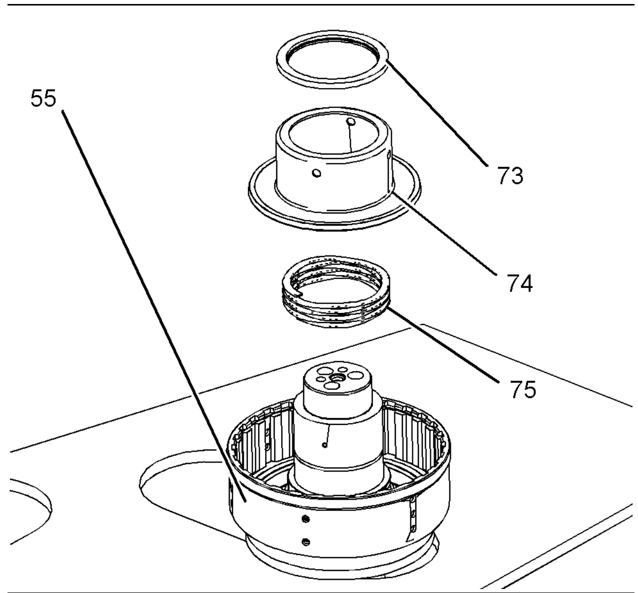


Illustration 127 g01269767

**WARNING**

**Improper assembly of parts that are spring loaded can cause bodily injury.**

**To prevent possible injury, follow the established assembly procedure and wear protective equipment.**

**19.** Use Tooling (J) in order to install spring (75). Install seal assembly (74) and spacer (73) onto shaft assembly (55). Use Tooling (H) in order to install retaining ring (71).

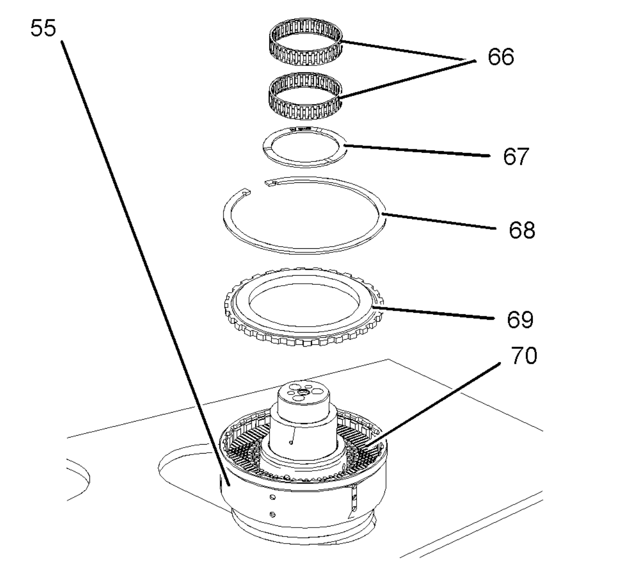


Illustration 128 g01269758

**20.** Install the friction discs and plates (70) onto shaft (55). Install clutch plate (69). Use Tooling (H) in order to install retaining ring (68). Install thrust washer (67) and bearings (66).

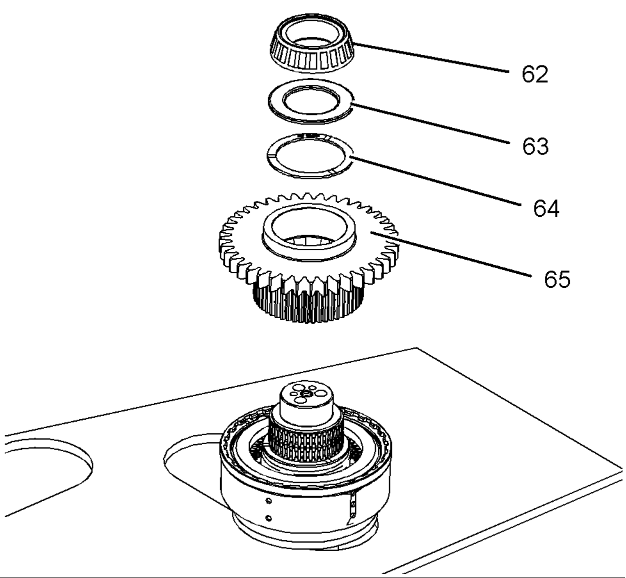


Illustration 129 g01269751

Reverse Shaft

**21.** Install gear (65) and thrust washer (64). Install spacer (63). Raise the temperature of bearing cone (62). Install bearing cone (62).

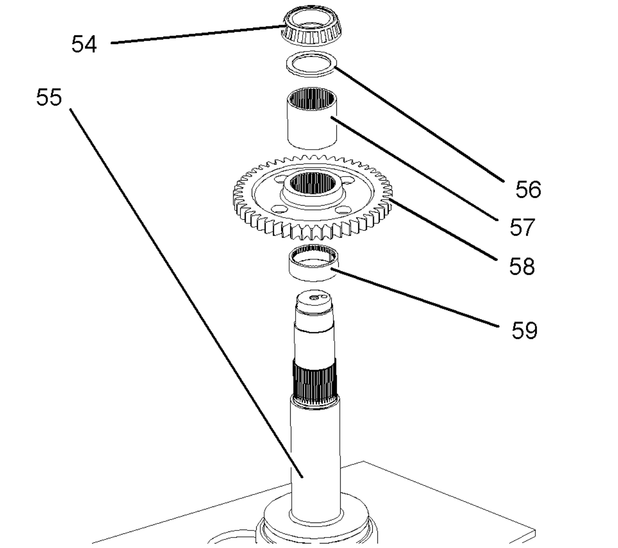


Illustration 130 g01269685

**22.** Install spacer (59), gear (58), spacer (57), and spacer (56) onto shaft assembly (55). Raise the temperature of bearing cone (54). Install bearing cone (54) onto shaft assembly (55).

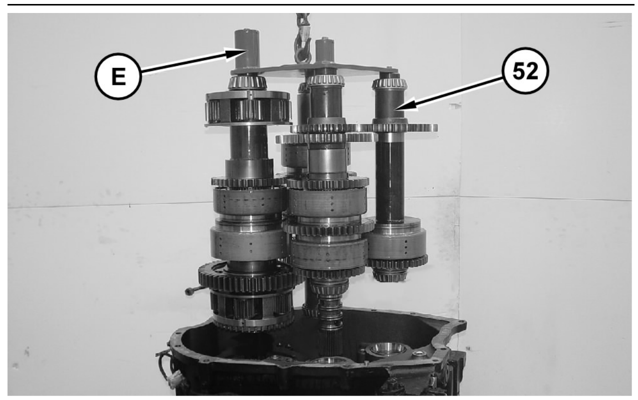


Illustration 131 g01281829

**23.** Attach Tooling (E) and a suitable lifting device to shaft assemblies (52). The weight of shaft assemblies (52) is approximately 370 kg (820 lb). Install shaft assemblies (52).

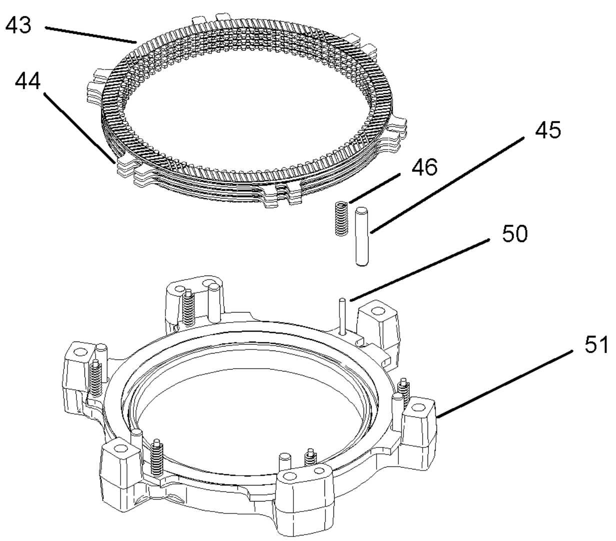


Illustration 132 g01269438

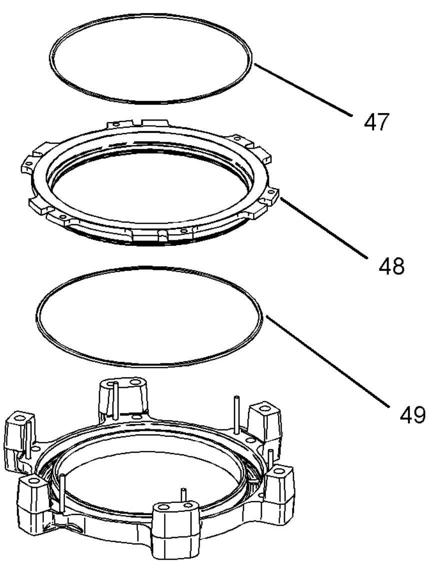


Illustration 133 g01269440

**WARNING**

**Improper assembly of parts that are spring loaded can cause bodily injury.**

**To prevent possible injury, follow the established assembly procedure and wear protective equipment.**

**24.** Install seals (47) and (49) onto piston (48).

**25.** Install dowels (50) onto housing (51), if necessary. Install springs (46) and dowels (45). Install plates (44) and discs (43).

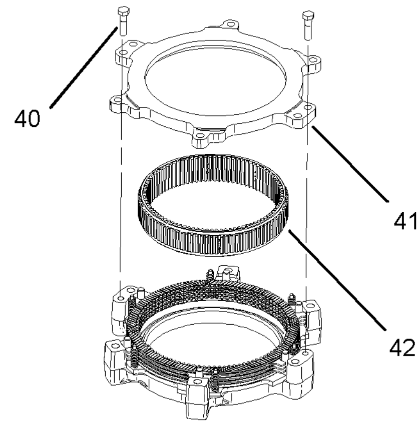


Illustration 134 g01269435

**26.** Install ring gear (42) and reaction plate (41). Install bolts (40).

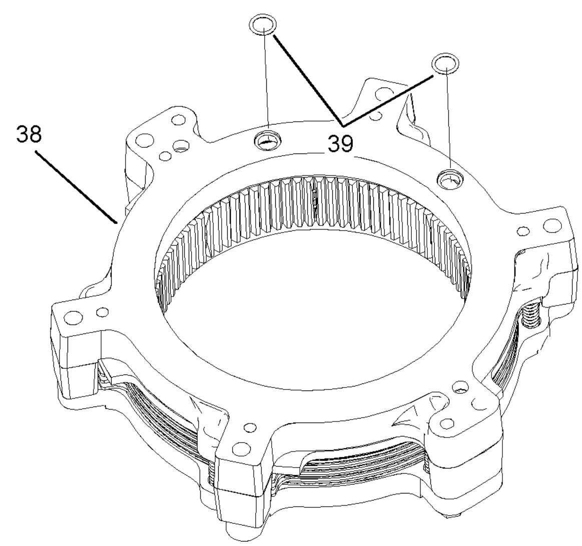


Illustration 135 g01269430

**27.** Install O-ring seals (39) onto clutch assembly (38).

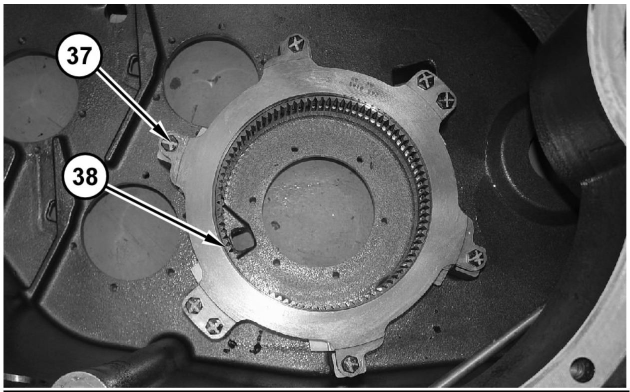


Illustration 136 g01269302

**28.** Use two people in order to install clutch assembly (38). The weight of clutch assembly (38) is approximately 25 kg (55 lb). Install bolts (37).

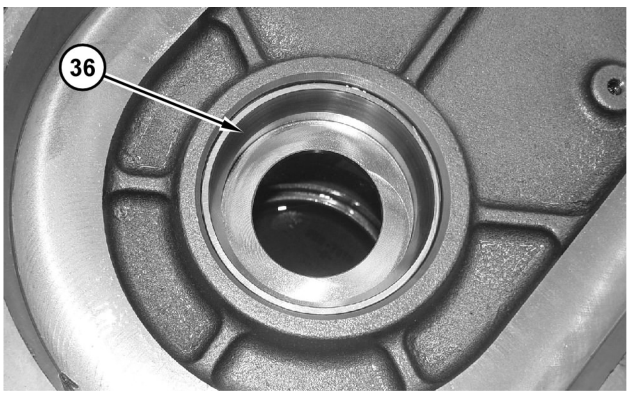


Illustration 137 g01269287

**29.** Lower the temperature of bearing cup (36). Install bearing cup (36).

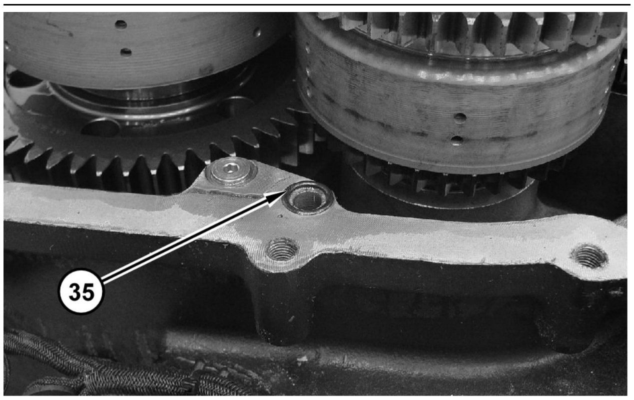


Illustration 138 g01269241

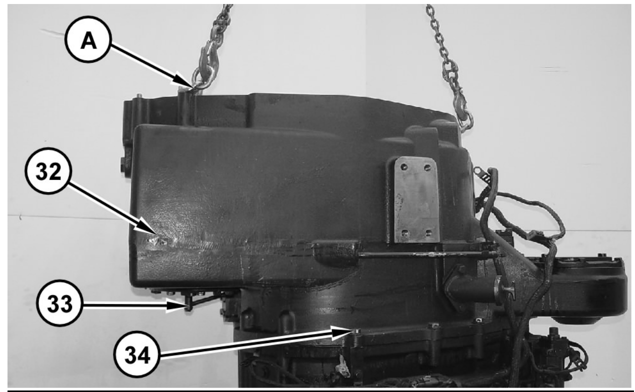


Illustration 139 g01269240

**30.** Install O-ring seal (35). Apply Tooling (L) to case assembly (32). Attach Tooling (A) and a suitable lifting device to case assembly (32). The weight of case assembly (32) is approximately 365 kg (800 lb). Install case assembly (32) and bolts (34). Install tube assembly (33).

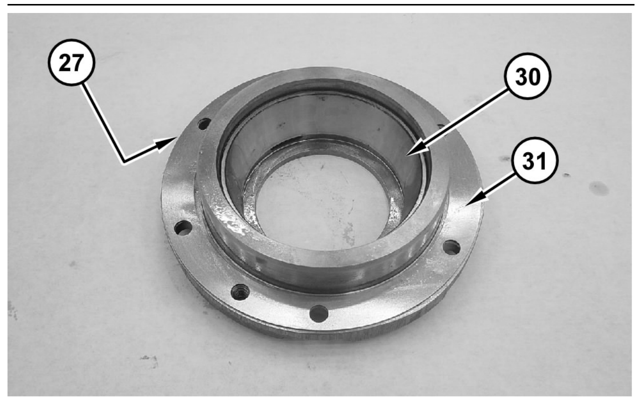


Illustration 140 g01269226

**31.** Lower the temperature of bearing cup (30). Install bearing cup (30) into bearing cage (27). Install shims (31).

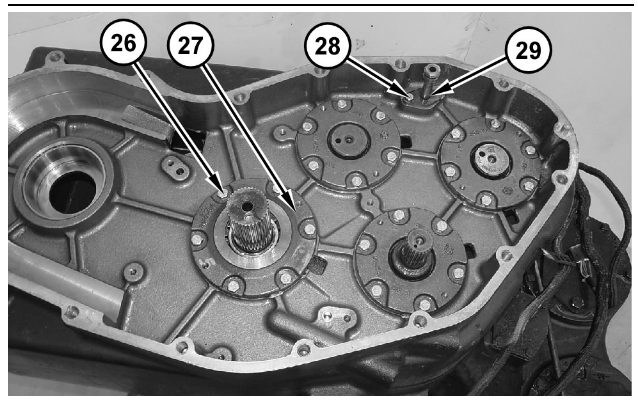


Illustration 141 g01269222

**32.** Install bearing cage (27) and bolt (26).

**33.** Repeat Steps 31 and 32 for the remaining bearing cages.

**34.** Install tube assembly (29) and bolt (28).

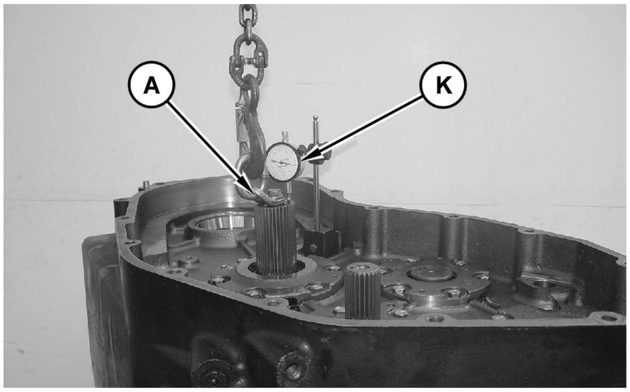


Illustration 142 g01281835

**35.** Attach Tooling (A) and a suitable lifting device to the shaft assembly. Install Tooling (K). Apply a slight lifting tension on the shaft assembly. Use Tooling (K) in order to check the end play of the shaft assembly. The end play should be between 0.050 mm (0.0020 inch) and 0.100 mm (0.0039 inch). Add or remove shims as shims are required.

**Note:** It is important to rotate the shaft during the end play adjustment in order to seat the bearings properly.

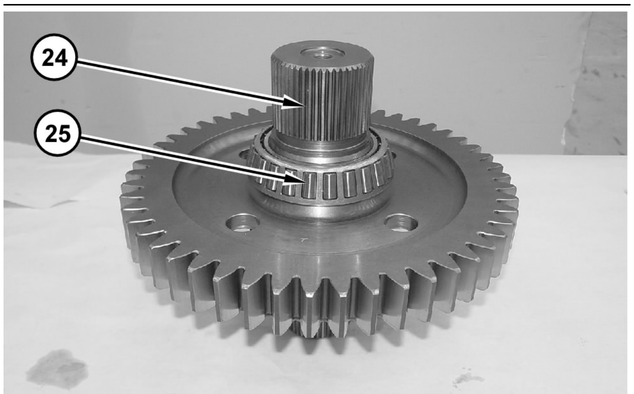


Illustration 143 g01269221

**36.** Install bearing cones (25) onto gear (24).

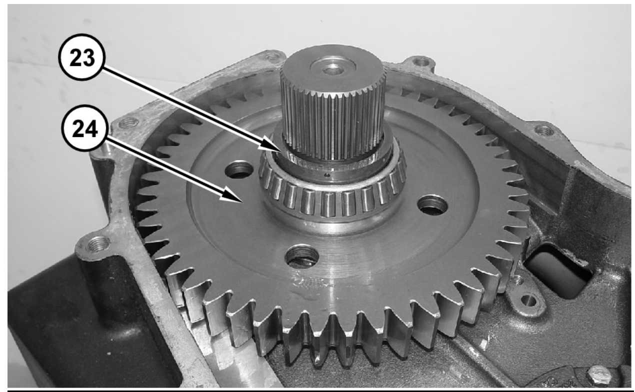


Illustration 144 g01269183

**37.** Use two people in order to install gear (24). The weight of gear (24) is approximately 32 kg (70 lb). Install ring (23).

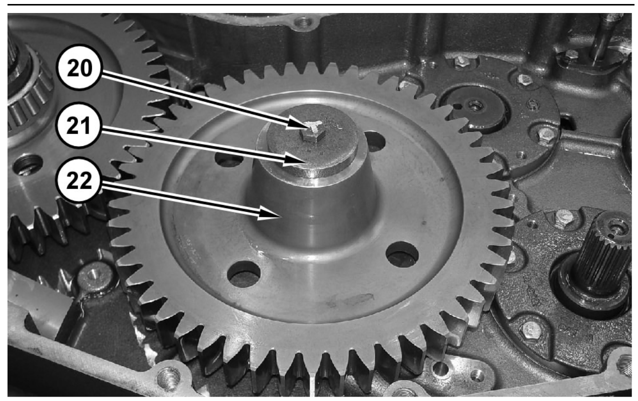


Illustration 145 g01269176

**38.** Use two people in order to install gear (22). The weight of gear (22) is approximately 23 kg (50 lb). Install retainer (21) and bolt (20).

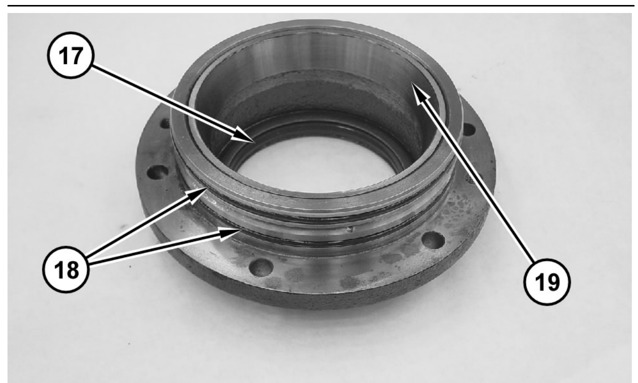


Illustration 146 g01269118

**39.** Lower temperature of bearing cup (19). Install bearing cup (19). Install lip seal (17) and O-ring seals (18) after adjusting the end play of the shaft assembly.

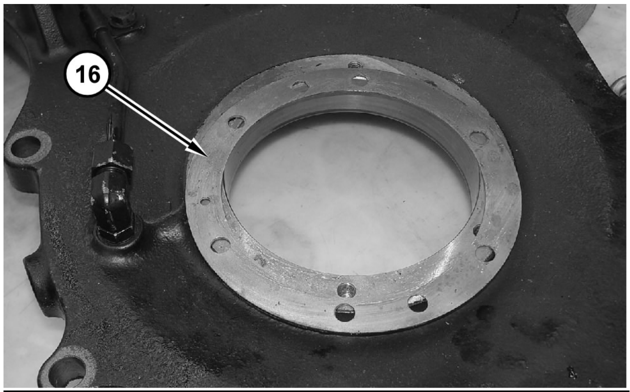


Illustration 147 g01269068

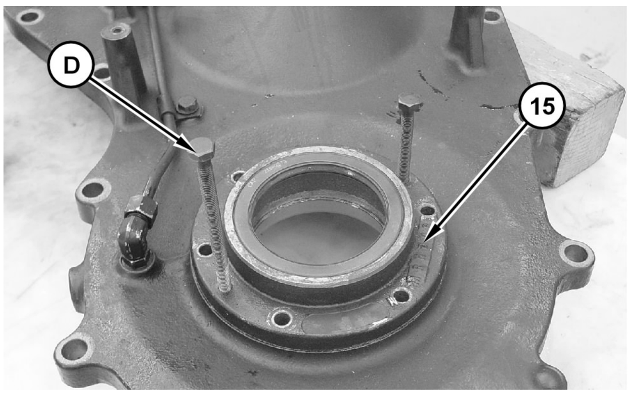


Illustration 148 g01269063

**40.** Position shims (16). Install bearing cage (15).

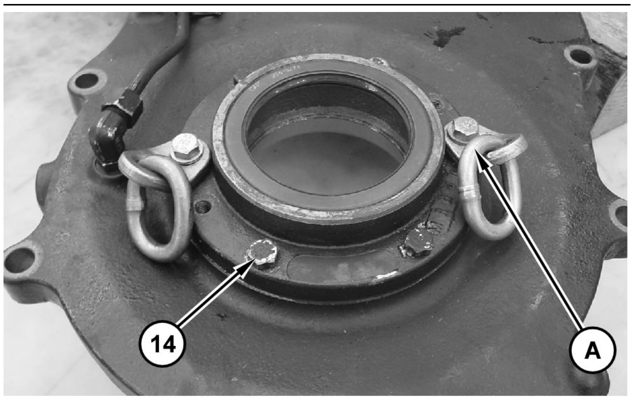


Illustration 149 g01269057

**41.** Install Tooling (A) and bolts (14).

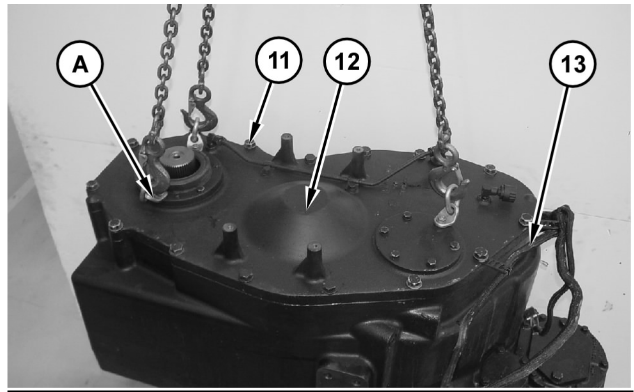


Illustration 150 g01269055

**42.** Install cover assembly (12). The weight of cover assembly (12) is approximately 60 kg (130 lb). Install bolts (11). Position harness assembly (13).

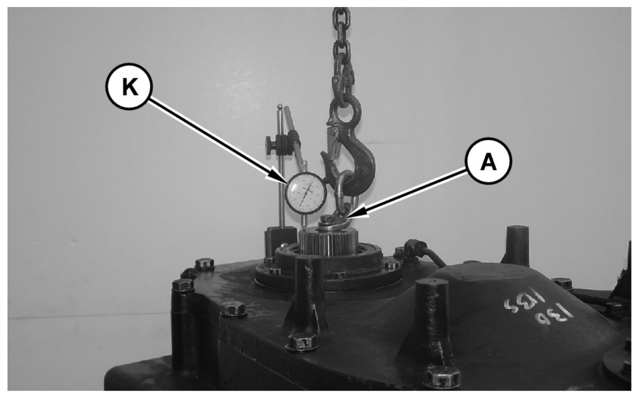


Illustration 151 g01281866

**43.** Attach Tooling (A) and a suitable lifting device to the shaft assembly. Install Tooling (K). Apply a slight lifting tension to the shaft assembly. Use Tooling (K) in order to check the end play of the shaft assembly. The end play should be between 0.050 mm (0.0020 inch) and 0.100 mm (0.0039 inch). Add or remove shims as shims are required.

**44.** Reinstall the bearing cage with the lip seal and the O-ring seals.

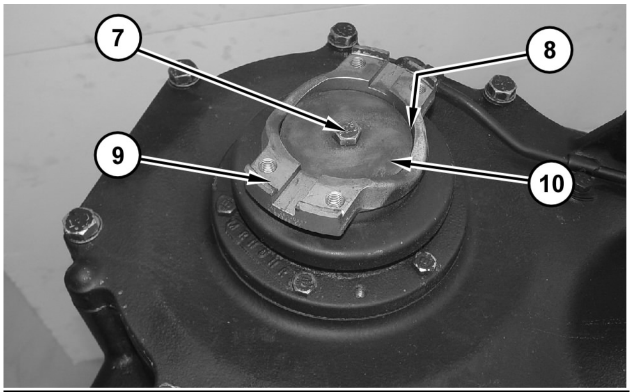


Illustration 152 g01269046

**45.** Install O-ring seal (8) and yoke (9). Install retainer (10) and bolt (7).

**46.** Use Tooling (A), Tooling (B), and a suitable lifting device in order to reposition transmission (6). The weight of transmission (6) is approximately 1315 kg (2900 lb).

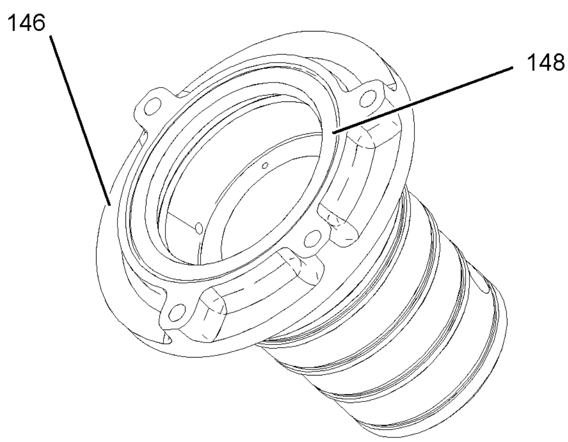


Illustration 153 g01270685

**47.** Install lip seal (148) into seal ring housing (146).

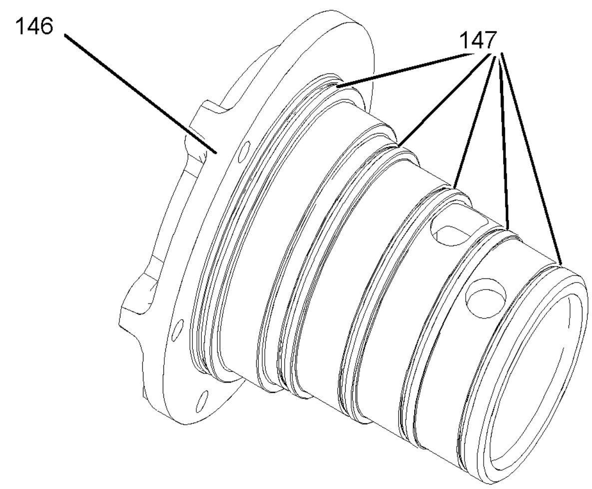


Illustration 154 g01270632

**48.** Install O-ring seals (147) into seal ring housing (146).

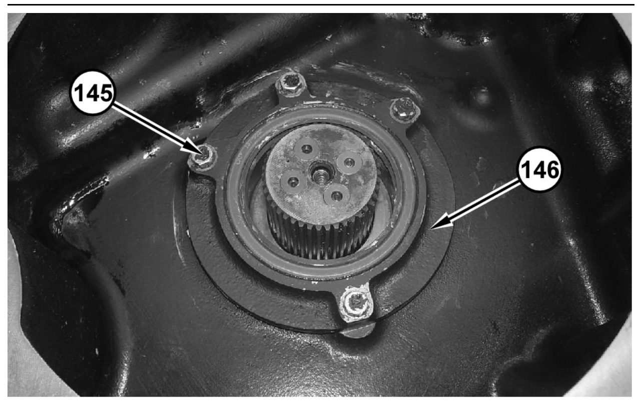


Illustration 155 g01279115

**49.** Install seal ring housing (146) and bolts (145).

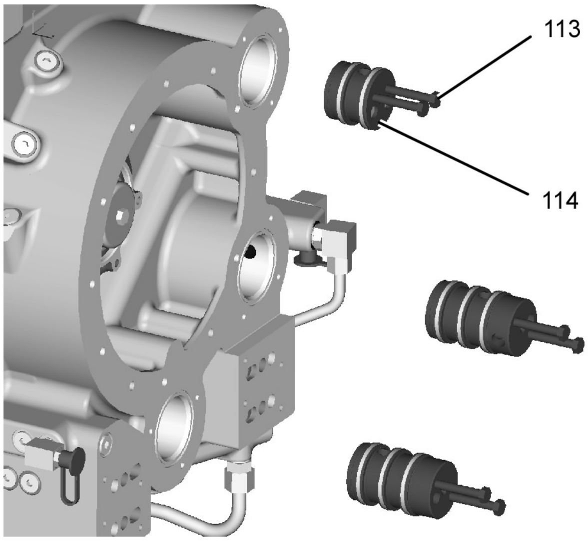


Illustration 156 g01280780

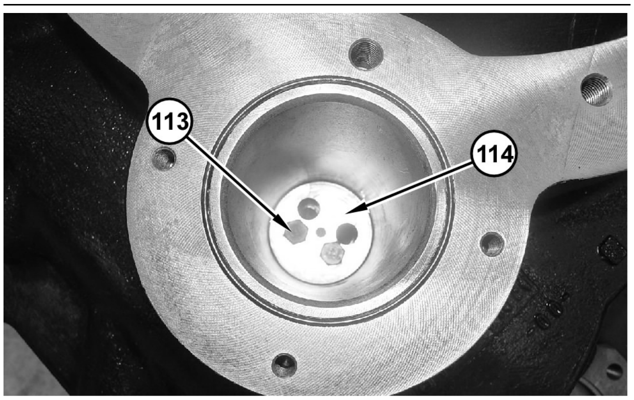


Illustration 157 g01279344

**50.** Install seal carriers (114) and install bolts (113).

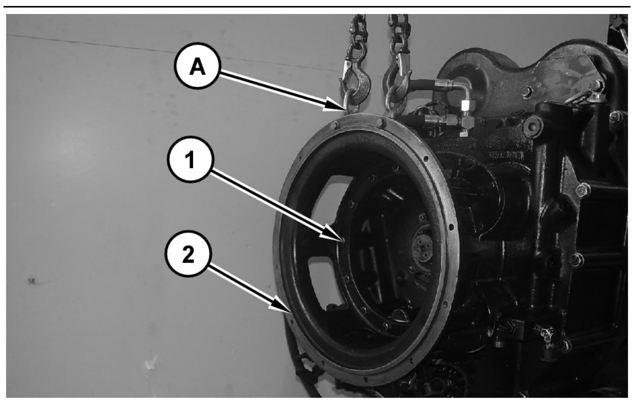


Illustration 158 g01269011

**51.** Install the O-ring seals. Use Tooling (A) and a suitable lifting device in order to install housing (2). The weight of housing (2) is approximately 35 kg (75 lb). Install bolts (1).

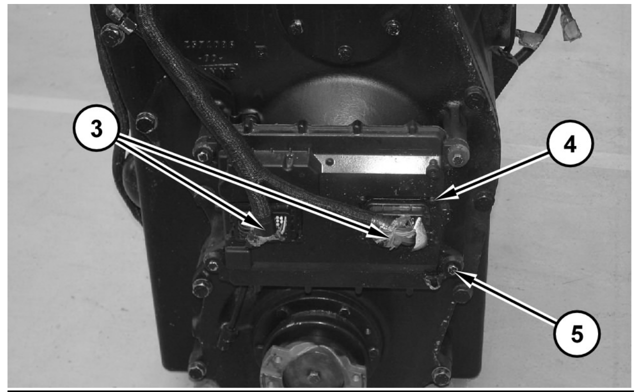


Illustration 159 g01269023

**52.** Install electronic control module (4) and bolts (5). Connect harness assemblies (3).

**End By:**

**a.** Install the input speed sensor. Refer to Disassembly and Assembly, “Speed Sensor (Transmission) - Install”.

i02649518

# Clutch (Front Wheel Assist) - Remove

**SMCS Code:** 3053-011-OJ; 3054-011-OJ; 3055-011-OJ

## Removal Procedure

Table 7

| Required Tools | | | |
|---|---|---|---|
| Tool | Part Number | Part Description | Qty |
| A | 138-7575 | Link Brackets | 2 |

**Start By:**

**a.** Remove the speed sensor for the front wheel assist. Refer to Disassembly and Assembly, “Speed Sensor for the Front Wheel Assist (Transmission) - Remove”.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

**1.** Remove the guard.

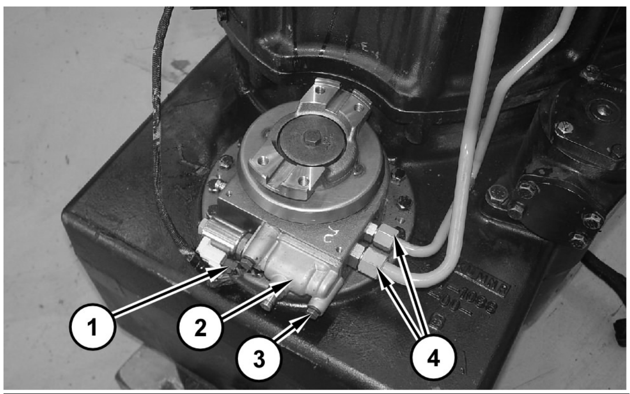


Illustration 160 g01267705

**2.** Remove tube assemblies (4). Disconnect harness assembly (1). Remove bolts (3) and modulating control valve (2).

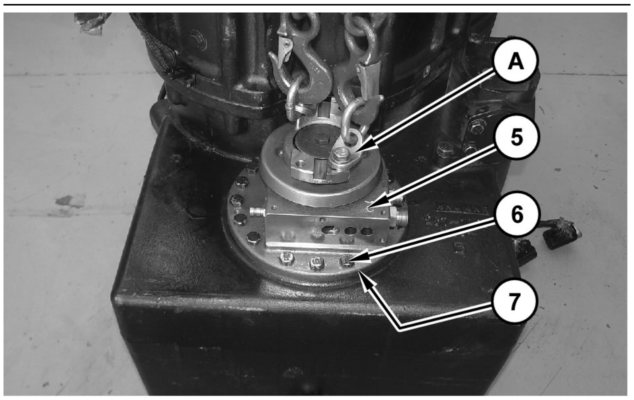


Illustration 161 g01267706

**3.** Attach Tooling (A) and a suitable lifting device to clutch assembly (5). The weight of clutch assembly (5) is approximately 70 kg (150 lb). Remove bolts (6) and clutch assembly (5). Remove O-ring (7).

i02649529

# Clutch (Front Wheel Assist) - Disassemble

**SMCS Code:** 3053-015-OJ; 3054-015-OJ; 3055-015-OJ

## Disassembly Procedure

Table 8

| Required Tools | | | |
|---|---|---|---|
| Tool | Part Number | Part Description | Qty |
| A | 207-8153 | Spring Compressor | 1 |
| B | 2P-8312 | Retaining Ring Pliers | 1 |
| C | 1P-0510 | Driver Gp | 1 |
| D | 8H-0663 | Bearing Puller Gp | 1 |

**Start By:**

**a.** Remove the clutch (front wheel assist). Refer to Disassembly and Assembly, "Clutch (Front Wheel Assist) - Remove".

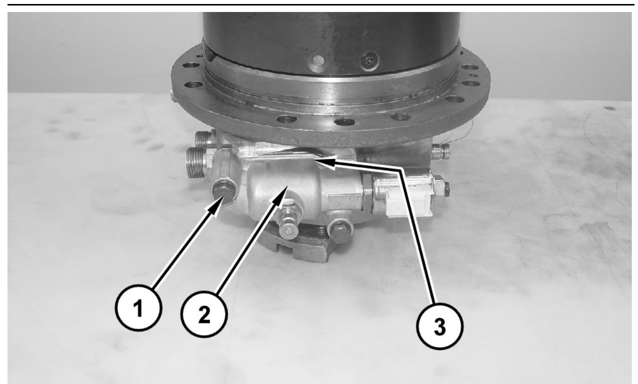


Illustration 162 g01267904

**1.** Remove bolts (1). Remove modulating control valve (2) and O-ring seal (3).

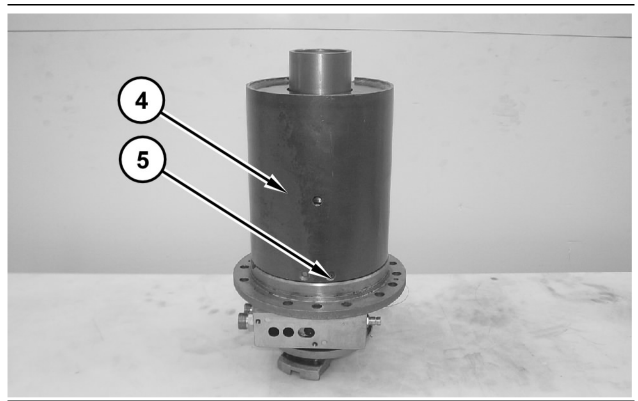


Illustration 163 g01267919

 

**2.** Remove bolts (5) and shroud assembly (4).

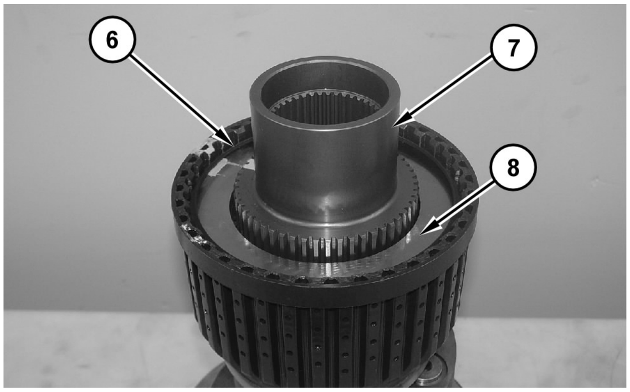


Illustration 164 g01267925

**3.** Remove retaining ring (6). Remove coupling (7) and clutch assembly (8).

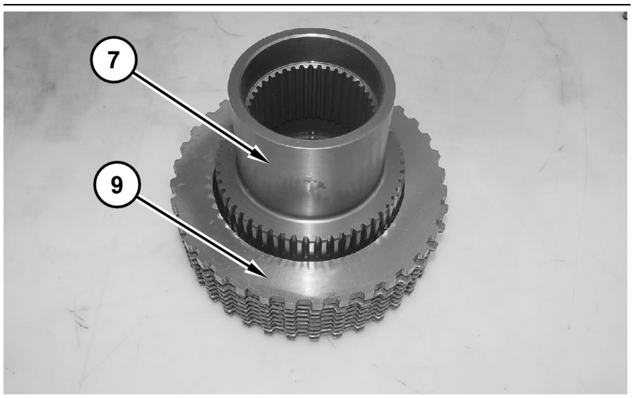


Illustration 165 g01267926

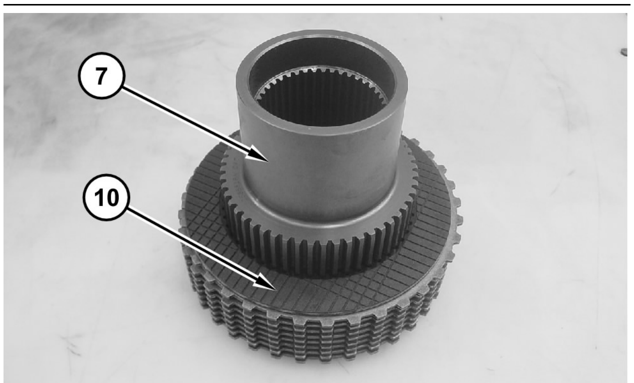


Illustration 166 g01267927

**4.** Remove plates (9) and discs (10) from coupling (7).

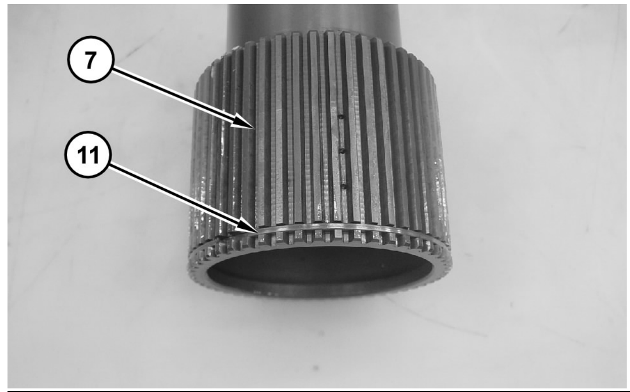


Illustration 167 g01267928

**5.** Remove retaining ring (11) from coupling (7).

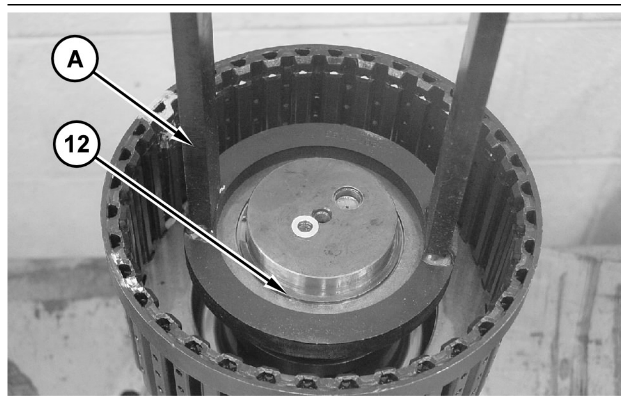


Illustration 168 g01267931

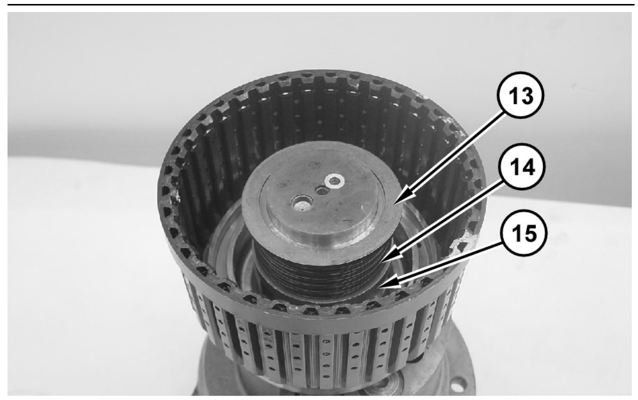


Illustration 169 g01267934

**⚠ WARNING**

**Personal injury can result from being struck by parts propelled by a released spring force.**

**Make sure to wear all necessary protective equipment.**

**Follow the recommended procedure and use all recommended tooling to release the spring force.**

**6.** Use Tooling (A) and a suitable press in order to compress spring (14). Use Tooling (B) in order to remove retaining ring (12). Remove retainer (13), spring (14), and sleeve (15).

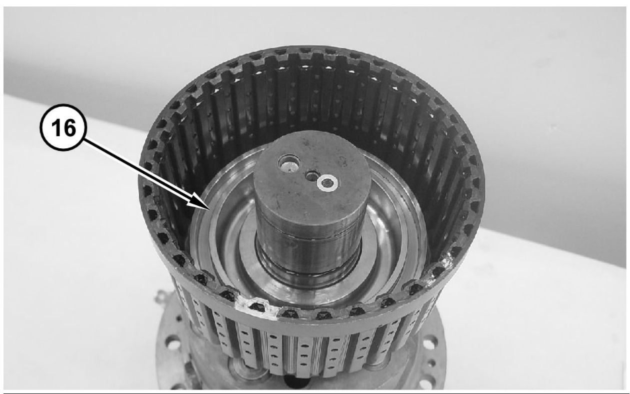


Illustration 170 g01267940

**7.** Remove piston (16).

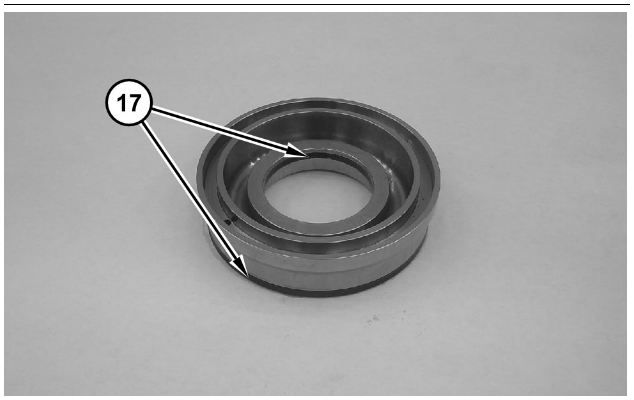


Illustration 171 g01267941

**8.** Remove seals (17).

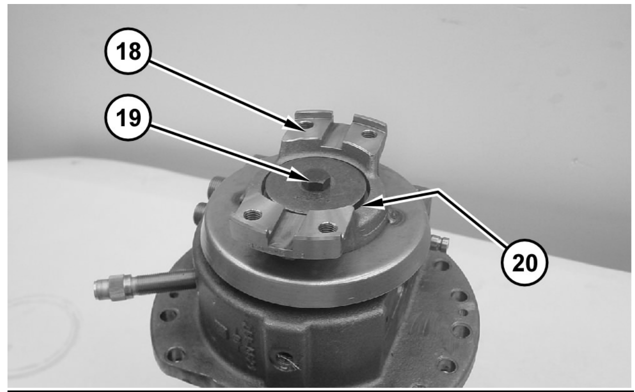


Illustration 172 g01267948

**9.** Remove bolt (19), yoke assembly (18), shims (20), the retainer, the spacer, and the O-ring seal.

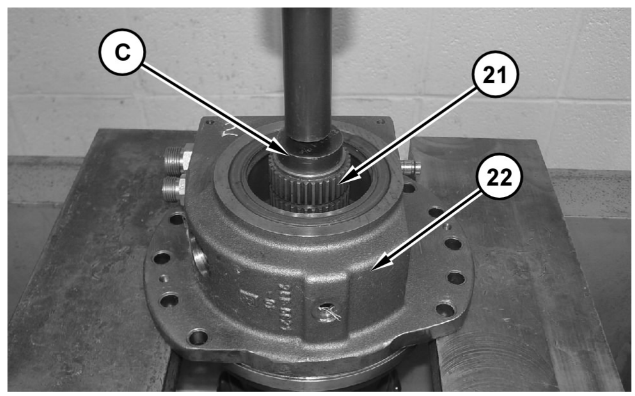


Illustration 173 g01267971

**10.** Use Tooling (C) and a suitable press in order to separate shaft assembly (21) from housing assembly (22).

**Note:** Support shaft assembly (21) from the bottom.

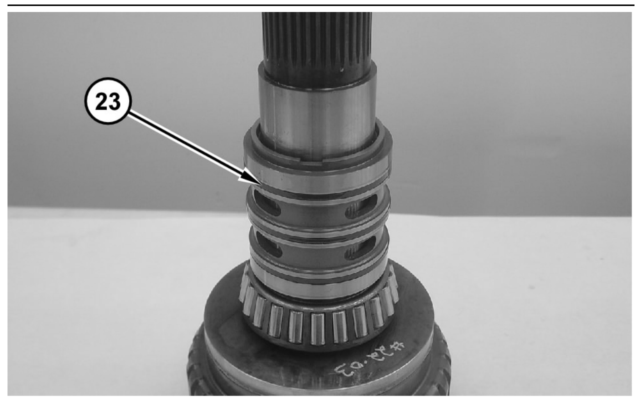


Illustration 174 g01267980

**11.** Remove seal rings (23).

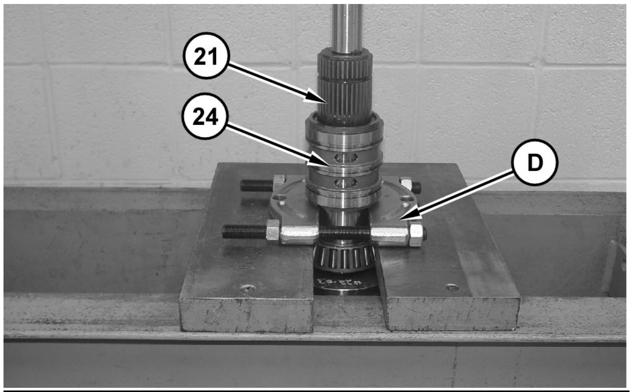


Illustration 175 g01267991

**12.** Use Tooling (D) and a suitable press in order to remove seal ring carrier (24) from shaft assembly (21).

**Note:** Support shaft assembly (21) from the bottom.

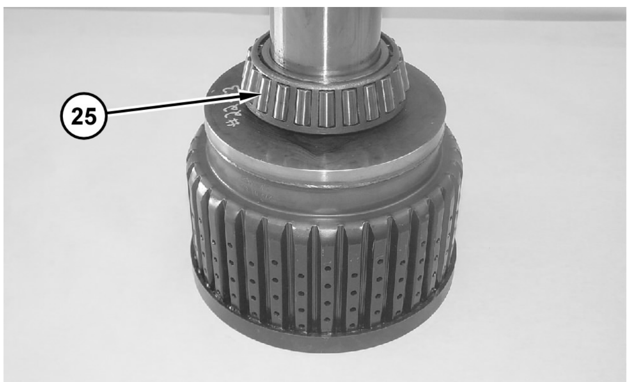


Illustration 176 g01267996

**13.** Remove bearing cone (25).

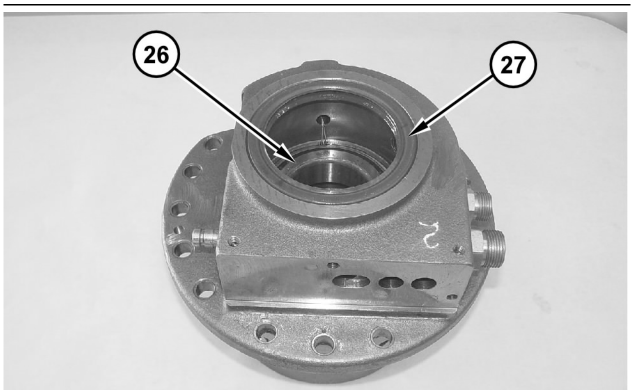


Illustration 177 g01267997

**14.** Remove lip seal (27) and bearing cone (26).

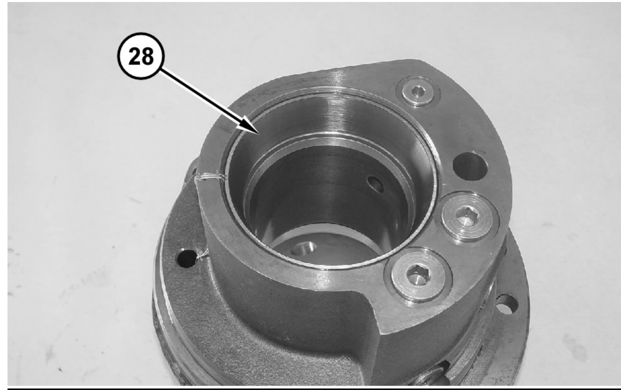


Illustration 178 g01267998

**15.** Remove bearing cups (28).

i02649552

# Clutch (Front Wheel Assist) - Assemble

**SMCS Code:** 3053-016-OJ; 3054-016-OJ; 3055-016-OJ

## Assembly Procedure

Table 9

| Required Tools | | | |
|---|---|---|---|
| Tool | Part Number | Part Description | Qty |
| A | 207-8153 | Spring Compressor | 1 |
| B | 2P-8312 | Retaining Ring Pliers | 1 |
| E | 8T-5096 | Dial Indicator Gp | 1 |

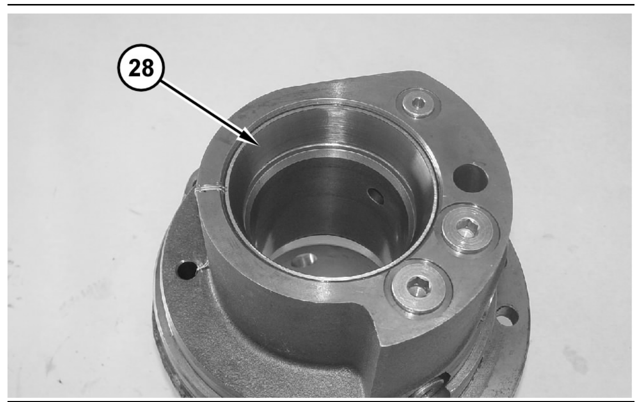


Illustration 179 g01267998

**1.** Lower the temperature of bearing cups (28). Install bearing cups (28).

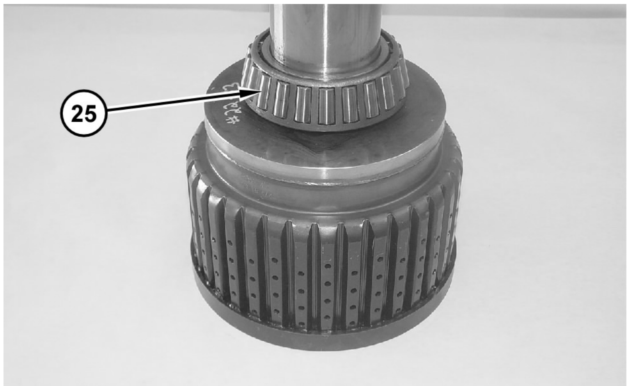


Illustration 180 g01267996

**2.** Raise the temperature of bearing cone (25). Install bearing cone (25).

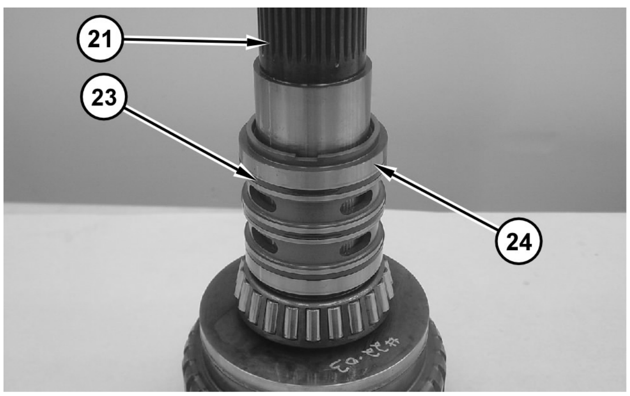


Illustration 181 g01276046

**3.** Raise the temperature of seal ring carrier (24) and install shaft assembly (21). Install seal rings (23).

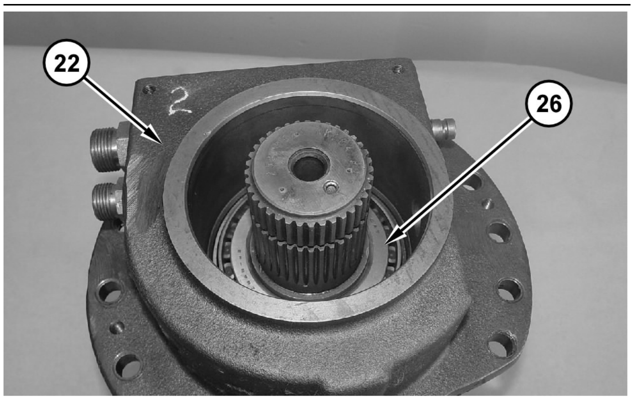


Illustration 182 g01274335

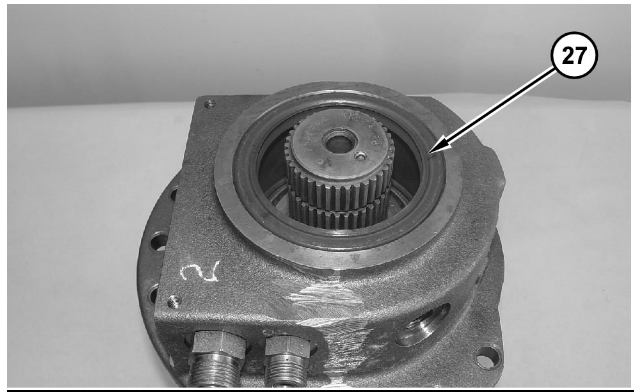


Illustration 183 g01274336

**4.** Position housing assembly (22) over the shaft assembly. Raise the temperature of bearing cone (26) and install bearing cone (26). Install lip seal (27) after adjusting the end play.

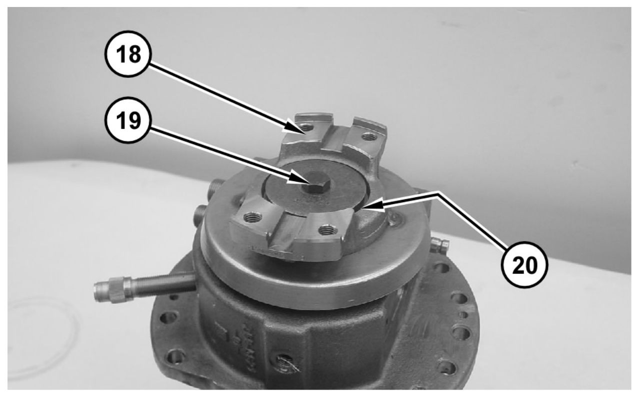


Illustration 184 g01267948

**5.** Use Tooling (E) to adjust shims (20) in order to allow 0.5 mm (0.02 inch) to 1.0 mm (0.04 inch) of end play. Install shims (20), yoke assembly (18), bolt (19), the retainer, the spacer, the O-ring seal, and the lip seal.

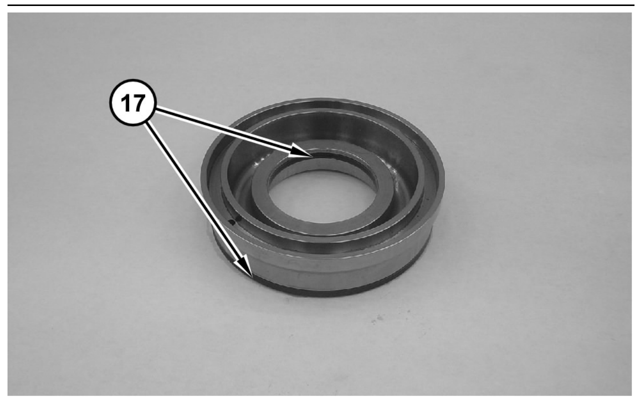


Illustration 185 g01267941

**6.** Install seals (17).

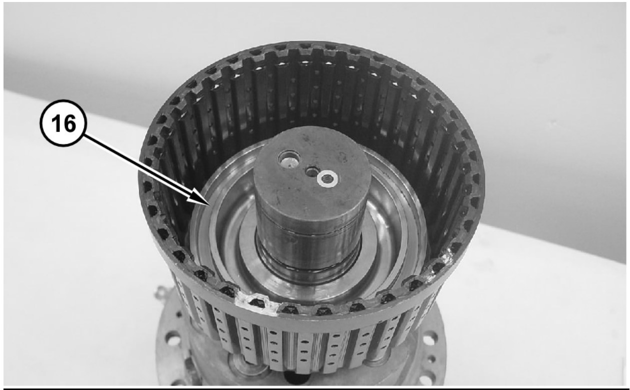


Illustration 186 g01267940

**7.** Install piston (16).

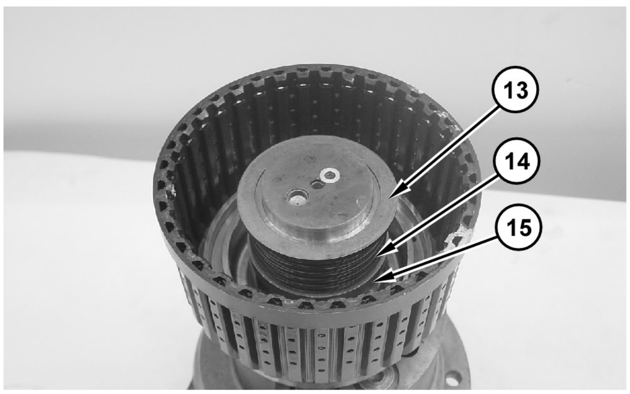


Illustration 187 g01267934

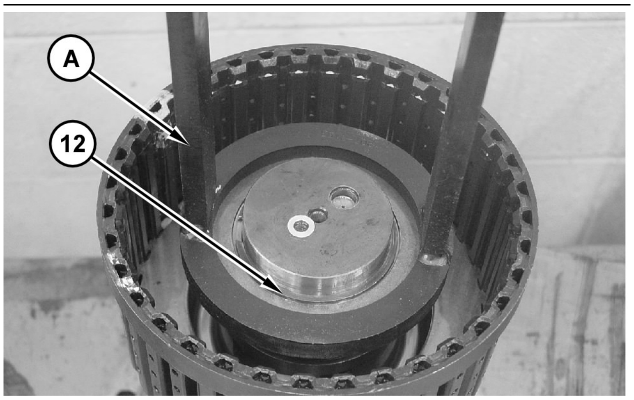


Illustration 188 g01267931

**WARNING**

**Improper assembly of parts that are spring loaded can cause bodily injury.**

**To prevent possible injury, follow the established assembly procedure and wear protective equipment.**

**8.** Install sleeve (15), spring (14), and retainer (13). Use Tooling (B) in order to install retaining ring (12). Use Tooling (A) and a suitable press in order to compress spring (14).

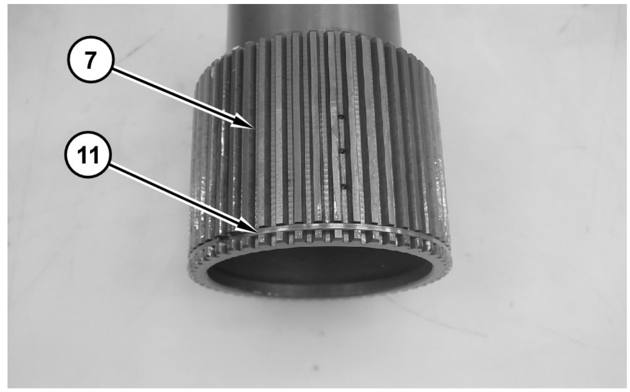


Illustration 189 g01267928

**9.** Install retaining ring (11) onto coupling (7).

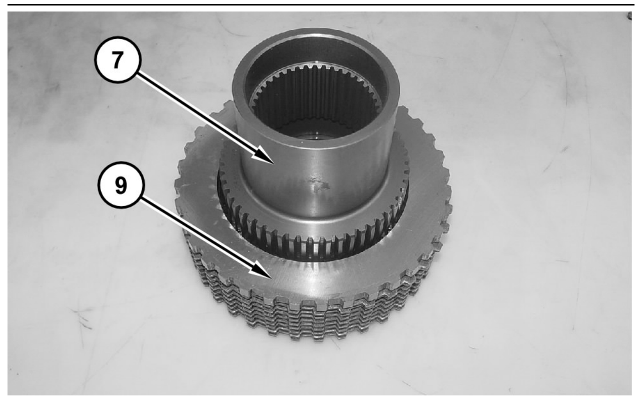


Illustration 190 g01267926

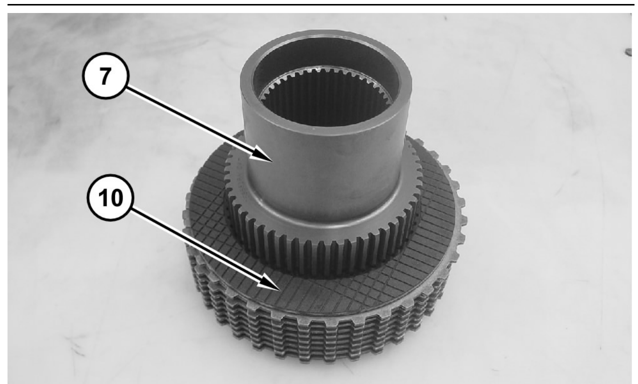


Illustration 191 g01267927

**10.** Install plates (9) and discs (10) onto coupling (7).

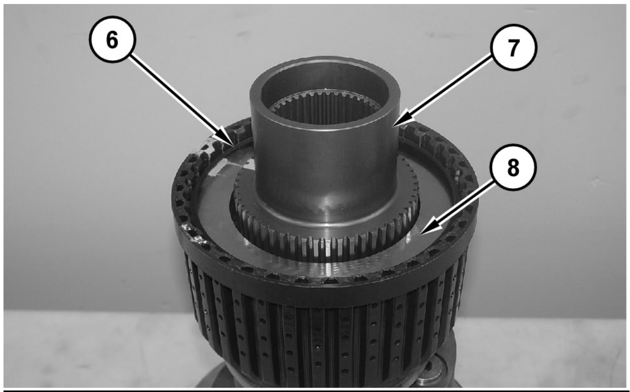


Illustration 192 g01267925

**11.** Install clutch assembly (8) and coupling (7). Install retaining ring (6).

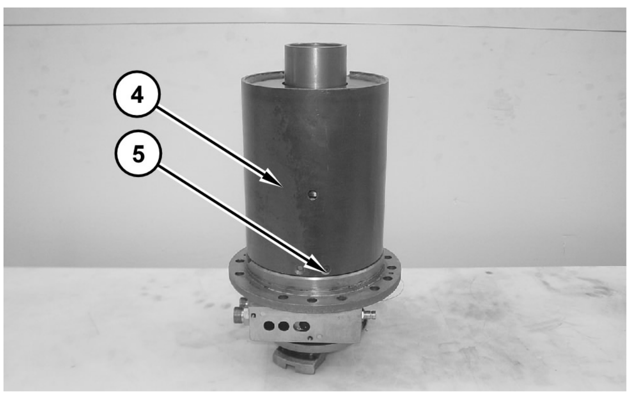


Illustration 193 g01267919

**12.** Install shroud assembly (4) and bolts (5).

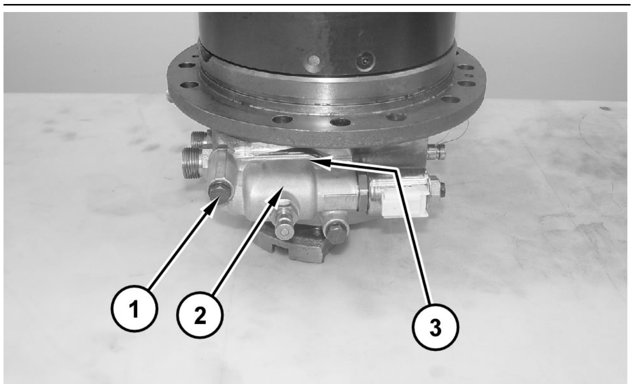


Illustration 194 g01267904

**13.** Install O-ring seal (3) and modulating control valve (2). Install bolts (1).

**End By:**

**a.** Install the clutch (front wheel assist). Refer to Disassembly and Assembly, "Clutch (Front Wheel Assist) - Install".

i02649577

# Clutch (Front Wheel Assist) - Install

**SMCS Code:** 3053-012-OJ; 3054-012-OJ; 3055-012-OJ

## Installation Procedure

Table 10

| Required Tools | | | |
|---|---|---|---|
| Tool | Part Number | Part Description | Qty |
| A | 138-7575 | Link Brackets | 2 |

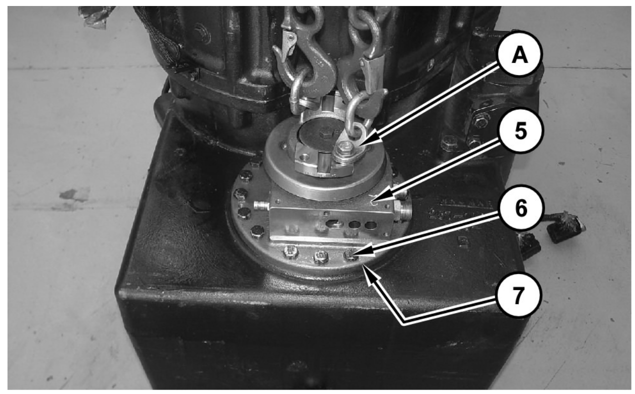


Illustration 195 g01267706

**1.** Attach Tooling (A) and a suitable lifting device to clutch assembly (5). The weight of clutch assembly (5) is approximately 70 kg (150 lb). Install O-ring seal (7). Install clutch assembly (5) and bolts (6).

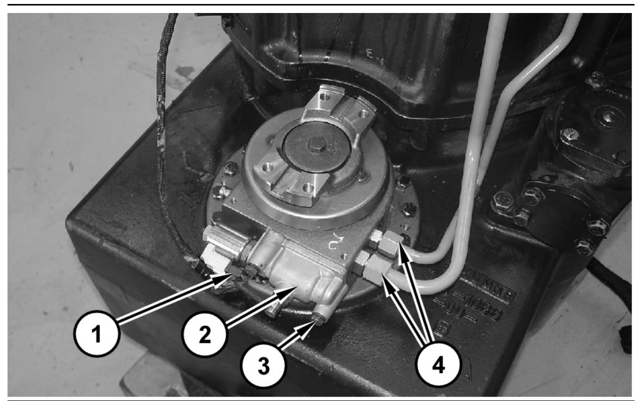


Illustration 196 g01267705

**2.** Install modulating control valve (2) and bolts (3). Connect harness assembly (1). Install tube assemblies (4).

**3.** Install the guard.

**End By:**

**a.** Install the speed sensor for the front wheel assist. Refer to Disassembly and Assembly, "Speed Sensor for the Front Wheel Assist (Transmission) - Install".

i02528493

# Speed Sensor (Transmission) - Remove

**SMCS Code:** 3175-011

## Removal Procedure

### Input Speed Sensor

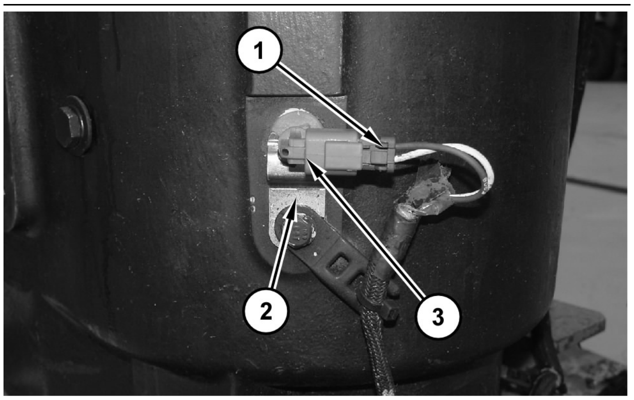


Illustration 197 g01265000

1. Disconnect harness assembly (1).
2. Remove retainer (2).
3. Remove speed sensor (3).

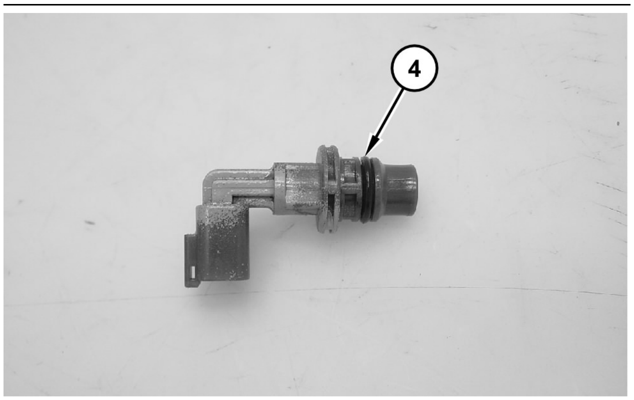


Illustration 198 g01265004

4. Remove O-ring seal (4).

### Output Speed Sensor

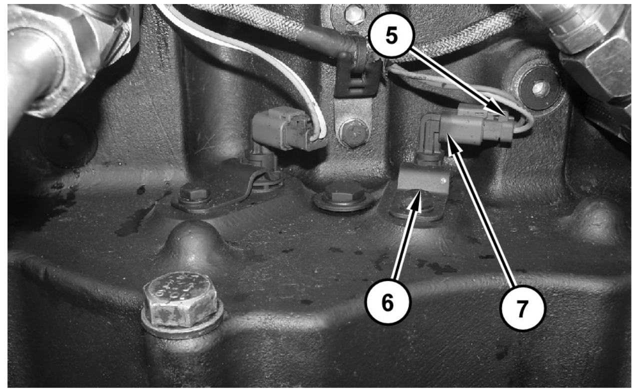


Illustration 199 g01265017

1. Disconnect harness assembly (5).
2. Remove retainer (6).
3. Remove speed sensor (7).

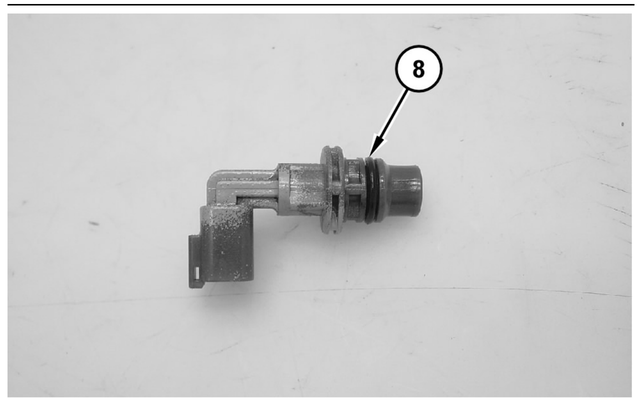


Illustration 200 g01265018

4. Remove O-ring seal (8).
5. Repeat Steps 1 through 4 for the remaining output sensor.

### Speed Sensor for Front Wheel Assist

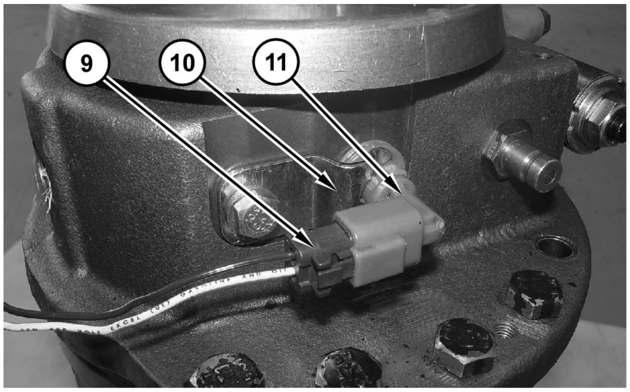


Illustration 201 g01267798

1. Disconnect harness assembly (9).
2. Remove retainer (10).
3. Remove speed sensor (11).

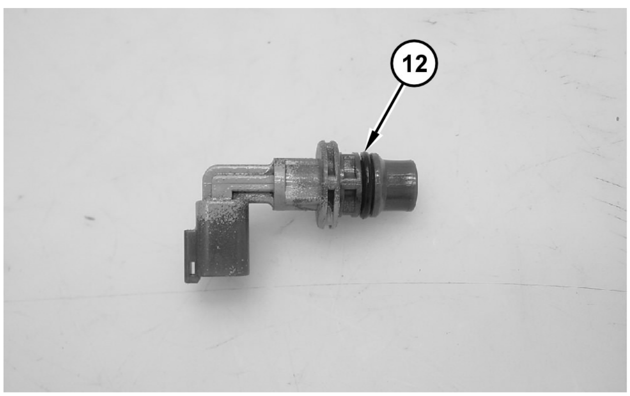


Illustration 202 g01267805

4. Remove O-ring seal (12).

i02528503

# Speed Sensor (Transmission) - Install

**SMCS Code:** 3175-012

## Installation Procedure

### Speed Sensor for Front Wheel Assist

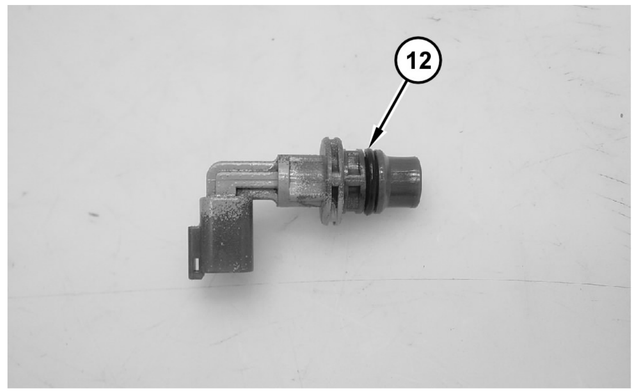


Illustration 203 g01267805

1. Install O-ring seal (12).

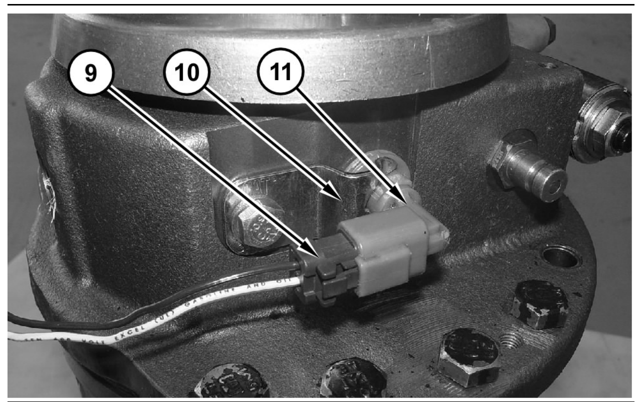


Illustration 204 g01267798

2. Install speed sensor (11).
3. Install retainer (10).
4. Connect harness assembly (9).

## Output Speed Sensor

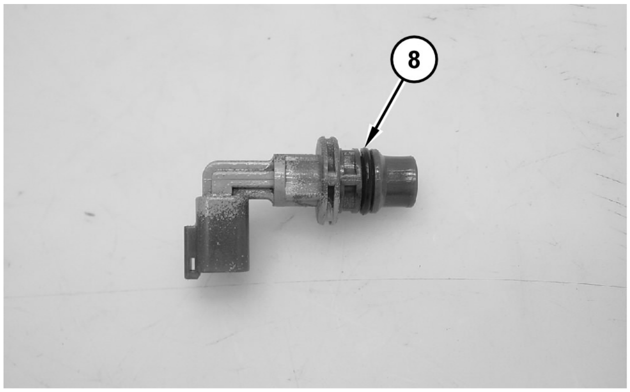


Illustration 205 g01265018

1. Install O-ring seal (8).

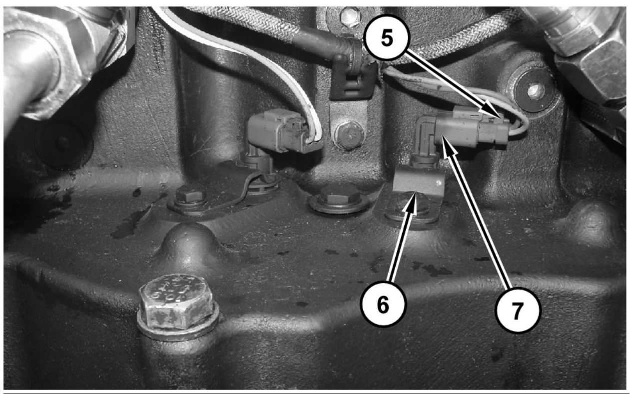


Illustration 206 g01265017

2. Install speed sensor (7).

3. Install retainer (6).

4. Connect harness assembly.

5. Repeat Steps 1 through 4 for the remaining output sensor.

## Input Speed Sensor

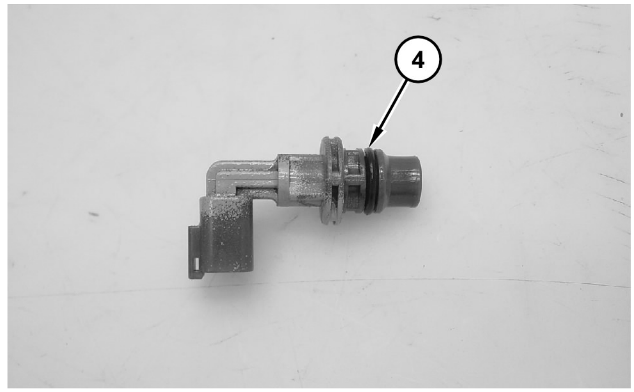


Illustration 207 g01265004

1. Install O-ring seal (4).

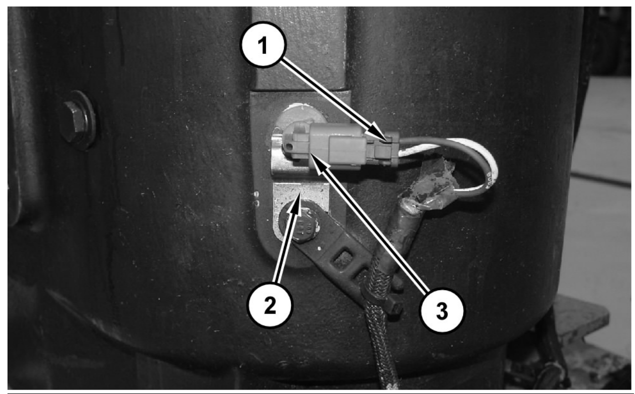


Illustration 208 g01265000

2. Install speed sensor (3).

3. Install retainer (2).

4. Connect harness assembly (1).

i02649606

# Modulating Valve (Transmission Clutch) - Remove and Install

**SMCS Code:** 3139-010-T3

## Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

**Note:** Put identification marks on all lines, on all hoses, on all wires, and on all tubes for installation purposes. Plug all lines, hoses, and tubes. This helps to prevent fluid loss and this helps to keep contaminants from entering the system.

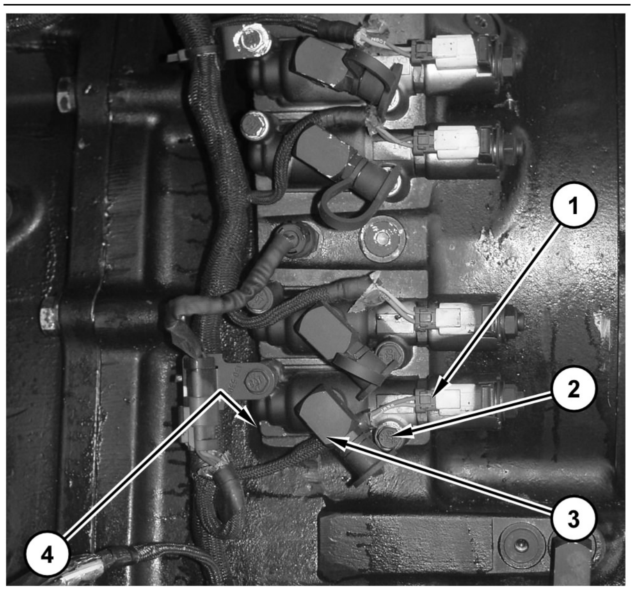


Illustration 209 g01330112

1. Disconnect harness assembly (1).

2. Remove bolts (2) and remove modulating control valve (3).

3. Remove O-ring seal (4).

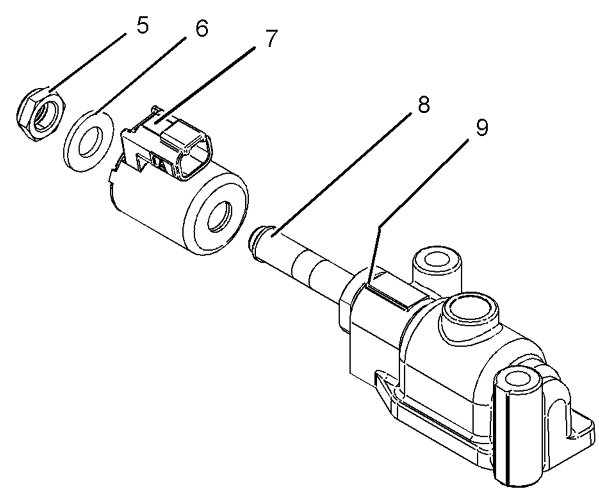


Illustration 210 g01265571

4. Remove nut (5) and washer (6).

5. Remove coil assembly (7).

6. Remove cartridge (8) and remove O-ring seal (9).

7. Repeat steps 1 through 6 for the remaining valves.

## Installation Procedure

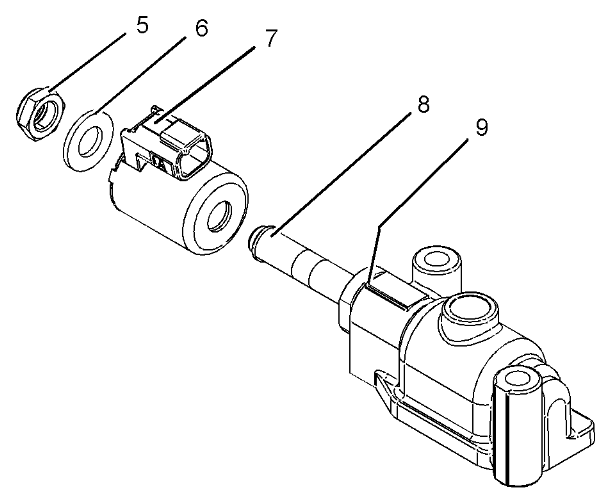


Illustration 211 g01265571

1. Lubricate O-ring seal (9) with lubricant that is being sealed. Install O-ring seal (9).

2. Install cartridge (8). Tighten cartridge (8) to a torque of 50 ± 5 N·m (37 ± 4 lb ft).

3. Install coil assembly (7).

4. Install washer (6) and nut (5).

5. Tighten nut (5) to a torque of 13 ± 1.5 N·m (115 ± 13 lb in).

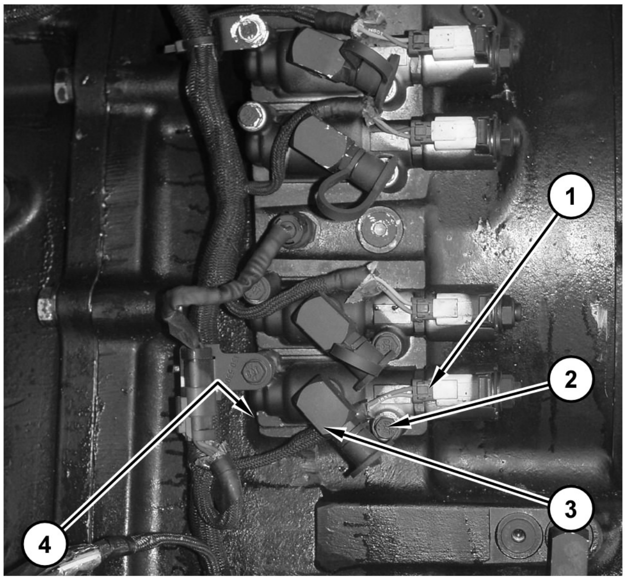


Illustration 212 g01330112

6. Install O-ring seal (4).

7. Install modulating control valve (3) and install bolts (2). Torque bolts (2) to a torque of 30 ± 4 N·m (22 ± 3 lb ft).

8. Connect harness assembly (1).

9. Repeat steps 1 through 8 for the remaining valves.

i02528248

# Temperature Sensor (Transmission Oil) - Remove and Install

**SMCS Code:** 301T-010-T3

## Removal Procedure

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

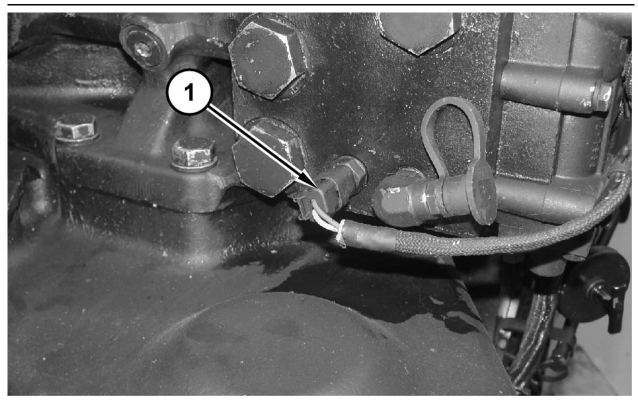


Illustration 213 g01264924

1. Disconnect harness assembly (1).

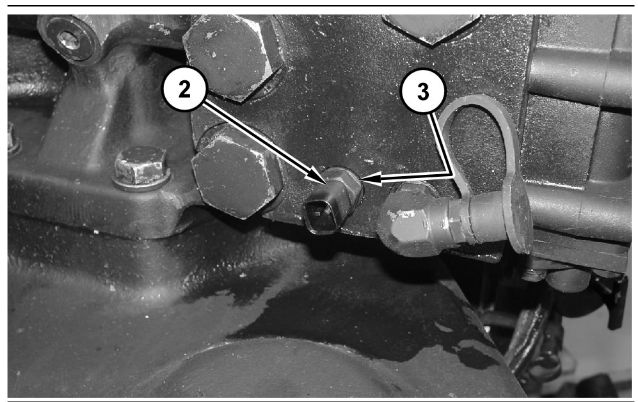


Illustration 214 g01264940

**2.** Remove temperature sensor (2). Remove O-ring seal (3).

## Installation Procedure

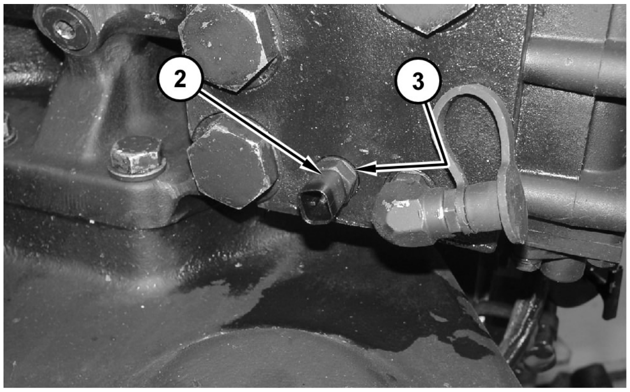


Illustration 215 g01264940

**1.** Install O-ring seal (3). Install temperature sensor (2). Tighten temperature sensor (2) to a torque of 15 ± 3 N·m (11 ± 2 lb ft).

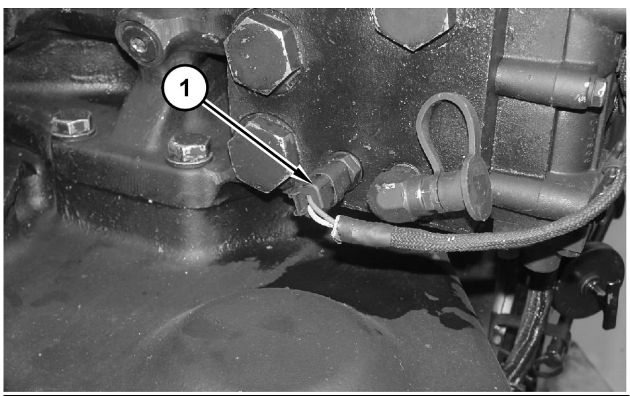


Illustration 216 g01264924

**2.** Connect harness assembly (1).

# Index

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# Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

**Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.**

**Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.**

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.

**⚠ WARNING**

The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

**Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.**

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.

**⚠ WARNING**

**When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.**

**Failure to heed this warning can lead to premature failures, product damage, personal injury or death.**

# Table of Contents

## Troubleshooting Section



## Testing and Adjusting Section



## Index Section

# Troubleshooting Section

# Introduction

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## General Information

**SMCS Code:** 4800

Troubleshooting the electronic control modules of the tractor requires additional information from the machine Service Manual, the Electrical System Schematic, and the Operation and Maintenance Manual.

As a guide, system schematics are provided in this manual. Refer to the Electrical System Schematic that is located in the machine Service Manual for a complete representation of the machine that is being diagnosed.

When the troubleshooting procedure instructs the service personnel to REPAIR THE HARNESS, always use the Electrical System Schematic that is located in the machine Service Manual to trace the circuit. Perform continuity checks at the connectors in order to locate the harness failures. At component connectors, always check the ground circuit. The power circuits of the control require less than 2 ohms of resistance between the ground contacts of the connector and frame ground. Signal circuits ("sensors, switches, solenoids etc.") require less than 5 ohms of resistance for normal operation. Resistance that is greater than 5 ohms can cause incorrect diagnosing of problems.

Repairs of the machine harness should be performed with the wire of the same gauge. All joints should be soldered. All joints should be taped tightly. Use the 1P-0810 Vinyl Tape or shrink sleeving for all repairs to the harness. Repairs to the data link circuit in the harness must maintain the same twist ratio in the wiring that was provided in the original harness. The two wires of the Cat Data Link must maintain a twist rate of 2 ±1 turns per inch. Twisting is VERY IMPORTANT! Twisting will minimize the electrical interference to other circuits that is caused by the data link. Interference to the data link from other circuits will also be minimized.

During troubleshooting, inspect all component and harness connections before any component is replaced. Electrical problems can be caused if harness connections are not clean and tight. The electrical problem can be permanent or the electrical problem can be intermittent. Make sure that the connections are tight before other tests are made.

The failure of an electrical component can cause the failure of one or more related components. Always attempt to find the cause of the electrical system failure and then correct the cause of the electrical system failure before replacing a component.

Some machine functions that use solenoid valves require a suppressor diode across the valve coil. If the suppressor diode is faulty, electronic noise that is generated by the solenoids turning ON and OFF can cause erratic operation of the display components. If the erratic operation of the display components appears to be associated with an activity such as "blade operation", check the appropriate suppressor diode for proper operation.

Data events and maintenance events are defined by the machine's configuration software. Diagnostic functions for a given event are also defined in the configuration software. The electronic control module may wait up to 30 SECONDS before displaying a system event. During troubleshooting, allow an adequate amount of time for the ECM to report that a new condition exists. For example, unplug a sensor from the machine harness. The ECM may wait up to 30 seconds before reporting this condition. Likewise, when the condition is corrected, several minutes may be required before the event ceases to be reported.

Repairs are considered complete when the system event is no longer present and the parameter appears to read the condition of the machine correctly.

**Note:** If an event is displayed for a switch and the switch has been replaced use the Electrical System Schematic as a troubleshooting aid. Check the components that are listed here: wire harness, the switch, and the ECM.

### Quick Reference

- See the Troubleshooting, "Diagnostic Trouble Codes List" section for failures that have diagnostics (MID/CID/FMI).
- See the Troubleshooting, " Switch Circuits" section for failures in the operation of the alert indicators.

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## Service Tools

**SMCS Code:** 0785

The following service tools should be used to aid in troubleshooting the electrical system.

Table 1

| Service Tools | |
|---|---|
| **Part Number** | **Part** |
| | Caterpillar Electronic Technician (ET) |
| 6V-7070<br>9U-7330 | Digital Multimeter |
| 8T-3224 | Needle Tip Group |
| 7X-1710 | Multimeter Probe Group |
| 8T-8726 | Adapter Cable Assembly |
| 9U-7246 | Connector Repair Kit<br>DT |
| 4C-3406 | Connector Repair Kit |
| 4C-8195 | Control Service Tool (Switch Box) |
| 157-4829 | Cable Adapter |

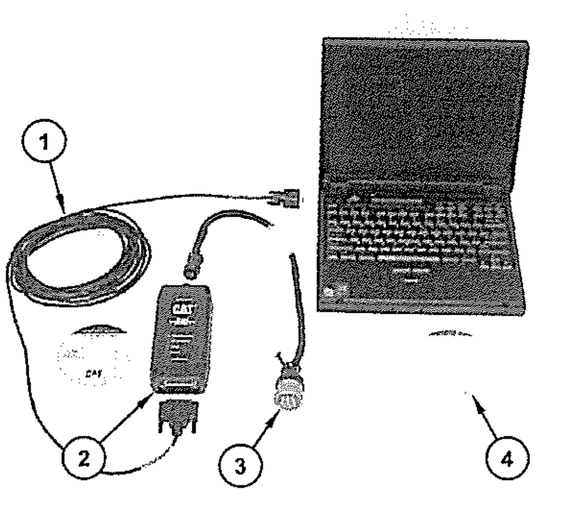


Illustration 1 g01309200

Connections for the Communication Adapter II and the Caterpillar Electronic Technician (Cat ET)

The components that are needed to use the Communication Adapter II and the Cat ET to determine diagnostic codes are listed:

(1) Cable
(2) 171-4400 Communication Adapter II
(3) Service diagnostic cable.
(4) Current version of Cat ET software and an IBM-COMPATIBLE personal computer

**Reference:** See Special Publication, NEHS0758, "Communications Adapter II User's Manual Contains Software".

**Note:** Cat ET is a software program that can be used on an IBM compatible personal computer.

In order to use the Cat ET, order the following materials: Special Publication, JERD2124, "ET Single Use Program License", Special Publication, JEHP1026, "Information and Requirements Sheet", 7X-1425 Data Link Cable and the Data Subscription, and Special Publication, JERD2142, "Data Subscription". The Special Publication, JEHP1026, "Information and Requirements Sheet" lists the required hardware and the features of the Cat ET.

The Cat ET is not required in order to determine the diagnostic codes and the Cat ET is not required in order to clear the diagnostic codes. However, the process of determining the diagnostic codes is easier and faster by using the Cat ET. The Cat ET can also display information on the history of a diagnostic code and the parameter status of diagnostic codes. These features allow the Cat ET to be a useful tool for troubleshooting.

The Cat ET is used to communicate to the electronic control module over the data link by connecting to the diagnostic connector. For more information and the locations of the connectors, see Troubleshooting, "Electrical Components and Connector Locations" and the Electrical System Schematic in your vehicle's Service Manual.

For instructions on servicing Sure Seal connectors, see Special Instruction, SMHS7531. For instructions on servicing Deutsch connectors, see Special Instruction, SEHS9615.

Use the digital multimeter for measuring resistance or for measuring voltage. For instructions about the use of the 6V-7070 Digital Multimeter, see Special Instruction, SEHS7734. The 7X-1710 Multimeter Probe measures the voltage at the connectors without disconnecting the connectors. The probe cables are pushed into the back of the connector along the wire. The 8T-8726 Adapter Cable has a breakout with 3 pins. The adapter cable is used for measurements in the sensor circuits.

**Note:** Except for harness tests, using continuity testers such as the 8T-0500 Continuity Tester or voltage testers such as the 5P-7277 Voltage Tester is not recommended for today's Caterpillar electrical circuits.

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# Connector Locations

**SMCS Code:** 7553-546-WW

## Service Tool Connector

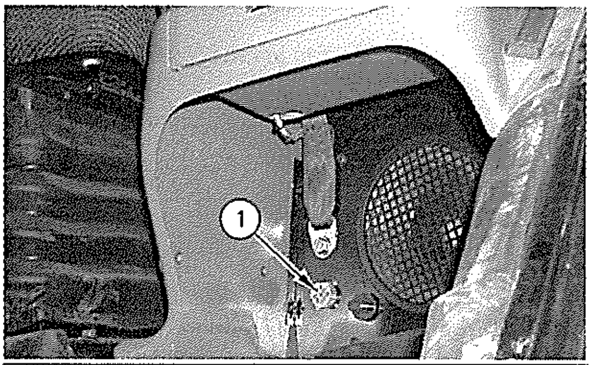


Illustration 2 g00777353

(1) Service tool connector

The service tool connector (1) is located under the trainer seat. The connector is facing toward the front of the tractor.

The service tool connector is used to communicate with the following components:

- The Transmission ECM
- The Caterpillar Electronic Technician (Cat ET)

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# Diagnostic Capabilities

**SMCS Code:** 4800

## The Caterpillar Electronic Technician (ET)

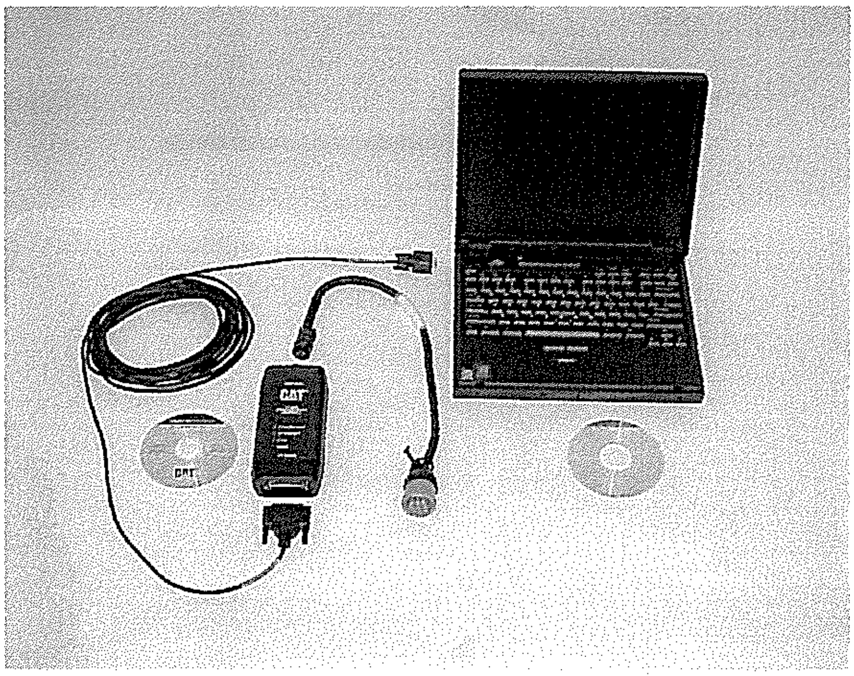

Illustration 3 g00777826

The Caterpillar Electronic Technician (ET) is a software program that is used to access data. The service technician will use the ET in order to perform the maintenance on the vehicle. Some of the options that are available with the Caterpillar Electronic Technician are listed below:

- Diagnosis of problems
- Viewing diagnostic trouble codes
- Viewing active event codes and logged event codes
- View the status of parameters.
- Clear active diagnostic trouble codes and clear logged diagnostic trouble codes
- Perform calibration of machine systems.
- Program the ECU (Flash). This is done with the "WINflash" program. See Testing and Adjusting, "Electronic Control Unit - Flash Program".
- Print reports.

See Troubleshooting, "Determining Diagnostic Trouble Codes". Diagnostic information is accessed with the following drop down menus:

- Active diagnostic trouble codes
- Logged diagnostic trouble codes

# Status Groups For The Electronic Technician

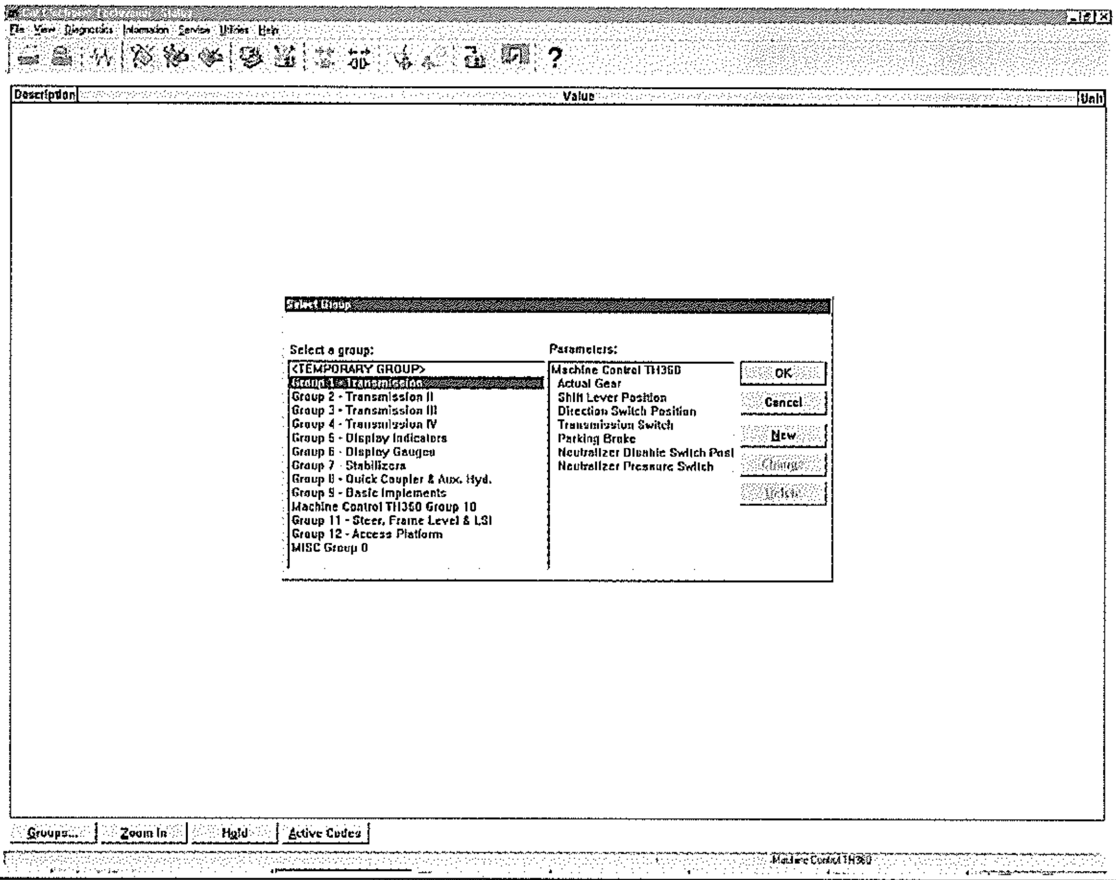

Illustration 4 g00912695

Typical Cat ET screen for parameters

The status groups are lists of machine parameters. The status of the parameters are shown in real time.

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# Machine Preparation for Troubleshooting

**SMCS Code:** 3030

## Preparation of the Tractor

**WARNING**

**Sudden movement of the machine or release of oil under pressure can cause serious injury to persons on or near the machine.**

**To prevent possible injury, perform the procedure that follows before testing and adjusting the hydraulic system.**

1. Move the tractor to a smooth horizontal location.

2. Lower all implements to the ground and lower the three-point hitch to the ground.

3. Make sure that the transmission control lever is in the PARK position.

4. Warm the oil to a minimum temperature of 60°C (140°F), if necessary.

5. Move all of the hydraulic control levers through the FLOAT position in order to relieve the hydraulic pressure.

6. Stop the engine and remove the key.

7. Remove the appropriate guards.

   **Reference:** Refer to Operations and Maintenance Manual, "Guards - Remove and Install" for more information.

## Procedure

**When you are defining a problem in any of the hydraulic systems, the following procedure should be followed:.**

Perform a visual check of the electrical system and the hydraulic system. If you complete the visual inspection and the problem is not identified, perform the mechanical system tests. If you complete the mechanical system tests and the problem is not identified, perform the electrical system tests. The troubleshooting manual lists the probable causes of a known problem.

Since more than one cause may exist for a problem, the troubleshooting section may suggest specific inspections or instrument tests. These inspections and tests will help identify the most probable cause.

## Test Equipment

**Hydraulic test procedures may be performed using either one of the following test equipment:**

- Dataview tool gp

- Appropriate pressure gauges

**Note:** During a diagnosis in any of the hydraulic systems, remember that correct oil flow and pressure are necessary for correct operation. Oil pressure is caused by resistance to the flow of oil. Oil temperature must be a minimum of 60 °C (140 °F). The temperature of the hydraulic oil can be viewed by using the Caterpillar Electronic Technician (Cat ET).

# Symptom Troubleshooting

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## Transmission

**SMCS Code:** 3030-035

### Transmission Clutch Engagement

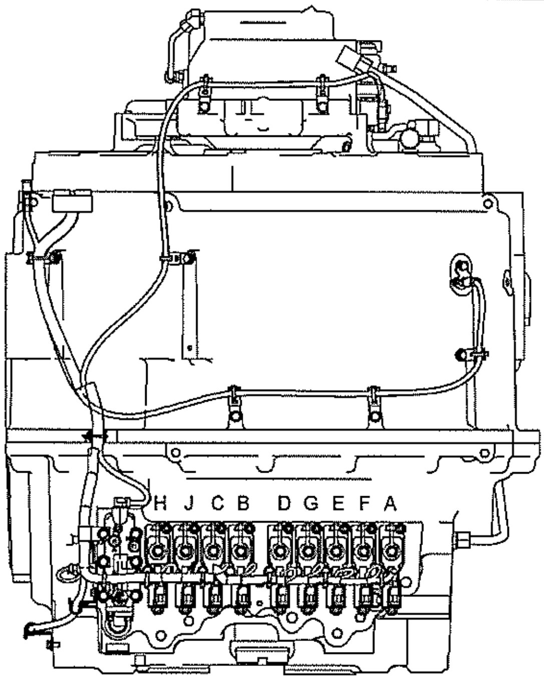


Illustration 5 g01343698

Modulating Valves (Transmission Control Valves)

Table 2

| Clutch | Clutch Designation |
|---|---|
| 1 | C |
| 2 | D |
| 3 | E |
| 4 | F |
| 5 | G |
| 6 | B |
| 7 | H |
| 8 | J |
| 9 | A |

Each transmission control valve has a designated letter, as shown. The letters have been cast into the transmission housing.

Each transmission control valve controls an individual clutch. Each letter is assigned to a corresponding transmission control valve. See Illustration 5.

These letters are used in Table 3 to show the clutches that are engaged for each gear.

No more than two clutches are ever engaged at a time. Also, no more than one clutch is ever engaged on a shaft.

Table 3

| Transmission Clutch Engagement Engine RPM at 2100 | | | | |
|---|---|---|---|---|
| **Gear** | **Reverse Shaft** | **Input Shaft** | **Intermediate Shaft** | **Output Shaft** |
| Fourth gear (reverse) | A | - | - | J |
| Third gear (reverse) | A | - | - | H |
| Second gear (reverse) | A | - | - | B |
| First gear (reverse) | A | - | - | G |
| Neutral | - | - | - | J |
| First gear | - | C | - | G |
| Second gear | - | D | - | G |
| Third gear | - | - | E | G |
| Fourth gear | - | - | F | G |
| Fifth gear | - | C | - | B |
| Sixth gear | - | C | | H |
| Seventh gear | - | D | - | B |
| Eighth gear | - | D | - | H |
| Ninth gear | - | - | E | B |
| Tenth gear | - | - | E | H |
| Eleventh gear | - | - | F | B |
| Twelfth gear | - | - | F | H |
| Thirteenth gear | - | C | - | J |
| Fourteenth gear | - | D | - | J |
| Fifteenth gear | - | - | E | J |
| Sixteenth gear | - | - | F | J |

## Problem List

**The following problems are covered in this story:**

- "The Tractor Does Not Move in Any Gear"
- "The Transmission Does Not Shift Into All of the Gears"
- "A Warning Event for Replacing the Transmission Oil Filters is Displayed on the (Cat ET)"
- "The Transmission Shifts Too Hard"
- "A Warning Event for Low Transmission Oil Pressure is Displayed on the (Cat ET)"
- "A Warning Event for Elevated Transmission Oil Temperature is Displayed on the (Cat ET)"
- "The Transmission Locks Into One Gear"
- "The Transmission Slips"
- "Inching Control Does Not Work Properly"

## The Tractor Does Not Move in Any Gear

1. Check the Caterpillar Electronic Technician (Cat ET) for diagnostic codes.

   **Reference:** See the appropriate sections in this manual that relate to the diagnostic codes. Repair any suspect components, as required.

2. Check the sump for the correct type of oil and check the sump for the correct quantity of oil.

   **Reference:** Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check" for additional information.

3. Perform the calibration procedure for the transmission clutches.

**Reference:** Refer to Testing and Adjusting, "Transmission Clutch Calibration" for additional information.

4. Repair any problems that are found in the calibration procedure.

**Note:** Operate the tractor. If the transmission does not function properly, continue with Step 5.

5. Perform the pressure tests for the transmission.

   **Reference:** Refer to Systems Operation/Testing and Adjusting for additional information.

6. Repair any failed components that are found while you perform the pressure tests.

## The Transmission Does Not Shift Into All of the Gears

1. Check for diagnostic codes.

   **Reference:** See the appropriate sections in this manual that relate to the diagnostic codes. Repair any suspect components, as required.

2. Check the reservoir for the correct type of oil and check the reservoir for the correct quantity of oil.

   **Reference:** Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check" for additional information.

3. Perform the calibration procedure for the transmission clutches.

   **Reference:** Refer to Testing and Adjusting, "Transmission Clutch Calibration" for additional information.

4. Repair any failed components or replace any failed components that are found during the calibration procedure.

**Note:** Operate the tractor. If the transmission does not function properly, continue with Step 5.

5. Perform the pressure tests for the transmission.

   **Reference:** Refer to Testing and Adjusting for additional information.

6. Repair any failed components or replace any failed components that are found during the pressure tests.

7. If a specific gear is missing, identify the clutches that are used for that gear. See Table 3.

8. Look for a gear that uses similar clutches.

9. Use a known working transmission control valve to replace the suspect transmission control valve. For example, if fourth gear (reverse) is working then you can use either transmission control valve (A) or (J) as a working transmission control valve. This will isolate the faulty solenoid valve. Replace any faulty solenoid valves that are found during the test.

## A Warning Event for Replacing the Transmission Oil Filters is Displayed in (Cat ET)

1. Replace the hydraulic oil filters.

   **Reference:** Refer to Operation and Maintenance Manual, "Hydraulic System Oil Filters - Replace" for additional information.

2. Check for diagnostic trouble codes.

   **Reference:** See the appropriate stories in this manual that relate to the diagnostic codes. Repair any suspect components, as required.

## The Transmission Shifts Too Hard

1. Check for diagnostic codes.

   **Reference:** See the appropriate sections in this manual that relate to the diagnostic codes. Repair any suspect components, as required.

2. Check the reservoir for the correct type of oil and check the reservoir for the correct quantity of oil.

   **Reference:** Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check" for additional information.

3. Perform the calibration procedure for the transmission clutches.

   **Reference:** Refer to Testing and Adjusting, "Transmission Clutch Calibration" for additional information.

4. Repair any problems that are found in the calibration procedure.

**Note:** Operate the tractor. If the transmission does not function properly, continue with Step 5.

5. Perform the pressure tests for the transmission.

   **Reference:** Refer to Testing and Adjusting for additional information.

6. Repair any failed components or replace any failed components that are found during the pressure tests.

7. If a specific gear is missing, identify the clutches that are used for that gear. See Table 3.

8. Look for a gear that uses similar clutches.

9. Use a known working transmission control valve to replace the suspect transmission control valve. For example, if fourth gear (reverse) is working then you can use either transmission control valve (A) or (J) as a working transmission control valve. This will isolate the faulty solenoid valve. Replace any faulty solenoid valves that are found during the test.

## A Warning Event for Low Transmission Oil Pressure is Displayed on the (Cat ET)

1. Check for diagnostic trouble codes.

   **Reference:** See the appropriate sections in this manual that relate to the diagnostic codes. Repair any suspect components, as required.

**Note:** Operate the tractor. If a warning event for low transmission oil pressure is still on, continue with Step 2.

2. Check the reservoir for the correct type of oil and check the reservoir for the correct quantity of oil.

   **Reference:** Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check" for additional information.

3. Perform the pressure tests for the transmission.

   **Reference:** Refer to Testing and Adjusting for additional information.

## A Warning Event for Elevated Transmission Oil Temperature is Displayed on the (Cat ET)

1. Check for diagnostic trouble codes.

   **Reference:** See the appropriate sections in this manual that relate to the diagnostic codes. Repair any suspect components, as required.

2. Check the reservoir for the correct type of oil and check the reservoir for the correct quantity of oil.

   **Reference:** Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check" for additional information.

3. Check the hydraulic oil cooler.

   a. Check the cooler for dirt or foreign material. Clean the cooler, if necessary.

      **Reference:** Refer to Operation and Maintenance Manual, "Cooling Cores - Clean" for additional information.

   b. Check the cooler for damage. As required, repair components or replace components.

   c. Check the cooler lines for damage. As required, repair components or replace components.

4. Air flow across the cooler is low.

   a. Check the fan for damage. If the fan is damaged, replace the fan.

   b. Check the fan drive belt. The speed of the fan may be reduced if the fan drive belt is loose or if the fan drive belt is damaged. If the fan drive belt is damaged, replace the belt.

      **Reference:** Refer to Operation and Maintenance Manual for additional information.

5. There appears to be air in the transmission oil.

   a. Find the location of the entry of the air into the system.

   b. As required, repair components or replace components.

## The Transmission Locks Into One Gear

1. Check the (Cat ET) for any diagnostic code that is displayed.

   **Reference:** See the appropriate sections in this manual that relate to the diagnostic codes. Repair any suspect components, as required.

2. Find the gear that is locked. Find the clutches that are used to engage the gear that is locked. See Table 3.

3. Perform the pressure tests for the transmission.

   **Reference:** Refer to Systems Operation/Testing and Adjusting for additional information.

## The Transmission Slips

1. Check for diagnostic trouble codes.

   **Reference:** See the appropriate sections in this manual that relate to the diagnostic codes. Repair any suspect components, as required.

2. Check the reservoir for the correct type of oil and check the reservoir for the correct quantity of oil.

   **Reference:** Refer to Operation and Maintenance Manual, "Hydraulic System Oil Level - Check" for additional information.

3. Perform the calibration procedure for the transmission clutches.

   **Reference:** Refer to Testing and Adjusting, "Transmission Clutch Calibration" for additional information.

4. Repair any problems that are found in the calibration procedure.

5. Perform the pressure tests for the transmission.

   **Reference:** Refer to Testing and Adjusting for additional information.

6. Repair any problems that are found during the pressure tests.

7. If the pressure is correct, the clutches may be worn. As required, repair components or replace components.

## Inching Control Does Not Work Properly

1. Check for diagnostic trouble codes.

   **Reference:** See the appropriate sections in this manual that relate to the diagnostic codes. Repair any suspect components, as required.

2. Perform the calibration procedure for the transmission clutches.

   **Reference:** Refer to Testing and Adjusting, "Transmission Clutch Calibration" for additional information.

# Diagnostic Trouble Code Procedures

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## Diagnostic Trouble Code List

**SMCS Code:** 7569

Use the instrument cluster or use the Caterpillar Electronic Technician (Cat ET) in order to determine the diagnostic trouble codes for the Transmission ECU. After determining the diagnostic trouble codes, refer to the corresponding test procedure for more information. Perform the procedure that corresponds with the correct diagnostic trouble code. The following table is a list of possible diagnostic trouble codes for the Transmission ECU.

Table 4

| Diagnostic Trouble Codes For The Transmission ECU | |
|---|---|
| **For troubleshooting, see the procedure with the same "SPN" and "FMI".** | |
| **"SPN"/ FMI** | **Description** |
| **SPN 117 Parking Brake Pressure Switch** | |
| FMI 2 | Data that is erratic, intermittent, or incorrect |
| **SPN 127 Transmission Oil Pressure Sensor** | |
| FMI 3 | Voltage above normal |
| FMI 4 | Data valid but above normal operating range (moderate severity) |
| **SPN 161 Transmission Input Speed Sensor** | |
| FMI 2 | Data that is erratic, intermittent, or incorrect |
| **SPN 168 Electrical System Voltage** | |
| FMI 3 | Voltage above normal |
| FMI 4 | Voltage below normal |
| **SPN 177 Temperature Sensor (Transmission Oil)** | |
| FMI 3 | Voltage above normal |
| FMI 4 | Voltage below normal |
| **SPN 191 Transmission Output Speed Sensor #1** | |
| FMI 12 | Speed failure |
| **SPN 625 (Cat Data Link)** | |
| FMI 9 | Abnormal update |
| **SPN 639 J1939 Data Link** | |
| FMI 9 | Abnormal update |
| **SPN 701 Transmission Clutch Solenoid 9** | |
| FMI 3 | Voltage above normal |
| FMI 5 | Current below normal or open circuit |

(continued)

(Table 4, contd)

| Diagnostic Trouble Codes For The Transmission ECU | |
|---|---|
| **For troubleshooting, see the procedure with the same "SPN" and "FMI".** | |
| **"SPN"/ FMI** | **Description** |
| FMI 6 | Current above normal or closed circuit |
| **SPN 702 Inching Pedal Switch** | |
| FMI 2 | Data that is erratic, intermittent, or incorrect |
| FMI 7 | Not responding |
| **SPN 703 Inching Pedal Position Sensor** | |
| FMI 0 | Voltage above normal |
| FMI 1 | Current below normal or open circuit |
| FMI 8 | Current above normal or closed circuit |
| **SPN 704 Auxiliary I/O #4** | |
| FMI 12 | Voltage above normal |
| **SPN 734 Transmission Clutch Solenoid 1** | |
| FMI 3 | Voltage above normal |
| FMI 5 | Current below normal or open circuit |
| FMI 6 | Current above normal or closed circuit |
| **SPN 735 Transmission Clutch Solenoid 2** | |
| FMI 3 | Voltage above normal |
| FMI 5 | Current below normal or open circuit |
| FMI 6 | Current above normal or closed circuit |
| **SPN 736 Transmission Clutch Solenoid 3** | |
| FMI 3 | Voltage above normal |
| FMI 5 | Current below normal or open circuit |
| FMI 6 | Current above normal or closed circuit |
| **SPN 737 Transmission Clutch Solenoid 4** | |
| FMI 3 | Voltage above normal |
| FMI 5 | Current below normal or open circuit |
| FMI 6 | Current above normal or closed circuit |
| **SPN 738 Transmission Clutch Solenoid 5** | |
| FMI 3 | Voltage above normal |
| FMI 5 | Current below normal or open circuit |
| FMI 6 | Current above normal or closed circuit |
| **SPN 739 Transmission Clutch Solenoid 6** | |
| FMI 3 | Voltage above normal |
| FMI 5 | Current below normal or open circuit |
| FMI 6 | Current above normal or closed circuit |
| **SPN 774 Upshift Switch** | |
| FMI 2 | Data that is erratic, intermittent, or incorrect |

(continued)

(Table 4, contd)

| Diagnostic Trouble Codes For The Transmission ECU | |
|---|---|
| For troubleshooting, see the procedure with the same "SPN" and "FMI". | |
| "SPN"/ FMI | Description |
| SPN 775 Downshift Switch | |
| FMI 2 | Data that is erratic, intermittent, or incorrect |
| SPN 1079 5 Volt Sensor Supply Voltage | |
| FMI 0 | Voltage is high - most severe |
| FMI 1 | Voltage is low - most severe |
| FMI 3 | Voltage above normal |
| FMI 4 | Voltage below normal |
| SPN 1542 10 Volt Sensor Supply Voltage | |
| FMI 0 | Voltage is high - most severe |
| FMI 1 | Voltage is low - most severe |
| SPN 1619 Transmission Lever Position Sensor | |
| FMI 0 | Voltage is high - most severe |
| FMI 1 | Voltage is low - most severe |
| FMI 8 | Abnormal frequency, pulse width, or period |
| SPN 1666 Auto Mode Switch | |
| FMI 2 | Data that is erratic, intermittent, or incorrect |
| SPN 2905 Transmission Clutch Solenoid 7 | |
| FMI 3 | Voltage above normal |
| FMI 5 | Current below normal or open circuit |
| FMI 6 | Current above normal or closed circuit |
| SPN 2906 Transmission Clutch Solenoid 8 | |
| FMI 3 | Voltage above normal |
| FMI 5 | Current below normal or open circuit |
| FMI 6 | Current above normal or closed circuit |

i02504899

# Determining Diagnostic Trouble Codes

**SMCS Code:** 0785-UE; 7490

## Using Caterpillar Electronic Technician to Determine Diagnostic Trouble Codes

Connect the Caterpillar Electronic Technician (ET) to the machine. Turn the key switch to the RUN position. Start the Cat ET. The Cat ET will initiate communications with the Electronic Control Modules on the machine. After communication has been established, the Cat ET will list the Electronic Control Modules. Choose the desired Electronic Control Module. After the diagnostic trouble codes have been determined with the Cat ET, see the test procedure for the corresponding diagnostic trouble code.

**Reference:** Troubleshooting, "Service Tools"

**Active Diagnostic Trouble Codes**

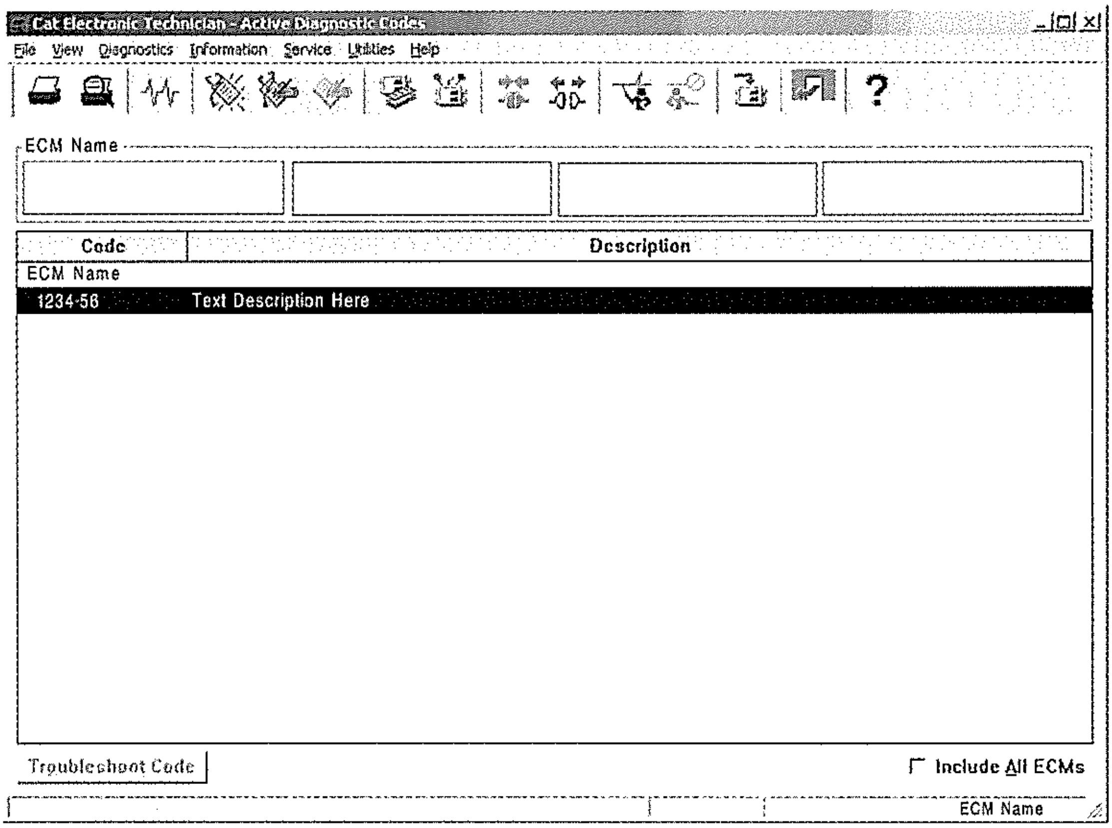


Illustration 6 g00859671

Typical Cat ET screen for active diagnostic trouble codes

The following procedures may cause new diagnostic trouble codes to be logged. Therefore, before any procedures are performed make a list of all the active diagnostic trouble codes in order to determine the system problems. Clear the diagnostic trouble codes that were caused by the procedure, when each procedure is complete.

**Note:** Before performing a procedure, always check all the circuit breakers. Repair the cause of any circuit breaker that is tripped.

A screen is provided in Cat ET for active diagnostic trouble codes. The screen will display the diagnostic trouble codes that are active. Active diagnostic information shall include a component identifier (CID), a failure mode identifier (FMI) and a text description of the problem.

### Logged Diagnostic Trouble Codes

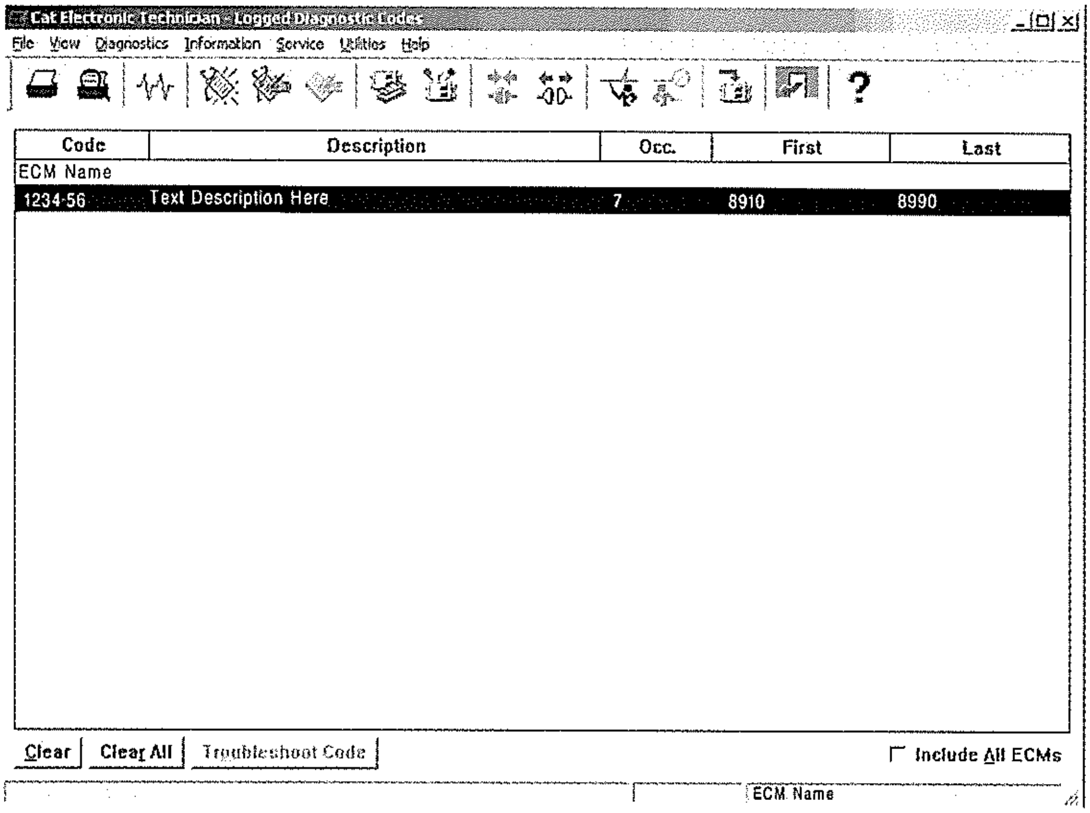


Illustration 7 g00859762

Typical Cat ET screen for logged diagnostic trouble codes

A screen is provided in Cat ET for logged diagnostic trouble codes. The screen will display diagnostic trouble codes that are logged. The Cat ET will log diagnostic trouble codes that are intermittent. The logged diagnostic data shall include a component identifier (CID), a failure mode identifier (FMI), and a text description of the problem. Also, the logged diagnostic data shall include the number of occurrences of the problem and two time stamps. The time stamp displays the first occurrence of the problem and the time stamp displays the most recent occurrence of the problem.

Diagnostics are logged in non-volatile memory. On powerup, the ECU will clear any diagnostic trouble codes that have not been detected or active within the last 150 hours of machine operation.

i02654778

# Transmission, SPN 117 - FMI 2

**SMCS Code:** 1435-038-BRK

**Conditions Which Generate This Code:**

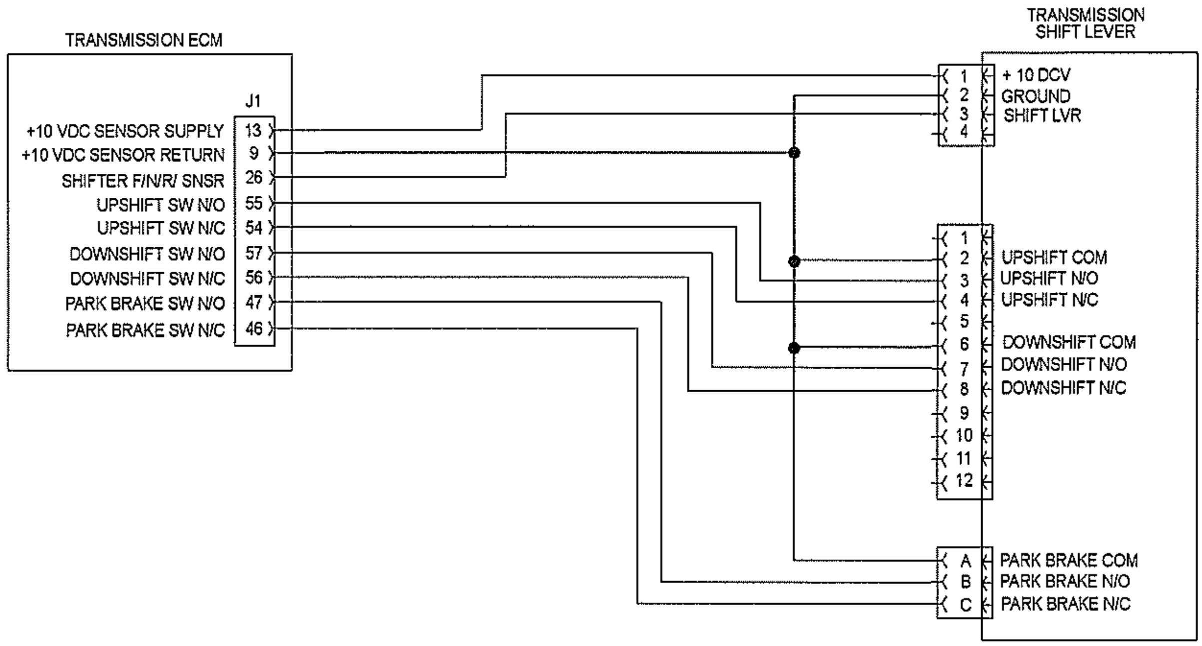


Illustration 8 g01343143

Connection of the parking brake switch

This diagnostic code is associated with the parking brake switch. The switch is connected to two inputs of the ECM. The inputs are "Normally Open" and "Normally Closed". One of the inputs is open and the other input is grounded during proper operation.

The FMI 2 means that the ECM has determined that the "Normally Open" and "Normally Closed" circuits are in the same state.

**Note:** The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 117 FMI 2 is active before performing this procedure.**

## Test Step 1. CHECK THE OPERATION OF THE SWITCH

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector or the wires from the switch.

**C.** Connect one lead from the multimeter to the common contact (A) for the switch.

**D.** Connect the other lead from the multimeter to the normally open contact (B) for the switch.

**E.** Measure the resistance between contact A and contact B. Note the resistance.

**F.** Disconnect the lead from contact B and connect the lead to the normally closed contact (C).

**G.** Measure the resistance between contact A and contact C. Note the resistance.

**Expected Result:**

The resistance from contact A to contact B is greater than 5000 ohms, and the resistance from contact A to contact C is less than 5 ohms.

**Results:**

- YES – The resistance from contact A to contact B is greater than 5000 ohms, and the resistance from contact A to contact C is less than 5 ohms. Proceed to Test Step 2.
- NO – The resistance measurements do not differ. The switch has failed.

  **Repair:** Replace the switch.

  STOP.

### Test Step 2. CHECK THE OPERATION OF THE SWITCH

**A.** Connect one lead from the multimeter to the common contact (A) for the switch.

**B.** Connect the other lead from the multimeter to the normally open contact (B) for the switch.

**C.** Actuate the switch and measure the resistance between contact A and contact B. Note the resistance.

**D.** Disconnect the lead from contact B and connect the lead to the normally closed contact (C).

**E.** Actuate the switch and measure the resistance between contact A and contact C. Note the resistance.

**Expected Result:**

The resistance from contact A to contact B is greater than 5 ohms, and the resistance from contact A to contact C is less than 5000 ohms.

**Results:**

- YES – The resistance from contact A to contact B is greater than 5 ohms, and the resistance from contact A to contact C is less than 5000 ohms. Proceed to Test Step 3.
- NO – The resistance measurements do not differ. The switch has failed.

  **Repair:** Replace the switch.

  STOP.

### Test Step 3. CHECK THE GROUND CIRCUIT OF THE SWITCH IN THE WIRE HARNESS.

**A.** Connect one lead from the multimeter to contact A of the wire harness connector for the switch.

**B.** Connect the other lead from the multimeter to frame ground.

**C.** Measure the resistance between contact A and frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5000 ohms. The circuit is open. The machine harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 4. CHECK THE SWITCH CIRCUITS FOR A SHORT CIRCUIT.

**A.** The disconnect switch and the key start switch remain in the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The connector for the switch remains disconnected.

**D.** At the machine harness connector for the ECM, measure the resistance from contact J1-47 and contact J1-46 of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The harness is correct. Proceed to Test Step 5.
- NO – One or more of the measurements were less than 5 ohms. There is a short in the machine harness.

**Repair:** The short is between J1-47 and the circuit with the lowest resistance measurement or the short is between J1-46 and the circuit with the lowest resistance measurement. Repair the machine harness or replace the machine harness.

STOP.

### Test Step 5. CHECK THE SWITCH CIRCUITS IN THE HARNESS.

**A.** The machine harness remains disconnected from the ECM and the switch.

**B.** At the harness connector for the switch, connect a jumper wire between contact B and contact C.

**C.** At the harness connector for the ECM, measure the resistance from contact J1-47 to contact J1-46.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. Proceed to Test Step 6.

- NOT OK – The resistance is greater than 5000 ohms. The circuit is open.

  **Repair:** The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the contacts of the harness connectors and clean the connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Determine if SPN 117 FMI 2 is active.

**Expected Result:**

The SPN 117 FMI 2 is active.

**Results:**

- YES – The SPN 117 FMI 2 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 117 FMI 2 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  **Repair:** The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02654781

## Transmission, SPN 127 - FMI 3

**SMCS Code:** 1435-038-PX

**Conditions Which Generate This Code:**

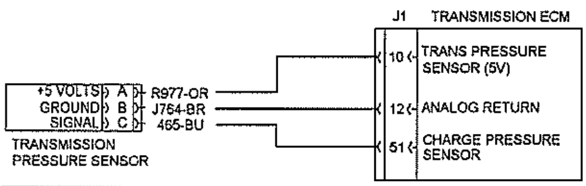


Illustration 9 g01338641

Connections of the transmission pressure sensor

This diagnostic code is associated with the transmission pressure sensor. The FMI 3 means that the ECM has determined that the voltage of the circuit for the sensor is above normal. The sensor monitors the hydraulic charge pressure.

The output of the sensor is an analog signal from 0.2 DCV to 4.95 DCV. The voltage changes as the pressure changes. The ECM recognizes a voltage in the range of 0.2 DCV to 4.95 DCV as valid input from the sensor. If the voltage is below 0.2 DCV for more than two seconds, the ECM determines that the sensor is shorted to ground.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is open.
- The signal circuit for the sensor is shorted to the +battery circuit.
- The sensor has failed.

- The power circuit or the ground circuit has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 127 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK FOR POWER AT THE SENSOR.

**A.** Do not disconnect the harness connector from the sensor.

**B.** Turn the key start switch and the disconnect switch to the ON position.

**C.** At the back of the harness connector for the sensor, insert a multimeter probe along the voltage supply wire (contact A).

**D.** Measure the voltage from contact A to frame ground.

**Expected Result:**

The voltage is +5 DCV.

**Results:**

- OK – The voltage is +5 DCV. Proceed to Test Step 2.
- NOT OK – The voltage is not +5 DCV. The + battery circuit in the machine harness has failed.

  **Repair:** Replace the machine harness or repair the machine harness.

  STOP.

## Test Step 2. CHECK FOR PROPER GROUND AT THE SENSOR.

**A.** The machine harness remains connected to the sensor.

**B.** Turn the key start switch and the disconnect switch to the OFF position.

**C.** Remove the multimeter probe from the voltage supply wire (contact A).

**D.** At the back of the harness connector for the sensor, insert a multimeter probe along the ground wire (contact B).

**E.** Measure the resistance from contact B to frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The ground circuit is correct. Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  **Repair:** Replace the machine harness or repair the machine harness.

  STOP.

## Test Step 3. CHECK THE WIRING HARNESS OF THE SENSOR FOR AN OPEN CIRCUIT.

**A.** The key start switch and the disconnect switch remain in the OFF position.

**B.** Disconnect the machine harness from the sensor.

**C.** At the harness connector for the sensor, connect a jumper wire between contact B and contact C.

**D.** Disconnect the machine harness connector(s) from the ECM.

**E.** At the harness connector for the ECM, measure the resistance between contact J1-12 and contact J1-51.

**Expected Result:**

The resistance measurement is less than 5 ohms.

**Results:**

- OK – The resistance measurement is less than 5 ohms. The circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The circuit is not correct. There is an open circuit in the wiring harness.

**Repair:** There is an open circuit in the wiring harness. Repair the wiring harness or replace the wiring harness.

STOP.

### Test Step 4. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** The key start switch and the disconnect switch remain in the OFF position.

**B.** The machine harness remains disconnected from the sensor. Remove the jumper wire that was installed in the previous step.

**C.** The machine harness connector(s) remains disconnected from the ECM.

**D.** At the machine harness connector for the ECM, measure the resistance from the signal contact J1-51 of the machine harness to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 5.

- NOT OK – One or more resistance measurements is not correct. There is a short in the machine harness.

  **Repair:** The short is between signal contact J1-51 and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 5. CHECK THE OUTPUT OF THE SENSOR.

**A.** Reconnect the machine harness connectors to the ECM. Reconnect the machine harness connector to the sensor.

**B.** At the back of the harness connector for the sensor, insert a multimeter probe along the signal wire (contact C).

**C.** At the back of the harness connector for the sensor, insert a multimeter probe along the ground wire (contact B).

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Measure the signal of the sensor. The proper signal is described at the beginning of this procedure.

**Expected Result:**

The signal from the sensor is valid.

**Results:**

- OK – The signal from the sensor is valid. Proceed to Test Step 6.

- NOT OK – The signal from the sensor is not valid.

  **Repair:** The sensor has failed. Replace the sensor.

  STOP.

### Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the contacts of the harness connectors and clean the connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Check the status of the SPN 127 FMI 3.

**Expected Result:**

The SPN 127 FMI 3 is active.

**Results:**

- YES – The SPN 127 FMI 3 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 127 FMI 3 is not active. The diagnostic code does not exist at this time.

**Repair:** The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02654798

# Transmission, SPN 127 - FMI 4

**SMCS Code:** 1435-038-PX

**Conditions Which Generate This Code:**

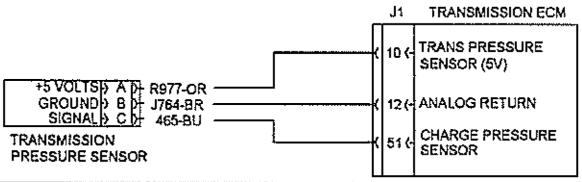


Illustration 10 g01338641

Connections of the transmission pressure sensor

This diagnostic code is associated with the transmission pressure sensor. The FMI 4 means that the ECM has determined that the voltage of the circuit for the position sensor is below normal. The sensor monitors the hydraulic charge pressure.

The output of the sensor is an analog signal from 0.2 DCV to 4.95 DCV. The voltage changes as the pressure changes. The ECM recognizes a voltage in the range of 0.2 DCV to 4.95 DCV as valid input from the sensor. If the voltage is above 4.95 DCV for more than two seconds, the ECM determines that the sensor is shorted to the + battery.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is shorted to ground.
- The sensor has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 127 FMI 4 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SENSOR.

**A.** Turn the disconnect switch and the key start switch to the ON position.

**B.** Ensure that the diagnostic code is active.

**C.** Observe the status of the diagnostic code. Disconnect the sensor from the machine harness.

**Expected Result:**

The SPN 127 FMI 4 remains active. The FMI has not changed and the 4 is still active.

**Results:**

- OK – The diagnostic code remains active. The sensor is correct. Proceed to Test Step 2.
- NOT OK – The diagnostic code is no longer active. The sensor has failed.

  **Repair:** Replace the sensor.

  STOP.

## Test Step 2. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness from the sensor.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector for the ECM, measure the resistance from the signal contact J1-51 of the machine harness to all possible sources of ground. Measure the resistance to all contacts of the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more resistance measurements is not correct. There is a short in the machine harness.

**Repair:** The short is between signal contact J1-51 and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the contacts of the harness connectors and clean the contacts.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Check the status of the SPN 127 FMI 4.

**Expected Result:**

The SPN 127 FMI 4 is active.

**Results:**

- YES – The SPN 127 FMI 4 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 127 FMI 4 is not active. The diagnostic code does not exist at this time.

  **Repair:** The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02654812

## Transmission, SPN 161 - FMI 2

**SMCS Code:** 1439-038-T3; 3175-038-IV

**Conditions Which Generate This Code:**

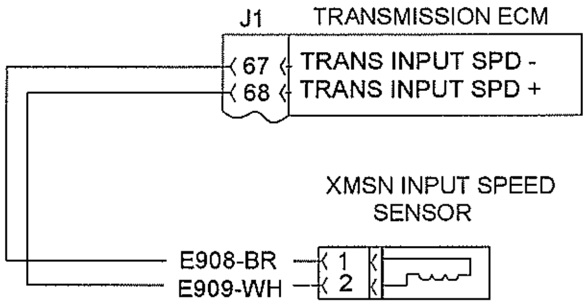


Illustration 11 g01338710

Connections of the transmission input speed sensor

This diagnostic code is associated with the transmission input speed sensor. The FMI 2 means that the ECM has determined that the signal frequency or the signal pulse width is not within the expected range.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- Intermittent connections or poor connections
- Mechanical devices are loose.
- The ECM has failed. This is unlikely.

**Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all of the connections in the circuit are clean and secure. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.**

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 161 FMI 2 is active before performing this procedure. The engine must be running in order for the diagnostic code to be active.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE SENSOR.

**A.** Turn the disconnect switch and the key start switch to the ON position.

**B.** Ensure that the diagnostic code is active.

**C.** Disconnect the sensor from the machine harness.

**Expected Result:**

The diagnostic code is no longer active.

**Results:**

- OK – The diagnostic code is no longer active. The sensor has failed.

  **Repair:** Replace the sensor. Verify that the new sensor corrected this diagnostic code. The diagnostic code should not be active.

  STOP.

- NOT OK – The diagnostic code remains active. The sensor is not the cause of the diagnostic code. Proceed to Test Step 2.

### Test Step 2. CHECK FOR A SHORT IN THE HARNESS.

**A.** The sensor remains disconnected from the machine harness.

**B.** Turn the key start switch and the disconnect switch to the OFF position.

**C.** Disconnect the J1 and J2 machine harness connectors from the Transmission ECM.

**D.** At the J1 machine harness connector for the ECM, measure the resistance between the signal contact J1-68 to all other J1 and J2 contacts.

**Expected Result:**

Each resistance measurement should be greater than 5000 ohms.

**Results:**

- OK – The resistance that is measured is greater than 5000 ohms for each measurement. The harness is correct. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this diagnostic code procedure again. If the cause of the diagnostic code is not found, replace the transmission ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NOT OK – The resistance that is measured is NOT greater than 5000 ohms for each measurement. The machine harness has failed.

  **Repair:** There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

i02654805

## Transmission, SPN 177 - FMI 3

**SMCS Code:** 1439-038-T3; 3194-038-OC

**Conditions Which Generate This Code:**

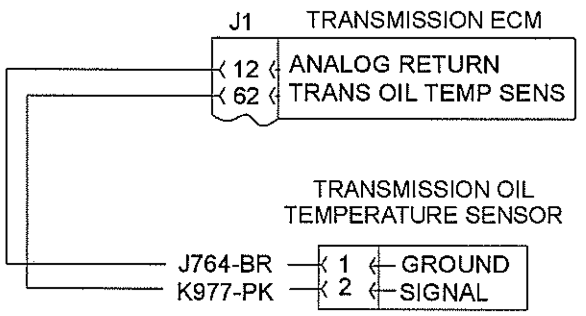


Illustration 12 g01338732

Connections of the transmission oil temperature sensor

This diagnostic code is associated with the transmission oil temperature sensor. The FMI 3 means that the ECM has determined that the voltage of the circuit for the sensor is above normal.

The possible causes of this diagnostic code are listed below:

- The transmission oil temperature is too high.
- The signal circuit for the sensor is open.
- The signal circuit for the sensor is shorted to a higher voltage.

- The sensor has failed.
- The power circuit or the ground circuit has failed.
- The ECM has failed. This is unlikely.

**Note: Do not connect the sensor to +battery voltage.**The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 177 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

**System Response:**

A warning of a level 1 is generated. Use the default value.

## Test Step 1. CHECK FOR POWER AT THE SENSOR.

**A.** Do not disconnect the harness connector from the sensor.

**B.** Turn the key start switch and the disconnect switch to the ON position.

**C.** At the back of the harness connector for the sensor, insert a multimeter probe along the voltage supply wire (contact 1).

**D.** Measure the voltage from contact 1 to frame ground.

**Expected Result:**

The voltage is 5 DCV.

**Results:**

- OK – The voltage is 5 DCV. Proceed to Test Step 2.
- NOT OK – The voltage is not 5 DCV. The + battery circuit in the machine harness has failed.

  **Repair:** Replace the machine harness or repair the machine harness.

  STOP.

## Test Step 2. CHECK FOR PROPER GROUND AT THE SENSOR.

**A.** The machine harness remains connected to the sensor.

**B.** Turn the key start switch and the disconnect switch to the OFF position.

**C.** Remove the multimeter probe from the voltage supply wire (contact 1).

**D.** At the back of the harness connector for the sensor, insert a multimeter probe along the ground wire (contact 2).

**E.** Measure the resistance from contact 2 to frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The ground circuit is correct. Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  **Repair:** Replace the machine harness or repair the machine harness.

  STOP.

## Test Step 3. CHECK THE WIRING HARNESS OF THE SENSOR FOR AN OPEN CIRCUIT.

**A.** The key start switch and the disconnect switch remain in the OFF position.

**B.** Disconnect the machine harness from the sensor.

**C.** At the harness connector for the sensor, connect a jumper wire between contact 1 and contact 2.

**D.** Disconnect the machine harness connector(s) from the ECM.

**E.** At the harness connector for the ECM, measure the resistance between contact J1-12 and contact J1-62.

**Expected Result:**

The resistance measurement is less than 5 ohms.

**Results:**

- OK – The resistance measurement is less than 5 ohms. The circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The circuit is not correct. There is an open circuit in the wiring harness.

**Repair:** There is an open circuit in the wiring harness. Repair the wiring harness or replace the wiring harness.

STOP.

### Test Step 4. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** The key start switch and the disconnect switch remain in the OFF position.

**B.** The machine harness remains disconnected from the sensor. Remove the jumper wire that was installed in the previous step.

**C.** The machine harness connector(s) remains disconnected from the ECM.

**D.** At the machine harness connector for the ECM, measure the resistance from the signal contact J1-62 of the machine harness to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 5.

- NOT OK – One or more resistance measurements is not correct. There is a short in the machine harness.

  **Repair:** The short is between signal contact J1-62 and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 5. CHECK THE OUTPUT OF THE SENSOR.

**A.** Reconnect the machine harness connectors to the ECM. Reconnect the machine harness connector to the sensor.

**B.** At the back of the harness connector for the sensor, insert a multimeter probe along the signal wire (contact 1).

**C.** At the back of the harness connector for the sensor, insert a multimeter probe along the ground wire (contact 2).

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Measure the voltage of the sensor.

**Expected Result:**

The signal from the sensor is valid.

**Results:**

- OK – The signal from the sensor is valid. Proceed to Test Step 6.

- NOT OK – The signal from the sensor is not valid.

  **Repair:** The sensor has failed. Replace the sensor.

  STOP.

### Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the contacts of the harness connectors and clean the connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Check the status of the SPN 177 FMI 3.

**Expected Result:**

The SPN 177 FMI 3 is active.

**Results:**

- YES – The SPN 177 FMI 3 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** Exit this procedure and perform the diagnostic code procedure again. If the problem persists, the ECM may have failed. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. See theTesting and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 177 FMI 3 is not active. The diagnostic code does not exist at this time.

  **Repair:** The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02654809

# Transmission, SPN 177 - FMI 4

**SMCS Code:** 1439-038-T3; 3194-038-OC

**Conditions Which Generate This Code:**

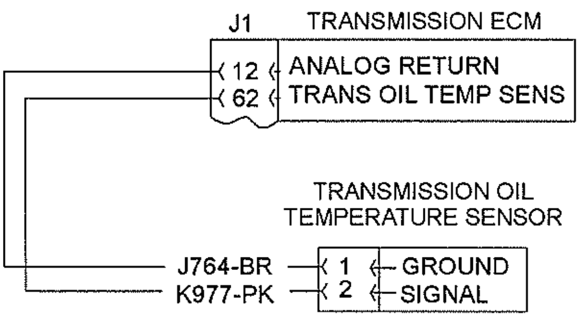


Illustration 13 g01338732

Connections of the transmission oil temperature sensor

This diagnostic code is associated with the transmission oil temperature sensor. The FMI 4 means that the ECM has determined that the voltage of the circuit for the position sensor is below normal.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is shorted to ground.
- The sensor has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 177 FMI 4 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

**System Response:**

A warning of a level 1 is generated. Use the default value.

## Test Step 1. CHECK THE SENSOR

**A.** Turn the disconnect switch and the key start switch to the ON position.

**B.** Ensure that the diagnostic code is active.

**C.** Observe the status of the diagnostic code. Disconnect the sensor from the machine harness.

**Expected Result:**

The SPN 177 FMI 4 remains active. The FMI has not changed and the "04" is still active.

**Results:**

- OK – The diagnostic code remains active. The sensor is correct. Proceed to Test Step 2.
- NOT OK – The diagnostic code is no longer active. The sensor has failed.

  **Repair:** Replace the sensor.

  STOP.

## Test Step 2. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness from the sensor.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector for the ECM, measure the resistance from the signal contact J1-62 of the machine harness to all possible sources of ground. Measure the resistance to all contacts of the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – One or more resistance measurements is not correct. There is a short in the machine harness.

  **Repair:** The short is between signal contact J1-62 and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the contacts of the harness connectors and clean the contacts.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Check the status of the SPN 177 FMI 4.

**Expected Result:**

The SPN 177 FMI 4 is active.

**Results:**

- YES – The SPN 177 FMI 4 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 177 FMI 4 is not active. The diagnostic code does not exist at this time.

  **Repair:** The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02654819

## Transmission, SPN 191 - FMI 12

**SMCS Code:** 1439-038-T3; 3175-038-OJ

**Conditions Which Generate This Code:**

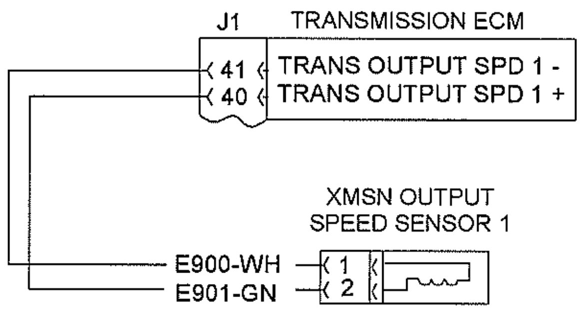


Illustration 14 g01338835

Connections of the transmission output speed sensor 1

This diagnostic code is associated with the transmission output speed sensor 1. The FMI 12 means that the ECM has determined that the signal frequency or the signal pulse width is not within the expected range.

**System Response:**

A diagnostic code will be displayed on the Caterpillar Electronic Technician (Cat ET). The tractor will operate normally unless more than one speed sensor has failed.

### Test Step 1. CHECK THE RESISTANCE OF THE CASE OF THE SENSOR .

**A.** Turn the key start switch and the disconnect switch (if equipped) to the OFF position.

**B.** Disconnect the machine harness connector from the sensor.

**C.** Measure the resistance from contact 1 and from contact 2 to the case of the sensor.

**Expected Result:**

The resistance is greater than 5,000 ohms.

**Results:**

- OK – The resistance is greater than 5,000 ohms. Proceed to Test Step 2.

- NOT OK – The resistance is NOT greater than 5,000 ohms. The speed sensor has failed.

  **Repair:** Replace the sensor.

  STOP.

## Test Step 2. CHECK THE RESISTANCE OF THE SENSOR.

**A.** The key start switch and the disconnect switch (if equipped) remain in the OFF position.

**B.** Measure the resistance between contact 1 and contact 2 of the connector of the sensor.

**Expected Result:**

The resistance is between 600 and 1800 ohms.

**Results:**

- OK – The resistance is between 600 and 1800 ohms. The resistance is correct. Proceed to Test Step 3.

- NOT OK – The resistance is NOT between 600 and 1800 ohms. The resistance is not correct. The sensor has failed.

  **Repair:** Replace the sensor.

  STOP.

## Test Step 3. CHECK FOR AN OPEN HARNESS.

**A.** The key start switch and the disconnect switch (if equipped) remain in the OFF position.

**B.** Reconnect the machine harness connector to the sensor.

**C.** Disconnect the machine harness connectors J1 and J2 from the machine ECM.

**D.** At the machine harness connector J1, measure the resistance from contact J1-41 to J1-40.

**Expected Result:**

The resistance is between 600 and 1800 ohms.

**Results:**

- OK – The resistance is between 600 and 1800 ohms. The circuit is correct. Proceed to Test Step 4.

- NOT OK – The resistance is NOT between 600 and 1800 ohms. The circuit is open in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 4. CHECK FOR A SHORT IN THE RETURN CIRCUIT OF THE MACHINE HARNESS.

**A.** The key start switch and the disconnect switch (if equipped) remain in the OFF position.

**B.** Disconnect the machine harness from the sensor.

**C.** At the machine harness connector J1, measure the resistance between contacts J1-40 and J1-41 to all sources of ground.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. Proceed to Test Step5.

- NOT OK – There is a short in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 5. INSPECT THE SENSOR AND ADJUST THE SENSOR.

**A.** The key start switch and the disconnect switch (if equipped) remain in the OFF position. The sensor remains disconnected from the machine harness.

**B.** Remove the speed sensor. Inspect the sensor for damage or the presence of foreign material on the tip.

**Expected Result:**

The sensor is free of foreign material and the sensor is not damaged.

**Results:**

- OK – The sensor is free of damage. Foreign material is present on the sensor.

  **Repair:** Clean the sensor and reinstall the sensor.

  Proceed to Test Step 6.

- NOT OK – The sensor is damaged.

**Repair:** Replace the speed sensor.

STOP.

### Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 191 FMI 12.

**Expected Result:**

The SPN 191 FMI 12 is active.

**Results:**

- YES – The SPN 191 FMI 12 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 191 FMI 12 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02654827

## Transmission, SPN 625 - FMI 9

**SMCS Code:** 7610-038-DTN

**Conditions Which Generate This Code:**

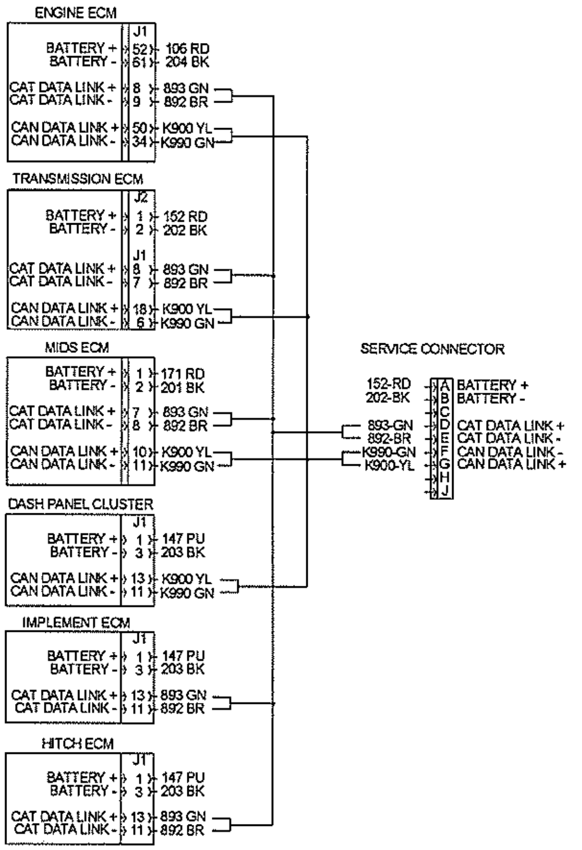


Illustration 15 g01342892

Connections of the Cat Data Link circuit

This diagnostic code is recorded when the Cat Data Link is not communicating correctly. For example, actual gear information is not received from other electronic control modules through the Cat Data Link. This diagnostic code causes the readouts, that are dependent upon the Cat Data Link information, to indicate abnormal values.

- Poor electrical connection at a machine harness connector
- The circuit for the Cat Data Link in the machine harness is shorted to ground.
- The circuit for the Cat Data Link in the machine harness is shorted to the +battery.

- The circuit for the Cat Data Link in the machine harness is open.

## Test Step 1. CHECK FOR OTHER CODES.

**A.** Check for other diagnostic codes that are related to the Cat Data Link.

**Expected Result:**

There are other diagnostic codes that are showing.

**Results:**

- YES – Exit this procedure and perform the other procedures for the diagnostic codes that are shown. STOP.

- NO – There are not any other diagnostic codes that are shown. Proceed to Test Step 2.

## Test Step 2. INSPECT THE HARNESS CONNECTORS.

**A.** Turn the disconnect switch to the OFF position.

**B.** Inspect the connections for the machine harness that are related to the Cat Data Link.

**C.** Make sure that connectors are clean and tight.

**Expected Result:**

The machine harness is correct.

**Results:**

- OK – The machine harness is correct. Proceed to Test Step 3.

- NOT OK – The machine harness is not correct.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK FOR A SHORT TO GROUND.

**A.** The disconnect switch remains OFF.

**B.** Disconnect the machine harness from all the electronic control modules that use the Cat Data Link.

**C.** At the machine harness connector for the ECM, measure the resistance between frame ground and the circuits of the Cat Data Link, contacts 7 (wire 893-GN) and 8 (wire 892-BR).

**Expected Result:**

The resistance is greater than 5000 ohms.

**Results:**

- YES – The resistance is greater than 5000 ohms. The harness circuit resistance is correct. Proceed to test step 4.

- NO – The resistance is less than 5000 ohms. The machine harness has failed. There is a short between the frame ground and the Cat Data Link circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 4. CHECK FOR A SHORT TO THE +BATTERY.

**A.** The disconnect switch remains OFF.

**B.** All related control modules remain disconnected from the machine harness.

**C.** At the machine harness connector for the ECM, measure the resistance between the +battery circuit J2-1 and the circuits of the Cat Data Link, contacts J1-7 (wire 893-GN) and J1-8 (wire 892-BR).

**Expected Result:**

The resistance is greater than 5000 ohms.

**Results:**

- OK – The resistance is greater than 5000 ohms. The harness circuit resistance is correct. Proceed to Test Step 5.

- NOT OK – The resistance is less than 5000 ohms. The machine harness has failed. There is a short between the +battery and the Cat Data Link circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 5. CHECK FOR AN OPEN HARNESS.

**A.** The disconnect switch remains in the OFF position.

**B.** All related control modules remain disconnected from the machine harness.

**C.** Check the continuity of the Cat Data Link circuit in the machine harness.

**D.** Measure the resistance from the connector contacts J1-7 (wire 893-GN) and J1-8 (wire 892-BR) of the ECM to the connector for each of the related electronic control modules.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- YES – The resistance is less than 5 ohms. The Cat Data Link circuit in the machine harness is correct.

  **Repair:** It is unlikely that the MIDS ECM has failed. Exit this procedure and perform this procedure again. Also, recheck if the diagnostic code indicator is illuminated for this diagnostic code. If the cause of the diagnostic code is not found, replace the MIDS ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The resistance is greater than 5 ohms. The machine harness has failed. The Cat Data Link circuit is open in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

i02654845

## Transmission, SPN 639 - FMI 9

**SMCS Code:** 4812-038; 7610-038-DTN

**Conditions Which Generate This Code:**

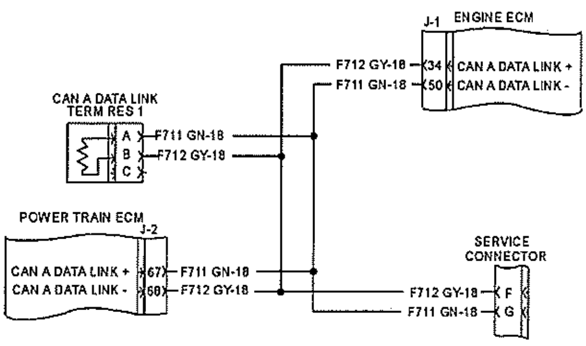


Illustration 16 g01204559

Connections of the J1939 Data Link circuit

This diagnostic code is recorded when the ECM stops receiving information on the J1939 Data Link.

**Note:** The resistance of the J1939 circuit should measure approximately 120 ohms between circuit components.

### Test Step 1. INSPECT THE HARNESS CONNECTIONS.

**A.** Turn the disconnect switch to the OFF position.

**B.** Inspect all harness connections that are related to the J1939 Data Link. Make sure that the connectors are clean and tight.

**C.** Check the connectors for proper mating. Ensure that all the seals are present and in place.

**D.** Check the harness for signs of damage or abrasion.

**E.** Check the wires at the connector. Ensure that the wires are secured tightly into the connector. **Take care not to pull the wire out of the connector.**

**F.** Check the exposed wires at the connectors for nicks or signs of abrasion.

**G.** Check for moisture inside the connector.

**H.** Check the connectors for dirty contacts or corroded contacts.

**I.** Check each pin and each socket of the machine harness connectors. Ensure that the contacts are properly installed. The contacts should mate correctly when the two pieces of the connector are placed together.

**Expected Result:**

The machine harness connectors are tight and free of corrosion.

**Results:**

- OK – The machine harness connectors are tight and free of corrosion. Proceed to Test Step 2.

- NOT OK – The machine harness connectors are in need of repair.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 2. CHECK FOR SHORTS TO GROUND

**A.** The disconnect switch remains in the OFF position.

**B.** Disconnect the machine harness connectors from all electronic control modules that use the CAN data link.

**C.** At the machine harness for the ECM, measure the resistance between frame ground and connector contacts J2-67 (wire F711-GN) and J2-68 (wire F712-GY) of the data link circuit.

**Expected Result:**

The resistance is greater than 5000 ohms.

**Results:**

- OK – The resistance is greater than 5000 ohms. The harness circuit resistance is correct. Proceed to Test Step 3.

- NOT OK – The resistance is less than 5000 ohms. The machine harness has failed.

  **Repair:** There is a short between frame ground and contacts J2-67 (wire F711-GN) and J2-68 (wire F712-GY) of the data link circuit in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK FOR SHORT TO THE +BATTERY CIRCUIT

**A.** The disconnect switch remains in the OFF position.

**B.** All related electronic control modules remain disconnected from the machine harness.

**C.** At the machine harness connector for the ECM, perform the checks that are listed here:

- Measure the resistance between all of the connector contacts that are used at the ECM, and connector contact J2-67 (wire F711-GN).

- Measure the resistance between all of the connector contacts that are used at the ECM, and connector contact J2-68 (wire F712-GY).

**Expected Result:**

Each of the resistance measurements is greater than 5000 ohms.

**Results:**

- OK – The harness circuit resistance is correct. Proceed to Test Step 4.

- NOT OK – One of the resistance measurements is less than 5000 ohms. The machine harness has failed.

  **Repair:** There is a short between the circuit with the low resistance measurement and contacts J2-67 (wire F711-GN) or J2-68 (wire F712-GY) of the data link circuit in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 4. CHECK FOR OPEN HARNESS

**A.** The disconnect switch remains in the OFF position.

**B.** All related electronic control modules remain disconnected from the machine harness.

**C.** Check the resistance of the data link circuit in the machine harness:

- Measure the resistance between connector contact J2-67 (wire F711-GN) of the ECM and the appropriate connector contact (wire F711-GN) of the other devices that are connected to the J1939 Data Link.

- Measure the resistance between connector contact J2-68 (wire F712-GY) of the ECM and the appropriate connector contact (wire F712-GY) of the other devices that are connected to the J1939 Data Link.

**Expected Result:**

Each resistance measurement is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The data link circuit in the machine harness is correct. Proceed to Test Step 5.

- NOT OK – The resistance is greater than 5 ohms. The machine harness has failed.

  **Repair:** The data link circuit is open in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 5. CHECK FOR ADDITIONAL DIAGNOSTIC CODES FOR THE OTHER ELECTRONIC CONTROL MODULES.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** One at a time, reconnect the electronic control modules that use the J1939 Data Link.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** After each of the electronic control modules has been reconnected, check for diagnostic codes that are logged against that electronic control module.

**Expected Result:**

Diagnostic codes are not present for the other electronic control modules.

**Results:**

- OK – Diagnostic codes are not present for the other electronic control modules. The dash panel cluster has failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the failure is not found, replace the ECM.

  STOP.

- NOT OK – Diagnostic codes are present for the other electronic control modules. The ECM has failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure. Perform this procedure again. If the failure is not found, replace the ECM. See the Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

i02654857

## Transmission, SPN 701 - FMI 3

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

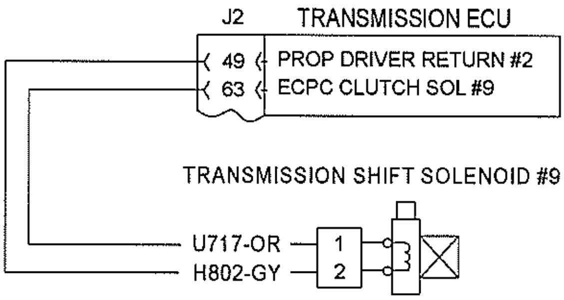


Illustration 17 g01338862

Connections of the transmission clutch solenoid 9

This diagnostic code is associated with the transmission clutch solenoid 9. The FMI 3 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 701 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connectors from the solenoid and the ECM.

C. At the machine harness connector for the ECM, measure the resistance from contact J2-63 to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-63 and the circuit that has a low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

A. Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

C. Reconnect all harness connectors in order to make sure that the connectors are fully seated. Also, make sure that the clips for each connector are completely fastened.

D. Turn the disconnect switch and the key start switch to the ON position.

E. Operate the machine.

F. Determine if the SPN 701 FMI 3 is active.

**Expected Result:**

The SPN 701 FMI 3 is active.

**Results:**

- YES – The SPN 701 FMI 3 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 701 FMI 3 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation. STOP.

i02654860

## Transmission, SPN 701 - FMI 5

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

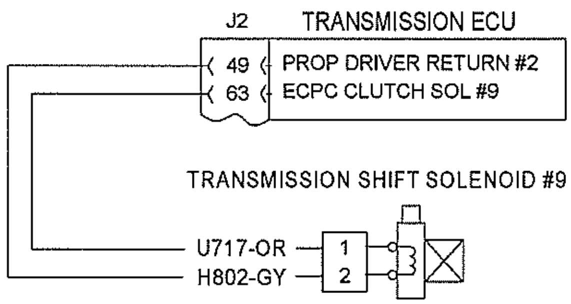


Illustration 18 g01338862

Connections of the transmission clutch solenoid 9

This diagnostic code is associated with the transmission clutch solenoid 9. The FMI 5 means that the ECM has determined that an open in the circuit exists.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.

- The return circuit of the solenoid is open.

- The solenoid has failed.

- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 701 FMI 5 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**C.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire U717-OR) to contact 2 (wire H802-GY).

**D.** Observe the status of the SPN 701 FMI 5.

**Expected Result:**

The diagnostic code is active. Then, the diagnostic code changes from FMI 5 to FMI 6 as the jumper wire is installed.

**Results:**

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.

- NO – The diagnostic is no longer active. The solenoid has failed.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

### Test Step 2. CHECK THE HARNESS FOR AN OPEN.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The jumper wire that was installed in the previous Test Step remains in place.

**D.** At the machine harness connector, measure the resistance from signal contact J2-63 to contact J2-49.

**Expected Result:**

The resistance is less than 5.0 ohms.

**Results:**

- OK – The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 701 FMI 5.

**Expected Result:**

The SPN 701 FMI 5 is active.

**Results:**

- YES – The SPN 701 FMI 5 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The SPN 701 FMI 5 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02654862

# Transmission, SPN 701 - FMI 6

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

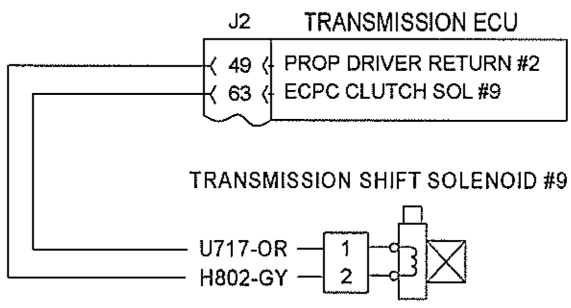


Illustration 19 g01338862

Connections of the transmission clutch solenoid 9

This diagnostic code is associated with the transmission clutch solenoid 9. The FMI 6 means that the ECM has determined that there is a short to ground in the solenoid circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 701 FMI 6 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Observe the status of the diagnostic code.

**C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**Expected Result:**

The FMI 6 changes to FMI 5 when the solenoid is disconnected.

**Results:**

- YES – The FMI 6 changes to FMI 5 when the solenoid is disconnected. The circuit is correct.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

- NO – The SPN 701 FMI 6 remains active. Proceed to Test Step 2.

### Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The solenoid remains disconnected from the machine harness.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector, measure the resistance from the signal contact J2-63 to all other contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-63 and the circuit with the low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 701 FMI 6.

**Expected Result:**

The SPN 701 FMI 6 is active.

**Results:**

- YES – The SPN 701 FMI 6 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 701 FMI 6 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02654888

## Transmission, SPN 702 - FMI 2

**SMCS Code:** 1435-038-T3

**Conditions Which Generate This Code:**

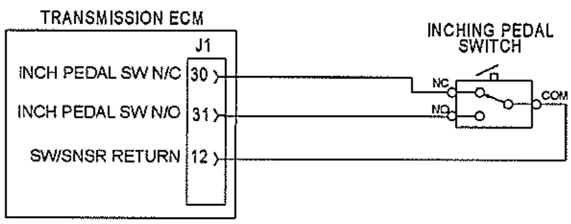


Illustration 20 g01343739

Connections of the inching pedal switch

This diagnostic code is associated with the inching pedal switch. The switch is connected to two inputs of the ECM. The inputs are "Normally Open" and "Normally Closed". One of the inputs is open and the other input is grounded during proper operation.

The FMI 2 means that the ECM has determined that the "Normally Open" and "Normally Closed" circuits are in the same state.

**Note:** The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 702 FMI 2 is active before performing this procedure.**

### Test Step 1. CHECK THE OPERATION OF THE SWITCH

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector or the wires from the switch.

**C.** Connect one lead from the multimeter to the common contact (COM) for the switch.

**D.** Connect the other lead from the multimeter to the normally open contact (NO) for the switch.

**E.** Measure the resistance between contact COM and contact NO. Note the resistance.

**F.** Disconnect the lead from contact NO and connect the lead to the normally closed contact (NC).

**G.** Measure the resistance between contact COM and contact NC. Note the resistance.

**Expected Result:**

The resistance from contact COM to contact NO is greater than 5000 ohms, and the resistance from contact COM to contact NC is less than 5 ohms.

**Results:**

- YES – The resistance from contact COM to contact NO is greater than 5000 ohms, and the resistance from contact COM to contact NC is less than 5 ohms. Proceed to Test Step 2.
- NO – The resistance measurements do not differ. The switch has failed.

  **Repair:** Replace the switch.

  STOP.

### Test Step 2. CHECK THE OPERATION OF THE SWITCH

**A.** Connect one lead from the multimeter to the common contact (COM) for the switch.

**B.** Connect the other lead from the multimeter to the normally open contact (NO) for the switch.

**C.** Actuate the switch and measure the resistance between contact COM and contact NO. Note the resistance.

**D.** Disconnect the lead from contact NO and connect the lead to the normally closed contact (NC).

**E.** Actuate the switch and measure the resistance between contact COM and contact NC. Note the resistance.

**Expected Result:**

The resistance from contact COM to contact NO is less than 5 ohms, and the resistance from contact COM to contact NC is greater than 5000 ohms.

**Results:**

- YES – The resistance from contact COM to contact NO is less than 5 ohms, and the resistance from contact COM to contact NC is greater than 5000 ohms. Proceed to Test Step 3.
- NO – The resistance measurements do not differ. The switch has failed.

  **Repair:** Replace the switch.

  STOP.

### Test Step 3. CHECK THE GROUND CIRCUIT OF THE SWITCH IN THE WIRE HARNESS.

**A.** Connect one lead from the multimeter to contact COM (wire J764-BR) of the wire harness connector for the switch.

**B.** Connect the other lead from the multimeter to frame ground.

**C.** Measure the resistance between contact COM (wire J764-BR) and frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5000 ohms. The circuit is open. The machine harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 4. CHECK THE SWITCH CIRCUITS FOR A SHORT CIRCUIT.

**A.** The disconnect switch and the key start switch remain in the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The connector for the switch remains disconnected.

**D.** At the machine harness connector for the ECM, measure the resistance from contact J1-31 and contact J1-30 of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The harness is correct. Proceed to Test Step 5.

- NO – One or more of the measurements were less than 5 ohms. There is a short in the machine harness.

  **Repair:** The short is between J1-31 and the circuit with the lowest resistance measurement or the short is between J1-30 and the circuit with the lowest resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 5. CHECK THE SWITCH CIRCUITS IN THE HARNESS.

**A.** The machine harness remains disconnected from the ECM and the switch.

**B.** At the harness connector for the switch, connect a jumper wire between contact NO and contact NC.

**C.** At the harness connector for the ECM, measure the resistance from contact J1-31 to contact J1-30.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. Proceed to Test Step 6.

- NOT OK – The resistance is greater than 5000 ohms. The circuit is open.

  **Repair:** The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the contacts of the harness connectors and clean the connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Determine if SPN 702 FMI 2 is active.

**Expected Result:**

The SPN 702 FMI 2 is active.

**Results:**

- YES – The SPN 702 FMI 2 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 702 FMI 2 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  **Repair:** The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02654919

# Transmission, SPN 702 - FMI 7

**SMCS Code:** 1435-038-T3

**Conditions Which Generate This Code:**

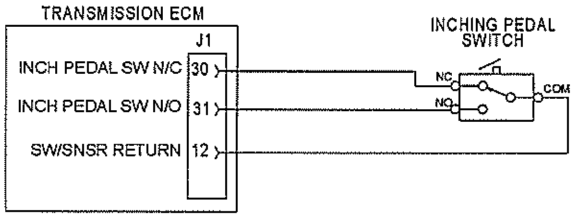


Illustration 21 g01343739

Connections of the inching pedal switch

This diagnostic code is associated with the inching pedal switch. The switch is connected to two inputs of the ECM. The inputs are "Normally Open" and "Normally Closed". One of the inputs is open and the other input is grounded during proper operation.

The FMI 7 means that the ECM is receiving an improper response from the switch.

**Note: The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. Ensure that the diagnostic code of SPN 702 FMI 7 is active before performing this procedure.**

## Test Step 1. CHECK THE OPERATION OF THE SWITCH

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector or the wires from the switch.

**C.** Connect one lead from the multimeter to the common contact (COM) for the switch.

**D.** Connect the other lead from the multimeter to the normally open contact (NO) for the switch.

**E.** Measure the resistance between contact COM and contact NO. Note the resistance.

**F.** Disconnect the lead from contact NO and connect the lead to the normally closed contact (NC).

**G.** Measure the resistance between contact COM and contact NC. Note the resistance.

**Expected Result:**

The resistance from contact COM to contact NO is greater than 5000 ohms, and the resistance from contact COM to contact NC is less than 5 ohms.

**Results:**

- YES – The resistance from contact COM to contact NO is greater than 5000 ohms, and the resistance from contact COM to contact NC is less than 5 ohms. Proceed to Test Step 2.
- NO – The resistance measurements do not differ. The switch has failed.

  **Repair:** Replace the switch.

  STOP.

## Test Step 2. CHECK THE OPERATION OF THE SWITCH

**A.** Connect one lead from the multimeter to the common contact (COM) for the switch.

**B.** Connect the other lead from the multimeter to the normally open contact (NO) for the switch.

**C.** Actuate the switch and measure the resistance between contact COM and contact NO. Note the resistance.

**D.** Disconnect the lead from contact NO and connect the lead to the normally closed contact (NC).

**E.** Actuate the switch and measure the resistance between contact COM and contact NC. Note the resistance.

**Expected Result:**

The resistance from contact COM to contact NO is less than 5 ohms, and the resistance from contact COM to contact NC is greater than 5000 ohms.

**Results:**

- YES – The resistance from contact COM to contact NO is less than 5 ohms, and the resistance from contact COM to contact NC is greater than 5000 ohms. Proceed to Test Step 3.
- NO – The resistance measurements do not differ. The switch has failed.

  **Repair:** Replace the switch.

  STOP.

## Test Step 3. CHECK THE GROUND CIRCUIT OF THE SWITCH IN THE WIRE HARNESS.

**A.** Connect one lead from the multimeter to contact COM (wire J764-BR) of the wire harness connector for the switch.

**B.** Connect the other lead from the multimeter to frame ground.

**C.** Measure the resistance between contact COM (wire J764-BR) and frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The circuit is correct. Proceed to Test Step 4.

- NOT OK – The resistance is greater than 5000 ohms. The circuit is open. The machine harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 4. CHECK THE SWITCH CIRCUITS IN THE HARNESS.

**A.** The machine harness remains disconnected from the ECM and the switch.

**B.** At the harness connector for the switch, connect a jumper wire between contact NO and contact NC.

**C.** At the harness connector for the ECM, measure the resistance from contact J1-31 to contact J1-30.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. Proceed to Test Step 5.

- NOT OK – The resistance is greater than 5000 ohms. The circuit is open.

  **Repair:** The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 5. CHECK THE SWITCH CIRCUITS FOR A SHORT CIRCUIT.

**A.** The disconnect switch and the key start switch remain in the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The connector for the switch remains disconnected.

**D.** At the machine harness connector for the ECM, measure the resistance from contact J1-31 and contact J1-30 of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The harness is correct. Proceed to Test Step 6.

- NO – One or more of the measurements were less than 5 ohms. There is a short in the machine harness.

  **Repair:** The short is between J1-31 and the circuit with the lowest resistance measurement or the short is between J1-30 and the circuit with the lowest resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the contacts of the harness connectors and clean the connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Determine if SPN 702 FMI 7 is active.

**Expected Result:**

The SPN 702 FMI 7 is active.

**Results:**

- YES – The SPN 702 FMI 7 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 702 FMI 7 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  **Repair:** The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02654920

# Transmission, SPN 703 - FMI 0

**SMCS Code:** 1439-038-PSN

**Conditions Which Generate This Code:**

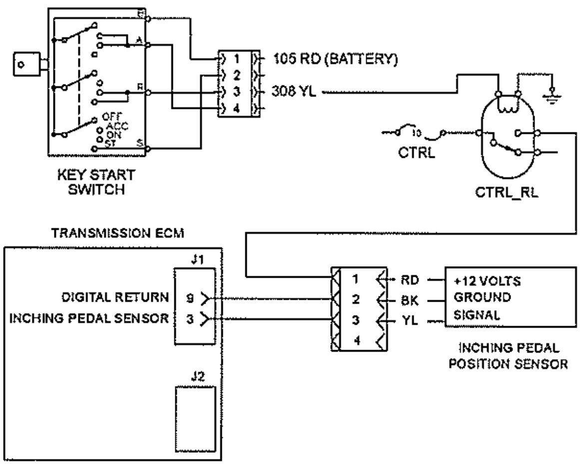


Illustration 22 g01342861

Connections of the inching pedal position sensor

This diagnostic code is associated with the inching pedal position sensor. The FMI 0 means that the ECM has determined that the signal of the sensor is above the normal range.

The output frequency of the position sensor is approximately 500 hertz. The value of the sensor's duty cycle is approximately 3.5% when the pedal is released. The duty cycle of the signal increases as the pedal is moved from the released position to the pressed position. The value of the sensor's duty cycle is approximately 96.5% in the pressed position.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- The signal circuit of the sensor is shorted to the + battery circuit.
- The sensor needs to be calibrated.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

**Note:** Use the digital multimeter for the measurements in this procedure.

**System Response:**

A warning will be displayed on the Caterpillar Electronic Technician (Cat ET). The transmission will be placed in the neutral gear until the diagnostic code is cleared.

## Test Step 1. INSPECT THE SENSOR.

**A.** Perform a visual inspection of the sensor, the wiring for the sensor and the hardware that is associated with the sensor.

**Expected Result:**

There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

**Results:**

- OK – There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor. Proceed to Test Step 2.
- NOT OK – There is apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

  **Repair:** Replace the damaged part.

  Proceed to Test Step 8.

## Test Step 2. CHECK FOR POWER AT THE SENSOR.

**A.** Do not disconnect the harness connector from the sensor.

**B.** At the back of the harness connector for the sensor, insert a multimeter probe along the voltage supply wire (contact 1).

**C.** Turn the key start switch and the disconnect switch to the ON position.

**D.** Measure the voltage from contact 1 to frame ground.

**Expected Result:**

The voltage is 12 DCV.

**Results:**

- OK – The voltage is 12 DCV. Proceed to Test Step 3.
- NOT OK – The voltage is not 12 DCV. The circuit is open.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK FOR PROPER GROUND AT THE SENSOR.

**A.** The machine harness remains connected to the sensor.

**B.** Turn the key start switch and the disconnect switch to the OFF position.

**C.** Remove the multimeter probe from the voltage supply wire (contact 1).

**D.** At the back of the harness connector for the sensor, insert a multimeter probe along the ground wire (contact 2).

**E.** Measure the resistance from contact 2 to frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The ground circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  **Repair:** Replace the machine harness or repair the machine harness.

  STOP.

## Test Step 4. CHECK THE SIGNAL OF THE SENSOR.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The multimeter probe remains along the ground wire (contact 2).

**C.** At the back of the harness connector for the sensor, insert the other multimeter probe along the signal wire (contact 3).

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Monitor the signal of the sensor with the digital multimeter.

**F.** Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the beginning of this procedure. The SPN 703 FMI 0 is not active at the maximum range of the sensor.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 5.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  **Repair:** Replace the sensor.

  STOP.

## Test Step 5. CHECK THE SIGNAL AT THE ECM.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Insert the multimeter probes into the back of the ECM connector along J1-3 and J1-9.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Monitor the signal of the sensor with the digital multimeter.

**E.** Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the beginning of this procedure. The SPN 703 FMI 0 is not active at the maximum range of the sensor.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 6. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

**A.** The key start switch and the disconnect switch remain in the OFF position.

**B.** Disconnect the machine harness connectors from the sensor and the ECM.

**C.** Measure the resistance between contact J1-3 and all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each of the resistance measurements are greater than 5000 ohms. The circuit is correct. Proceed to Test Step 7.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 7. CHECK IF THE DIAGNOSTIC CODE REMAINS

**A.** Inspect the harness connectors and clean the contacts of the machine harness connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine and take the sensor through the operating range of the sensor.

**E.** Check the status of the SPN 703 FMI 0.

**Expected Result:**

The SPN 703 FMI 0 is not active at the maximum range of the sensor.

**Results:**

- OK – The SPN 703 FMI 0 is not active at the maximum range of the sensor. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation. STOP.
- NOT OK – The SPN 703 FMI 0 is active at the maximum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor, if necessary. Then perform the calibration procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

### Test Step 8. CHECK THE ADJUSTMENT AND/OR THE CALIBRATION OF THE SENSOR.

**A.** Turn the disconnect switch and the key start switch to the ON position.

**B.** Perform the adjustment procedure for the position sensor, if necessary. Then perform the calibration of the position sensor. Refer to the Testing and Adjusting section of the manual for additional information on these procedures.

**C.** Without disconnecting the sensor or the hardware that is associated with the sensor, move the sensor through the entire range of motion.

**Note:** On some machines, it may be necessary to start the engine in order to move the sensor through the entire range of motion.

**D.** Check the status of the diagnostic code.

**Expected Result:**

The SPN 703 FMI 0 is not active.

**Results:**

- OK – The diagnostic is not active. The adjustment and/or the calibration has corrected the failure. Resume normal operation. STOP.

- NOT OK – SPN 703 FMI 0 is still active.

  **Repair:** Exit this procedure. Perform this procedure again.

  STOP.

i02654923

## Transmission, SPN 703 - FMI 1

**SMCS Code:** 1439-038-PSN

**Conditions Which Generate This Code:**

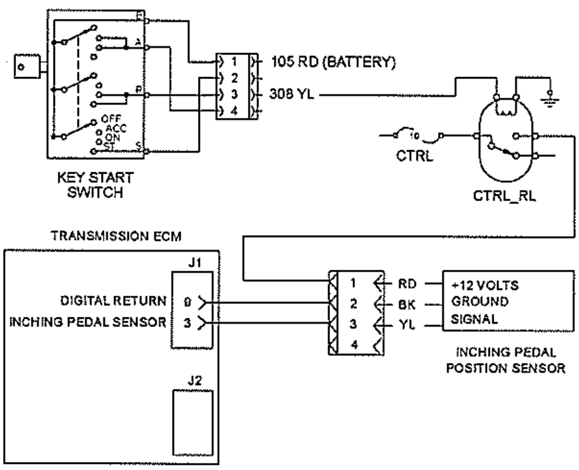


Illustration 23 g01342861

Connections of the inching pedal position sensor

This diagnostic code is associated with the inching pedal position sensor. The FMI 1 means that the ECM has determined that the signal of the sensor is below the normal range.

The output frequency of the position sensor is approximately 500 hertz. The value of the sensor's duty cycle is approximately 3.5% when the pedal is released. The duty cycle of the signal increases as the pedal is moved from the released position to the pressed position. The value of the sensor's duty cycle is approximately 96.5% in the pressed position.

The possible causes of this failure are listed below:

- The position sensor has failed.

- The signal circuit of the sensor is shorted to the ground.

- The sensor needs to be calibrated.

- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

**Note:** Use a digital multimeter for the measurements in this procedure.

**System Response:**

A warning will be displayed on the Caterpillar Electronic Technician (Cat ET). The transmission will be placed in the neutral gear until the diagnostic code is cleared.

## Test Step 1. INSPECT THE SENSOR.

**A.** Perform a visual inspection of the sensor, the wiring for the sensor and the hardware that is associated with the sensor.

**Expected Result:**

There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

**Results:**

- OK – There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor. Proceed to Test Step 2.
- NOT OK – There is apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

  **Repair:** Replace the damaged part.

  Proceed to Test Step 8.

## Test Step 2. CHECK FOR POWER AT THE SENSOR.

**A.** Do not disconnect the harness connector from the sensor.

**B.** At the back of the harness connector for the sensor, insert a multimeter probe along the voltage supply wire (contact 1).

**C.** Turn the key start switch and the disconnect switch to the ON position.

**D.** Measure the voltage from contact 1 to frame ground.

**Expected Result:**

The voltage is 12 DCV.

**Results:**

- OK – The voltage is 12 DCV. Proceed to Test Step 3.
- NOT OK – The voltage is not 12 DCV. The circuit is open.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK FOR PROPER GROUND AT THE SENSOR.

**A.** The machine harness remains connected to the sensor.

**B.** Turn the key start switch and the disconnect switch to the OFF position.

**C.** Remove the multimeter probe from the voltage supply wire (contact 1).

**D.** At the back of the harness connector for the sensor, insert a multimeter probe along the ground wire (contact 2).

**E.** Measure the resistance from contact 2 to frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The ground circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  **Repair:** Replace the machine harness or repair the machine harness.

  STOP.

## Test Step 4. CHECK THE SIGNAL OF THE SENSOR.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** At the back of the harness connector for the sensor, remove the multimeter probe from contact 1 and insert the probe along the signal wire (contact 3).

**C.** At the back of the harness connector for the sensor, insert the multimeter probe along the ground wire (contact 2).

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Monitor the signal of the sensor with the digital multimeter.

F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the beginning of this procedure. The SPN 703 FMI 1 is not active at the maximum range of the sensor.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 5.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  **Repair:** Replace the sensor.

  STOP.

## Test Step 5. CHECK THE SIGNAL AT THE ECM.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Insert the multimeter probes into the back of the ECM connector along J1-3 and J1-9.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Monitor the signal of the sensor with the digital multimeter.

E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the beginning of this procedure. The SPN 703 FMI 1 is not active at the maximum range of the sensor.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 6. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

A. The key start switch and the disconnect switch remain in the OFF position.

B. Disconnect the machine harness connectors from the sensor and the ECM.

C. Measure the resistance between contact J1-3 and all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each of the resistance measurements are greater than 5000 ohms. The circuit is correct. Proceed to Test Step 7.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 7. CHECK IF THE DIAGNOSTIC CODE REMAINS

A. Inspect the harness connectors and clean the contacts of the machine harness connectors.

B. Reconnect all harness connectors.

C. Turn the disconnect switch and the key start switch to the ON position.

D. Operate the machine and take the sensor through the operating range of the sensor.

**E.** Check the status of the SPN 703 FMI 1.

**Expected Result:**

The SPN 703 FMI 1 is not active at the minimum range of the sensor.

**Results:**

- OK – The SPN 703 FMI 1 is not active at the minimum range of the sensor. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation. STOP.

- NOT OK – The SPN 703 FMI 1 is active at the minimum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor, if necessary. Then perform the calibration procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

### Test Step 8. CHECK THE ADJUSTMENT AND/OR THE CALIBRATION OF THE SENSOR.

**A.** Turn the disconnect switch and the key start switch to the ON position.

**B.** Perform the adjustment procedure for the position sensor, if necessary. Then perform the calibration of the position sensor. Refer to the Testing and Adjusting section of the manual for additional information on these procedures.

**C.** Without disconnecting the sensor or the hardware that is associated with the sensor, move the sensor through the entire range of motion.

**Note:** On some machines, it may be necessary to start the engine in order to move the sensor through the entire range of motion.

**D.** Check the status of the diagnostic code.

**Expected Result:**

The SPN 703 FMI 1 is not active.

**Results:**

- OK – The diagnostic is not active. The adjustment and/or the calibration has corrected the failure. Resume normal operation. STOP.

- NOT OK – SPN 703 FMI 1 is still active.

  **Repair:** Exit this procedure. Perform this procedure again.

  STOP.

i02654940

## Transmission, SPN 703 - FMI 8

**SMCS Code:** 1439-039-PSN

**Conditions Which Generate This Code:**

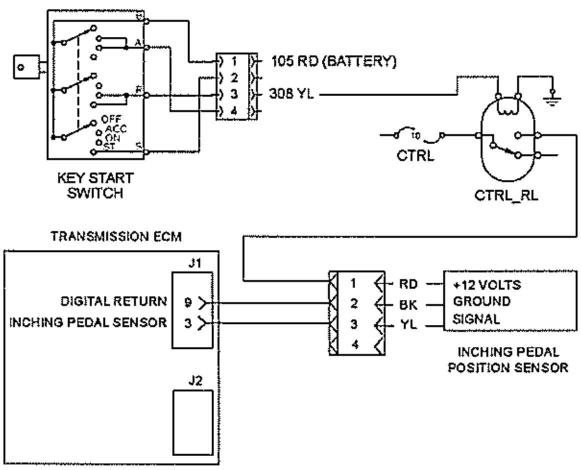


Illustration 24 g01342861

Connections of the inching pedal position sensor

This diagnostic code is associated with the inching pedal position sensor. The FMI 8 means that the ECM has determined that the signal frequency or the signal pulse width is not within the expected range.

The output frequency of the position sensor is approximately 500 hertz. The value of the sensor's duty cycle is approximately 3.5% when the pedal is released. The duty cycle of the signal increases as the pedal is moved from the released position to the pressed position. The value of the sensor's duty cycle is approximately 96.5% in the pressed position.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.

- Intermittent connections or poor connections
- Mechanical devices are loose.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 703 FMI 8 is active before performing this procedure.**

**Note:** Use the digital multimeter for the measurements in this procedure.

**System Response:**

A warning will be displayed on the Caterpillar Electronic Technician (Cat ET). The transmission will be placed in the neutral gear until the diagnostic code is cleared.

## Test Step 1. CHECK FOR POWER AT THE SENSOR.

**A.** Do not disconnect the harness connector from the sensor.

**B.** At the back of the harness connector for the sensor, insert a multimeter probe along the voltage supply wire (contact 1).

**C.** Turn the key start switch and the disconnect switch to the ON position.

**D.** Measure the voltage from contact 1 to frame ground.

**Expected Result:**

The voltage is 12 DCV.

**Results:**

- OK – The voltage is 12 DCV. Proceed to Test Step 3.
- NOT OK – The voltage is not 12 DCV. The circuit is open.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 2. CHECK THE SIGNAL CIRCUIT OF THE SENSOR.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** At the back of the harness connector for the sensor, remove the multimeter probe from contact 1 and insert the probe along the signal wire (contact 3).

**C.** At the back of the harness connector for the sensor, insert the multimeter probe along the ground wire (contact 2).

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Monitor the signal of the sensor with the digital multimeter.

**F.** Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the begining of this procedure.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 3.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  **Repair:** Replace the sensor.

  STOP.

## Test Step 3. CHECK THE SIGNAL CIRCUIT AT THE ECM.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Insert the multimeter probe into the back of the ECM connector along J1-3 and J1-9.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Monitor the signal of the sensor with the digital multimeter.

**E.** Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the begining of this procedure.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 4.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

**A.** The key start switch and the disconnect switch remain in the OFF position.

**B.** Disconnect the machine harness connectors from the sensor and the ECM.

**C.** Measure the resistance between contact J1-3 and all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

The resistance is greater than 5000 ohms.

**Results:**

- OK – The resistance is greater than 5000 ohms. The circuit is correct. Proceed to Test Step 5.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS

**A.** Inspect the harness connectors and clean the contacts of the machine harness connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Check the status of the SPN 703 FMI 8.

**Expected Result:**

The SPN 703 FMI 8 is not active.

**Results:**

- OK – The SPN 703 FMI 8 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation. STOP.
- NOT OK – The SPN 703 FMI 8 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

i02654954

# Transmission, SPN 704 - FMI 12

**SMCS Code:** 3175-038-OJ

**Conditions Which Generate This Code:**

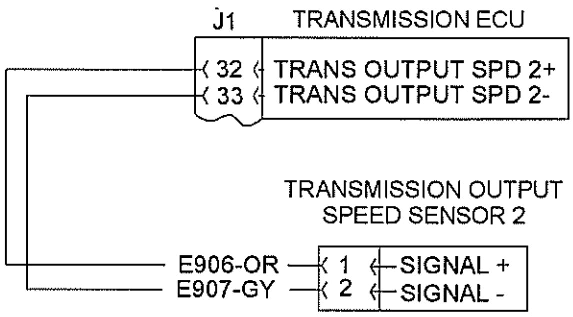


Illustration 25 g01338888

Connections of the transmission output speed sensor 2

This diagnostic code is associated with the transmission output speed sensor 2. The FMI 12 means that the Transmission ECM has determined that the signal frequency is not within the expected range.

**System Response:**

A diagnostic code will be displayed on the Caterpillar Electronic Technician (Cat ET). The tractor will operate normally unless more than one speed sensor has failed.

### Test Step 1. CHECK THE RESISTANCE OF THE CASE OF THE SENSOR .

**A.** Turn the key start switch and the disconnect switch (if equipped) to the OFF position.

**B.** Disconnect the machine harness connector from the sensor.

**C.** Measure the resistance from contact 1 (wire E906-OR) and from contact 2 (wire E907-GY) to the case of the sensor.

**Expected Result:**

The resistance is greater than 5000 ohms.

**Results:**

- OK – The resistance is greater than 5000 ohms. Proceed to Test Step 2.
- NOT OK – The resistance is NOT greater than 5000 ohms. The speed sensor has failed.

  **Repair:** Replace the sensor.

  STOP.

### Test Step 2. CHECK THE RESISTANCE OF THE SENSOR.

**A.** The key start switch and the disconnect switch (if equipped) remain in the OFF position.

**B.** Measure the resistance between contact 1 (wire E906-OR) and contact 2 (wire E907-GY) of the connector of the sensor.

**Expected Result:**

The resistance is between 600 and 1800 ohms.

**Results:**

- OK – The resistance is between 600 and 1800 ohms. The resistance is correct. Proceed to Test Step 3.
- NOT OK – The resistance is NOT between 600 and 1800 ohms. The resistance is not correct. The sensor has failed.

  **Repair:** Replace the sensor.

  STOP.

### Test Step 3. CHECK FOR AN OPEN HARNESS.

**A.** The key start switch and the disconnect switch (if equipped) remain in the OFF position.

**B.** Reconnect the machine harness connector to the sensor.

**C.** Disconnect the machine harness connectors J1 and J2 from the ECM.

**D.** At the machine harness connector J1, measure the resistance from contact J1-32 to contact J1-33.

**Expected Result:**

The resistance is between 600 and 1200 ohms.

**Results:**

- OK – The resistance is between 600 and 1800 ohms. The circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is NOT between 600 and 1800 ohms. The circuit is open in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 4. CHECK FOR A SHORT IN THE RETURN CIRCUIT OF THE MACHINE HARNESS.

**A.** The key start switch and the disconnect switch (if equipped) remain in the OFF position.

**B.** Disconnect the machine harness from the sensor.

**C.** At the machine harness connector J1, measure the resistance between contacts J1-32 and J1-33 to all sources of ground.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. Proceed to Test Step5.
- NOT OK – There is a short in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 5. INSPECT THE SENSOR AND ADJUST THE SENSOR.

**A.** The key start switch and the disconnect switch (if equipped) remain in the OFF position. The sensor remains disconnected from the machine harness.

**B.** Remove the speed sensor. Inspect the sensor for damage or the presence of foreign material on the tip.

**Expected Result:**

The sensor is free of foreign material and the sensor is not damaged.

**Results:**

- OK – The sensor is free of damage. Foreign material is present on the sensor.

  **Repair:** Clean the sensor and reinstall the sensor.

  Proceed to Test Step 6.

- NOT OK – The sensor is damaged.

  **Repair:** Replace the speed sensor.

  STOP.

### Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 704 FMI 12.

**Expected Result:**

The SPN 704 FMI 12 is active.

**Results:**

- YES – The SPN 704 FMI 12 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 704 FMI 12 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655277

## Transmission, SPN 734 - FMI 3

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

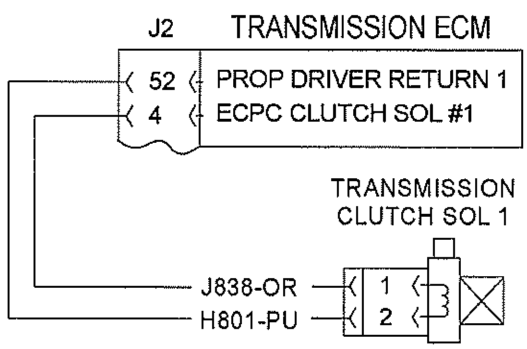


Illustration 26 g01335041

Connections of the transmission clutch solenoid 1

This diagnostic code is associated with the transmission clutch solenoid 1. The FMI 3 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 734 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connectors from the solenoid and the ECM.

**C.** At the machine harness connector for the ECM, measure the resistance from contact J2-4 to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-4 and the circuit that has a low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors in order to make sure that the connectors are fully seated. Also, make sure that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the machine.

**F.** Determine if the SPN 734 FMI 3 is active.

**Expected Result:**

The SPN 734 FMI 3 is active.

**Results:**

- YES – The SPN 734 FMI 3 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 734 FMI 3 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation. STOP.

i02655279

# Transmission, SPN 734 - FMI 5

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

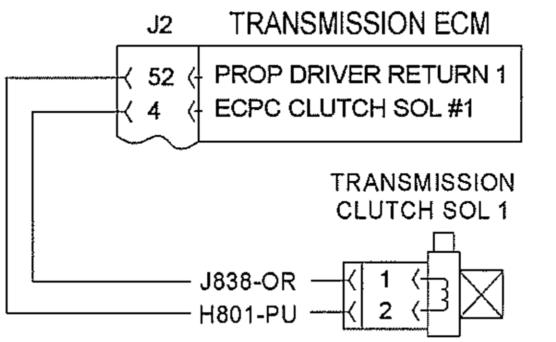


Illustration 27 g01335041

Connections of the transmission clutch solenoid 1

This diagnostic code is associated with the transmission clutch solenoid 1. The FMI 5 means that the ECM has determined that an open in the circuit exists.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 734 FMI 5 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**C.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire J838-OR) to contact 2 (wire H801-PU).

**D.** Observe the status of the SPN 734 FMI 5.

**Expected Result:**

The diagnostic code is active. Then, the diagnostic code changes from FMI 5 to FMI 6 as the jumper wire is installed.

**Results:**

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

## Test Step 2. CHECK THE HARNESS FOR AN OPEN.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The jumper wire that was installed in the previous Test Step remains in place.

**D.** At the machine harness connector, measure the resistance from signal contact J2-4 to contact J2-52.

**Expected Result:**

The resistance is less than 5.0 ohms.

**Results:**

- OK – The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 734 FMI 5.

**Expected Result:**

The SPN 734 FMI 5 is active.

**Results:**

- YES – The SPN 734 FMI 5 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 734 FMI 5 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655280

## Transmission, SPN 734 - FMI 6

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

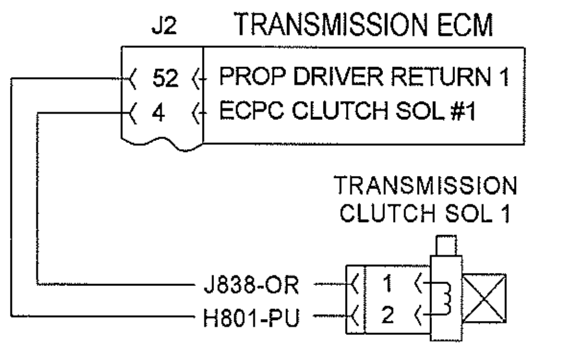


Illustration 28 g01335041

Connections of the transmission clutch solenoid 1

This diagnostic code is associated with the transmission clutch solenoid 1. The FMI 6 means that the ECM has determined that there is a short to ground in the solenoid circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 734 FMI 6 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Observe the status of the diagnostic code.

**C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**Expected Result:**

The FMI 6 changes to FMI 5 when the solenoid is disconnected.

**Results:**

- YES – The FMI 6 changes to FMI 5 when the solenoid is disconnected. The circuit is correct.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

- NO – The SPN 734 FMI 6 remains active. Proceed to Test Step 2.

## Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The solenoid remains disconnected from the machine harness.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector, measure the resistance from the signal contact J2-4 to all other contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-4 and the circuit with the low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 734 FMI 6.

**Expected Result:**

The SPN 734 FMI 6 is active.

**Results:**

- YES – The SPN 734 FMI 6 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 734 FMI 6 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655282

# Transmission, SPN 735 - FMI 3

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

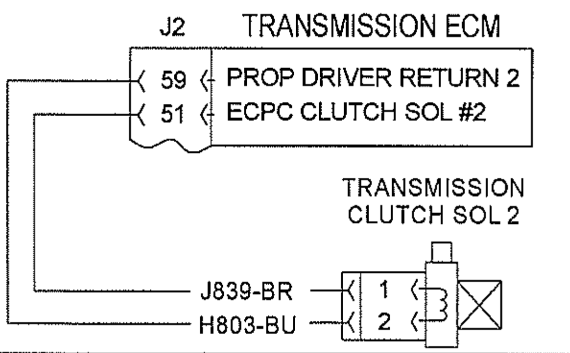


Illustration 29 g01335058

Schematic of the transmission clutch solenoid 2

This diagnostic code is associated with the transmission clutch solenoid 2. The FMI 3 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 735 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connectors from the solenoid and the ECM.

**C.** At the machine harness connector for the ECM, measure the resistance from contact J2-51 to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-51 and the circuit that has a low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors in order to make sure that the connectors are fully seated. Also, make sure that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the machine.

**F.** Determine if the SPN 735 FMI 3 is active.

**Expected Result:**

The SPN 735 FMI 3 is active.

**Results:**

- YES – The SPN 735 FMI 3 is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The SPN 735 FMI 3 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation. STOP.

i02655283

# Transmission, SPN 735 - FMI 5

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

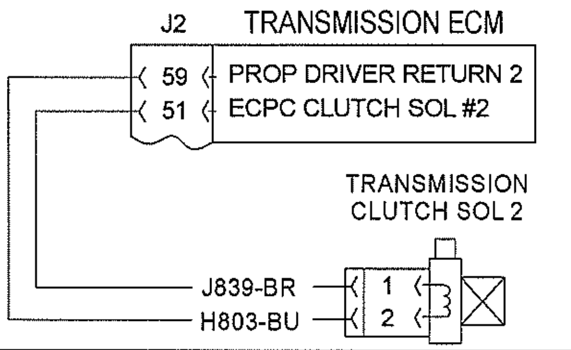


Illustration 30 g01335058

Connections of the transmission clutch solenoid 2

This diagnostic code is associated with the transmission clutch solenoid 2. The FMI 5 means that the ECM has determined that an open in the circuit exists.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 735 FMI 5 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire J839-BR) to contact 2 (wire H803-BU).

D. Observe the status of the SPN 735 FMI 5.

**Expected Result:**

The diagnostic code is active. Then, the diagnostic code changes from FMI 5 to FMI 6 as the jumper wire is installed.

**Results:**

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.

- NO – The diagnostic is no longer active. The solenoid has failed.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

### Test Step 2. CHECK THE HARNESS FOR AN OPEN.

A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector(s) from the ECM.

C. The jumper wire that was installed in the previous Test Step remains in place.

D. At the machine harness connector, measure the resistance from signal contact J2-51 to contact J2-59.

**Expected Result:**

The resistance is less than 5.0 ohms.

**Results:**

- OK – The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 735 FMI 5.

**Expected Result:**

The SPN 735 FMI 5 is active.

**Results:**

- YES – The SPN 735 FMI 5 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 735 FMI 5 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655285

## Transmission, SPN 735 - FMI 6

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

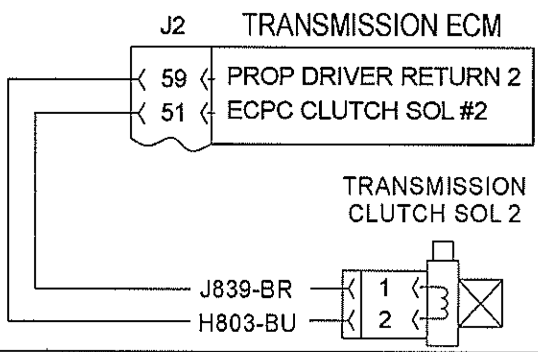


Illustration 31 g01335058

Connections of the transmission clutch solenoid 2

This diagnostic code is associated with the transmission clutch solenoid 2. The FMI 6 means that the ECM has determined that there is a short to ground in the solenoid circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.

- The solenoid has failed.

- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 735 FMI 6 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Observe the status of the diagnostic code.

**C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**Expected Result:**

The FMI 6 changes to FMI 5 when the solenoid is disconnected.

**Results:**

- YES – The FMI 6 changes to FMI 5 when the solenoid is disconnected. The circuit is correct.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

- NO – The SPN 735 FMI 6 remains active. Proceed to Test Step 2.

## Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The solenoid remains disconnected from the machine harness.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector, measure the resistance from the signal contact J2-63 to all other contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-51 and the circuit with the low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 735 FMI 6.

**Expected Result:**

The SPN 735 FMI 6 is active.

**Results:**

- YES – The SPN 735 FMI 6 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The SPN 735 FMI 6 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655288

# Transmission, SPN 736 - FMI 3

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

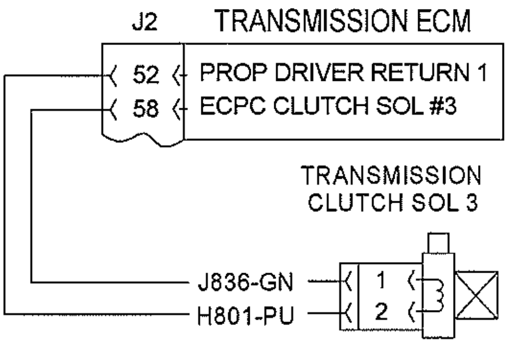


Illustration 32 g01335065

Connections of the transmission clutch solenoid 3

This diagnostic code is associated with the transmission clutch solenoid 3. The FMI 3 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 736 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connectors from the solenoid and the ECM.

**C.** At the machine harness connector for the ECM, measure the resistance from contact J2-58 to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-58 and the circuit that has a low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors in order to make sure that the connectors are fully seated. Also, make sure that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the machine.

**F.** Determine if the SPN 736 FMI 3 is active.

**Expected Result:**

The SPN 736 FMI 3 is active.

**Results:**

- YES – The SPN 736 FMI 3 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 736 FMI 3 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation. STOP.

i02655290

# Transmission, SPN 736 - FMI 5

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

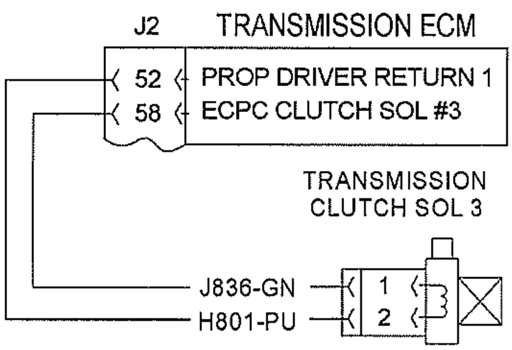


Illustration 33 g01335065

Connections of the transmission clutch solenoid 3

This diagnostic code is associated with the transmission clutch solenoid 3. The FMI 5 means that the ECM has determined that an open in the circuit exists.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 736 FMI 5 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**C.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire J836-GN) to contact 2 (wire H801-PU).

**D.** Observe the status of the SPN 736 FMI 5.

**Expected Result:**

The diagnostic code is active. Then, the diagnostic code changes from FMI 5 to FMI 6 as the jumper wire is installed.

**Results:**

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.

- NO – The diagnostic is no longer active. The solenoid has failed.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

### Test Step 2. CHECK THE HARNESS FOR AN OPEN.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The jumper wire that was installed in the previous Test Step remains in place.

**D.** At the machine harness connector, measure the resistance from signal contact J2-58 to contact J2-52.

**Expected Result:**

The resistance is less than 5.0 ohms.

**Results:**

- OK – The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 736 FMI 5.

**Expected Result:**

The SPN 736 FMI 5 is active.

**Results:**

- YES – The SPN 736 FMI 5 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 736 FMI 5 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655291

## Transmission, SPN 736 - FMI 6

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

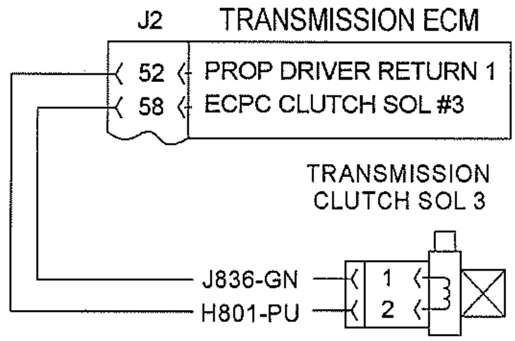


Illustration 34 g01335065

Connections of the transmission clutch solenoid 3

This diagnostic code is associated with the transmission clutch solenoid 3. The FMI 6 means that the ECM has determined that there is a short to ground in the solenoid circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 736 FMI 6 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Observe the status of the diagnostic code.

**C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**Expected Result:**

The FMI 6 changes to FMI 5 when the solenoid is disconnected.

**Results:**

- YES – The FMI 6 changes to FMI 5 when the solenoid is disconnected. The circuit is correct.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

- NO – The SPN 736 FMI 6 remains active. Proceed to Test Step 2.

## Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The solenoid remains disconnected from the machine harness.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector, measure the resistance from the signal contact J2-58 to all other contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-58 and the circuit with the low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 736 FMI 6.

**Expected Result:**

The SPN 736 FMI 6 is active.

**Results:**

- YES – The SPN 736 FMI 6 is active. The diagnostic code has not been corrected.

**Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The SPN 736 FMI 6 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655292

# Transmission, SPN 737 - FMI 3

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

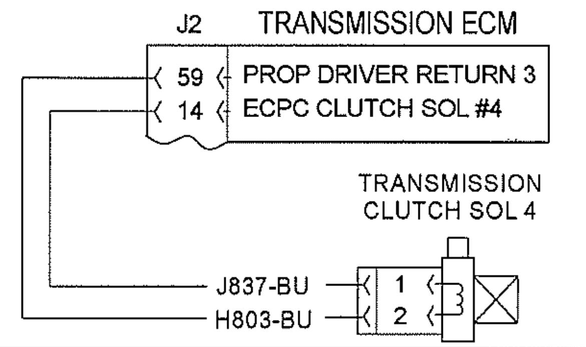


Illustration 35 g01335068

Connections of the transmission clutch solenoid 4

This diagnostic code is associated with the transmission clutch solenoid 4. The FMI 3 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 737 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connectors from the solenoid and the ECM.

**C.** At the machine harness connector for the ECM, measure the resistance from contact J2-14 to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-14 and the circuit that has a low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

C. Reconnect all harness connectors in order to make sure that the connectors are fully seated. Also, make sure that the clips for each connector are completely fastened.

D. Turn the disconnect switch and the key start switch to the ON position.

E. Operate the machine.

F. Determine if the SPN 737 FMI 3 is active.

**Expected Result:**

The SPN 737 FMI 3 is active.

**Results:**

- YES – The SPN 737 FMI 3 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 737 FMI 3 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation. STOP.

i02655295

# Transmission, SPN 737 - FMI 5

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

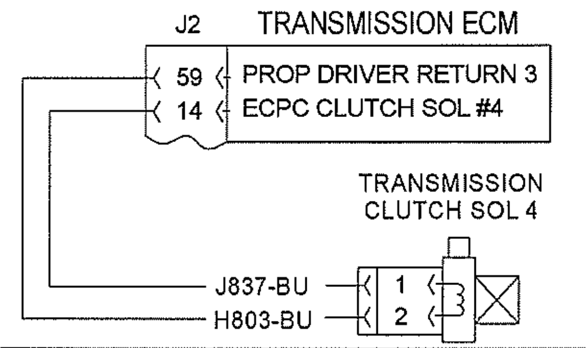


Illustration 36 g01335068

Connections of the transmission clutch solenoid 4

This diagnostic code is associated with the transmission clutch solenoid 4. The FMI 5 means that the ECM has determined that an open in the circuit exists.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 737 FMI 5 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

B. Disconnect the solenoid with the active diagnostic code from the machine harness.

C. At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire J837-BU) to contact 2 (wire H803-BU).

**D.** Observe the status of the SPN 737 FMI 5.

**Expected Result:**

The diagnostic code is active. Then, the diagnostic code changes from FMI 5 to FMI 6 as the jumper wire is installed.

**Results:**

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.

- NO – The diagnostic is no longer active. The solenoid has failed.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

## Test Step 2. CHECK THE HARNESS FOR AN OPEN.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The jumper wire that was installed in the previous Test Step remains in place.

**D.** At the machine harness connector, measure the resistance from signal contact J2-14 to contact J2-59.

**Expected Result:**

The resistance is less than 5.0 ohms.

**Results:**

- OK – The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 737 FMI 5.

**Expected Result:**

The SPN 737 FMI 5 is active.

**Results:**

- YES – The SPN 737 FMI 5 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 737 FMI 5 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655296

# Transmission, SPN 737 - FMI 6

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

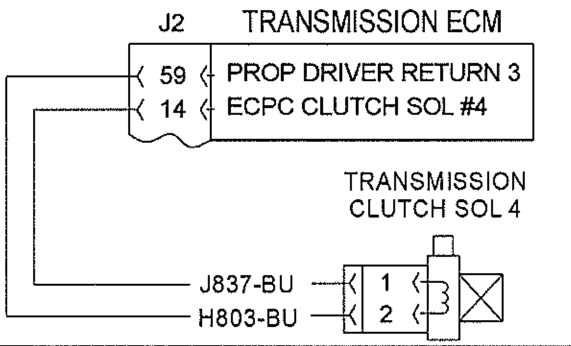


Illustration 37 g01335068

Connections of the transmission clutch solenoid 4

This diagnostic code is associated with the transmission clutch solenoid 4. The FMI 6 means that the ECM has determined that there is a short to ground in the solenoid circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 737 FMI 6 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Observe the status of the diagnostic code.

**C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**Expected Result:**

The FMI 6 changes to FMI 5 when the solenoid is disconnected.

**Results:**

- YES – The FMI 6 changes to FMI 5 when the solenoid is disconnected. The circuit is correct.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

- NO – The SPN 737 FMI 6 remains active. Proceed to Test Step 2.

## Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The solenoid remains disconnected from the machine harness.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector, measure the resistance from the signal contact J2-14 to all other contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-14 and the circuit with the low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 737 FMI 6.

**Expected Result:**

The SPN 737 FMI 6 is active.

**Results:**

- YES – The SPN 737 FMI 6 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 737 FMI 6 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655298

## Transmission, SPN 738 - FMI 3

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

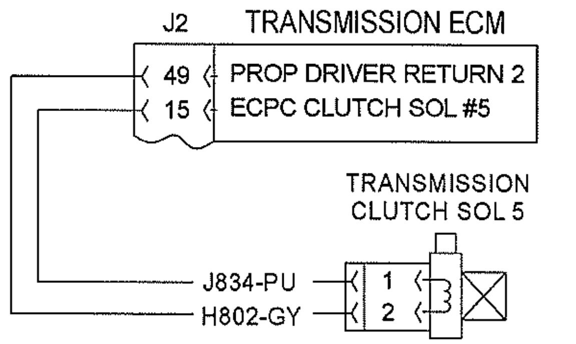


Illustration 38 g01335076

Connections of the transmission clutch solenoid 5

This diagnostic code is associated with the transmission clutch solenoid 5. The FMI 3 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 738 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connectors from the solenoid and the ECM.

**C.** At the machine harness connector for the ECM, measure the resistance from contact J2-15 to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-15 and the circuit that has a low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors in order to make sure that the connectors are fully seated. Also, make sure that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the machine.

**F.** Determine if the SPN 738 FMI 3 is active.

**Expected Result:**

The SPN 738 FMI 3 is active.

**Results:**

- YES – The SPN 738 FMI 3 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 738 FMI 3 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation. STOP.

i02655299

## Transmission, SPN 738 - FMI 5

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

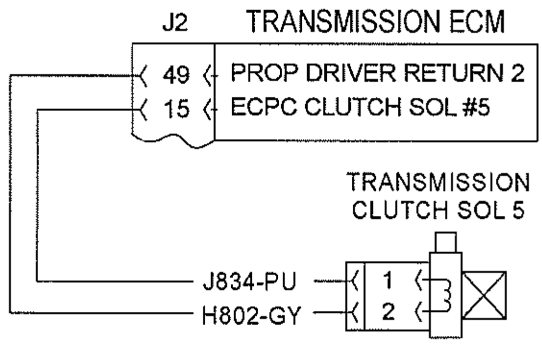


Illustration 39 g01335076

Connections of the transmission clutch solenoid 5

This diagnostic code is associated with the transmission clutch solenoid 5. The FMI 5 means that the ECM has determined that an open in the circuit exists.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.

- The return circuit of the solenoid is open.

- The solenoid has failed.

- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 738 FMI 5 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**C.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire J834-PU) to contact 2 (wire H802-GY).

**D.** Observe the status of the SPN 738 FMI 5.

**Expected Result:**

The diagnostic code is active. Then, the diagnostic code changes from FMI 5 to FMI 6 as the jumper wire is installed.

**Results:**

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.

- NO – The diagnostic is no longer active. The solenoid has failed.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

## Test Step 2. CHECK THE HARNESS FOR AN OPEN.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The jumper wire that was installed in the previous Test Step remains in place.

**D.** At the machine harness connector, measure the resistance from signal contact J2-15 to contact J2-49.

**Expected Result:**

The resistance is less than 5.0 ohms.

**Results:**

- OK – The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 738 FMI 5.

**Expected Result:**

The SPN 738 FMI 5 is active.

**Results:**

- YES – The SPN 738 FMI 5 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The SPN 738 FMI 5 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655302

# Transmission, SPN 738 - FMI 6

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

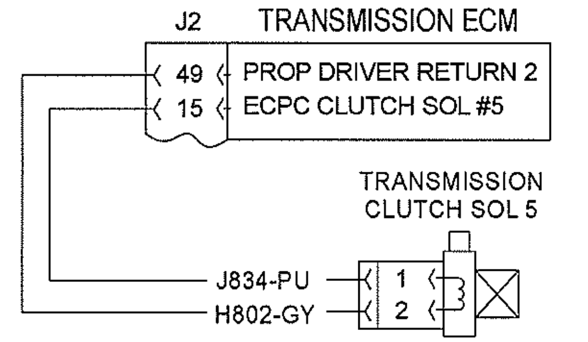


Illustration 40 g01335076

Connections of the transmission clutch solenoid 5

This diagnostic code is associated with the transmission clutch solenoid 5. The FMI 6 means that the ECM has determined that there is a short to ground in the solenoid circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 738 FMI 6 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Observe the status of the diagnostic code.

**C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**Expected Result:**

The FMI 6 changes to FMI 5 when the solenoid is disconnected.

**Results:**

- YES – The FMI 6 changes to FMI 5 when the solenoid is disconnected. The circuit is correct.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

- NO – The SPN 738 FMI 6 remains active. Proceed to Test Step 2.

## Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The solenoid remains disconnected from the machine harness.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector, measure the resistance from the signal contact J2-15 to all other contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-15 and the circuit with the low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 738 FMI 6.

**Expected Result:**

The SPN 738 FMI 6 is active.

**Results:**

- YES – The SPN 738 FMI 6 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 738 FMI 6 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655886

## Transmission, SPN 739 - FMI 3

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

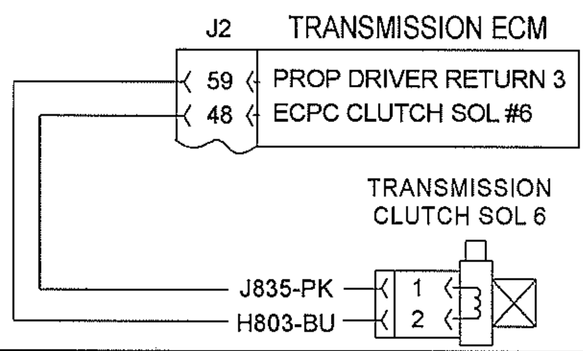


Illustration 41 g01334247

Connections of the transmission clutch solenoid 6

This diagnostic code is associated with the transmission clutch solenoid 6. The FMI 3 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.

- The energize circuit of the solenoid is shorted to the +battery circuit.

- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 739 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connectors from the solenoid and the ECM.

**C.** At the machine harness connector for the ECM, measure the resistance from contact J2-48 to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-48 and the circuit that has a low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors in order to make sure that the connectors are fully seated. Also, make sure that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the machine.

**F.** Determine if the SPN 739 FMI 3 is active.

**Expected Result:**

The SPN 739 FMI 3 is active.

**Results:**

- YES – The SPN 739 FMI 3 is active. The diagnostic trouble code has not been corrected.

  **Repair:** Check the circuit again. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic trouble code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 739 FMI 3 is not active. The diagnostic trouble code does not exist at this time. The initial diagnostic trouble code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation. STOP.

i02655898

## Transmission, SPN 739 - FMI 5

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

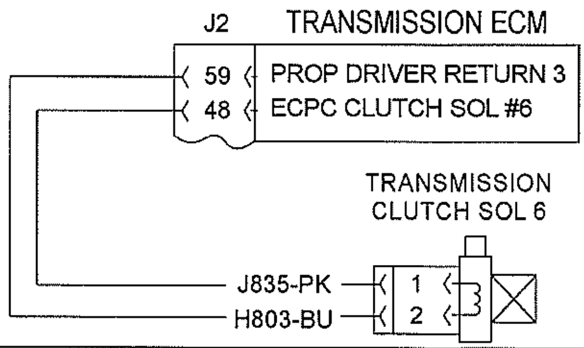


Illustration 42 g01334247

Connections of the transmission clutch solenoid 6

This diagnostic code is associated with the transmission clutch solenoid 6. The FMI 5 means that the ECM has determined that an open in the circuit exists.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 739 FMI 5 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**C.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire J835-PK) to contact 2 (wire H803-BU).

**D.** Observe the status of the SPN 739 FMI 5.

**Expected Result:**

The diagnostic code is active. Then, the diagnostic code changes from FMI 5 to FMI 6 as the jumper wire is installed.

**Results:**

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

## Test Step 2. CHECK THE HARNESS FOR AN OPEN.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The jumper wire that was installed in the previous Test Step remains in place.

**D.** At the machine harness connector, measure the resistance from signal contact J2-48 to contact J2-59.

**Expected Result:**

The resistance is less than 5.0 ohms.

**Results:**

- OK – The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 739 FMI 5.

**Expected Result:**

The SPN 739 FMI 5 is active.

**Results:**

- YES – The SPN 739 FMI 5 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 739 FMI 5 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655908

# Transmission, SPN 739 - FMI 6

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

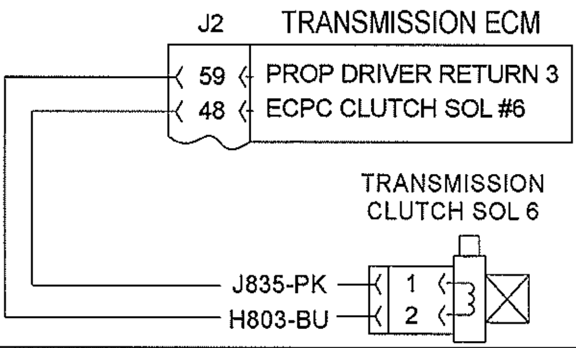


Illustration 43 g01334247

Connections of the transmission clutch solenoid 6

This diagnostic code is associated with the transmission clutch solenoid 6. The FMI 6 means that the ECM has determined that there is a short to ground in the solenoid circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 739 FMI 6 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Observe the status of the diagnostic code.

**C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**Expected Result:**

The FMI 6 changes to FMI 5 when the solenoid is disconnected.

**Results:**

- YES – The FMI 6 changes to FMI 5 when the solenoid is disconnected. The circuit is correct.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

- NO – The SPN 739 FMI 6 remains active. Proceed to Test Step 2.

## Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The solenoid remains disconnected from the machine harness.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector, measure the resistance from the signal contact J2-48 to all other contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-48 and the circuit with the low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 739 FMI 6.

**Expected Result:**

The SPN 739 FMI 6 is active.

**Results:**

- YES – The SPN 739 FMI 6 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 739 FMI 6 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02654956

# Transmission, SPN 774 - FMI 2

**SMCS Code:** 7332-038-Q9

**Conditions Which Generate This Code:**

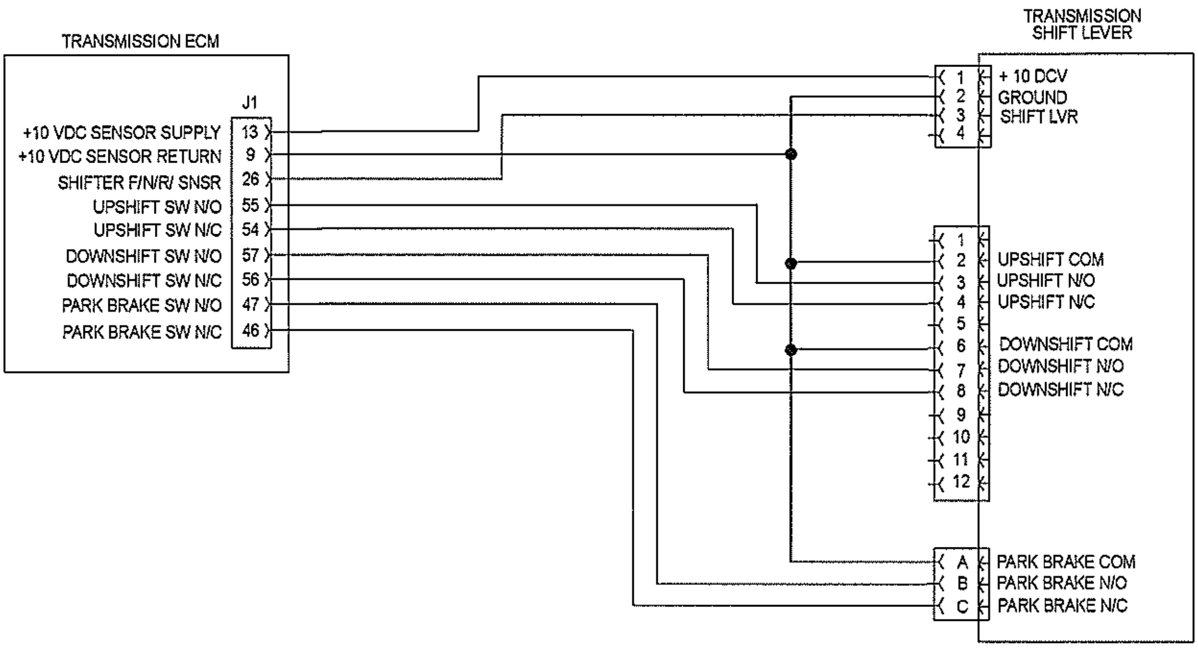


Illustration 44 g01343143

Connections of the upshift switch on the transmission shift lever

This diagnostic code is associated with the upshift switch on the transmission shift lever. The switch is connected to two inputs of the ECM. The inputs are "Normally Open" and "Normally Closed". One of the inputs is open and the other input is grounded during proper operation.

The FMI 02 means that the ECM has determined that the "Normally Open" and "Normally Closed" circuits are in the same state.

**Note:** The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 774 FMI 2 is active before performing this procedure.**

## Test Step 1. CHECK THE OPERATION OF THE SWITCH

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector or the wires from the switch.

**C.** Connect one lead from the multimeter to the common contact (2) for the switch.

**D.** Connect the other lead from the multimeter to the normally open contact (3) for the switch.

**E.** Measure the resistance between contact 2 and contact 3. Note the resistance.

**F.** Disconnect the lead from contact 3 and connect the lead to the normally closed contact (4).

**G.** Measure the resistance between contact 2 and contact 4. Note the resistance.

**Expected Result:**

The resistance from contact 2 to contact 3 is greater than 5000 ohms, and the resistance from contact 2 to contact 4 is less than 5 ohms.

**Results:**

- YES – The resistance from contact 2 to contact 3 is greater than 5000 ohms, and the resistance from contact 2 to contact 4 is less than 5 ohms. Proceed to Test Step 2.

- NO – The resistance measurements do not differ. The switch has failed.

  **Repair:** Replace the switch.

  STOP.

### Test Step 2. CHECK THE OPERATION OF THE SWITCH

**A.** Connect one lead from the multimeter to the common contact (2) for the switch.

**B.** Connect the other lead from the multimeter to the normally open contact (3) for the switch.

**C.** Actuate the switch and measure the resistance between contact 2 and contact 3. Note the resistance.

**D.** Disconnect the lead from contact 3 and connect the lead to the normally closed contact (4).

**E.** Actuate the switch and measure the resistance between contact 2 and contact 4. Note the resistance.

**Expected Result:**

The resistance from contact 2 to contact 3 is less than 5 ohms, and the resistance from contact 2 to contact 4 is greater than 5000 ohms.

**Results:**

- YES – The resistance from contact 2 to contact 3 is less than 5 ohms, and the resistance from contact 2 to contact 4 is greater than 5000 ohms. Proceed to Test Step 3.

- NO – The resistance measurements do not differ. The switch has failed.

  **Repair:** Replace the switch.

  STOP.

### Test Step 3. CHECK THE GROUND CIRCUIT OF THE SWITCH IN THE WIRE HARNESS.

**A.** Connect one lead from the multimeter to contact 2 (wire J766-PU) of the wire harness connector for the switch.

**B.** Connect the other lead from the multimeter to frame ground.

**C.** Measure the resistance between contact 2 (wire J766-PU) and frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The circuit is correct. Proceed to Test Step 4.

- NOT OK – The resistance is greater than 5000 ohms. The circuit is open. The machine harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 4. CHECK THE SWITCH CIRCUITS FOR A SHORT CIRCUIT.

**A.** The disconnect switch and the key start switch remain in the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The connector for the switch remains disconnected.

**D.** At the machine harness connector for the ECM, measure the resistance from contact J1-55 and contact J1-54 of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The harness is correct. Proceed to Test Step 5.

- NO – One or more of the measurements were less than 5 ohms. There is a short in the machine harness.

**Repair:** The short is between contact J1-55 and the circuit with the lowest resistance measurement or the short is between contact J1-55 and the circuit with the lowest resistance measurement. Repair the machine harness or replace the machine harness.

STOP.

### Test Step 5. CHECK THE SWITCH CIRCUITS IN THE HARNESS.

**A.** The machine harness remains disconnected from the ECM and the switch.

**B.** At the harness connector for the switch, connect a jumper wire between contact 3 and contact 4 of the 12-pin connector.

**C.** At the harness connector for the ECM, measure the resistance from contact J1-55 to contact J1-54.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. Proceed to Test Step 6.
- NOT OK – The resistance is greater than 5000 ohms. The circuit is open.

  **Repair:** The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the contacts of the harness connectors and clean the connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Determine if SPN 774 FMI 2 is active.

**Expected Result:**

The SPN 774 FMI 2 is active.

**Results:**

- YES – The SPN 774 FMI 2 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 774 FMI 2 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  **Repair:** The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02654957

# Transmission, SPN 775 - FMI 2

**SMCS Code:** 7332-038-Q9

**Conditions Which Generate This Code:**

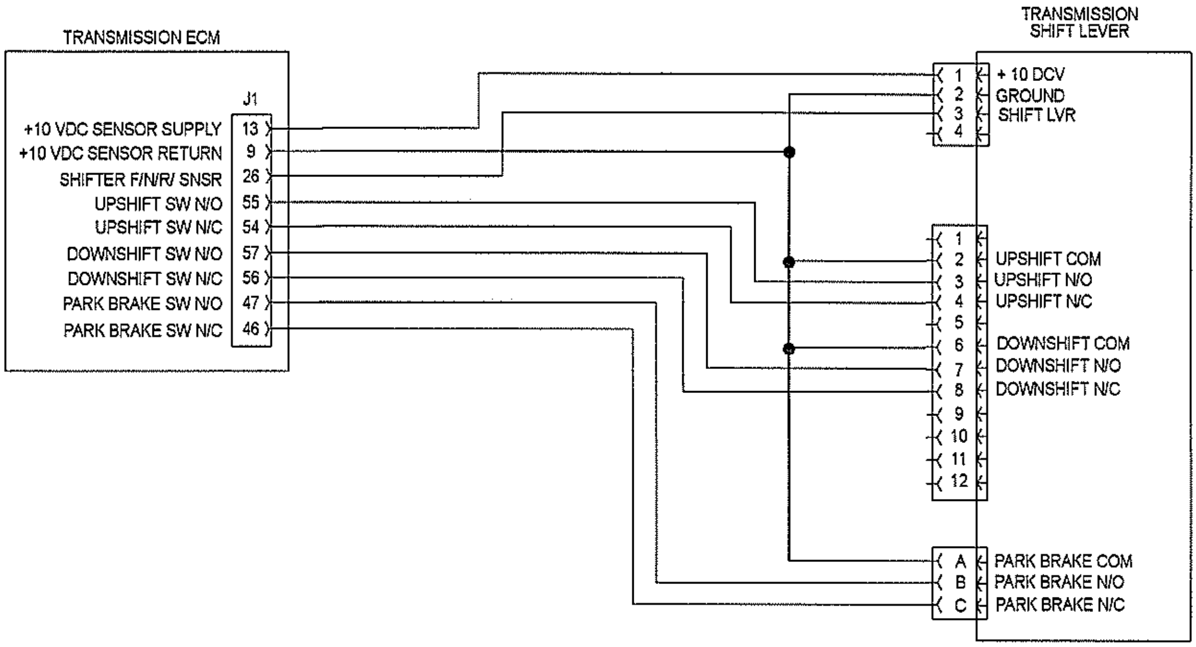


Illustration 45 g01343143

Connection of the downshift switch on the transmission shift lever

This diagnostic code is associated with the downshift switch on the transmission shift lever. The switch is connected to two inputs of the ECM. The inputs are "Normally Open" and "Normally Closed". One of the inputs is open and the other input is grounded during proper operation.

The FMI 2 means that the ECM has determined that the "Normally Open" and "Normally Closed" circuits are in the same state.

**Note:** The following test procedure may create other diagnostic codes. Ignore these diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 775 FMI 2 is active before performing this procedure.**

## Test Step 1. CHECK THE OPERATION OF THE SWITCH

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector or the wires from the switch.

**C.** Connect one lead from the multimeter to the common contact (6) for the switch.

**D.** Connect the other lead from the multimeter to the normally open contact (7) for the switch.

**E.** Measure the resistance between contact 6 and contact 7. Note the resistance.

**F.** Disconnect the lead from contact 7 and connect the lead to the normally closed contact (8).

**G.** Measure the resistance between contact 6 and contact 8. Note the resistance.

**Expected Result:**

The resistance from contact 6 to contact 7 is greater than 5000 ohms, and the resistance from contact 6 to contact 8 is less than 5 ohms.

**Results:**

- YES – The resistance from contact 6 to contact 7 is greater than 5000 ohms, and the resistance from contact 6 to contact 8 is less than 5 ohms. Proceed to Test Step 2.

- NO – The resistance measurements do not differ. The switch has failed.

  **Repair:** Replace the switch.

  STOP.

### Test Step 2. CHECK THE OPERATION OF THE SWITCH

**A.** Connect one lead from the multimeter to the common contact (6) for the switch.

**B.** Connect the other lead from the multimeter to the normally open contact (7) for the switch.

**C.** Actuate the switch and measure the resistance between contact 6 and contact 7. Note the resistance.

**D.** Disconnect the lead from contact 7 and connect the lead to the normally closed contact (8).

**E.** Actuate the switch and measure the resistance between contact 6 and contact 8. Note the resistance.

**Expected Result:**

The resistance from contact 6 to contact 7 is less than 5 ohms, and the resistance from contact 6 to contact 8 is greater than 5000 ohms.

**Results:**

- YES – The resistance from contact 6 to contact 7 is less than 5 ohms, and the resistance from contact 6 to contact 8 is greater than 5000 ohms. Proceed to Test Step 3.

- NO – The resistance measurements do not differ. The switch has failed.

  **Repair:** Replace the switch.

  STOP.

### Test Step 3. CHECK THE GROUND CIRCUIT OF THE SWITCH IN THE WIRE HARNESS.

**A.** Connect one lead from the multimeter to contact 6 of the wire harness connector for the switch.

**B.** Connect the other lead from the multimeter to frame ground.

**C.** Measure the resistance between contact 6 and frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The circuit is correct. Proceed to Test Step 4.

- NOT OK – The resistance is greater than 5000 ohms. The circuit is open. The machine harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 4. CHECK THE SWITCH CIRCUITS FOR A SHORT CIRCUIT.

**A.** The disconnect switch and the key start switch remain in the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The connector for the switch remains disconnected.

**D.** At the machine harness connector for the ECM, measure the resistance from contact J1-57 and contact J1-56 of the machine harness to all the contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The harness is correct. Proceed to Test Step 5.

- NO – One or more of the measurements were less than 5 ohms. There is a short in the machine harness.

  **Repair:** The short is between contact J1-57 and the circuit with the lowest resistance measurement or the short is between contact J1-56 and the circuit with the lowest resistance measurement. Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 5. CHECK THE SWITCH CIRCUITS IN THE HARNESS.

**A.** The machine harness remains disconnected from the ECM and the switch.

**B.** At the harness connector for the switch, connect a jumper wire between contact 7 and contact 8 .

**C.** At the harness connector for the ECM, measure the resistance from contact J1-57 to contact J1-56 .

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. Proceed to Test Step 6.
- NOT OK – The resistance is greater than 5000 ohms. The circuit is open.

  **Repair:** The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the contacts of the harness connectors and clean the connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Determine if SPN 775 FMI 2 is active.

**Expected Result:**

The SPN 775 FMI 2 is active.

**Results:**

- YES – The SPN 775 FMI 2 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 775 FMI 2 is not active. The diagnostic code is NOT present. The diagnostic code does not exist at this time.

  **Repair:** The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

  STOP.

i02654962

## Transmission, SPN 1079 - FMI 0

**SMCS Code:** 1439-038

**Conditions Which Generate This Code:**

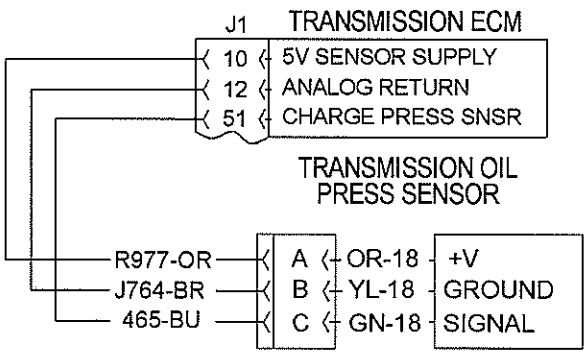


Illustration 46 g01343715

Connections of the 5 Volt Supply

The sensor supply is a power supply that is internal to the ECM. The sensor supply provides 5 VDC in order to operate the oil temperature sensor. The ECM monitors the sensor supply voltage for a high voltage condition. If the voltage rises above 7 VDC for 1 second, a diagnostic code will be generated. The active diagnostic code is cleared when the voltage drops below 6 VDC for 5 seconds.

This diagnostic code will be recorded when the ECM reads the voltage for the circuit of the sensor supply as being above normal.

The results of this diagnostic code are listed:

- All of the associated sensors will also log diagnostic codes.
- When this diagnostic code occurs, the action lamp and the action alarm are ON.

The possible causes of the diagnostic code are listed:

- The supply circuit (wire R977-OR) is shorted to the +battery circuit in the machine harness.
- The ECM has failed. This is unlikely.

## CHECK FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness from the ECM.

**C.** Perform the following measurement at the connectors of the ECM. Measure the resistance between the contacts for the +battery and the contact for the sensor supply voltage.

**Expected Result:**

The resistance that is measured should be greater than 5000 ohms.

**Results:**

- OK – The resistance measurement is greater than 5000 ohms. The harness circuit is correct. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Perform this diagnostic code again. Replace the ECM if the cause of the diagnostic code is NOT found. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NOT OK – The resistance measurement is less than 5000 ohms.

  **Repair:** The machine harness has failed. There is a short between the +battery circuit and the circuit for the sensor power supply in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

i02654966

# Transmission, SPN 1079 - FMI 1

**SMCS Code:** 1439-038

**Conditions Which Generate This Code:**

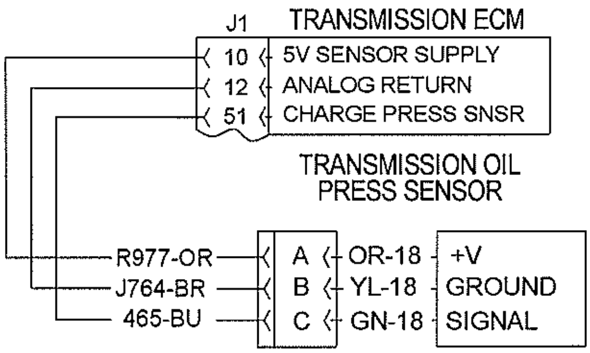


Illustration 47 g01343715

Connections of the 5 Volt Supply

The sensor supply is a power supply that is internal to the ECM. The sensor supply provides 5 DCV in order to operate the oil temperature sensor. The control module shall monitor sensor supply voltage for a low voltage condition. If the voltage drops below 4 DCV for 5 seconds, a diagnostic code is generated. The delay will prevent a diagnostic code from being logged when the machine is started. The diagnostic code will be cleared when the voltage is above 4.2 DCV for 5 seconds.

The results of this diagnostic code are listed:

- All of the associated sensors will also log diagnostic codes.
- When this diagnostic code occurs, the action lamp and the action alarm are ON.

The possible causes of the diagnostic code are listed:

- The supply circuit (wire R977-OR) is shorted to the ground circuit in the machine harness.
- The ECM has failed. This is unlikely.

### Test Step 1. CHECK THE SENSOR.

**A.** Ensure that the diagnostic code is present. The diagnostic code should be active.

**B.** Observe the status of the diagnostic code.

**C.** Disconnect the machine harness from the sensor.

**Expected Result:**

The diagnostic code is NO longer active.

**Results:**

- OK – The diagnostic code is NO longer active.

  **Repair:** The sensor has failed. Replace the sensor.

  STOP.

- NOT OK – The diagnostic code remains active. The sensor is NOT causing the diagnostic code. Proceed to test step 2.

### Test Step 2. CHECK FOR SHORT TO GROUND

**A.** The sensor remains disconnected from the machine harness.

**B.** Turn the disconnect switch to the OFF position.

**C.** Disconnect the machine harness from the ECM.

**D.** At the ECM, measure the resistance between the contact of the sensor supply voltage and frame ground.

**Expected Result:**

The resistance that is measured should be greater than 5000 ohms.

**Results:**

- OK – The resistance that is measured is greater than 5000 ohms. The harness circuit is correct. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this diagnostic code procedure and perform this diagnostic code procedure again. Replace the ECM if the cause of the diagnostic code is NOT found. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NOT OK – The resistance that is measured is less than 5000 ohms.

  **Repair:** The machine harness has failed. There is a short between frame ground and the contact for the sensor supply voltage in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

i02654968

## Transmission, SPN 1079 - FMI 3

**SMCS Code:** 1439-038

**Conditions Which Generate This Code:**

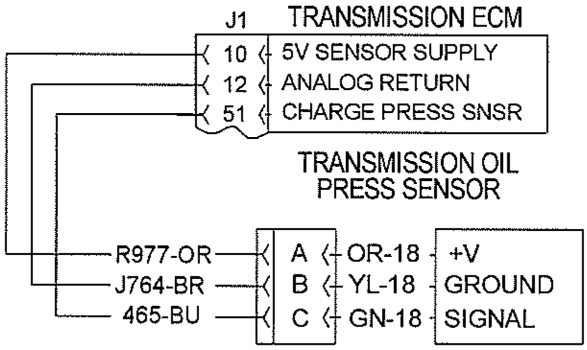


Illustration 48 g01343715

Connections of the 5 Volt Supply

The sensor supply is a power supply that is internal to the ECM. The sensor supply provides +5 DCV in order to operate the sensors.

This diagnostic code will be recorded when the Transmission ECM reads the voltage for the circuit of the sensor supply as being above normal.

The results of this diagnostic code are listed:

- All of the associated sensors will also log diagnostic codes.

The possible causes of the diagnostic code are listed:

- +5 DCV (wire R997-OR) is shorted to the +battery circuit in the machine harness.

- The ECM has failed. This is unlikely.

### CHECK FOR SHORT TO THE +BATTERY CIRCUIT

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness from the ECM.

**C.** At the machine harness connectors for the ECM, measure the resistance between the +battery contact and the contact for the sensor supply voltage. See the schematic for more detailed information about the sensor power supply for the sensor that is being tested.

**Expected Result:**

The resistance that is measured should be greater than 5000 ohms.

**Results:**

- OK – The resistance is greater than 5000 ohms. The harness circuit is correct. The ECM has failed.

  **Repair:** It is unlikely that the ECM has failed. Perform this SPN 1079 FMI 3 again. If the cause of the diagnostic code is NOT found, replace the Transmission ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NOT OK – The resistance measures less than 5000 ohms. The machine harness has failed. There is a short between the +battery circuit and the circuit for the sensor power supply in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

i02654972

# Transmission, SPN 1079 - FMI 4

**SMCS Code:** 1439-038

**Conditions Which Generate This Code:**

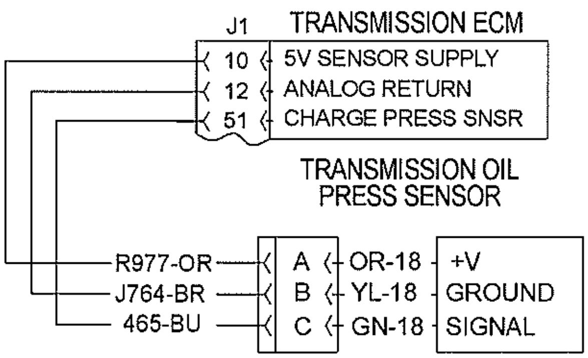


Illustration 49 g01343715

Connections of the 5 Volt Supply

The sensor supply is a power supply that is internal to the ECM. The sensor supply provides +5 DCV in order to operate the sensors.

This diagnostic code will be recorded when the Transmission ECM reads the voltage for the circuit of the sensor supply as being below normal.

The results of this diagnostic code are listed:

- All of the associated sensors will also log diagnostic codes.

The possible causes of the diagnostic code are listed:

- +5 DCV (wire R997-OR) is shorted to ground between the sensor and the ECM.

- The ECM has failed. This is unlikely.

## Test Step 1. CHECK THE SENSOR.

**A.** Ensure that the diagnostic code of SPN 1079 FMI 4 is present. The diagnostic code should be active.

**B.** Observe the status of the diagnostic code. The diagnostic code is active or the diagnostic code is NOT active.

**C.** Disconnect the machine harness from the sensor.

**Expected Result:**

The diagnostic code is NO longer active.

**Results:**

- OK – The diagnostic code is NO longer active. The sensor has failed.

  **Repair:** Replace the sensor.

  STOP.

- NOT OK – The diagnostic code remains active. The sensor is NOT causing the diagnostic code. Proceed to Test Step 2.

## Test Step 2. CHECK FOR A SHORT TO GROUND.

**A.** The sensor remains disconnected from the machine harness.

**B.** Turn the disconnect switch and the key start switch to the OFF position.

**C.** Disconnect the machine harness from the ECM.

**D.** At the ECM, measure the resistance between the contact of the sensor supply voltage and frame ground. See the schematic for more detailed information about the voltage of the sensor power supply for the sensor that is being tested.

**Expected Result:**

The resistance is greater than 5000 ohms.

**Results:**

- OK – The resistance that is measured is greater than 5000 ohms. The harness circuit is correct. The ECM has failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure. Perform the diagnostic code procedure for SPN 1079 FMI 4 again. If the cause of the diagnostic code is NOT found, replace the ECM . See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NOT OK – The resistance that is measured is less than 5000 ohms. The machine harness has failed. There is a short between frame ground and the contact for the sensor supply voltage in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

i02654974

# Transmission, SPN 1542 - FMI 0

**SMCS Code:** 1439-038

**Conditions Which Generate This Code:**

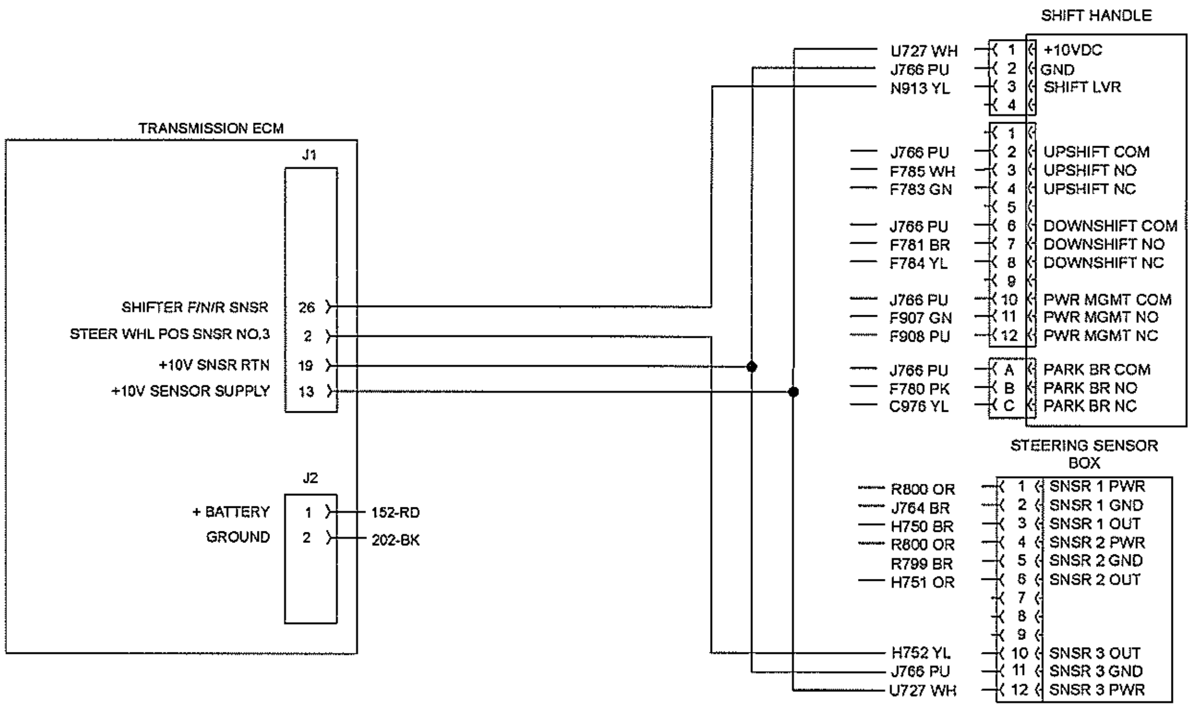


Illustration 50 g01343159

Connections of the 10 volt sensor supply

The sensor supply is a power supply that is internal to the ECM. The sensor supply provides 10 VDC in order to operate the sensors.

This diagnostic code will be recorded when the Transmission ECM reads the voltage for the circuit of the sensor supply as being above normal.

The possible causes of the diagnostic code are listed:

- The +10 VDC is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

## CHECK FOR SHORT TO THE +BATTERY CIRCUIT

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness from the ECM.

**C.** At the machine harness connectors for the ECM, measure the resistance between the +battery contact (J2-1) and the contact for the sensor supply voltage (J1-13).

**Expected Result:**

The resistance that is measured should be greater than 5000 ohms.

**Results:**

- OK – The resistance is greater than 5000 ohms. The harness circuit is correct. The ECM has failed.

  **Repair:** It is unlikely that the ECM has failed. Perform the Test Step again. If the cause of the diagnostic code is NOT found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NOT OK – The resistance measures less than 5000 ohms. The machine harness has failed. There is a short between the +battery circuit and the circuit for the sensor power supply in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

i02654979

# Transmission, SPN 1542 - FMI 1

**SMCS Code:** 1439-038

**Conditions Which Generate This Code:**

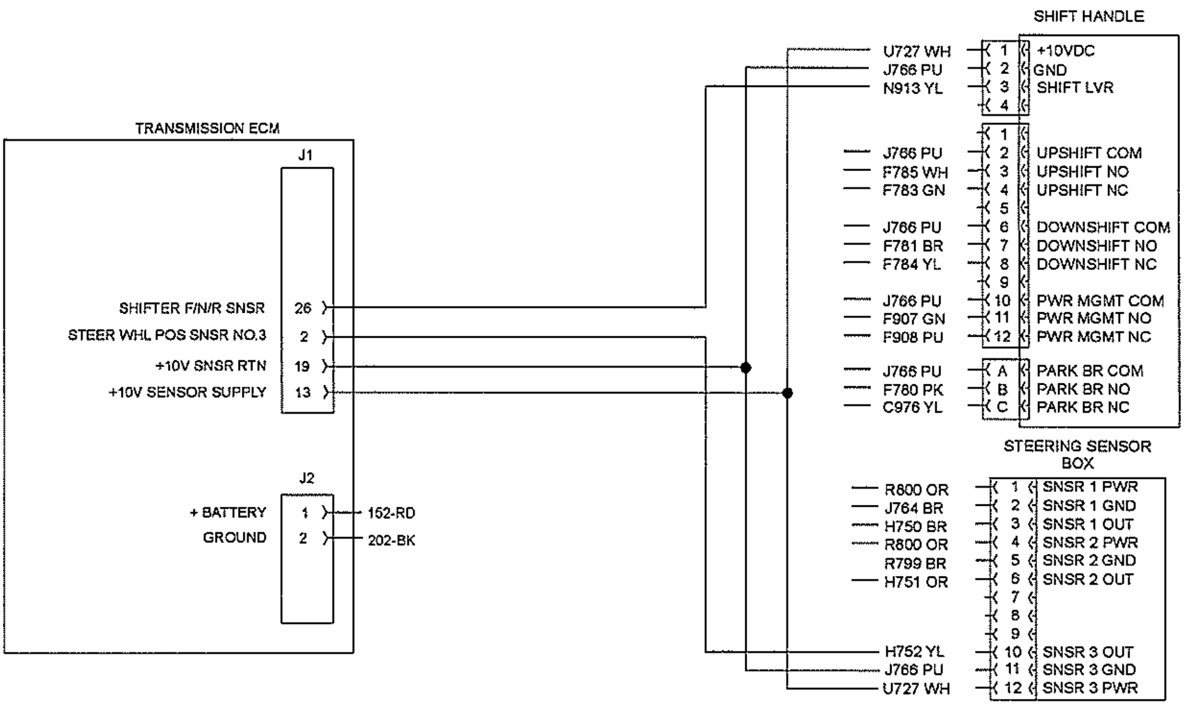


Illustration 51 g01343159

Connections for the 10 volt sensor supply

The sensor supply is a power supply that is internal to the ECM. The sensor supply provides 10 VDC in order to operate the sensors.

This diagnostic code will be recorded when the Transmission ECM reads the voltage for the circuit of the sensor supply as being below normal.

The possible causes of the diagnostic code are listed:

- 10 VDC is shorted to ground between the sensor and the ECM.
- The ECM has failed. This is unlikely.

**System Response:**

The results of this diagnostic code are listed:

- All of the associated sensors will also log diagnostic codes.

## Test Step 1. CHECK THE SENSOR.

**A.** Ensure that the diagnostic code of SPN 1542 FMI 1 is present. The diagnostic code should be active.

**B.** Disconnect the machine harness from all of the sensors in the circuit.

**Expected Result:**

The diagnostic code is NO longer active.

**Results:**

- OK – The diagnostic code is NO longer active. One of the sensors have failed.

  **Repair:** Reconnect the sensors one at a time until the diagnostic code becomes active. Replace the sensor that causes the active diagnostic code.

  STOP.

- NOT OK – The diagnostic code remains active. The sensors are NOT causing the diagnostic code. Proceed to Test Step 2.

## Test Step 2. CHECK FOR A SHORT TO GROUND.

**A.** The sensors remain disconnected from the machine harness.

**B.** Turn the disconnect switch and the key start switch to the OFF position.

**C.** Disconnect the machine harness from the ECM.

**D.** At the ECM, measure the resistance between the contact of the sensor supply voltage (J1-13) and frame ground.

**Expected Result:**

The resistance is greater than 5000 ohms.

**Results:**

- OK – The resistance that is measured is greater than 5000 ohms. The harness circuit is correct. The ECM has failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure. Perform the diagnostic code procedure for SPN 1542 FMI 1 again. If the cause of the diagnostic code is NOT found, replace the ECM . See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NOT OK – The resistance that is measured is less than 5000 ohms. The machine harness has failed. There is a short between frame ground and the contact for the sensor supply voltage in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

i02654989

# Transmission, SPN 1619 - FMI 0

**SMCS Code:** 5737-038-T3

**Conditions Which Generate This Code:**

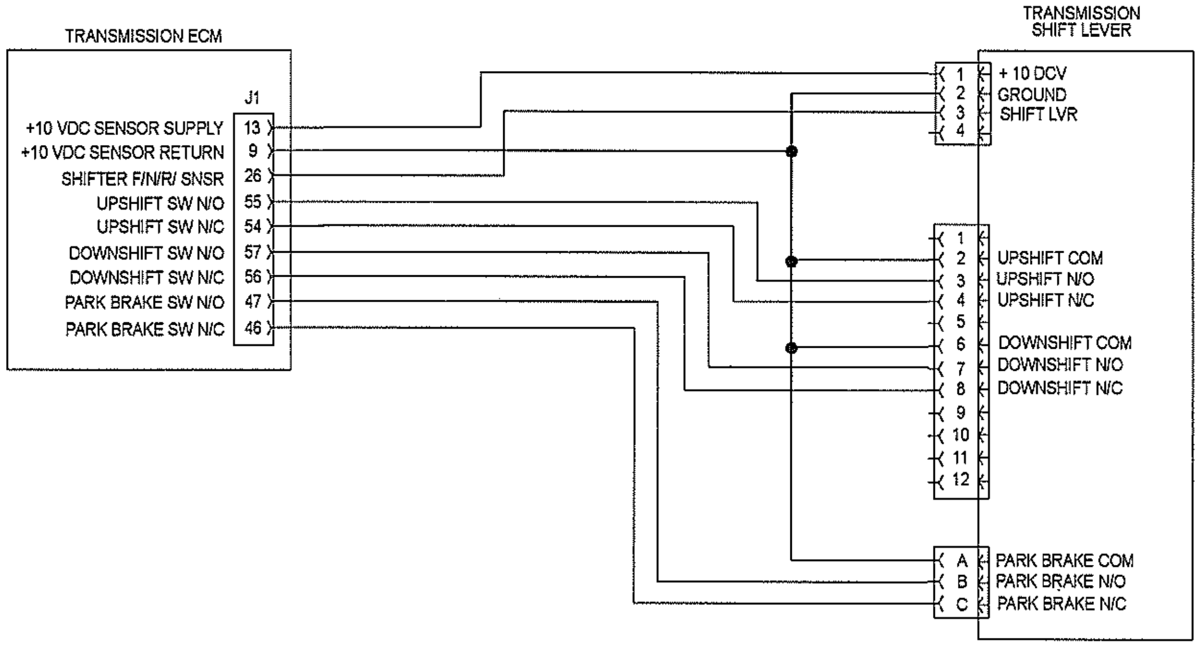


Illustration 52 g01343143

Connections of the position sensor (shift lever)

This diagnostic code is associated with the position sensor (shift lever). The FMI 0 means that the ECM has determined that the signal of the sensor is above the normal range.

The output frequency of the position sensor is approximately 500 hertz. The value of the sensor's duty cycle is approximately 50% in the neutral position. The duty cycle of the signal increases as the lever is moved from the neutral position to the forward position. The value of the sensor's duty cycle is approximately 80% ± 10% in the forward position. The duty cycle of the signal decreases as the lever is moved from the neutral position to the reverse position. The value of the sensor's duty cycle is approximately 20% ± 10% in the reverse position.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- The signal circuit of the sensor is shorted to the + battery circuit.
- The sensor needs to be calibrated.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

**Note:** Use a digital multimeter for the measurements in this procedure.

**System Response:**

A warning will be displayed on the TMC. The transmission will be placed in the neutral gear until the diagnostic code is cleared.

### Test Step 1. INSPECT THE SENSOR.

**A.** Perform a visual inspection of the sensor, the wiring for the sensor and the hardware that is associated with the sensor.

**Expected Result:**

There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

**Results:**

- OK – There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor. Proceed to Test Step 2.
- NOT OK – There is apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

  **Repair:** Replace the damaged part.

  Proceed to Test Step 8.

### Test Step 2. CHECK FOR POWER AT THE SENSOR.

**A.** Do not disconnect the harness connector from the sensor.

**B.** At the back of the harness connector for the sensor, insert a multimeter probe along the voltage supply wire (contact 1).

**C.** Turn the key start switch and the disconnect switch to the ON position.

**D.** Measure the voltage from contact 1 to frame ground.

**Expected Result:**

The voltage is 10 VDC.

**Results:**

- OK – The voltage is 10 VDC. Proceed to Test Step 3.
- NOT OK – The voltage is not 10 VDC. The circuit is open.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK FOR PROPER GROUND AT THE SENSOR.

**A.** The machine harness remains connected to the sensor.

**B.** Turn the key start switch and the disconnect switch to the OFF position.

**C.** Remove the multimeter probe from the voltage supply wire (contact 1).

**D.** At the back of the harness connector for the sensor, insert a multimeter probe along the ground wire (contact 2).

**E.** Measure the resistance from contact 2 to frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The ground circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  **Repair:** Replace the machine harness or repair the machine harness.

  STOP.

### Test Step 4. CHECK THE SIGNAL OF THE SENSOR.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The multimeter probe remains along the ground wire (contact 2).

**C.** At the back of the harness connector for the sensor, insert the other multimeter probe along the signal wire (contact 3).

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Monitor the signal of the sensor with the multimeter.

**F.** Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the beginning of this procedure. The CID 0299 FMI 00 is not active at the maximum range of the sensor.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 5.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  **Repair:** Replace the sensor.

  STOP.

## Test Step 5. CHECK THE SIGNAL AT THE ECM.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Insert the multimeter probes into the back of the ECM connector along J1-26 and J1-9.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Monitor the signal of the sensor with the multimeter.

**E.** Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the beginning of this procedure. The SPN 1619 FMI 0 is not active at the maximum range of the sensor.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 6. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

**A.** The key start switch and the disconnect switch remain in the OFF position.

**B.** Disconnect the machine harness connectors from the sensor and the ECM.

**C.** Measure the resistance between contact J1-26 and all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each of the resistance measurements are greater than 5000 ohms. The circuit is correct. Proceed to Test Step 7.
- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 7. CHECK IF THE DIAGNOSTIC CODE REMAINS

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

F. Check the status of the SPN 1619 FMI 0.

**Expected Result:**

The SPN 1619 FMI 0 is not active at the maximum range of the sensor.

**Results:**

- OK – The SPN 1619 FMI 0 is not active at the maximum range of the sensor. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation. STOP.

- NOT OK – The SPN 1619 FMI 0 is active at the maximum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor, if necessary. Then perform the calibration procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

## Test Step 8. CHECK THE ADJUSTMENT AND/OR THE CALIBRATION OF THE SENSOR.

**A.** Turn the disconnect switch and the key start switch to the ON position.

**B.** Perform the adjustment procedure for the position sensor, if necessary. Then perform the calibration of the position sensor. Refer to the Testing and Adjusting section of the manual for additional information on these procedures.

**C.** Without disconnecting the sensor or the hardware that is associated with the sensor, move the sensor through the entire range of motion.

**Note:** On some machines, it may be necessary to start the engine in order to move the sensor through the entire range of motion.

**D.** Check the status of the diagnostic code.

**Expected Result:**

The SPN 1619 FMI 0 is not active.

**Results:**

- OK – The diagnostic is not active. The adjustment and/or the calibration has corrected the failure. Resume normal operation. STOP.

- NOT OK – SPN 1619 FMI 0 is still active.

  **Repair:** Exit this procedure. Perform this procedure again.

  STOP.

i02654985

# Transmission, SPN 1619 - FMI 1

**SMCS Code:** 5737-038-T3

**Conditions Which Generate This Code:**

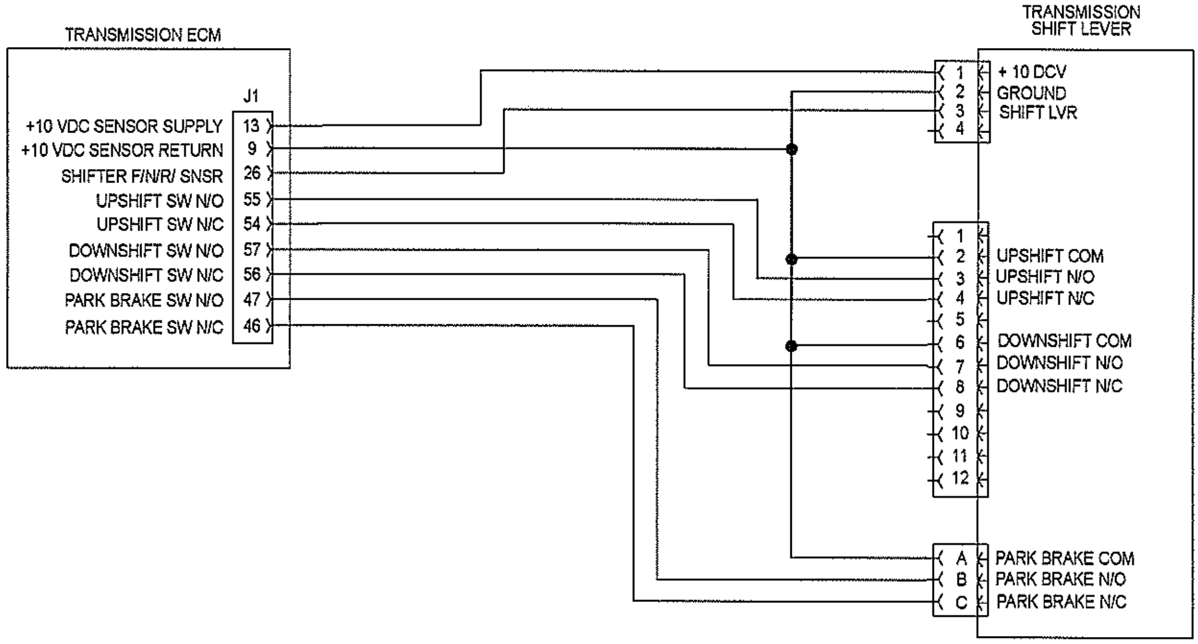


Illustration 53 g01343143

Connections of the position sensor (shift lever)

This diagnostic code is associated with the position sensor (shift lever). The FMI 1 means that the ECM has determined that the signal of the sensor is below the normal range.

The output frequency of the position sensor is approximately 500 hertz. The value of the sensor's duty cycle is approximately 50% in the neutral position. The duty cycle of the signal increases as the lever is moved from the neutral position to the forward position. The value of the sensor's duty cycle is approximately 80% ± 10% in the forward position. The duty cycle of the signal decreases as the lever is moved from the neutral position to the reverse position. The value of the sensor's duty cycle is approximately 20% ± 10% in the reverse position.

The possible causes of this failure are listed below:

- The position sensor has failed.
- The signal circuit of the sensor is shorted to the ground.
- The sensor needs to be calibrated.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

**Note:** Use a digital multimeter for the measurements in this procedure.

**System Response:**

A warning will be displayed on the Caterpillar Electronic Technician (Cat ET). The transmission will be placed in the neutral gear until the diagnostic code is cleared.

## Test Step 1. INSPECT THE SENSOR.

**A.** Perform a visual inspection of the sensor, the wiring for the sensor and the hardware that is associated with the sensor.

**Expected Result:**

There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

**Results:**

- OK – There is no apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor. Proceed to Test Step 2.
- NOT OK – There is apparent damage to the sensor, the wiring for the sensor or the hardware that is associated with the sensor.

  **Repair:** Replace the damaged part.

  Proceed to Test Step 8.

## Test Step 2. CHECK FOR POWER AT THE SENSOR.

**A.** Do not disconnect the harness connector from the sensor.

**B.** At the back of the harness connector for the sensor, insert a multimeter probe along the voltage supply wire (contact 1).

**C.** Turn the key start switch and the disconnect switch to the ON position.

**D.** Measure the voltage from contact 1 to frame ground.

**Expected Result:**

The voltage is 10 DCV.

**Results:**

- OK – The voltage is 10 DCV. Proceed to Test Step 3.
- NOT OK – The voltage is not 10 DCV. The circuit is open.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK FOR PROPER GROUND AT THE SENSOR.

**A.** The machine harness remains connected to the sensor.

**B.** Turn the key start switch and the disconnect switch to the OFF position.

**C.** Remove the multimeter probe from the voltage supply wire (contact 1).

**D.** At the back of the harness connector for the sensor, insert a multimeter probe along the ground wire (contact 2).

**E.** Measure the resistance from contact 2 to frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The ground circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

  **Repair:** Replace the machine harness or repair the machine harness.

  STOP.

## Test Step 4. CHECK THE SIGNAL OF THE SENSOR.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** At the back of the harness connector for the sensor, remove the multimeter probe from contact 1 and insert the probe along the signal wire (contact 3).

**C.** At the back of the harness connector for the sensor, insert the multimeter probe along the ground wire (contact 2).

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Monitor the signal of the sensor with the digital multimeter.

**F.** Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the beginning of this procedure. The SPN 1619 FMI 1 is not active at the maximum range of the sensor.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 5.

- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  **Repair:** Replace the sensor.

  STOP.

## Test Step 5. CHECK THE SIGNAL AT THE ECM.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Insert the multimeter probes into the back of the ECM connector along J1-26 and J1-9.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Monitor the signal of the sensor with the digital multimeter.

**E.** Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the beginning of this procedure. The SPN 1619 FMI 1 is not active at the maximum range of the sensor.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.

- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 6. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

**A.** The key start switch and the disconnect switch remain in the OFF position.

**B.** Disconnect the machine harness connectors from the sensor and the ECM.

**C.** Measure the resistance between contact J1-26 and all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each of the resistance measurements are greater than 5000 ohms. The circuit is correct. Proceed to Test Step 7.

- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 7. CHECK IF THE DIAGNOSTIC CODE REMAINS

**A.** Inspect the harness connectors and clean the contacts of the machine harness connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine and take the sensor through the operating range of the sensor.

**E.** Check the status of the SPN 1619 FMI 1.

**Expected Result:**

The SPN 1619 FMI 1 is not active at the minimum range of the sensor.

**Results:**

- OK – The SPN 1619 FMI 1 is not active at the minimum range of the sensor. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation. STOP.

- NOT OK – The SPN 1619 FMI 1 is active at the minimum range of the sensor. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure. Perform the adjustment procedure for the sensor, if necessary. Then perform the calibration procedure for the sensor. Perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

## Test Step 8. CHECK THE ADJUSTMENT AND/OR THE CALIBRATION OF THE SENSOR.

**A.** Turn the disconnect switch and the key start switch to the ON position.

**B.** Perform the adjustment procedure for the position sensor, if necessary. Then perform the calibration of the position sensor. Refer to the Testing and Adjusting section of the manual for additional information on these procedures.

**C.** Without disconnecting the sensor or the hardware that is associated with the sensor, move the sensor through the entire range of motion.

**Note:** On some machines, it may be necessary to start the engine in order to move the sensor through the entire range of motion.

**D.** Check the status of the diagnostic code.

**Expected Result:**

The SPN 1619 FMI 1 is not active.

**Results:**

- OK – The diagnostic is not active. The adjustment and/or the calibration has corrected the failure. Resume normal operation. STOP.

- NOT OK – SPN 1619 FMI 1 is still active.

**Repair:** Exit this procedure. Perform this procedure again.

STOP.

i02654990

# Transmission, SPN 1619 - FMI 8

**SMCS Code:** 5737-038-T3

**Conditions Which Generate This Code:**

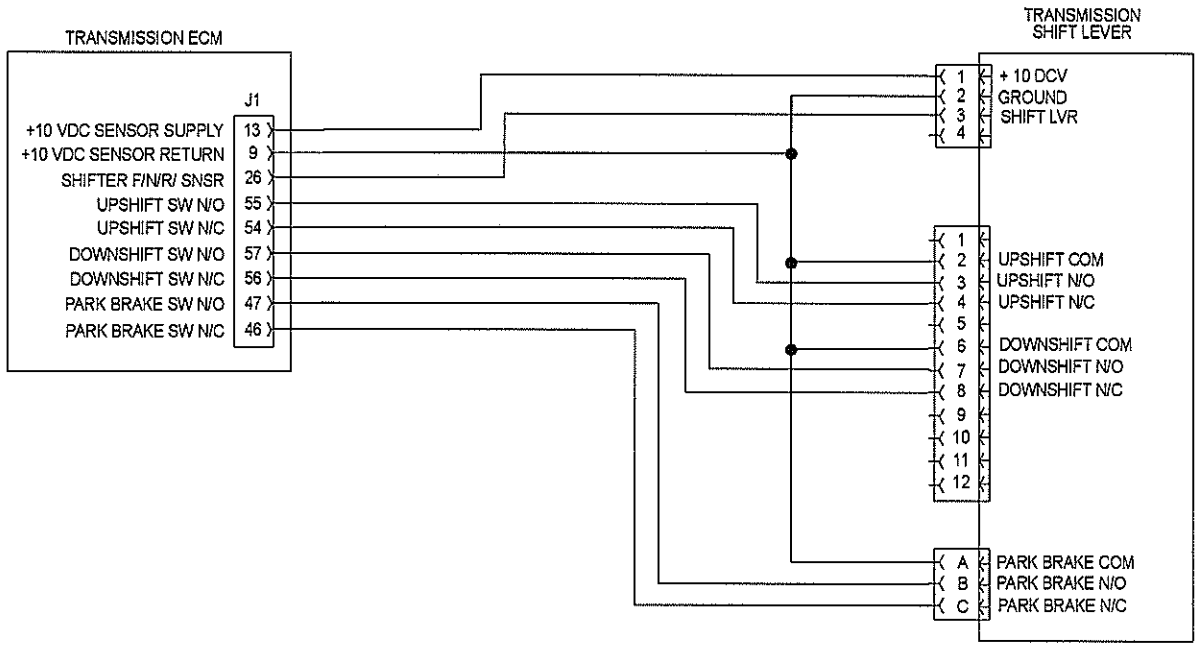


Illustration 54 g01343143

Connections of the position sensor (shift lever)

This diagnostic code is associated with the position sensor (shift lever). The FMI 8 means that the ECM has determined that the signal frequency or the signal pulse width is not within the expected range.

The output frequency of the position sensor is approximately 500 hertz. The value of the sensor's duty cycle is approximately 50% in the neutral position. The duty cycle of the signal increases as the lever is moved from the neutral position to the forward position. The value of the sensor's duty cycle is approximately 80% ± 10% in the forward position. The duty cycle of the signal decreases as the lever is moved from the neutral position to the reverse position. The value of the sensor's duty cycle is approximately 20% ± 10% in the reverse position.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- Intermittent connections or poor connections
- Mechanical devices are loose.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 1619 FMI 8 is active before performing this procedure.**

**Note:** Use the digital multimeter for the measurements in this procedure.

**System Response:**

A warning will be displayed on the Caterpillar Electronic Technician (Cat ET). The transmission will be placed in the neutral gear until the diagnostic code is cleared.

### Test Step 1. CHECK FOR POWER AT THE SENSOR.

**A.** Do not disconnect the harness connector from the sensor.

**B.** At the back of the harness connector for the sensor, insert a multimeter probe along the voltage supply wire (contact 1).

**C.** Turn the key start switch and the disconnect switch to the ON position.

**D.** Measure the voltage from contact 1 to frame ground.

**Expected Result:**

The voltage is 10 DCV.

**Results:**

- OK – The voltage is 10 DCV. Proceed to Test Step 3.
- NOT OK – The voltage is not 10 DCV. The circuit is open.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 2. CHECK THE SIGNAL CIRCUIT OF THE SENSOR.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** At the back of the harness connector for the sensor, remove the multimeter probe from contact 1 and insert the probe along the signal wire (contact 3).

**C.** At the back of the harness connector for the sensor, insert the multimeter probe along the ground wire (contact 2).

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Monitor the signal of the sensor with the digital multimeter.

**F.** Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the begining of this procedure.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 3.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

  **Repair:** Replace the sensor.

  STOP.

### Test Step 3. CHECK THE SIGNAL CIRCUIT AT THE ECM.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Insert the multimeter probes into the back of the ECM connector along J1-26 and J1-9.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Monitor the signal of the sensor with the digital multimeter.

**E.** Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

**Note:** On some machines, it may be necessary to start the engine in order to take the sensor through the full operating range of the sensor.

**Expected Result:**

The sensor's signal responds in the manner that is described at the begining of this procedure.

**Results:**

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 4.
- NOT OK – The sensor's signal does not respond correctly. The harness has failed.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT IN THE HARNESS.

**A.** The key start switch and the disconnect switch remain in the OFF position.

**B.** Disconnect the machine harness connectors from the sensor and the ECM.

**C.** Measure the resistance between contact J1-26 and all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

The resistance is greater than 5000 ohms.

**Results:**

- OK – The resistance is greater than 5000 ohms. The circuit is correct. Proceed to Test Step 5.

- NOT OK – The resistance is less than 5 ohms. The signal circuit is shorted to another circuit in the harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 5. CHECK IF THE DIAGNOSTIC CODE REMAINS

**A.** Inspect the harness connectors and clean the contacts of the machine harness connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the disconnect switch and the key start switch to the ON position.

**D.** Operate the machine.

**E.** Check the status of the SPN 1619 FMI 8.

**Expected Result:**

The SPN 1619 FMI 8 is not active.

**Results:**

- OK – The SPN 1619 FMI 8 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation. STOP.

- NOT OK – The SPN 1619 FMI 8 is active. The diagnostic code has not been corrected. The ECM may have failed.

  **Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

i02655015

## Transmission, SPN 1666 - FMI 2

**SMCS Code:** 7332-038-T3

**Conditions Which Generate This Code:**

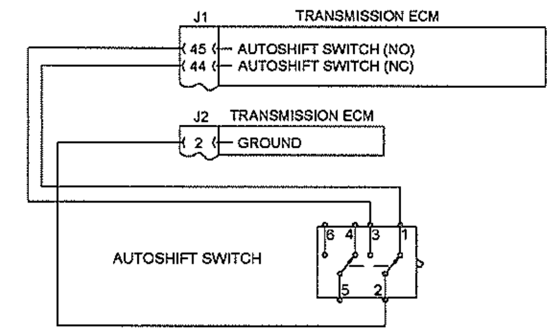


Illustration 55 g01340975

Connections of the autoshift switch

The autoshift switch has two inputs for the ECM. The inputs are Normally Open or Normally Closed. During normal operation, one of the inputs is open and the other input is grounded. A failure is detected when the Normally Open input and the Normally Closed input are in the same state.

This diagnostic code is recorded when the Normally Open input and the Normally Closed input are in the same state.

The possible causes of the problem are listed below:

- There is an Open wire between F849-WH and the ECM.

- There is an Open wire or a grounded wire between F848-OR and the ECM.

- There is an Open or a grounded wire between F849-WH and the ECM.

- The switch has failed.
- The ECM has failed. This is unlikely.

### Test Step 1. CHECK THE NORMALLY CLOSED CIRCUIT FOR PROPER OPERATION.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness from the ECM.

**C.** At machine harness connector J1, measure the resistance from contact J1-44 to contact J2-2.

**Expected Result:**

With the autoshift switch in the ON position, the resistance should measure more than 5000 ohms. With the autoshift switch in the OFF position, the resistance should measure less than 5 ohms.

**Results:**

- OK – With the autoshift switch in the ON position, the resistance is more than 5000 ohms. With the autoshift switch in the OFF position, the resistance is less than 5 ohms. Proceed to Test Step 3.
- NOT OK – The switch or the machine harness has failed. Proceed to Test Step 2.

### Test Step 2. CHECK THE NORMALLY CLOSED CIRCUIT OF THE SWITCH.

**A.** Disconnect the autoshift switch from the machine harness.

**B.** At the switch, measure the resistance between contact 1 and contact 2. Measure the resistance between contact 3 and contact 2.

**Expected Result:**

With the autoshift switch in the ON position, the resistance should measure more than 5000 ohms. With the autoshift switch in the OFF position, the resistance should measure less than 5 ohms.

**Results:**

- OK – With the autoshift switch in the ON position, the resistance is more than 5000 ohms. With the autoshift switch in the OFF position, the resistance is less than 5 ohms.

  **Repair:** The machine harness has failed. Either the Normally Closed circuit (F849-WH) or the return circuit (202-BK) is open or grounded in the machine harness. Repair the machine harness or replace the machine harness.

  STOP.

- NOT OK – The switch has failed.

  **Repair:** Replace the autoshift switch. Verify that the new switch corrects the problem.

  STOP.

### Test Step 3. CHECK THE NORMALLY OPEN CIRCUIT FOR PROPER OPERATION.

**A.** At machine harness connector J1, measure the resistance from contact J1-45 (Normally Open contact) to contact J2-2.

**Expected Result:**

With the autoshift switch in the ON position, the resistance should measure less than 5 ohms. With the autoshift switch in the OFF position, the resistance should measure more than 5000 ohms.

**Results:**

- OK – With the autoshift switch in the ON position, the resistance is less than 5 ohms. With the autoshift switch in the OFF position, the resistance is more than 5000 ohms. Proceed to Test Step 5.
- NOT OK – The switch or the machine harness has failed. Proceed to Test Step 4.

### Test Step 4. CHECK THE NORMALLY OPEN CIRCUIT OF THE SWITCH.

**A.** Disconnect the autoshift switch from the machine harness.

**B.** Measure the resistance between contact 3 and contact 2 at the switch.

**Expected Result:**

With the autoshift switch in the ON position, the resistance should measure less than 5 ohms. With the autoshift switch in the OFF position, the resistance should measure more than 5000 ohms.

**Results:**

- OK – With the autoshift switch in the ON position, the resistance should measure less than 5 ohms. With the autoshift switch in the OFF position, the resistance should measure more than 5000 ohms.

**Repair:** The machine harness has failed. Either the Normally Open circuit (F848-OR) or the return circuit (202-BK) is open or grounded in the machine harness. Repair the machine harness or replace the machine harness.

STOP.

- NOT OK

**Repair:** The switch has failed. Replace the autoshift switch. Verify that the new switch corrects the problem.

STOP.

### Test Step 5. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

**A.** Clean the contacts of the harness connectors.

**B.** Reconnect all harness connectors.

**C.** Turn the key start switch to the ON position.

**D.** Clear all of the inactive diagnostic codes with the Cat ET.

**E.** Operate the machine.

**F.** Determine if the SPN 1666 - FMI 2 is present.

**Expected Result:**

SPN 1666 - FMI 2 is present.

**Results:**

- YES – SPN 1666 - FMI 2 is present.

**Repair:** It is unlikely that the ECM has failed. Exit this procedure and perform the diagnostic code procedure again. If the problem persists, the ECM may have failed. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission ECM. See the Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – SPN 1666 - FMI 2 is not present.

**Repair:** The problem does not exist at this time. The initial problem was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02655017

## Transmission, SPN 2905 - FMI 3

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

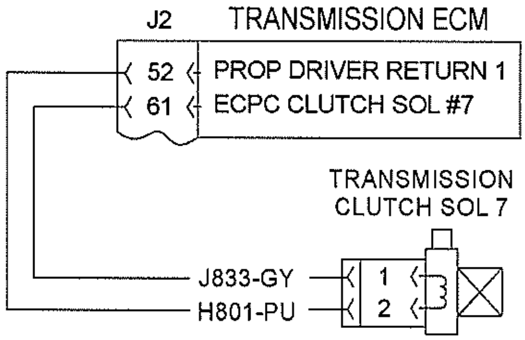


Illustration 56 g01335089

Connections of the transmission clutch solenoid 7

This diagnostic code is associated with the transmission clutch solenoid 7. The FMI 3 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 2905 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connectors from the solenoid and the ECM.

**C.** At the machine harness connector for the ECM, measure the resistance from contact J2-61 to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-61 and the circuit that has a low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors in order to make sure that the connectors are fully seated. Also, make sure that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the machine.

**F.** Determine if the SPN 2905 FMI 3 is active.

**Expected Result:**

The SPN 2905 FMI 3 is active.

**Results:**

- YES – The SPN 2905 FMI 3 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 2905 FMI 3 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation. STOP.

i02655018

## Transmission, SPN 2905 - FMI 5

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

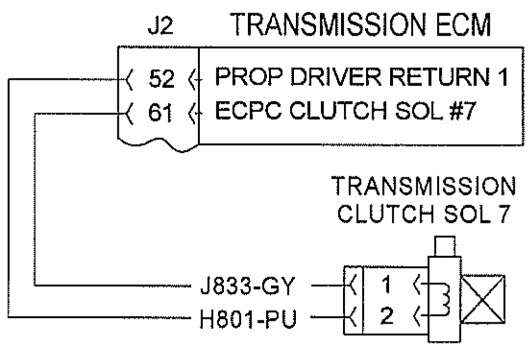


Illustration 57 g01335089

Connections of the transmission clutch solenoid 7

This diagnostic code is associated with the transmission clutch solenoid 7. The FMI 5 means that the ECM has determined that an open in the circuit exists.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.

- The return circuit of the solenoid is open.

- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 2905 FMI 5 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**C.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire J833-GY) to contact 2 (wire H801-PU).

**D.** Observe the status of the SPN 2905 FMI 5.

**Expected Result:**

The diagnostic code is active. Then, the diagnostic code changes from FMI 5 to FMI 6 as the jumper wire is installed.

**Results:**

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

### Test Step 2. CHECK THE HARNESS FOR AN OPEN.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The jumper wire that was installed in the previous Test Step remains in place.

**D.** At the machine harness connector, measure the resistance from signal contact J2-61 to contact J2-52.

**Expected Result:**

The resistance is less than 5.0 ohms.

**Results:**

- OK – The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 2905 FMI 5.

**Expected Result:**

The SPN 2905 FMI 5 is active.

**Results:**

- YES – The SPN 2905 FMI 5 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The SPN 2905 FMI 5 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655020

# Transmission, SPN 2905 - FMI 6

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

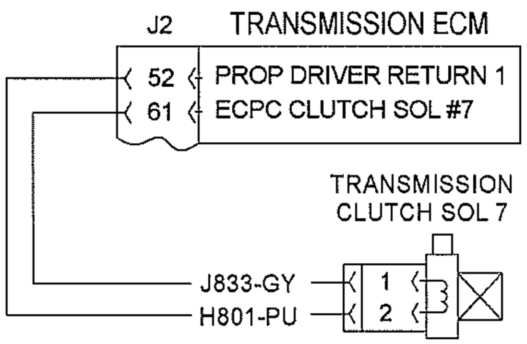


Illustration 58 g01335089

Connections of the transmission shift solenoid 7

This diagnostic code is associated with the transmission clutch solenoid 7. The FMI 6 means that the ECM has determined that there is a short to ground in the solenoid circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 2905 FMI 6 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Observe the status of the diagnostic code.

**C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**Expected Result:**

The FMI 6 changes to FMI 5 when the solenoid is disconnected.

**Results:**

- YES – The FMI 6 changes to FMI 5 when the solenoid is disconnected. The circuit is correct.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

- NO – The SPN 2905 FMI 6 remains active. Proceed to Test Step 2.

## Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The solenoid remains disconnected from the machine harness.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector, measure the resistance from the signal contact J2-61 to all other contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-61 and the circuit with the low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 2905 FMI 6.

**Expected Result:**

The SPN 2905 FMI 6 is active.

**Results:**

- YES – The SPN 2905 FMI 6 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 2905 FMI 6 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655125

## Transmission, SPN 2906 - FMI 3

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

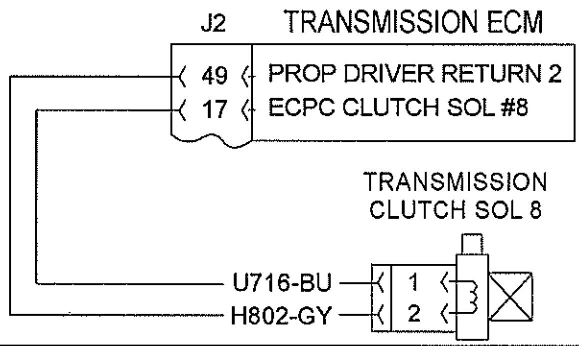


Illustration 59 g01341071

Connections of the transmission shift solenoid 8

This diagnostic code is associated with the transmission clutch solenoid 8. The FMI 3 means that the ECM has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 2906 FMI 3 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connectors from the solenoid and the ECM.

**C.** At the machine harness connector for the ECM, measure the resistance from contact J2-17 to all contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-17 and the circuit that has a low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 2. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors in order to make sure that the connectors are fully seated. Also, make sure that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the machine.

**F.** Determine if the SPN 2906 FMI 3 is active.

**Expected Result:**

The SPN 2906 FMI 3 is active.

**Results:**

- YES – The SPN 2906 FMI 3 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 2906 FMI 3 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation. STOP.

i02655133

## Transmission, SPN 2906 - FMI 5

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

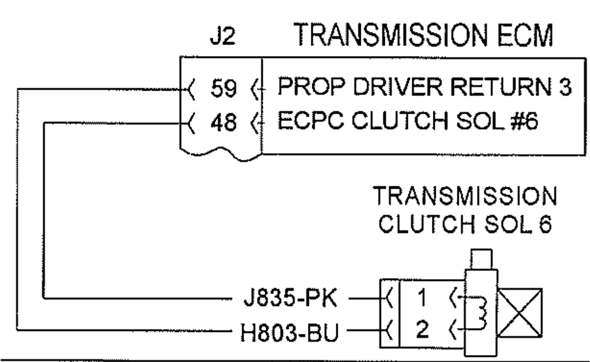


Illustration 60 g01334247

Connections of the transmission clutch solenoid 8

This diagnostic code is associated with the transmission clutch solenoid 8. The FMI 5 means that the ECM has determined that an open in the circuit exists.

The possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 2906 FMI 5 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

## Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**C.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire U716-BU) to contact 2 (wire H802-GY).

**D.** Observe the status of the SPN 2906 FMI 5.

**Expected Result:**

The diagnostic code is active. Then, the diagnostic code changes from FMI 5 to FMI 6 as the jumper wire is installed.

**Results:**

- YES – The diagnostic code remains active. The jumper wire does not affect the diagnostic code. Proceed to Test Step 2.
- NO – The diagnostic is no longer active. The solenoid has failed.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

## Test Step 2. CHECK THE HARNESS FOR AN OPEN.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Disconnect the machine harness connector(s) from the ECM.

**C.** The jumper wire that was installed in the previous Test Step remains in place.

**D.** At the machine harness connector, measure the resistance from signal contact J2-17 to contact J2-49.

**Expected Result:**

The resistance is less than 5.0 ohms.

**Results:**

- OK – The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5000 ohms. The resistance measurement is not correct. There is an open circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 2906 FMI 5.

**Expected Result:**

The SPN 2906 FMI 5 is active.

**Results:**

- YES – The SPN 2906 FMI 5 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 2906 FMI 5 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

i02655136

# Transmission, SPN 2906 - FMI 6

**SMCS Code:** 3139-038-T3

**Conditions Which Generate This Code:**

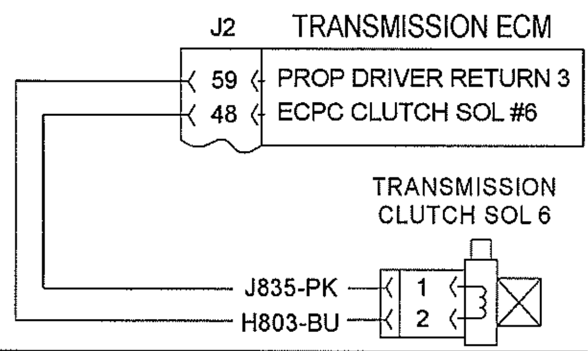


Illustration 61 g01334247

Connections of the transmission shift solenoid 8

This diagnostic code is associated with the transmission clutch solenoid 8. The FMI 6 means that the ECM has determined that there is a short to ground in the solenoid circuit.

The possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

**Note:** The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of SPN 2906 FMI 6 is active before performing this procedure.**

**Note:** Use a digital multimeter for the measurements in this procedure.

### Test Step 1. CHECK THE SOLENOID.

**A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

**B.** Observe the status of the diagnostic code.

**C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

**Expected Result:**

The FMI 6 changes to FMI 5 when the solenoid is disconnected.

**Results:**

- YES – The FMI 6 changes to FMI 5 when the solenoid is disconnected. The circuit is correct.

  **Repair:** The solenoid has failed. Replace the solenoid. Verify that the new solenoid corrects the problem.

  STOP.

- NO – The SPN 2906 FMI 6 remains active. Proceed to Test Step 2.

### Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** The solenoid remains disconnected from the machine harness.

**C.** Disconnect the machine harness connector(s) from the ECM.

**D.** At the machine harness connector, measure the resistance from the signal contact J2-17 to all other contacts that are used in the machine harness connectors for the ECM.

**Expected Result:**

Each resistance measurement is greater than 5000 ohms.

**Results:**

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-17 and the circuit with the low resistance measurement.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

### Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

**A.** Inspect the harness connectors. Clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

**B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.

**C.** Reconnect all harness connectors. Make sure that the harness connectors are fully seated and that the clips for each connector are completely fastened.

**D.** Turn the disconnect switch and the key start switch to the ON position.

**E.** Operate the vehicle.

**F.** Check the status of the SPN 2906 FMI 6.

**Expected Result:**

The SPN 2906 FMI 6 is active.

**Results:**

- YES – The SPN 2906 FMI 6 is active. The diagnostic code has not been corrected.

  **Repair:** Check the circuit again. If the Caterpillar Electronic Technician (Cat ET) is available, use the Cat ET service tool in order to perform a "Wiggle Test" on the machine wiring harness. The "Wiggle Test" can detect shorts and opens in the machine wiring harness that are momentary or intermittent.

  It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NO – The SPN 2906 FMI 6 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal vehicle operation. STOP.

# Diagnostic System Procedures

i01462041

## Sensor Signal Voltage

**SMCS Code:** 1439-038

**System Operation Description:**

**Note:** The electronic control module is connected.

Table 5

| Sensor Voltage Specifications Sensor Voltage Test | | |
|---|---|---|
| 100-3055 Temperature Sensor And 131-0427 Temperature Sensor | | |
| Temperature | Signal Voltage(1) | Duty Cycle |
| −20 to 0°C (−4 to 32°F) | 1.1 to 1.4 DCV | 11 to 15% |
| 0 to 20°C (32 to 68°F) | 1.4 to 2.0 DCV | 15 to 23% |
| 20 to 40°C (68 to 104°F) | 2.0 to 3.1 DCV | 23 to 37% |
| 40 to 60°C (104 to 140°F) | 3.1 to 4.5 DCV | 37 to 55% |
| 60 to 80°C (140 to 176°F) | 4.5 to 5.7 DCV | 55 to 71% |
| 80 to 100°C (176 to 212°F) | 5.7 to 6.6 DCV | 71 to 82% |
| 100 to 120°C (212 to 248°F) | 6.6 to 7.2 DCV | 82 to 89% |
| 120 to 140°C (248 to 275°F) | 7.2 to 7.4 DCV | 89 to 93% |

(1) The voltages that are listed in this table are guidelines for troubleshooting. The values should not be considered to be exact. The tolerance for these measurements is ±10 percent. The proper operation of the sensor is more important. The output voltage of the sensor should change smoothly when the temperature changes.

Table 6

| Sensor Voltage Specifications Sensor Voltage Test | | |
|---|---|---|
| 3E-5370 Temperature Sensor Group And 131-0784 Temperature Sensor | | |
| Temperature | Signal Voltage(1) | Duty Cycle |
| −40 to 20°C (−40 to −4°F) | 0.8 to 1.5 DCV | 4 to 11% |
| −20 to 0°C (−4 to 32°F) | 1.5 to 2.5 DCV | 11 to 22% |
| 0 to 20°C (32 to 68°F) | 2.5 to 3.7 DCV | 22 to 34% |
| 20 to 40°C (68 to 104°F) | 3.7 to 4.8 DCV | 34 to 46% |
| 40 to 60°C (104 to 140°F) | 4.8 to 6.0 DCV | 46 to 59% |
| 60 to 80°C (140 to 176°F) | 6.0 to 7.2 DCV | 59 to 71% |
| 80 to 100°C (176 to 212°F) | 7.2 to 8.1 DCV | 71 to 81% |
| 100 to 120°C (212 to 248°F) | 8.1 to 8.8 DCV | 81 to 87% |
| 120 to 140°C (248 to 275°F) | 8.8 to 9.2 DCV | 87 to 92% |

(1) The voltages that are listed in this table are guidelines for troubleshooting. The values should not be considered to be exact. The tolerance for these measurements is ±10 percent. The proper operation of the sensor is more important. The output voltage of the sensor should change smoothly when the temperature changes.

Locate the suspect sensor. Identify the sensor wires and connector contacts. See Diagnostic Function, "Pulse Width Modulated (PWM) Sensor - Test". DO NOT DISCONNECT ANY HARNESS CONNECTORS AT THIS TIME. Turn the key start switch to the ON position. DO NOT START THE ENGINE.

### Test Step 1. CHECK THE SENSOR POWER.

**A.** Identify the supply circuit and the ground circuit at the connector of the sensor.

**B.** Insert the 7X-1710 Cable Probes into the back of the connector of the sensor. Place the leads of the probe along side of the wires of the supply circuit and wires of the ground circuit.

**C.** Measure the system voltage.

**Expected Result:**

The voltage that is measured is between 7.5 and 8.5 DCV.

**Results:**

- YES – The voltage is between 7.5 and 8.5 DCV. The system voltage is present. Proceed to test step 2.
- NO – The voltage is not between 7.5 and 8.5 DCV. There is an open circuit. Trace the supply circuit and the ground circuit in the machine harness.

  **Repair:** Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 2. CHECK THE SIGNAL VOLTAGE.

**A.** At the sensor connector, identify the signal and ground circuits.

**B.** Push the 7X-1710 Cable Probes in the back of the sensor connector along side of the signal and the ground circuit wires.

**C.** Measure the signal voltage and record the signal voltage.

**Note:** If a precise signal voltage is necessary, use the specifications that are listed in the provided tables.

**Expected Result:**

The measured signal voltage is approximately between 1.0 and 7.0 DCV. The signal voltage is between 1.0 and 9.0 DCV with the 3E-5370 Temperature Sensor Group.

**Results:**

- FROM 1.0 TO 7.0 (9.0) DCV – The voltage is between 1.0 and 7.0 DCV (9.0 DCV for 3E-5370 Temperature Sensor Group). The signal voltage at the sensor is correct.

  **Repair:** The harness and the main display module are working properly. The voltage that is measured is correct. The sensor has failed. Replace the sensor.

  Proceed to test step 3.

- GREATER THAN 7.0 (9.0) – The voltage is NOT between 1.0 and 7.0 DCV. (The Voltage is approximately 9.0 DCV for the 3E-5370 Temperature Sensor Group.) The signal voltage is not correct. The signal circuit of the machine harness is shorted to the +battery circuit.

  **Repair:** Repair the machine harness or replace the machine harness. Repeat this test step in order to verify that the problem has been corrected. If the problem has not been corrected replace the main display module. See Testing and Adjusting, "Module - Replace".

  STOP.

- LESS THAN 1.0 DCV – The voltage is less than 1.0 DCV. The signal voltage is not correct. The signal circuit of the machine harness is shorted to ground.

  **Repair:** Repair the machine harness or replace the machine harness. Repeat this test step in order to verify that the problem has been corrected. If the problem has not been corrected replace the main display module. See Testing and Adjusting, "Module - Replace".

  STOP.

## Test Step 3. CHECK THE SIGNAL CIRCUIT FOR THE MACHINE HARNESS .

**A.** At the machine harness connector for the main display module, identify the signal and ground circuits.

**Note:** DO NOT DISCONNECT THE HARNESS CONNECTOR.

**B.** Push the 7X-1710 Cable Probes in the back of the machine harness connector along side of the signal and ground circuit wires.

**C.** Measure the signal voltage.

**D.** Compare this measurement with the voltage that was measured in the previous test "Check the signal voltage".

**Expected Result:**

The main display module is receiving a valid signal voltage of 1.0 to 7.0 DCV.

**Results:**

- OK – The main display module is receiving a valid signal voltage. If the problem has been corrected exit this procedure. No further testing is required. If the problem still persists, further testing is required. Proceed to test step 4.
- NOT OK – The voltage is different from the voltage that was measured in the previous test. The machine harness has an open in the signal or ground circuits.

**Repair:** Repair the machine harness or replace the machine harness.

STOP.

### Test Step 4.

Perform the following diagnostic procedure: "Sensor Dynamic Operation"

**Results:**

- OK – STOP.
- REPAIRED, OK – STOP.

i01461730

## Sensor Dynamic Operation

**SMCS Code:** 1439-038

**System Operation Description:**

**Note:** The electronic control module is connected.

Table 7

| Sensor Voltage Specifications (1) Sensor Dynamic Test | | |
|---|---|---|
| 100-3055 Temperature Sensor And 131-0427 Temperature Sensor | | |
| Temperature | Signal Voltage(2) | Duty Cycle |
| −40 to 20°C (−40 to −4°F) | 1.0 to 1.1 DCV | 10 to 11% |
| −20 to 0°C (−4 to 32°F) | 1.1 to 1.4 DCV | 11 to 15% |
| 0 to 20°C (32 to 68°F) | 1.4 to 2.0 DCV | 15 to 23% |
| 20 to 40°C (68 to 104°F) | 2.0 to 3.1 DCV | 23 to 37% |
| 40 to 60°C (104 to 140°F) | 3.1 to 4.5 DCV | 37 to 55% |
| 60 to 80°C (140 to 176°F) | 4.5 to 5.7 DCV | 55 to 71% |
| 80 to 100°C (176 to 212°F) | 5.7 to 6.6 DCV | 71 to 82% |
| 100 to 120°C (212 to 248°F) | 6.6 to 7.2 DCV | 82 to 89% |
| 120 to 140°C (248 to 275°F) | 7.2 to 7.4 DCV | 89 to 93% |

(1) If you desire, use these specifications with the following procedure.
(2) The voltages that are listed in this table are guidelines for troubleshooting. The values should not be considered to be exact. The tolerance for these measurements is ±10 percent. The proper operation of the sensor is more important. The output voltage of the sensor should change smoothly when the temperature changes.

Table 8

| Sensor Voltage Specifications (1) Sensor Dynamic Test | | |
|---|---|---|
| 3E-5370 Temperature Sensor Group And 131-0784 Temperature Sensor | | |
| Temperature | Signal Voltage(2) | Duty Cycle |
| −40 to 20°C (−40 to −4°F) | 0.8 to 1.5 DCV | 4 to 11% |
| −20 to 0°C (−4 to 32°F) | 1.5 to 2.5 DCV | 11 to 22% |
| 0 to 20°C (32 to 68°F) | 2.5 to 3.7 DCV | 22 to 34% |
| 20 to 40°C (68 to 104°F) | 3.7 to 4.8 DCV | 34 to 46% |
| 40 to 60°C (104 to 140°F) | 4.8 to 6.0 DCV | 46 to 59% |
| 60 to 80°C (140 to 176°F) | 6.0 to 7.2 DCV | 59 to 71% |
| 80 to 100°C (176 to 212°F) | 7.2 to 8.1 DCV | 71 to 81% |
| 100 to 120°C (212 to 248°F) | 8.1 to 8.8 DCV | 81 to 87% |
| 120 to 140°C (248 to 275°F) | 8.8 to 9.2 DCV | 87 to 92% |

(1) If you desire, use these specifications with the following procedure.
(2) The voltages that are listed in this table are guidelines for troubleshooting. The values should not be considered to be exact. The tolerance for these measurements is ±10 percent. The proper operation of the sensor is more important. The output voltage of the sensor should change smoothly when the temperature changes.

To use the following procedure, it is necessary to know the connector contact of the main display module and the contact that corresponds to the service code. See the Electrical System Schematic in the Service Manual for the machine in order to determine the proper connector contact of the main display module. Use the 7X-1710 Cable Probe on the connector contact of the sensor signal wire on the main display module.

**Note:** The sensors are provided power from the main display module . Therefore, the main display module must be connected in order for the sensors to function.

Two items are checked in this test:

- A sensor signal is present at the main display module.
- For an increase and/or a decrease in the system that is being monitored, the signal voltage will increase and/or the signal voltage will decrease.

### Test Step 1. CHECK THE INITIAL SIGNAL VOLTAGE.

**A.** The engine coolant and the temperature sensors should be below operating temperature.

**B.** Ensure that the engine coolant and temperature sensors are below normal. Ensure that the key switch is OFF and that the sensor is connected to the machine harness.

**C.** Turn the key switch to the ON position. DO NOT START THE ENGINE.

**D.** At the machine harness connector for the main display module, measure the voltage and record the voltage (DCV) between the signal contact and frame ground. For correct operation, the approximate voltage is between 1.0 and 7.0 DCV. The approximate voltage is between 1.0 and 9.0 DCV for the 3E-5370 and 131-0784 Temperature Sensor Groups.

**Note:** When precise specifications for the signal voltage are necessary, use the specifications that are listed in the provided tables.

**Expected Result:**

The voltage that is measured is within the specifications.

**Results:**

- YES – The approximate voltage is between 1.0 and 7.0 DCV. The approximate voltage is between 1.0 and 9.0 DCV for the 3E-5370 and 131-0784 Temperature Sensor Groups. The signal voltage to the main display module is correct. Proceed to test step 2.
- NO – The approximate voltage is NOT between 1.0 and 7.0 DCV. The approximate voltage is NOT between 1.0 and 9.0 DCV for the 3E-5370 and 131-0784 Temperature Sensor Groups. The signal voltage to the main display module is not correct. The probable cause is a failed sensor.

  **Repair:** The sensor has failed. Replace the sensor.

  STOP.

### Test Step 2. CHECK THE SIGNAL VOLTAGE WITH THE NEW CONDITIONS.

**A.** Increase the temperature, the pressure or the fuel level of the system that is being tested. The following procedures are examples: Run the engine in order to increase the temperature of the engine coolant. , Operate the implement controls in order to increase the temperature of hydraulic oil. , and Add fuel to the fuel tank in order to increase the level of the fuel. .

**B.** At the machine harness connector for the main display module, measure the voltage (DCV) between the signal contact and frame ground.

**C.** The voltage (DCV) is greater than the voltage that was recorded in the previous test "Check the initial signal voltage". The voltage increases smoothly.

**Note:** The difference in voltage that is seen between this test and the previous test is dependent on the amount of change that was introduced in the system.

**Expected Result:**

The voltage increases during the test procedure.

**Results:**

- OK – The voltage increase during the test procedure and the sensor operates smoothly. The sensor has not failed. STOP.
- NOT OK – The voltage does not increase during the test procedure. The probable cause is a failed sensor.

  **Repair:** The sensor has failed. Replace the sensor.

  STOP.

i01463871

## Switch Circuits

**SMCS Code:** 1435-038; 7332-038

**System Operation Description:**

When a filter has been replaced and the bypass switch continues to indicate that a problem exists, further troubleshooting is necessary to isolate the fault. Refer to the Systems Operations section of the applicable Service Manual for additional information on the individual switches.

The possible causes of these failures are listed below:

- The signal circuit in the machine harness is open.
- The switch has failed.
- The ECM has failed.

## Test Step 1. CHECK FOR AN OPEN IN THE HARNESS

**A.** Locate the switch that corresponds to the data event that is displayed on the message center. (If necessary, use the Electrical System Schematic to assist in locating the switch.)

**B.** Disconnect the signal wire from the switch.

**C.** Place a jumper wire from the signal wire to the ground wire.

**Expected Result:**

The data event is no longer active on the message center.

**Results:**

- OK – The data event is no longer active on the message center.

  **Repair:** The switch has failed. Check or replace the switch.

  STOP.

- NOT OK – The data event remains on the message center. The machine harness is open or the ECM has failed. Proceed to test step 2.

## Test Step 2. CHECK THE VOLTAGE OF THE ECM.

**A.** Remove the jumper that was used in the previous test step.

**B.** The signal wire remains disconnected.

**C.** Measure the pull-up voltage from the signal wire to the ground wire with a digital multimeter.

**Expected Result:**

The voltage is 8 ± 0.5 volts.

**Results:**

- OK – The voltage is 8 ± 0.5 volts.

  **Repair:** The voltage is correct. The ECM has failed. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the fault is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NOT OK – The voltage is NOT 8 ± 0.5 volts. Proceed to Test Step 3.

## Test Step 3. CHECK THE SIGNAL CIRCUIT OF THE HARNESS.

**A.** Turn the key start switch and the disconnect switch to the OFF position.

**B.** Use the Electrical System Schematic to trace the signal wire from the switch back to the ECM.

**C.** Determine the signal contact (connector contact) of the machine harness at the ECM.

**D.** Disconnect the machine harness connectors J1 and J2 from the ECM.

**E.** At the machine harness connector for the ECM, measure the resistance between the signal contact and contact 2 of the switch.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms. The signal circuit of the harness is correct. Proceed to test step 4.

- NOT OK – The resistance is greater than 5.0 ohms.

  **Repair:** The signal circuit of the harness is not correct. Repair the machine harness or replace the machine harness.

  STOP.

## Test Step 4. CHECK THE GROUND CIRCUIT OF THE HARNESS.

**A.** The key start switch and the disconnect switch remain in the OFF position.

**B.** The machine harness connectors J1 and J2 remain disconnected.

**C.** Use the Electrical System Schematic to trace the ground for the switch.

D. At the switch, measure the resistance between the ground wire and frame ground.

**Expected Result:**

The resistance is less than 5 ohms.

**Results:**

- OK – The resistance is less than 5 ohms.

  **Repair:** The machine harness is not the cause of the failure. The ECM has failed. It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the fault is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

  STOP.

- NOT OK – The resistance is greater than 5.0 ohms.

  **Repair:** The machine harness has failed. Repair the machine harness or replace the machine harness.

  STOP.

# Testing and Adjusting Section

# Testing and Adjusting

i02682399

## Transmission Fill - Calibrate

**SMCS Code:** 3155-524

### Accessing Calibrations For The Transmission Solenoid Valves

#### Introduction

**Calibration is required when one of the following conditions occur:**

- The component has been replaced.
- The ECM has been replaced.
- Normal wear on a component
- Physical alteration of the component or the linkage

#### Required Tools

Table 9

| Service Tools |
|---|
| Caterpillar Electronic Technician (ET) |

The Caterpillar Electronic Technician service tool (ET) is used to access the calibration procedures. A message on the ET screen will give instructions that guide the user through the calibration procedure. Refer to the Manual that is provided with the ET for more information.

#### Calibration Procedure

1. Connect the ET to the tractor.

   Once communication has been established, the ET will list the electronic control modules that are on the tractor.

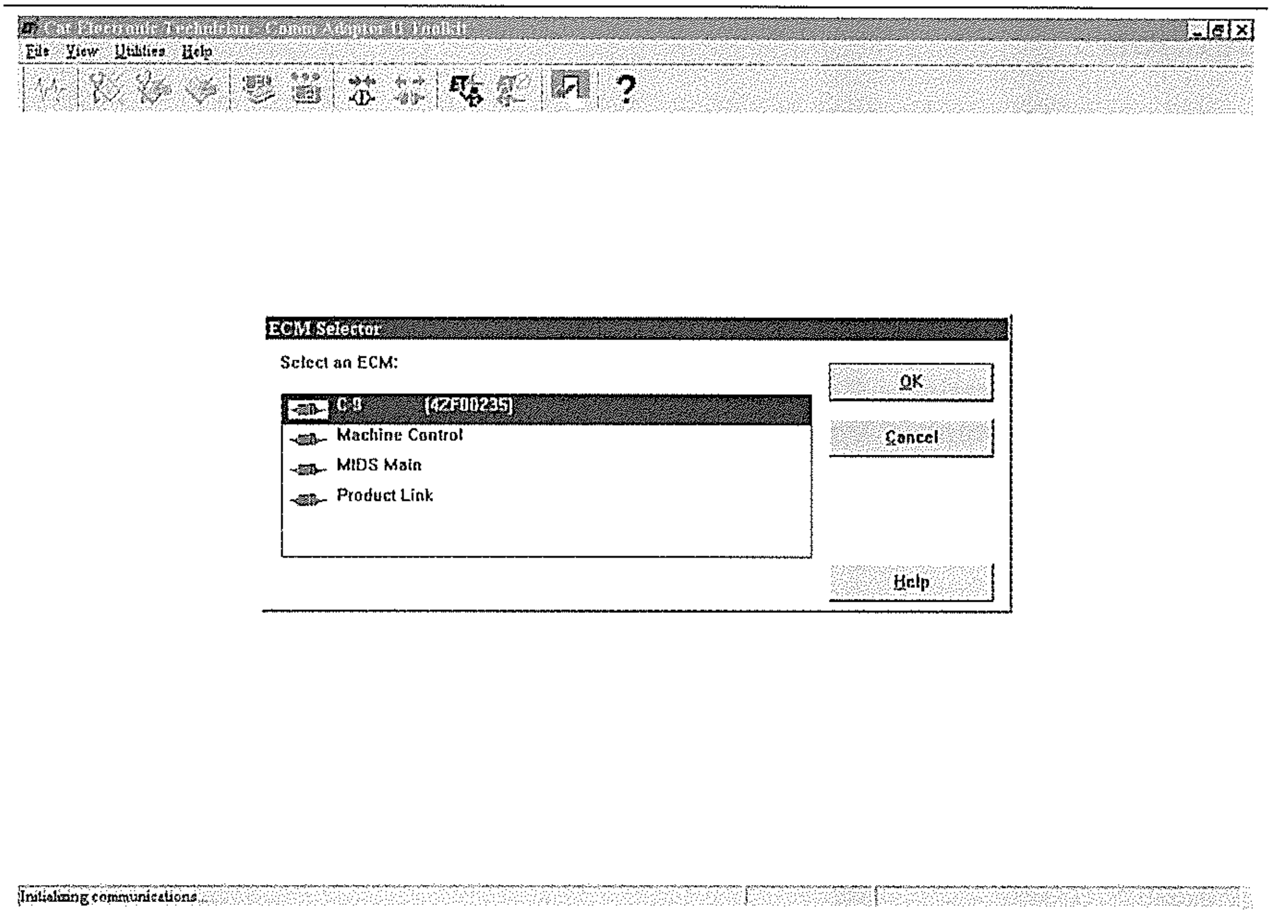


Illustration 62 g01347535

ET Screen of Available Electronic Control Modules (ECM)

**2.** Choose the menu item "Machine Control".

**3.** Select "Service" from the menu bar.

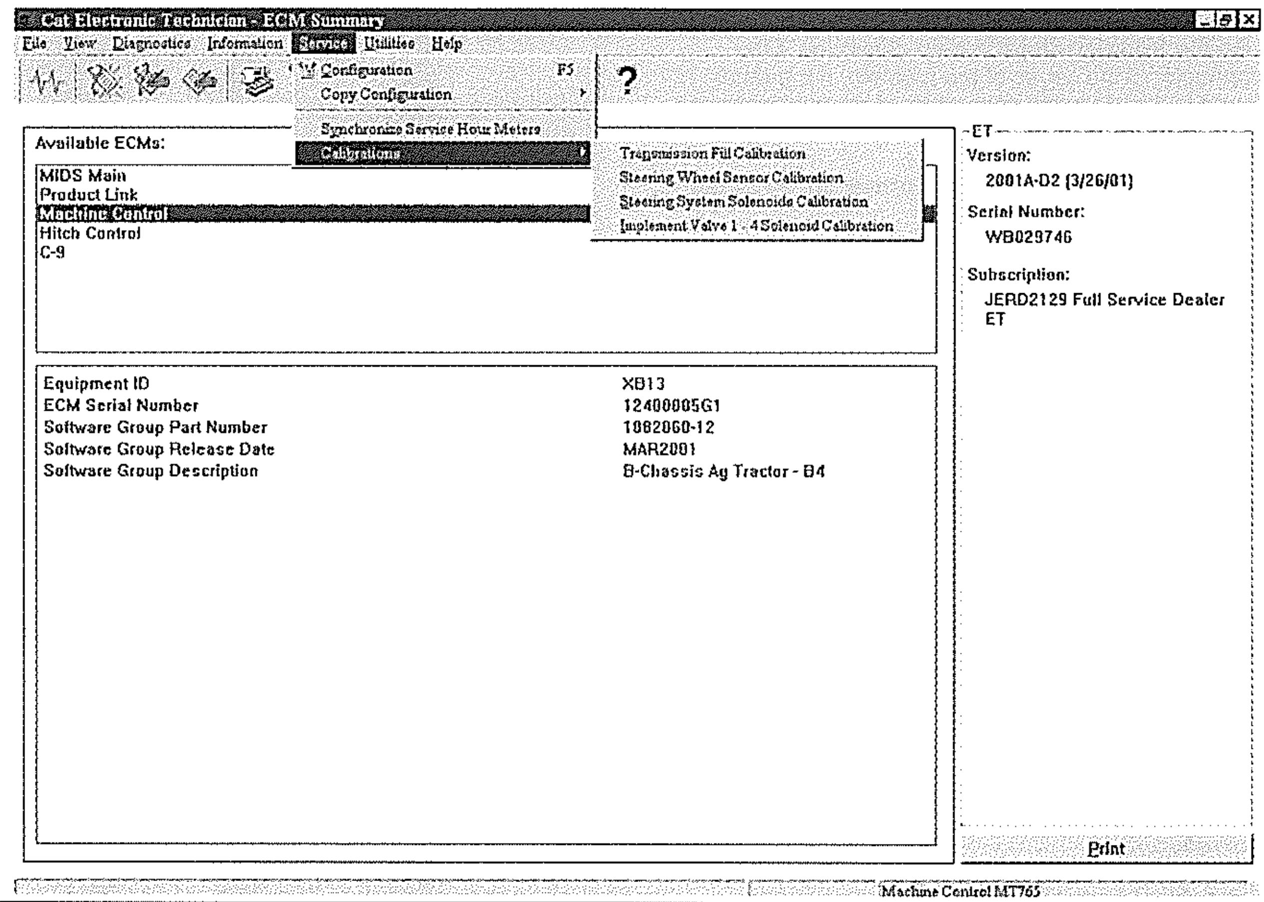


Illustration 63 g01347536

ET Screen of the Calibration Menu for Transmission ECM

4. Select "Calibrations" from the drop-down menu ("Service").

   Another drop-down menu will appear. The menu will list each available calibration.

5. Select "Transmission Fill Calibration".

6. Follow all instructions on the ET in order to complete the calibration procedures.

**Note:** Calibration will require certain conditions to be set prior to the start of the calibration. For example, set the shift lever to PARK. The user must ensure that all the setup for the conditions of the calibration are satisfied.

i02287347

# Electrical Connector - Inspect

**SMCS Code:** 7553-040-WW

**Reference:** Special Instruction, SEHS9615, "Servicing DT Connectors".

**Reference:** Special Instruction, REHS0148, "Listing Of Deutsch Connector Components"

**Reference:** Special Instruction, SEHS9065, "Use Of CE Connector Tools".

**Reference:** Service Magazine, SEPD0342, 27 January 97, "Field Repair Of Single Wire Breaks In Harnesses (Sealed Splice)".

**Reference:** Service Magazine, SEPD0371, 28 July 97, "Protection Of Unsealed Electrical Terminations For Machines In Corrosive Applications".

**Reference:** Service Magazine, SEPD0473, 24 May 99, "New DT Connector Plugs With Improved Seal Retention".

**Reference:** Service Magazine, SEPD0545, 09 October 00, "Dielectric Grease Should Not Be Used In Electrical Connectors".

**Reference:** Pocket Guide, SEBD0402, "Guidelines For Routing And Installing Wire Harness Assemblies".

**Use this procedure under the following situation:**

Use the following steps to help determine if the connector is the cause of the problem. If a problem is found in the electrical connector, repair the connector and verify that the problem has been corrected.

**The following background information is related to this procedure:**

Many of the operational procedures and the diagnostic code procedures in this troubleshooting guide will instruct you to check a specific electrical connector.

Intermittent electrical problems are often caused by poor connections. Always check for an active diagnostic code before breaking any connections. Also, always check for an active diagnostic code after the connector is reconnected in order to verify that the problem disappears.

Simply disconnecting the connectors and then reconnecting the connectors can temporarily solve a problem at times. If this occurs, likely causes are loose terminals, bent terminals, improperly crimped terminals, corrosion, or harness routing that is improper.

The original source of the problem must then be identified in order to ensure that the problem does not reoccur.

Follow this procedure to thoroughly inspect the connectors in order to determine if the connectors are the cause of the problem.

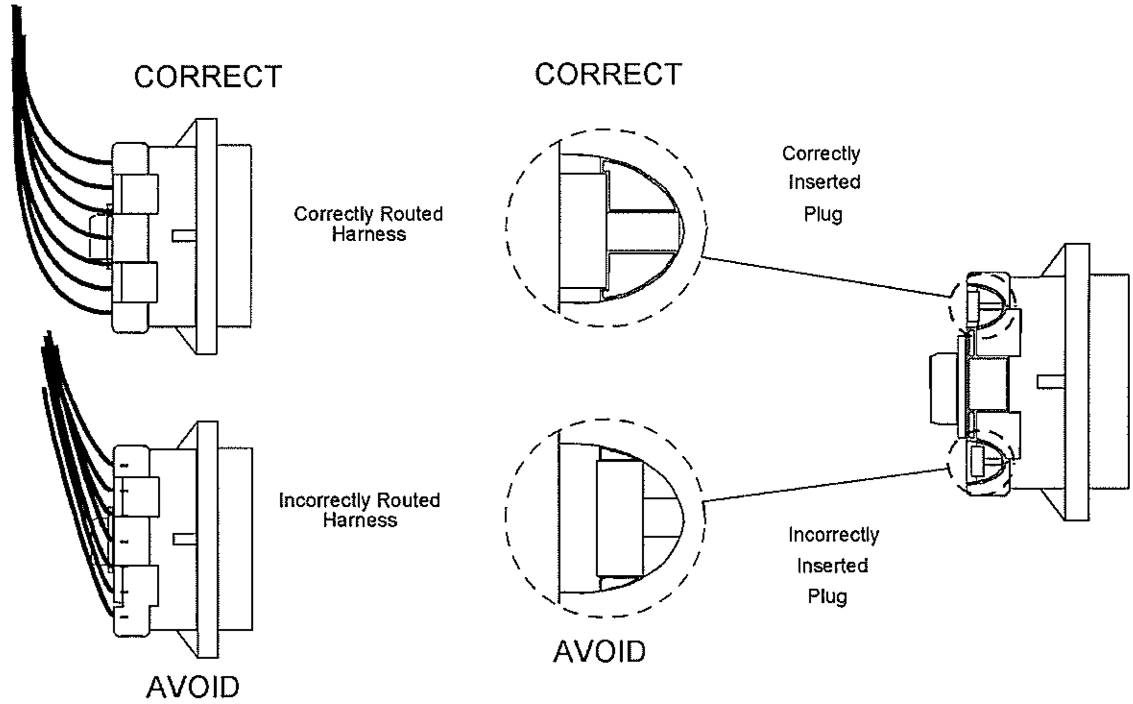


Illustration 64 g01135980

Correct way to route a harness and insert a plug

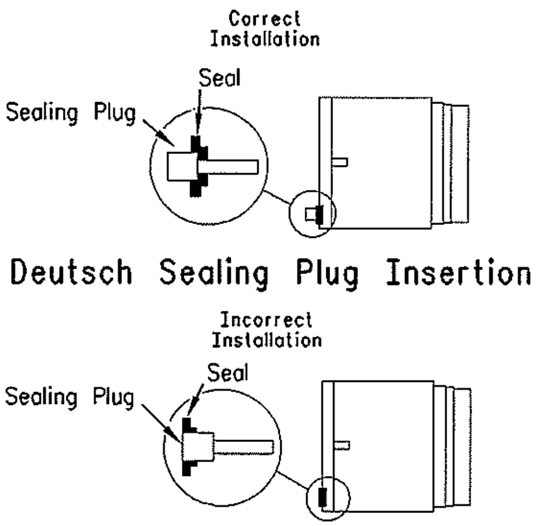


Illustration 65 g00690571

Proper Installation of Plug

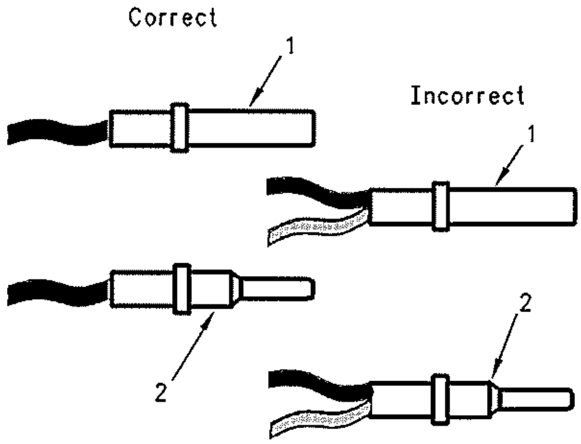


Illustration 66 g00828600

DT Type sealing plug

The 8T-8729 Connector Pin (2) and the 8T-8730 Connector Socket (1) is designed to accept only one 16/18 AWG wire. Do not insert multiple wires of a smaller wire size. An incorrect method would be using two 24 AWG wires. The 9W-0852 Connector Pin and the 9W-0844 Connector Socket is designed to accept only one 14 AWG wire. Do not insert multiple wires of a smaller wire size. An example of an incorrect method is the use of two 20 AWG wires.

**1. CHECK THE CONNECTORS.**

**a.** Ensure that the connector is properly locked. Also, ensure that the two halves of the connector can not be pulled apart.

**b.** Verify that the latch tab of the connector is properly latched. Verify that the latch tab of the connector is fully latched.

**Expected Result:** The connector will securely lock. The connector and the locking mechanism are without cracks or breaks.

**Results:**

**OK** – The connector will securely lock. The connector and the locking mechanism are without cracks or breaks. Proceed to test step 2.

**NOT OK** – A problem exists with the connector.

**Repair:** Repair the connector or replace the connector, as required.

**STOP.**

**2. CHECK THE ALLEN HEAD SCREW ON THE HARNESS CONNECTOR OF THE ECM.**

**a.** Ensure that the connector bolt is properly tightened. Be careful not to tighten the bolt too much. The bolt may break.

**b.** Do not exceed 6.0 N·m (53.0 lb in) of torque on the connector bolt of the harness when the connector is being installed on the ECM.

**Expected Result:** The harness connector is secure and the connector bolt of the ECM is properly torqued.

**Results:**

**OK** – The harness connector is secure and the connector is properly torqued. Proceed to test step 3.

**NOT OK** – A problem exists with the connector.

**Repair:** Secure the harness connector of the ECM. Ensure that the connector bolt is properly torqued.

**STOP.**

**3. PERFORM A PULL TEST ON EACH CONNECTOR CONTACT.**

**a.** Each connector contact should withstand 45 N (10 lb) of pull. Each wire should remain in the connector body. This test checks whether the wire was properly crimped in the contact and whether the contact was properly inserted into the connector.

**b.** The DT connectors use an orange wedge to lock the terminals in place.

**c.** Check in order to ensure that the orange wedge is not missing and that the orange wedge is installed properly on the DT connectors.

**Note:** A Crimp Tool should ALWAYS be used in order to crimp wires on connector contacts. Do not solder the terminals. Use the proper Crimp Tool.

**Expected Result:** Each connector contact should withstand 45 N (10 lb) of pull. Each wire remains in the connector body.

**Results:**

**OK** – Each connector contact withstands 45 N (10 lb) of pull. Each wire remains in the connector body. Proceed to test step 4.

**NOT OK** – A problem exists with the connector.

**Repair:** Repair the wiring or replace the connector contact.

**STOP.**

**4. CHECK THE WIRES FOR NICKS OR ABRASIONS IN THE INSULATION.**

**a.** Carefully inspect each wire for signs of abrasion, nicks, or cuts.

The following areas are locations that should be checked:

- Exposed insulation
- Points of rubbing wire

**b.** Check all of the hold down clamps for the harness in order to verify that the harness is properly clamped. Also check all of the hold down clamps for the harness in order to verify that the harness is not compressed by the clamp. Pull back the harness sleeves in order to check for a flattened portion of wire. The flattened portion of wire is caused by the clamp that holds the harness.

**Expected Result:** The wires are free of abrasion, nicks, or cuts and the harness is properly clamped.

**Results**:

**OK** – The wires are free of abrasion, nicks, or cuts and the harness is properly clamped. Proceed to test step 5.

**NOT OK** – A problem exists with the wiring.

**Repair**: Repair the wires or replace the wires, as required.

**STOP.**

**5. CHECK THE CONNECTORS FOR MOISTURE OR CORROSION.**

**a.** Ensure that the connector seals and the white sealing plugs are in place. If any of the seals or plugs are missing, replace the seal or plug. If necessary, replace the connector.

**b.** Check all of the wiring harnesses in order to verify that the harness does not make a sharp bend out of a connector. This will deform the connector seal and this will create a path for the entrance of moisture. See Illustration 64.

**Note:** It is normal to see some minor seal abrasion on the ECM connector seals. Minor seal abrasion will not allow the entry of moisture.

**c.** Thoroughly inspect ECM connectors for evidence of moisture entry. If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and the source of the moisture entry must be repaired. If the source of the moisture entry is not repaired, the problem will reoccur. Simply drying the connector will not fix the problem. Likely paths for the entrance of moisture are from missing seals, improperly installed seals, nicks in exposed insulation, and improperly mated connectors.

**Note:** Moisture can also travel from one connector through the inside of a wire to the ECM Connector. If moisture is found in the ECM connector, thoroughly check all connectors and wires on the harness that connect to the ECM. The ECM is not the source of the moisture. Do not replace an ECM if moisture is found in either ECM connector.

**Note:** If corrosion is evident on the contacts or the connector, use only denatured alcohol to remove the corrosion. Use a cotton swab or a soft brush to remove the corrosion. Do not use cleaners that contain trichloro-ethylene because trichloro-ethylene may damage the connector.

**Expected Result**: All of the connectors should be completely coupled and all of the seals should be completely inserted. The harness and the wiring should be free of corrosion, moisture, abrasion or pinch points.

**Results**:

**OK** – All of the connectors are completely coupled and all of the seals are completely inserted. The harness and the wiring are free of corrosion, moisture, abrasions or pinch points. Proceed to test step 6.

**NOT OK** – A problem exists with the connector, the wiring or the wiring harness. Moisture is present.

**Repair**: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem by operating the machine for several minutes and by checking again for moisture.

**STOP.**

**6. INSPECT THE CONNECTOR CONTACTS.**

**a.** Verify that the contacts are not damaged. Verify that the contacts are properly aligned in the connector and verify that the contacts are properly located in the connector.

**Expected Result**: The contacts are properly aligned and the contacts appear undamaged.

**Results**:

**OK** – The contacts are properly aligned and the contacts appear undamaged. Proceed to test step 7.

**NOT OK** – A problem exists with the connector contacts.

**Repair**: Repair the contacts and wiring and/or replace the contacts and wiring.

**STOP.**

**7. CHECK THE FIT OF THE CONTACTS.**

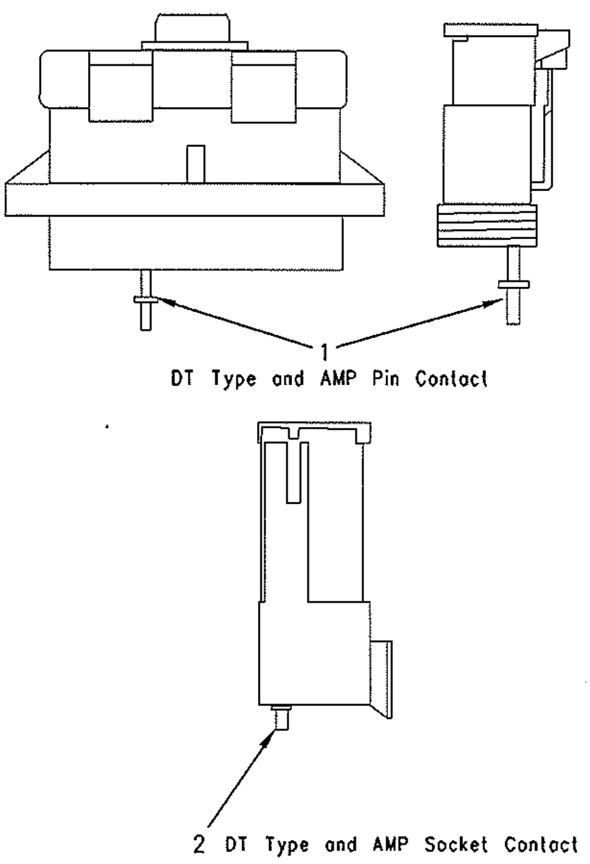


Illustration 67 g00838765

Retention of the Connector

(1) Pin Contact
(2) Socket Contact

**Note:** This is especially important for intermittent problems.

**a.** Use a new pin contact. Insert the pin contact into each socket contact one at a time in order to check for a good grip on the pin contact by the socket contact.

**b.** Use a new socket contact. Insert the pin contact into each socket contact one at a time in order to check for a good grip on the pin contact by the socket contact. The pin contact are located on the mating side of the connector.

**c.** The connector contact should stay connected when the connector is held in the position shown in Illustration 67. The connector contact is the pin contact or the socket contact.

**Expected Result:** The pin contacts and the socket contacts appear to be OK.

**Results:**

**OK** – The pin contacts and the socket contacts appear to be OK. **STOP.**

**NOT OK** – A problem exists with the connector terminal.

**Repair:** Replace the connector contact.

**STOP.**

i02510616

# Wiring Harness (Open Circuit) - Test

**SMCS Code:** 1408-081

An open is a failure of an electrical circuit that results in no flow of electrical current. An open circuit is usually caused by failed electrical wires or a poor connection of electrical connectors. If an electrical wire or a connection is broken, the flow of electrical current through the circuit is interrupted. A normally closed circuit will have less than 5 ohms of resistance. The following procedure explains the test for an open circuit:

**Reference:** For a complete electrical schematic, refer to Electrical System Schematic for the machine that is being serviced.

**TEST FOR AN OPEN CIRCUIT.**

1. Identify the connectors and the wire numbers of the suspect circuits. Use the Electrical System Schematic of the machine to identify the circuits.

2. Turn the key start switch and the disconnect switch to the OFF position.

3. Disconnect the component and the ECM from the wiring harness.

4. At one of the disconnected harness connections, place a jumper wire from the contact of the suspect wire to frame ground.

5. At the other connector of the machine harness, use the multimeter probes to measure the resistance from the contact of the suspect wire to frame ground.

   **Expected Result:** The resistance is less than 5 ohms.

   **OK** – The resistance is less than 5 ohms. The harness circuit is correct.

**Stop.**

**NOT OK** – The resistance is greater than 5000 ohms. There is an open in the machine harness.

**Repair:** Repair the machine harness or replace the machine harness.

**Stop.**

i01547498

## Wiring Harness (Short Circuit) - Test

**SMCS Code:** 1408-081

A short circuit is a failure of an electrical circuit that results in undesired electrical current. Usually, a short circuit is a bypass of the circuit across a load. For example, a short across the wires in a circuit for a lamp produces too much current in the wires but no current is felt at the lamp. The lamp is shorted out. The resistance in a normal circuit is greater than 5000 ohms. The following procedure explains the test for a short circuit:

**Reference:** For a complete electrical schematic, refer to Electrical System Schematic for the machine that is being serviced.

**TEST FOR A SHORT CIRCUIT.**

1. Identify the connectors and the wire numbers of the suspect circuits. Use the Electrical System Schematic of the machine to identify the circuits.

2. Turn the key start switch and the disconnect switch to the OFF position.

3. Disconnect the component and the ECM from the wiring harness.

4. At the machine harness connector for the ECM, place one of the multimeter probes on the contact of the suspect wire.

5. Use the other multimeter probe to check the resistance across all other contacts in the connector(s) of the ECM and frame ground.

   **Expected Result:** The resistance is greater than 5000 ohms for all the measurements.

   **OK** – The resistance is greater than 5000 ohms for all the measurements. The harness circuits are correct.

   **Stop.**

   **NOT OK** – The resistance is less than 5 ohms. There is a short in the machine harness. The short is between the suspected wire and the wire with the lowest resistance measurement.

   **Repair:** Repair the machine harness or replace the machine harness.

   **Stop.**

i01722100

## Electronic Control Module (ECM) - Flash Program

**SMCS Code:** 7610-591-DTN

Perform the following procedure in order to flash program the ECM. The ECM is flashed in order to upgrade the software. Flash programming of the ECM must also be done if the ECM has been replaced. The Caterpillar Electronic Technician (ET) contains the program WinFlash. WinFlash is used in order to load software into the ECM. The following procedure is used in order to FLASH software into the ECM.

1. **Procedure**

   a. Connect the data link cable between the communication adapter and the electronic technician.

   b. Connect the data link cable between the communication adapter and the diagnostic connector of the machine.

   c. Turn the disconnect switch and the key start switch to the ON position.

   d. Use WinFlash in order to load the software.

   e. Cycle the key start switch.

   f. Clear any active diagnostic codes for the ECM.

   g. Clear any active diagnostic codes that are associated with the flash program for all other ECM.

2. Verify proper operation.

i01891289

# Electronic Control Module (ECM) - Replace

**SMCS Code:** 7610-510-DTN

Prior to replacement of the ECM, ensure that replacement is absolutely necessary. The ECM is seldom the cause of a diagnostic code. Always check that power is available to the ECM. Battery voltage is required between J1-1 and J1-2 of the machine harness connector for the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

**Note:** The New Electronic Control Modules are either pre-programmed for a particular machine or the modules are not programmed. An unprogrammed electronic control module must be programmed by using the Caterpillar Electronic Technician (ET). See Testing And Adjusting, "Electronic Control Module - Flash Program". In order to determine that the ECM is programmed or that the ECM is not programmed, proceed to 6.

1. Turn the key start switch and the disconnect switch to the OFF position. Disconnect the machine harness from the ECM.
2. Remove the ECM.
3. Make sure that the new ECM has the correct part number.
4. Connect the machine harness to the replacement ECM.
5. Install the replacement ECM.
6. Determine if the replacement ECM is programmed or If the replacement ECM is not programmed. This can be done in two different ways. Proceed to 6.a or 6.b.

   a. Enter the component data display mode.

      If the display shows blanks, then the ECM is NOT programmed. See Testing and Adjusting, "Electronic Control Module - Flash Program".

      If the display shows the expected information, then the ECM is programmed. Proceed to 7.

   b. Connect the service tool for the Caterpillar Electronic Technician (ET) to the service connector for the data link of the machine. The ET service tool will communicate with the power train ECM.

      If the ECM is NOT programmed, the ET service tool will indicate the problem.

      If the ECM is programmed, the ET service tool provides access to the expected areas of the ECM.

7. Proceed to Testing and Adjusting, "Calibration". Perform ALL of the calibration and adjustment procedures.

**Note:** Performance will be greatly affected if ANY of the calibration procedures are omitted. PERFORM ALL OF THE CALIBRATION PROCEDURES. Even if the replacement ECM was acquired from a similar machine, perform all calibration procedures.

i02654348

# Connector Contact Description

**SMCS Code:** 7610-CY

## Transmission ECM

Table 10

| The Contact Description for the Transmission ECM (Connector "J1")(1) | |
|---|---|
| **No.** | **Function** |
| 3 | Inching Pedal Sensor |
| 6 | SAE J1939 CAN Low |
| 7 | Cat Data Link - |
| 8 | Cat Data Link + |
| 9 | Digital Sensor Return |
| 10 | 5 Volt supply |
| 11 | 8 Volt supply |
| 12 | Analog Sensor Return |
| 13 | 10 Volt supply |
| 18 | SAE J1939 CAN High |
| 19 | CAN Shield |
| 26 | Transmission Control Lever |
| 30 | Switch (inching pedal) (NC) |
| 31 | Switch (inching pedal) (NO) |
| 32 | Speed sensor (transmission output) (No. 2) + |
| 33 | Speed sensor (transmission output) (No. 2) - |
| 40 | Speed sensor (transmission output) (No. 1) + |

(continued)

(Table 10, contd)

| The Contact Description for the Transmission ECM (Connector "J1")[1] | |
|---|---|
| **No.** | **Function** |
| 41 | Speed sensor (transmission output) (No. 1) - |
| 44 | Autoshift (NC) |
| 45 | Autoshift (NO) |
| 46 | Parking Brake Switch (NC) |
| 47 | Parking Brake Switch (NO) |
| 51 | Charge Pressure Sensor |
| 54 | Switch (upshift) (NC) |
| 55 | Switch (upshift) (NO) |
| 56 | Switch (downshift) (NC) |
| 57 | Switch (downshift) (NO) |
| 58 | Key Switch |
| 62 | Transmission Oil Temperature Sensor |
| 67 | Transmission Input Speed Sensor - |
| 68 | Transmission Input Speed Sensor + |

(1) "J1" is a 70 pin connector.

Table 11

| Contact Description for the Transmission ECM (Connector "J2")[1] | |
|---|---|
| No. | Function |
| 1 | +Battery |
| 2 | Ground |
| 4 | ECPC Clutch Solenoid 1 |
| 12 | Proportional Driver Return #5 |
| 13 | Proportional Driver Return #4 |
| 14 | ECPC Clutch Solenoid 4 |
| 15 | ECPC Clutch Solenoid 5 |
| 17 | ECPC Clutch Solenoid 8 |
| 18 | Proportional Driver Return #6 |
| 22 | Ground |
| 23 | +Battery |
| 36 | On/Off Driver Return |
| 38 | Transmission Filter Bypass Switch (NO) |
| 39 | Key switch (crank) |
| 47 | +Battery |
| 48 | ECPC Clutch Solenoid 6 |
| 49 | Proportional Driver Return #2 |
| 51 | ECPC Clutch Solenoid 2 |
| 52 | Proportional Driver Return #1 |
| 58 | ECPC Clutch Solenoid 3 |
| 59 | Proportional Driver Return #3 |
| 61 | ECPC Clutch Solenoid 7 |
| 63 | ECPC Clutch Solenoid 9 |
| 68 | Neutral Start Relay |

(1) "J2" is a 70 pin connector.

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# Parameters

**SMCS Code:** 7610-DTN

Table 12

| Table of Events | | |
|---|---|---|
| **Event Identifier (EID) / Warning Level** | **Message on the Main Display** (1) | **Description of Event** |
| 24-3<br><br>"High Transmission Oil Temperature Warning" | **"HIGH TRANSMISSION OIL TEMP"**<br>**"WARNING"**<br><br>**"SHUTDOWN THE TRACTOR"**<br>**"IMMEDIATELY!"** | The temperature of the transmission oil is monitored and the operator is alerted when a high temperature condition exists. If temperature of the transmission oil is above the desired level for the specified period, a Warning Level 3 will occur. This event will remain active until the transmission oil temperature has fallen below the trip level by the specified reset for a specified reset delay. This event can not be snoozed. |
| 41-1<br><br>"Low System Voltage" | **"LOW SYSTEM VOLTAGE"**<br><br>**"TURN OFF THE KEY SWITCH TO"**<br>**"PREVENT BATTERY RUNDOWN."** | This event alerts the operator when the system voltage is too low. When the system voltage has fallen below 12.25 volts, a Warning Level 1 will occur. This event will remain active until system voltage is greater than 12.5 volts. This event can be snoozed for 5 min. |
| 41-2<br><br>"Low System Voltage" | **"LOW SYSTEM VOLTAGE"**<br><br>**"SEE OPERATORS MANUAL"** | This event is intended to alert the operator when the system voltage has become too low. When the system voltage has fallen below 12.0 volts, a Warning Level 2 will occur. This event will remain active until system voltage is greater than 12.25 volts. This event can be snoozed for 30 minutes. |
| 42-3<br><br>"Low System Voltage Warning" | **"LOW SYSTEM VOLTAGE"**<br>**"WARNING"**<br><br>**"SHUTDOWN THE TRACTOR"**<br>**"IMMEDIATELY!"** | This event is intended to alert the operator when system voltage is very low and correct operation of the tractor cannot be guaranteed. When the system voltage has fallen below 11.5 volts, a Warning Level 3 will occur. This event will remain active until system voltage is greater than 11.75 volts. |
| 43-1<br><br>"Low System Voltage Warning" | **"LOW SYSTEM VOLTAGE "**<br><br>**"SEE OPERATORS MANUAL"** | This event is intended to alert the operator of a low voltage situation that cannot be rectified by raising the engine speed. The low system voltage event identifies a bad battery with the engine on. This event will identify a bad alternator with the engine on. When the system voltage has fallen below 12.4 volts, a Warning Level 1 will occur. This event will remain active until system voltage is greater than 13.0 volts. This event can be snoozed for 30 minutes. |

(continued)

(Table 12, contd)

| Table of Events | | |
|---|---|---|
| **Event Identifier (EID) / Warning Level** | **Message on the Main Display (1)** | **Description of Event** |
| 43-2<br>"Low System Voltage" | **"LOW SYSTEM VOLTAGE "**<br>**"SEE OPERATORS MANUAL"** | This event is intended to alert the operator of a low voltage situation that can be rectified by raising the engine speed. This event can identify situations when the alternator cannot produce the required current that is needed at low idle. When the system voltage has fallen below 12.4 volts, a Warning Level 2 will occur. This event will remain active until system voltage is greater than 13.0 volts. This event can be snoozed for 300 seconds (5 minutes). |
| 50-1<br>"High System Voltage" | **"HIGH SYSTEM VOLTAGE"**<br>**"CHECK CHARGING SYSTEM"**<br>**"FOR PROPER OPERATION!"** | This event is intended to alert the operator when system voltage has become too high. When the system voltage has risen above 14.75 volts, a Warning Level 1 will occur. This event will remain active until system voltage is less than 14.5 volts. This event can be snoozed for 30 minutes. |
| 50-3<br>"High System Voltage Warning" | **"HIGH SYSTEM VOLTAGE"**<br>**"WARNING"**<br>**"SHUTDOWN THE TRACTOR"**<br>**"IMMEDIATELY!"** | This event is intended to alert the operator when system voltage is high and correct operation of the tractor cannot be guaranteed. When the system voltage has risen above 16.0 volts, a Warning Level 3 will occur. This event will remain active until system voltage is less than 15.75 volts. This event cannot be snoozed. |
| 53-1<br>"Low Fuel Pressure Warning" | **"LOW FUEL PRESSURE"**<br>**"WARNING"**<br>**"INVESTIGATE AND CORRECT"**<br>**"CAUSE"** | The operator is alerted when the condition of low fuel pressure exists. If the fuel pressure is below the desired level for the specified period, a Warning Level 1 will occur. This event will remain active until the fuel pressure has risen above the trip level by the specified reset value for the specified reset delay. This event can be snoozed for 5 minutes. |
| 83-2<br>"Transmission Overspeed" | **"TRANSMISSION OVERSPEED"**<br>**"GEAR CHANGED"** | The operator is alerted when a transmission overspeed condition exists. If the transmission output speed is above the desired level for the specified period, a Warning Level 2 will occur. This event will remain active until the transmission output speed has fallen below desired level for the specified period. This event can be snoozed for 5 minutes. |
| 283-3<br>"Low Transmission Charge Pressure Warning" | **"LOW TRANS CHARGE PRESSURE"**<br>**"WARNING"**<br>**"SHUTDOWN THE TRACTOR"**<br>**"IMMEDIATELY!"** | The transmission charge pressure is monitored and the operator is alerted when the pressure falls below the desired level. This warning will also illuminate the supplemental steering indicator. If the charge pressure is less than 150 psi , a Warning Level 3 will occur. This event will remain active until the charge pressure is greater than 160 psi. |

(continued)

(Table 12, contd)

| Table of Events | | |
|---|---|---|
| Event Identifier (EID) / Warning Level | Message on the Main Display [1] | Description of Event |
| 452-3<br>"Inch Pedal Sensor/Switch Fault Warning" | "INCH PEDAL SENSOR/SW FAULT"<br>"WARNING"<br>"SEE OPERATORS MANUAL" | This event warns the operator when a fault occurs with the inch pedal sensor / switch. When the condition is met, a Warning Level 3 will occur. This event will remain active until the condition is no longer met for a specified period of time. This event cannot be snoozed. |
| 453-1<br>"Shift Speed Inhibited" | "SHIFT SPEED INHIBITED"<br>"CHANGE GEAR SELECTION" | This event warns the operator that the shift speed is inhibited. When the condition is met, a Warning Level 1 will occur. This event will remain active until the condition is no longer met for a specified period of time. |

(1) Each set of quotation marks is one line of text on the display.

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# Glossary of Electrical Terms

**SMCS Code:** 1400

**Active** – This pertains to the status of a fault or to the status of a service code. When the fault is active, the fault is currently present.

**+Battery** – This pertains to any of the harness wiring which is part of the circuit that connects to the + battery post.

**+V** – +V is a constant voltage that is supplied to a component. This voltage provides electrical power for the component's operation. +V is provided by an electronic control module or the battery.

**Caterpillar Electronic Technician (ET)** – This is a diagnostic service tool for a personal computer (PC).

**Caterpillar Monitoring System** – This is a sophisticated monitoring system.

**Clear** – This pertains to removing diagnostic information from the memory of the ECM. Before a fault is cleared, a fault must be on hold and a fault must not be present.

**Component Identifier (CID)** – A CID is a code that is used to identify a particular component. The CID is a four digit code that is shown on the ECM display when the ECM is in service mode or normal mode.

**Connector Contact** – A connector contact is the component that actually makes the electrical connection between the harness connector and another connector plug. Connector contacts are either pins or sockets.

**Detected Fault** – This is a fault that has been found by the ECM. The fault is recorded and diagnostic information is available in the service mode.

**Diagnostic** – This is a code that pertains to abnormal information. Diagnostic information is available when the ECM is in service mode.

**Display** – The display consists of the readout and the indicators. The display is visible on the Caterpillar Monitoring System at all times.

**Electronic Control Analyzer Programmer (ECAP)** – This is a service tool which helps diagnose electronic control systems.

**Fault** – A fault is a failure of a component or a circuit in an ECM system. The ECM detects a fault when a signal at the ECM connector is outside a valid range. An FMI and a CID identify the type of fault.

**Failure Mode Identifier (FMI)** – An FMI is a diagnostic code that identifies the type of failure that has occurred. This code is shown on the Caterpillar Monitoring System.

**Harness Code** – The harness code provides machine information to the power train ECM. The Caterpillar Monitoring System uses the data link in order to provide the harness code to the ECM. The harness codes are created by the pins that are grounded or floating on the Caterpillar Monitoring System.

**Hold or On Hold** – This pertains to the holding of diagnostic information that is shown in the display area when the ECM is in the service mode. It is necessary to hold the set of diagnostic information before troubleshooting or clearing.

**Jumper** – A jumper is a piece of wire that is used to make an electrical connection during troubleshooting.

**Location Code** – The location code provides the characteristics of the control such as brake control or transmission/chassis ECM.

**Module Identifier (MID)** – A MID is a diagnostic code that identifies the ECM which diagnosed the fault. The three-digit code is displayed in the display area of the Caterpillar Monitoring System when the machine is in the service mode. The MID for the power train ECM is 081.

**Present** – This pertains to the status of a fault or the status of a service code. The fault is currently active when the fault is present.

**Scroll** – When you scroll through information in the display area, all available sets of diagnostic information are shown by one set at a time. A set of diagnostic information is shown briefly. Then, the display automatically advances to the next set. After all sets have been shown, the display shows "END". Then, the sets are repeated.

**Service Code** – A service code describes a condition in an electrical system. This code is stored in the ECM for the service technician. The code is made up of the CID, the FMI, and the MID.

**Signal** – A signal is an input to the ECM. A ground signal has continuity with the frame ground. An open signal is not connected to the frame ground and the voltage is approximately 5 DCV. A +battery signal is at the same voltage as the battery (25 to 30 DCV).

**Signal Wire** – The signal wire is the harness wire that provides a connection to the sensor or the switch input to the ECM.

**Switch Input** – The switch input is any input to the ECM which is expecting a ground signal, an open signal or a +battery signal.

**System Voltage** – System voltage is the actual voltage that exists between the + battery post and the frame ground. System voltage is also known as +battery voltage.

**Undetected Fault** – This is a fault that is not detected by the ECM, but the fault is found by the operator or by a service technician.

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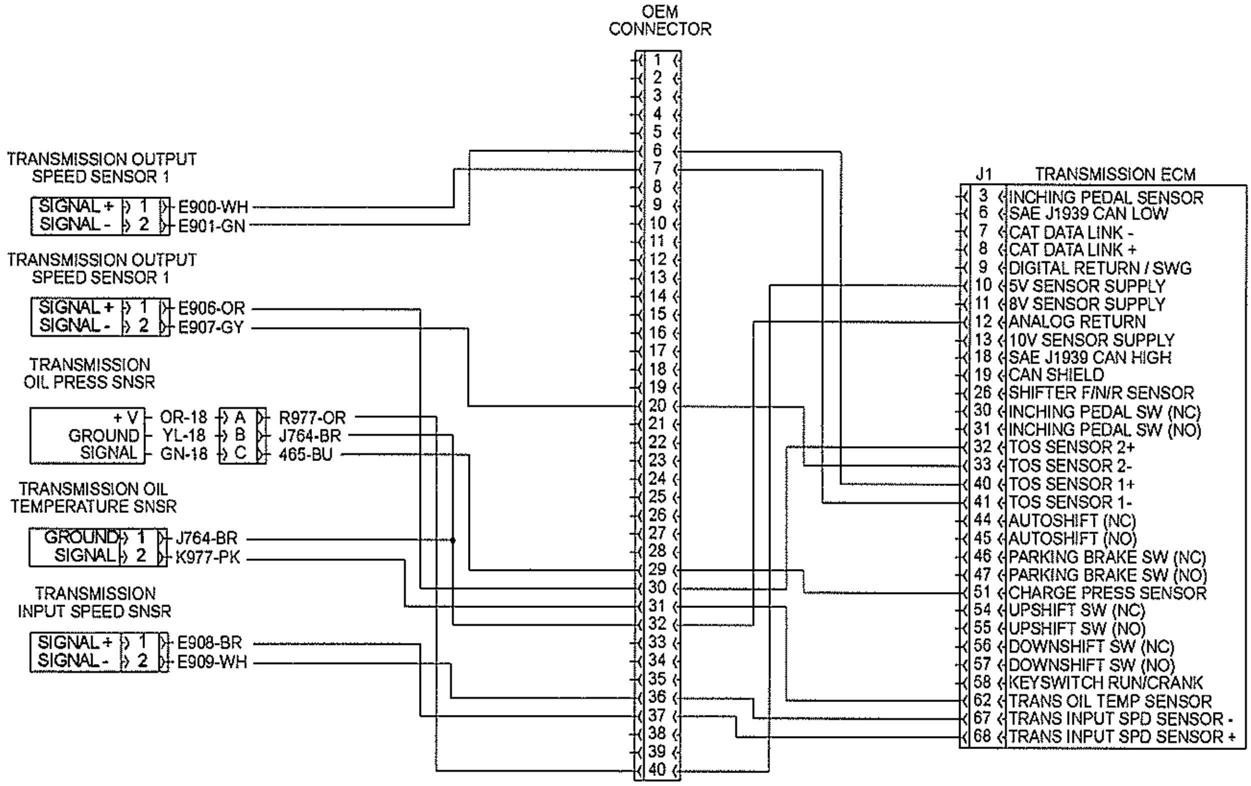
## System Schematic

**SMCS Code:** 7566-T3

See the entire electrical system schematic of the machine for more information. The entire schematic illustrates every component and the wire connections. All of the wiring harnesses that are important to troubleshooting and repair are illustrated on the system schematic. The part number of the components is listed in addition to the number for the harnesses.

For an accurate electrical schematic of the connector for the "Bravo", see Electrical Schematic, KENR5887 in the Service Manual.

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Connections of the J1 connector

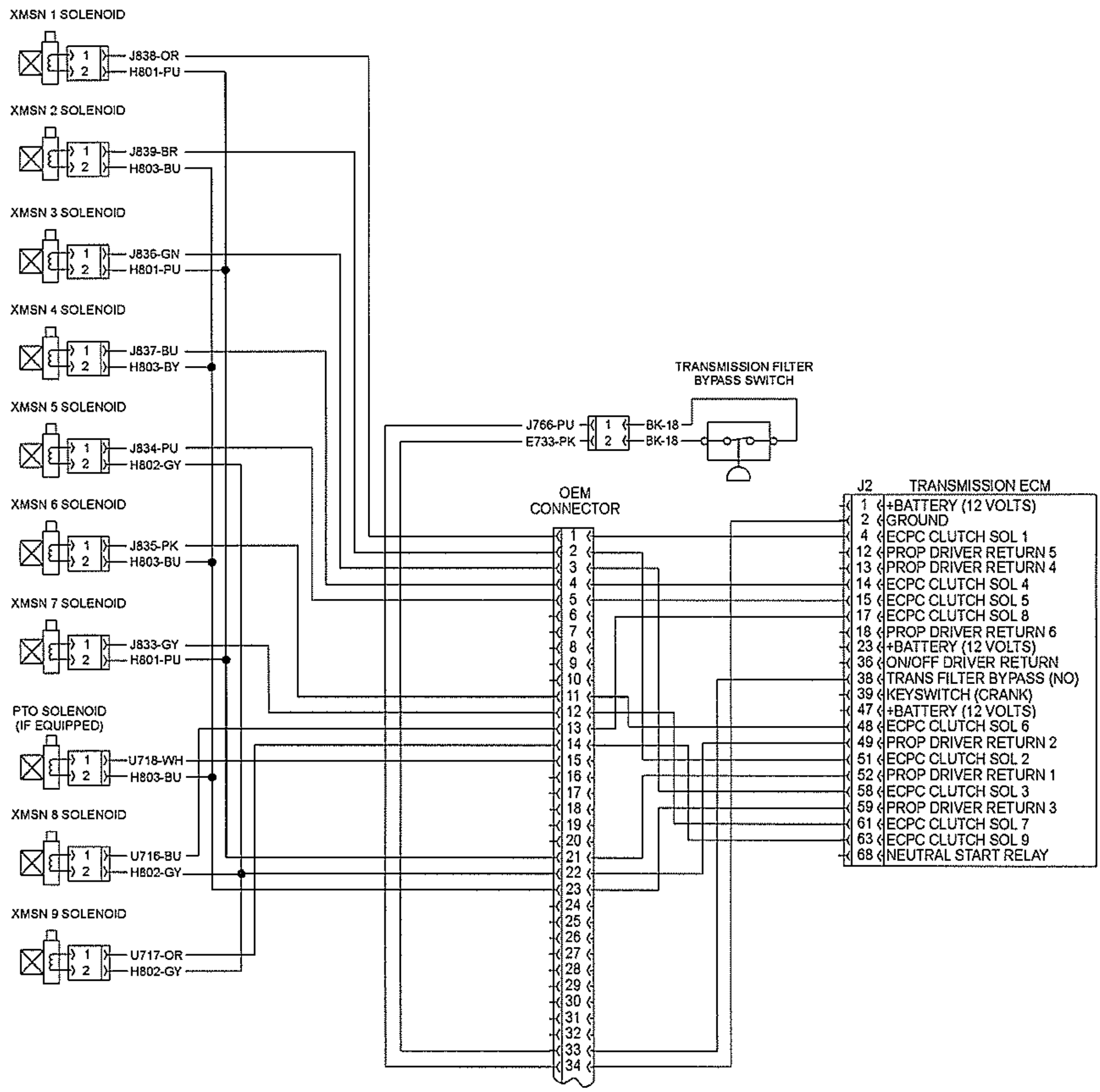


Illustration 69

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Connections of the J2 connector

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## C



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# Challenger®

## Terra Gator 3244
## Chassis

# SERVICE MANUAL
## 627333-A

# 04 - Chassis

## Contents

# Contents

# BRAKES

## INTRODUTION

**WARNING: Never operate the vehicle if there is any brake problem, no matter how minor. Brakes can fail causing injury or death.**

## Non-Asbestos Fibers Warning

**FIG. 1:**

**WARNING: The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from AxleTech.**

### Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some scientists believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

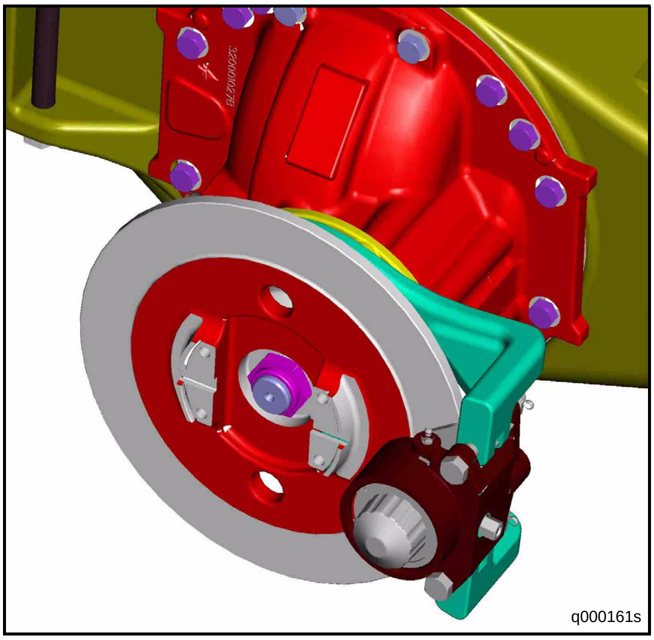



**FIG. 1**

### Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.
2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m3 as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

   Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.
3. Procedures for Servicing Brakes:
   a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

   b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

   c. If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

   d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

   e. NEVER use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies.

   NEVER use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.
4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. NEVER use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, to minimize exposure. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.
5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.
6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

### Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

## Brake Operation

The two brake pads slide on the guide bolts in the housing. When the brake is actuated, the cup springs move the piston, adjusting screw thrust bolts and inner brake pad contacts the brake disc. When the inner brake pad contacts the brake disc, the housing shifts onto the guide bolts and the outer brake pad pressed against the brake disc also.

The brake is released by hydraulic pressure. When the brake is released, the piston compresses the cup springs, pulling the inner brake pad away from the brake disc.

Brake lining and brake wear reduces braking force. The brake must be adjusted to maintain braking force.

When replacing parts. Only use factory original parts and part sets. Parts must be ordered through your AGCO dealer. Any damage to parts not described in this manual must be repaired or replaced using original parts.

**WARNING: Park the vehicle on the level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.**

**FIG. 2:**

**WARNING: When the parking brake is released, the vehicle does not have any brake function. You must block the wheels to prevent the vehicle from moving. Serious personal injury or death and damage to components can result.**

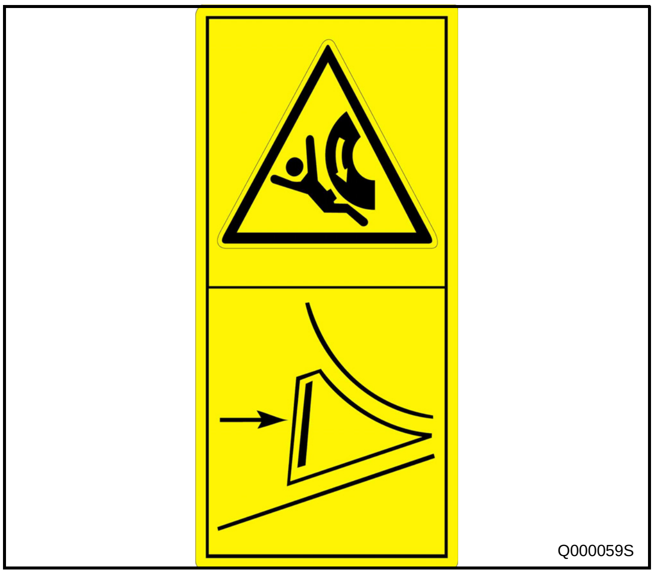



**FIG. 2**

## CLEAN, DRY AND INSPECT

**WARNING: Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, and emulsion-type and petroleum-base cleaners. Read the manufacturer's instructions before using a solvent cleaner, then carefully follow the instructions. Also follow the procedures below.**

**Wear safe eye protection;**

**Wear clothing that protects your skin;**

**work in a well-ventilated area;**

**Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.**

**You must use hot solution tanks or alkaline solutions correctly. Read the manufacturer's instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.**

### Clean Parts

**CAUTION: Do not use hot solution tanks or water alkaline solutions to clean ground or polished parts. Damage to parts can result.**

1. Use a cleaning solvent or kerosene or diesel fuel to clean ground or polished metal parts or surfaces. Examples of ground or polished parts are the piston and the piston bore in the caliper;
2. Use a wire brush to clean fastener and fitting threads;
3. Remove mud and dirt on the linings. Replace all linings contaminated with oil or grease.

### Dry and Inspect Parts

1. Use soft, clean paper or cloth rags or compressed air to completely dry parts immediately after you clean them;
2. Carefully inspect all parts for wear or damage before you assemble them;
3. Repair or replace worn damaged parts.

### Apply Corrosion Protection

1. Apply brake system hydraulic fluid to cleaned, dried parts. Be careful that you do not apply the grease to the linings or rotor.
2. If you will store the parts, apply a special material, which prevents corrosion and rust, to all surfaces. Store parts inside special paper or other material that prevents rust and corrosion.

## SERVICE BRAKE

### Release pressure

**WARNING: Before disconnect brake lines. Be sure there is no pressure in the brake system. Even when the engine is not running there can still be high pressure in the brake system.**

To release the pressure of the brake system, do the follow steps:

- Turn of the engine;

**FIG. 3:** Measure point (1) priority valve.

- Connect a pressure gauge to the priority valve. Place the pressure gauge so it is readable for the driver seat;
- Keep pushing down the brake pedal until the pressure of the brake system is completely gone.

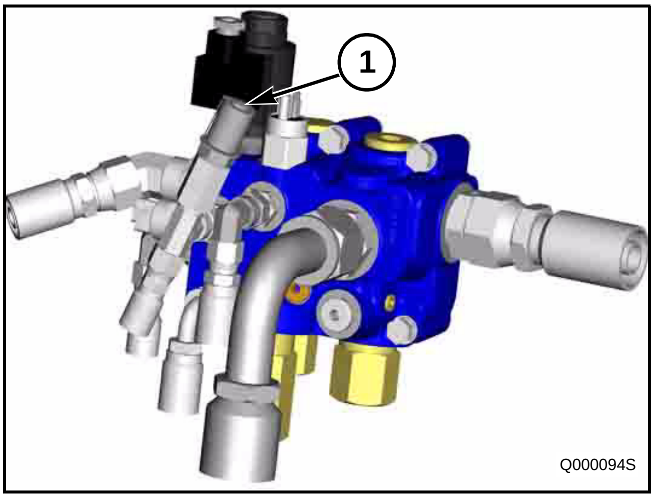



**FIG. 3**

### Bleed Brake

*NOTE: When you loosen any brake system hydraulic connection, you must bleed the brake to remove all air from the system.*

1. Make sure that the master cylinder is filled to the specified level with the type of hydraulic fluid specified by the equipment manufacturer. Keep the master cylinder filling during bleeding so that you do not pull air into the system through the master cylinder. Make sure the master cylinder is filled when you are done bleeding the system.
2. Put a clear tube on the bleeder screw. Submerge the other end of the tube in a clear container of the specified fluid.
3. Bleed brake.
   - For full hydraulic system:

     Slowly apply low hydraulic pressure to the brake. Loosen the bleeder screw. Continue to apply pressure until no air bubbles appear in the container of fluid. Tighten the bleeder screw 12 - 16 Nm (9 - 12 lb-ft), then release the pressure to the brake.
4. Check for fluid leaks.

## BRAKE ADJUSTMENT

Brake adjustment is required after installing new brake pads or brake discs, after all repairs , and to improve braking performance. Adjust the brakes when the brake is cold. The park brake must be in the released condition during the adjustment procedure.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. If it is necessary to service the brake, use a jack to raise the vehicle. Support the vehicle with safety stands.
2. Apply 100 bar (1450 psi) of hydraulic pressure to release the parking brake.
3. Remove the screw cap.
4. Loosen the lock nut. Use a male hex wrench, M8 to adjusting screw clockwise until both brake pads contact the brake disc.
5. Turn the adjusting screw counterclockwise to set the TOTAL clearance specified in the following table.

| **Total Lining-to-Disc Clearance** | | | **Adjusting Screw Revolutions** |
|---|---|---|---|
| | **Inch** | **mm** | |
| Minimum | 0,020 | 0,5 | 1/4 |
| Rated | 0,040 | 1,0 | 1/2 |
| Maximum | 0,060 | 1,5 | 3/4 |

6. Hold the adjusting screw in position. Tighten the lock nut securely.
7. Install and hand-tighten the screw cap.
8. Actuate the brake several times.
9. Check the parking brake on a slope.

## PARKING BRAKE EMERGENCY RELEASE

**WARNING: When the parking brake is released, the vehicle does not have any park brake function. You must block the wheels to prevent the vehicle from moving. Serious personal injury and damage to components can result.**

If hydraulic pressure is not available, the parking brake can be manually released using the following procedure.

**FIG. 4:**

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Remove the screw cap.
3. Loosen the lock nut.
4. Use a male hex wrench M8, turn the adjusting screw counterclockwise until the brake is released. Emergency release requires approximately 40 Nm (30 lb-ft) torque on the adjusting screw.
5. Tighten the lock nut. Install and hand-tighten the screw cap.
6. Before you return the vehicle to service, adjust the brake using the procedure in this section.

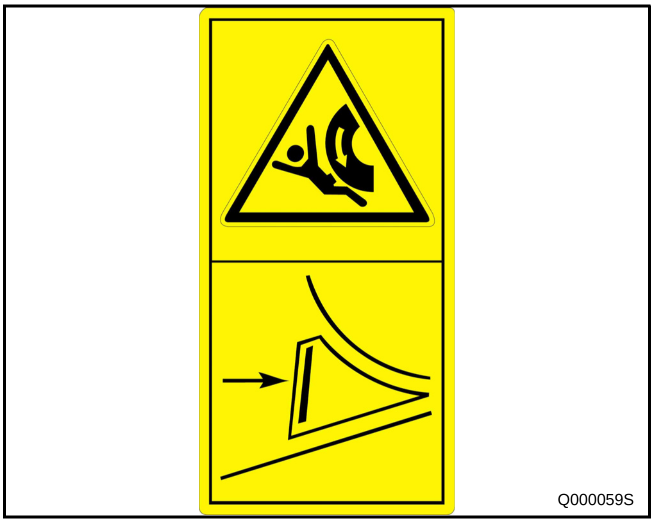



**FIG. 4**

## NOTES

# AXLE

## FRONT AXLE

### Description

The rear axle is an Axle Tech axle is attached directly to the frame with twelve M22 x 240 10.9 bolts. Weight of the axle approximately 1150 Kg (2535 lb)

### Removal

Park chassis on hard, level surface and block the rear wheels.

Drain axle fluid into suitable container.

*NOTE: Be prepard to collect and contain all fluids in an approved container.*

Place jacks under the machine and raise the frame until the weight is off the rear wheels. Install jack stands to securely support the machine frame.

*IMPORTANT: Make sure the jack stands are rated for supporting the weight of the machine.*

Remove the wheels from the front axle.

**FIG. 1:** Place an alignment mark on the slide yoke in the event the slide yoke should come apart. Remove the four bolts (1) that mount the front driveline assembly (2) to the front axle. Disconnect the rear drive shaft assembly

Using a suitable lifting device support the axle (3).

Loosen and remove the twelve nuts with washer that secure the axle. Remove the twelve M22 x 240 10.9 bolts (4) and carefully remove the axle.

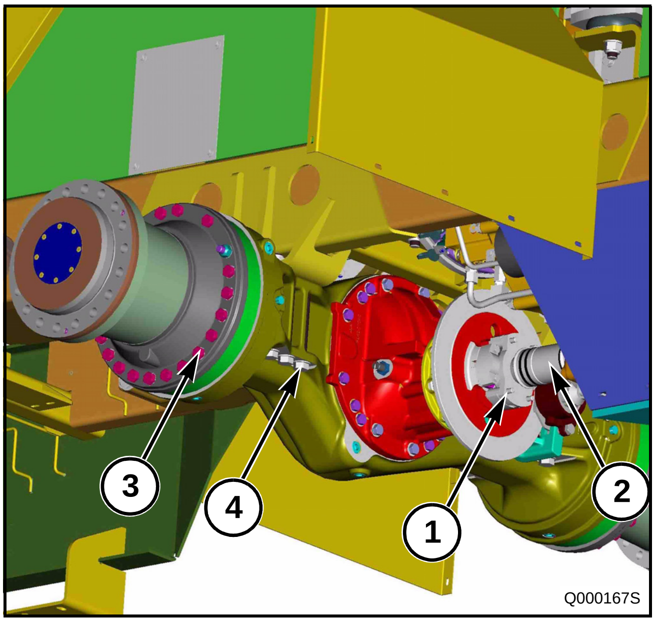


**FIG. 1**

### Installation

Make sure the machine is adequately supporteed with jackstands.

*IMPORTANT: Make sure the jack stands are rated for supporting the weight of the machine.*

Position the axle (3) unter the machine. Raise the axle and mount to the frame with twelve M22 x240 10.9 bolts (4) and fasten with eight nuts with washers.

*IMPORTANT: Always use new nuts, or use Loctite 242-41.*

Install the wheels to the axle.

Once the machine has been lowered to the ground and the full weight applied to the wheels a final tightening will be necessary. Tighten the twelve bolts in even increments to 515 Nm (380 lbf - ft)

*IMPORTANT: Check the bolt torque daily for the next 50 hours of operation and every 500 thereafter.*

Install the front drive shaft (2) assembly to the front axle. Mount the driveline with four bolts (1). Torque bolts to 215 Nm (158 lbf - ft).

## REAR AXLE

### Description

The rear axle is an Axle Tech axle is attached directly to the frame with twelve M22 x 240 10.9 bolts. Weight of the axle approximately 1150 Kg (2535 lb)

### Removal

Park chassis on hard, level surface and block the front wheels.

Drain axle fluid into suitable container.

*NOTE: Be prepard to collect and contain all fluids in an approved container.*

Place jacks under the machine and raise the frame until the weight is off the rear wheels. Install jack stands to securely support the machine frame.

*IMPORTANT: Make sure the jack stands are rated for supporting the weight of the machine.*

Remove the wheels from the rear axle.

**FIG. 2:** Place an alignment mark on the slide yoke in the event the slide yoke should come apart. Remove the four bolts (1) that mount the rear driveline assembly (2) to the rear axle. Disconnect the rear drive shaft assembly

Using a suitable lifting device support the axle (3).

Loosen and remove the twelve nuts with washer that secure the axle. Remove the twelve M22 x 240 10.9 bolts (4) and carefully remove the axle.

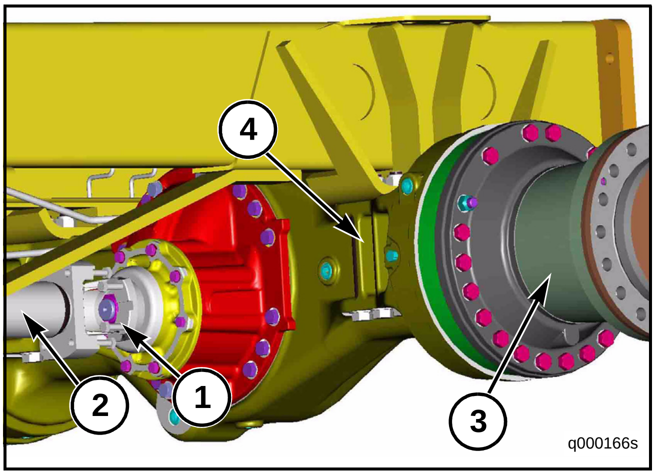



**FIG. 2**

### Installation

Make sure the machine is adequately supporteed with jackstands.

*IMPORTANT: Make sure the jack stands are rated for supporting the weight of the machine.*

Position the axle (3) unter the machine. Raise the axle and mount to the frame with twelve M22 x240 10.9 bolts (4) and fasten with eight nuts with washers.

*IMPORTANT: Always use new nuts, or use Loctite 242-41.*

Install the wheels to the axle.

Once the machine has been lowered to the ground and the full weight applied to the wheels a final tightening will be necessary. Tighten the twelve bolts in even increments to 515 Nm (380 lbf - ft)

*IMPORTANT: Check the bolt torque daily for the next 50 hours of operation and every 500 thereafter.*

Install the rear drive shaft (2) assembly to the rear axle. Mount the driveline with four bolts (1). Torque bolts to 215 Nm (158 lbf - ft).

# REAR AXLE (DOG WALK CHASSIS)

## Description

The rear axle is an Axle Teck axle is attached directly to the frame with twelve M22 x 300 10.9 bolts. Weight of the axle approximately 1150 Kg (2535 lb)

## Removal

Park chassis on hard, level surface and block the front wheels.

Drain axle fluid into suitable container.

*NOTE: Be prepard to collect and contain all fluids in an approved container.*

Place jacks under the machine and raise the frame until the weight is off the rear wheels. Install jack stands to securely support the machine frame.

*IMPORTANT: Make sure the jack stands are rated for supporting the weight of the machine.*

Remove the wheels from the rear axle.

**FIG. 3:** Place an alignment mark on the slide yoke in the event the slide yoke should come apart. Remove the four bolts (1) that mount the rear driveline assembly (2) to the rear axle. Disconnect the rear drive shaft assembly

Remove at both sides the hitch support (3) underneath the axle.

Using a suitable lifting device support the axle (4).

Loosen and remove the twelve M22 x 300 10.9 bolts (5) and carefully remove the axle.

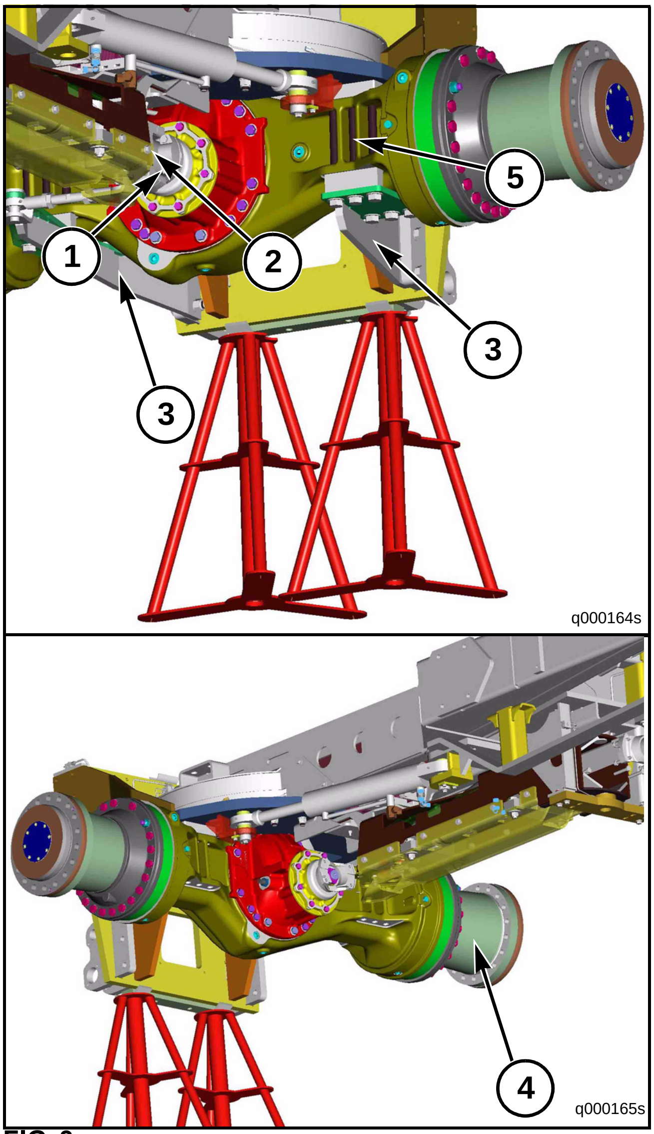


**FIG. 3**

## Installation

Make sure the machine is adequately supporteed with jackstands.

*IMPORTANT: Make sure the jack stands are rated for supporting the weight of the machine.*

Position the axle (4) unter the machine. Raise the axle and mount to the frame with twelve M22 x300 10.9 bolts (5). Use Loctite 242-41.

Install the hitch supports (3).

Install the wheels to the axle.

Once the machine has been lowered to the ground and the full weight applied to the wheels a final tightening will be necessary. Tighten the twelve bolts in even increments to 515 Nm (380 lbf - ft)

*IMPORTANT: Check the bolt torque daily for the next 50 hours of operation and every 500 thereafter.*

Install the rear drive shaft assembly (2) to the rear axle. Mount the driveline with four bolts (1), use Loctite 242-41. Torque bolts to 215 Nm (158 lbf - ft).

## AXLE PRC2715

See for Axletech service manual see end of this chapter.

# CHASSIS

## INTRODUCTION

*IMPORTANT: If bolts with self locking nuts are mounted. Do not use loctite. Bolts can be retorque if this is necessary.*

*If bolts are mounted in a thread hole, always use Loctite 242-41. Do not retorque bolts. After retorque the bolts the adhesion of Loctite is gone.*

### Straight Chassis

By a Terra Gator with a straight chassis, is the rear axle with bolts against the chassis mounted.

Retorque the rear axle bolts every 500 hours of operation.

### Dog Walk Chassis

By a Terra Gator with a dog walk chassis, is the rear axle mounted against a circular plate. The position of the axle is controlled by cylinders.

The function of dog walk is to drive in multi tracks.

### Articulation Joint

All Terra Gators contains a Articulation Joint. This Articulation Joint enables the steering of the machine. The Articulation Joint is controlled by cylinders.

## ARTICULATION JOINT

**WARNING: The Terra Gator is extremely heavy and requires proper handling equipment to safely spilt it. Failures to use proper procedures and equipment may result in personal injury or death due to crushing. The weight of the Terra Gator may be as much as 13,100 kg (28880 lb).**

*NOTE: Put identification marks on all hoses, on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid los, and this helps to keep contaminants from entering the system.*

*NOTE: Cleanliness is an important factor. Before beginning the splitting procedure, the exterior of the components should be thoroughly cleaned. This will help to prevent dirt from entering the internal mechanism.*

Park the Terra Gator on a flat level surface.

When replacement of the bearings in the Articulation Joint is necessary follow the following instructions to support the chassis

### Disassembly Articulation Joint

**DANGER: During maintenance on the Articulation Joint be extreme careful. Disassembly of the Articulation Joint can give abrupt movements of the front and rear chassis. This can lead to serious injury or death.**

**FIG. 1:** Before disammebly

When disassembly the articulation joint follow the steps below:

1. Remove all hydraulic hoses and electrical wires;
2. Remove the steering cylinders;
3. Disconnect the driveshaft and the cross bearings;
4. Disconnect the lower articulation joint;.

*IMPORTANT: Notice the number of shims between the articulation joint.*

5. Disconnect the upper articulation joint;

*IMPORTANT: Notice the number of shims between the articulation joint.*

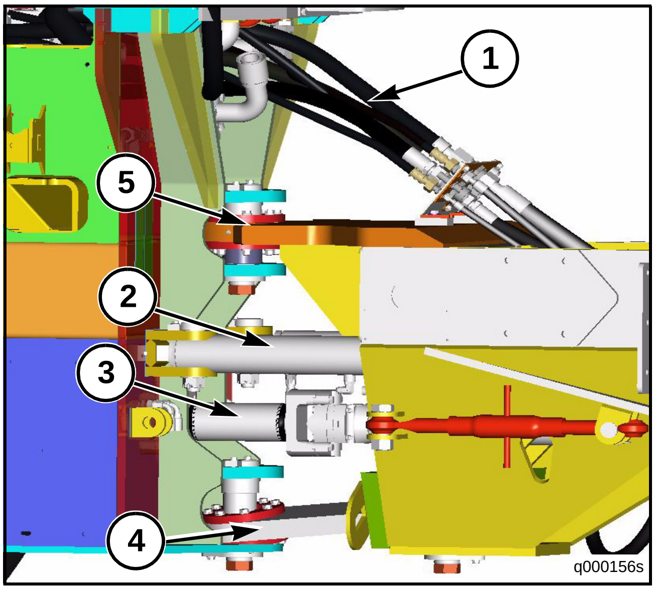



**FIG. 1**

**FIG. 2:** After disassembly the concetion between the front and rear chassis.

6. Move the rear chassis backwards as much as need. Use a moveable jack to move the rear chassis.

**WARNING: Be extremely careful when moving the rear chassis backwards.**

**Be sure there is nobody in the working area of the chassis.**

**Keep a safe distance to other objects/machines.**

**WARNING: Never leave the rear chassis on the moveable jack. A jack can loose this force. Always place supports underneath the chassis.**

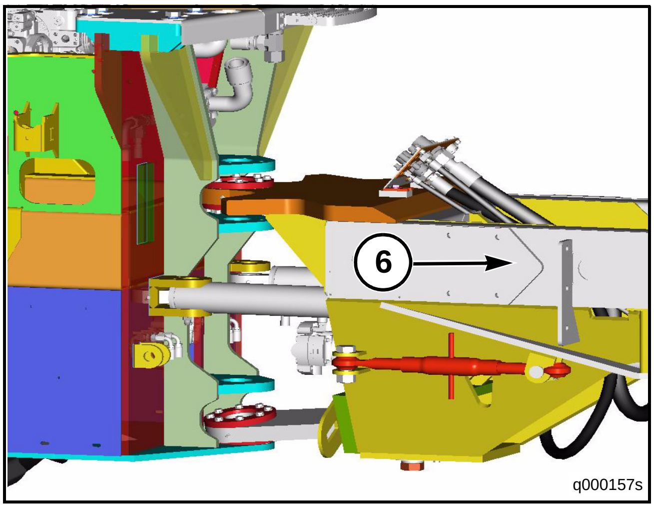



**FIG. 2**

## Assembly Articulation Joint

**DANGER: During maintenance on the Articulation Joint be extreme careful. Disassembly of the Articulation Joint can give abrupt movements of the front and rear chassis. This can lead to serious injury or death.**

When assembly the articulation joint follow the steps below:

**FIG. 3:** The rear chassis is position to assembly all the connections.

1. Move the rear chassis with a moveable jack to the front chassis.
2. Connect the upper articulation joint;

*IMPORTANT: Use the same numbers of shims as before the disassembly.*

3. Connect the lower articulation joint;

*IMPORTANT: Use the same numbers of shims as before the disassembly.*

4. Connect the driveshaft and the cross bearings;
5. Install the steering cylinders;
6. Install all hydraulic hoses and electrical wires.

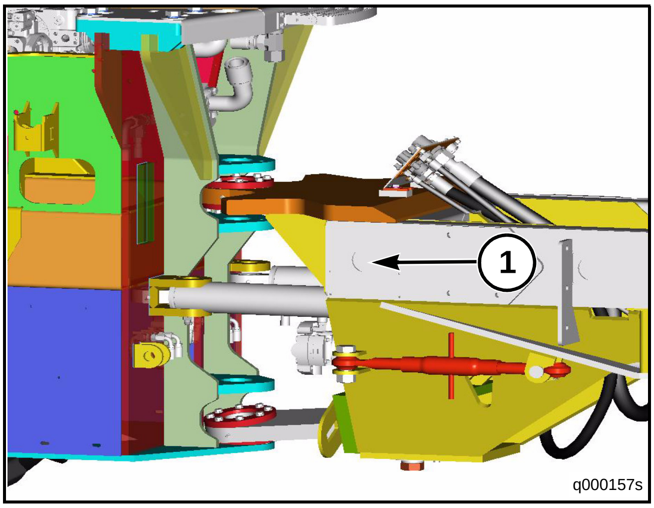



FIG. 3

**FIG. 4:** After assembly

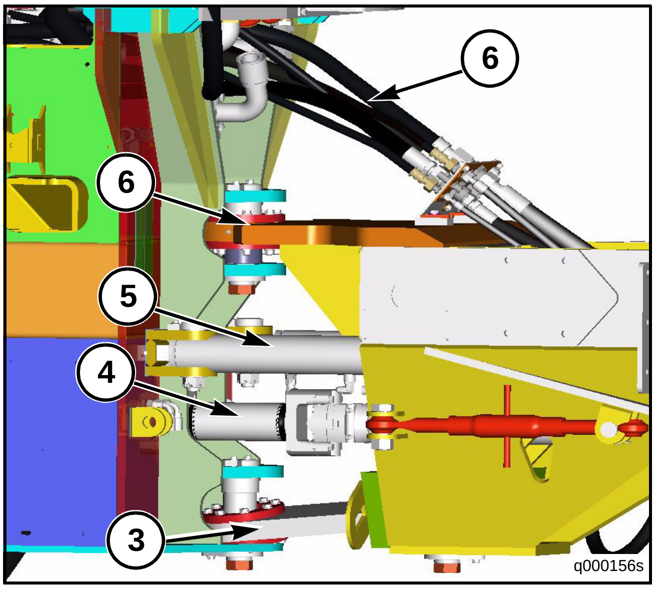



FIG. 4

# TROUBLESHOOTING

## TROUBLESCHOOTING

Any errors in the CAN Buss sytem will be displayed on the RH EIP panel. See the table follwing the troubleshooting methods for error code definition. Any possible errors displayed can be diagnosed by the following 5 methods:

### 1. Over Temp/Current

This error signals that the applicable component is attempting to draw too much current through the I/O module. Check for a shorted load, s shorted wire, or swap this component with another. When all other possible causes have been eliminated, replace the appropriate Module.

### 2. Open Load

This error signals that the applicable component is drawing no current through the I/O module. Check for a broken wire or faulty connection, an open component, or swap the component with another. When all other possible causes have been eliminated, replace the appropriate Module.

### 3. Short to GND

This error signals that the applicable component is shorted to ground. Check for bare wire or an improper connection, a shorted component, or swap this component with another. When all other possible causes have been eliminated, replace the Master Module.

### 4. Short to Bat/OT

This error signals that the applicable component is either shorted to power, or the module is creating too much heat. Check for bare wires or an improper connection, a faulty component, or swap this component with another. When all possible causes have been eliminated, replace the Master Module.

### 5. No error listed

No error code is present and a component is not working. Check switch or control inputs to the Master Module. Check continuity on the CAN Buss wires. Check outputs.

## ERROR CODES CHASSIS CAN

### 600 - 650

| Error Code | Module Number | Pin Number | Failure | Function |
|---|---|---|---|---|
| 646 | I/O MODULE 6 | J3 PIN 4 | Over temp/current | FOGLIGHTS |
| 647 | I/O MODULE 6 | J3 PIN 4 | Open load | FOGLIGHTS |
| 648 | I/O MODULE 6 | J3 PIN 5 | Over temp/current | BEACON LIGHTS |
| 649 | I/O MODULE 6 | J3 PIN 5 | Open load | BEACON LIGHTS |
| 650 | I/O MODULE 6 | J3 PIN 6 | Over temp/current | WORKLIGHT #5 (loaction on rear side of the application) |

## 651 - 699

| Error Code | Module Number | Pin Number | Failure | Function |
|---|---|---|---|---|
| 651 | I/O MODULE 6 | J3 PIN 6 | Open load | WORKLIGHT #5 (Location on rear of application) |
| 652 | I/O MODULE 6 | J3 PIN 7 | Over temp/current | WORKLIGHT #6 (On system) |
| 653 | I/O MODULE 6 | J3 PIN 7 | Open load | WORKLIGHT #6 (On system) |
| 654 | I/O MODULE 6 | J3 PIN 8 | Over temp/current | WORKLIGHT #7 (On system) |
| 655 | I/O MODULE 6 | J3 PIN 8 | Open load | WORKLIGHT #7 (On system) |
| 664 | I/O MODULE 6 | J3 PIN 4 | Over temp/current | LH END ROW |
| 665 | I/O MODULE 6 | J3 PIN 4 | Open load | LH END ROW |
| 666 | I/O MODULE 1 | J3 PIN 5 | Over temp/current | SECTION 1 |
| 667 | I/O MODULE 1 | J3 PIN 5 | Open load | SECTION 1 |
| 668 | I/O MODULE 1 | J3 PIN 6 | Over temp/current | SECTION 2 |
| 669 | I/O MODULE 1 | J3 PIN 6 | Open load | SECTION 2 |
| 670 | I/O MODULE 1 | J3 PIN 7 | Over temp/current | SECTION 3 |
| 671 | I/O MODULE 1 | J3 PIN 7 | Open load | SECTION 3 |
| 672 | I/O MODULE 1 | J3 PIN 8 | Over temp/current | SECTION 4 |
| 673 | I/O MODULE 1 | J3 PIN 8 | Open load | SECTION 4 |
| 674 | I/O MODULE 1 | J3 PIN 9 | Over temp/current | SECTION 5 |
| 675 | I/O MODULE 1 | J3 PIN 9 | Open load | SECTION 5 |
| 676 | I/O MODULE 1 | J3 PIN 10 | Over temp/current | RH END ROW |
| 677 | I/O MODULE 1 | J3 PIN 10 | Open load | RH END ROW |
| 678 | I/O MODULE 1 | J3 PIN 11 | Over temp/current | BOOM CLEANOUT / WETBOOM PUMP |
| 679 | I/O MODULE 1 | J3 PIN 11 | Open load | BOOM CLEANOUT / WETBOOM PUMP |
| 680 | I/O MODULE 1 | J2 PIN 10/11 | Over temp/current | MAIN BOOM SHUTOFF |
| 681 | I/O MODULE 1 | J2 PIN 10/11 | Open load | MAIN BOOM SHUTOFF |

## 801 - 850

| Error Code | Module Number | Pin Number | Failure | Function |
|---|---|---|---|---|
| 810 | I/O MODULE 3 | J3 PIN 4 | Over temp/current | LOW BEAMS |
| 811 | I/O MODULE 3 | J3 PIN 4 | Open load | LOW BEAMS |
| 812 | I/O MODULE 3 | J3 PIN 5 | Over temp/current | HIGH BEAMS |
| 813 | I/O MODULE 3 | J3 PIN 5 | Open load | HIGH BEAMS |
| 814 | I/O MODULE 3 | J3 PIN 6 | Over temp/current | WORK LIGHT #1 (location engine hood) |
| 815 | I/O MODULE 3 | J3 PIN 6 | Open load | WORK LIGHT #1 (location engine hood) |
| 816 | I/O MODULE 3 | J3 PIN 7 | Over temp/current | WORK LIGHT# 2 (location engine hood) |
| 817 | I/O MODULE 3 | J3 PIN 7 | Open load | WORK LIGHT #2 (location engine hood) |
| 818 | I/O MODULE 3 | J3 PIN 8 | Over temp/current | LEFT TURN SIGNAL |
| 819 | I/O MODULE 3 | J3 PIN 8 | Open load | LEFT TURN SIGNAL |
| 820 | I/O MODULE 3 | J3 PIN 9 | Over temp/current | RIGHT TURN SIGNAL |
| 821 | I/O MODULE 3 | J3 PIN 9 | Open load | RIGHT TURN SIGNAL |
| 826 | I/O MODULE 3 | J2 PIN 10/11 | Over temp/current | WORK LIGHT #4 |
| 827 | I/O MODULE 3 | J2 PIN 10/11 | Open load | WORK LIGHT #4 |
| 846 | HC MODULE 7 | J3 PIN 4 | Over temp/current | PARK LIGHTS AND REAR LIGHTS |
| 847 | HC MODULE 7 | J3 PIN 4 | Open load | PARK LIGHTS AND REAR LIGHTS |
| 848 | HC MODULE 7 | J3 PIN 5 | Over temp/current | BRAKE LIGHTS |
| 849 | HC MODULE 7 | J3 PIN 5 | Open load | BRAKE LIGHTS |
| 850 | HC MODULE 7 | J3 PIN 6 | Over temp/current | REVERSE LIGHTS |

## 851 - 900

| Error Code | Module Number | Pin Number | Failure | Function |
|---|---|---|---|---|
| 851 | HC MODULE 7 | J3 PIN 6 | Open load | REVERSE LIGHTS |
| 852 | HC MODULE 7 | J3 PIN 7 | Over temp/current | LEFT TURN SIGNAL |
| 853 | HC MODULE 7 | J3 PIN 7 | Open load | LEFT TURN SIGNAL |
| 854 | HC MODULE 7 | J3 PIN 8 | Over temp/current | RIGHT TURN SIGNAL |
| 855 | HC MODULE 7 | J3 PIN 8 | Open load | RIGHT TURN SIGNAL |
| 860 | HC MODULE 7 | J3 PIN 11 | Over temp/current | WORK LIGHTS #4 |
| 861 | HC MODULE 7 | J3 PIN 11 | Open load | WORK LIGHTS 4 |
| 873 | MASTER | J2 pin 26 | Open load | FUEL LEVEL |
| 874 | MASTER | J2 pin 26 | Over temp/current | FUEL LEVEL |
| 875 | MASTER | J2 pin 26 | Open load | FUEL LEVEL |
| 876 | MASTER | J2 pin 25 | Over temp/current | RADAR |
| 877 | MASTER | J2 pin 25 | Open load | RADAR |
| 878 | MASTER | J2 pin 25 | Over temp/current | RADAR |
| 890 | MASTER | J2 pin 28 | Over temp/current | AIR PRESSURE |
| 891 | MASTER | J2 pin 28 | Open load | AIR PRESSURE |
| 896 | MASTER | J2 pin 21 | Over temp/current | FOAM MARKER ON (system) |
| 897 | MASTER | J2 pin 21 | Open load | FOAM MARKER ON (system) |
| 898 | N/A | N/A | Invalid I/O Message | N/A |

NOTES

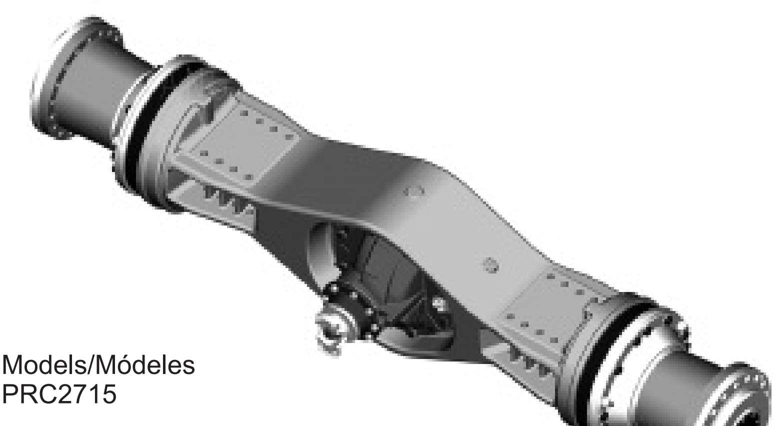
# INDEX

NOTES

# AxleTech International

# Planetary Drive Axles
# Pont Double Réduction

| Maintenance Manual 9L | Issued 9-06 |
|---|---|
| Manuel de maintenance 9L | Edité Septembre 06 |



Models/Módeles
PRC2715

# Service Notes

## Before You Begin

This maintenance manual describes the correct service and repair procedures for all AxleTech planetary axle models listed on front cover. The information contained in this manual was current at time of printing and is subject to change without notice or liability.

You must follow your company procedures when you service or repair equipment or components. You must understand all procedures and instructions before you begin to work on a unit. Some procedures require the use of special tools for safe and correct service. Failure to use special tools when required can cause serious personal injury to service personnel, as well as damage equipment and components.

AxleTech International uses the following notations to warn the user of possible safety problems and to provide information that will prevent damage to equipment and components.

## Safety Alerts, Torque Symbol and Notes

| | |
|---|---|
| WARNING | A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury. |
| CAUTION | A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components. |
| T | The torque symbol alerts you to tighten fasteners to a specified torque value. |
| NOTE: | A Note provides information or suggestions that help you correctly service a component. |

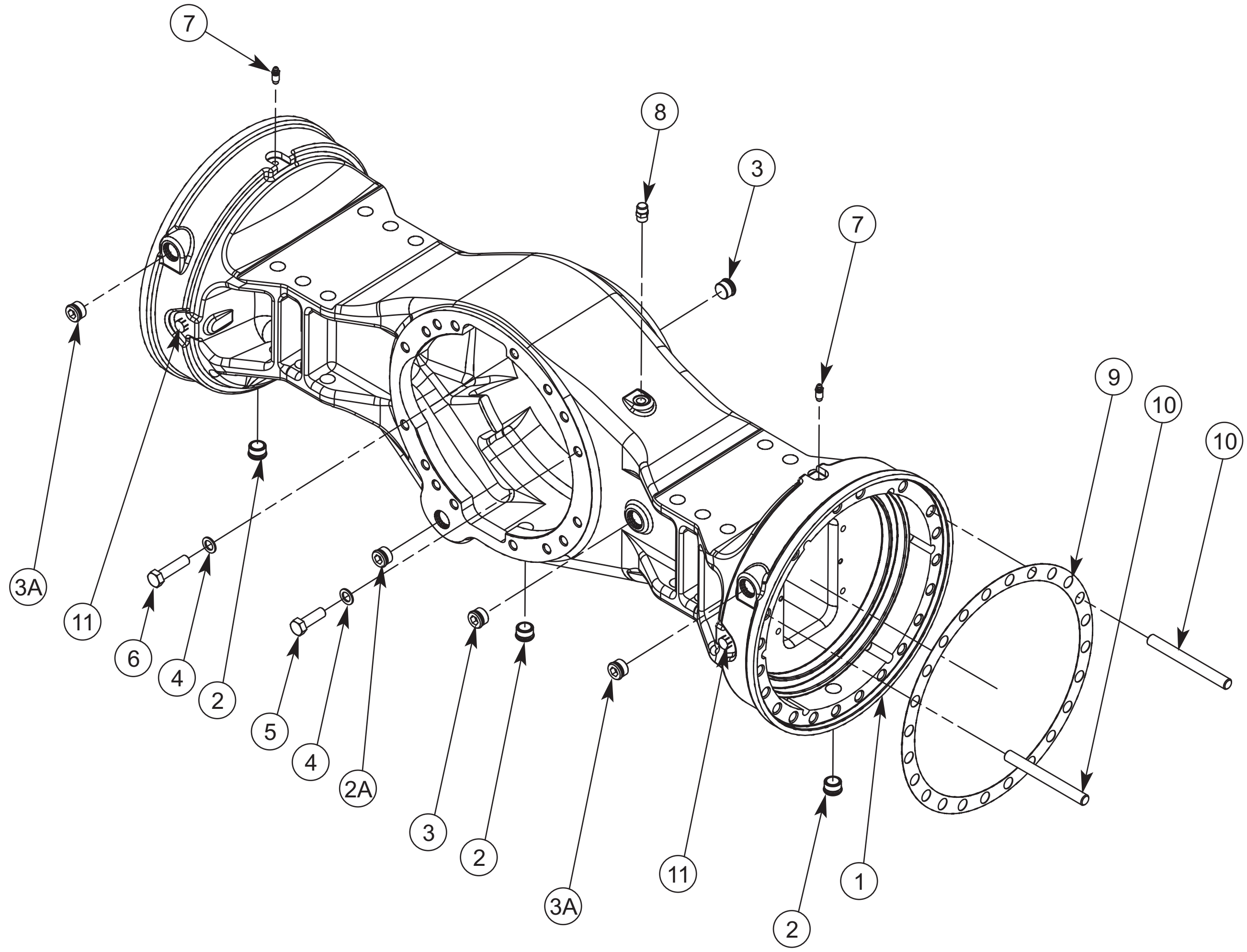
The instructions contained in this Field Maintenance Manual are intended for use by skilled and experienced mechanics knowledgeable in the installation, repair and replacement of the AxleTech product described herein. Installation, maintenance and replacement of such products require a high degree of skill and experience. The consequences of improper installation, maintenance or replacement (including the use of inferior or substandard components) are grave and can result in product failure and resulting loss of control of the vehicle, possible injury to or death of persons and/or possible future or additional axle damage. AxleTech does not authorize anyone other than highly skilled and experienced individuals to attempt to utilize the instructions contained in this Manual for the installation, maintenance or replacement of the product described herein, and AxleTech shall have no liability of any kind for damages arising out of (or in connection with) any other use of the information contained in this Manual.

AxleTech™ International

# Table of Contents

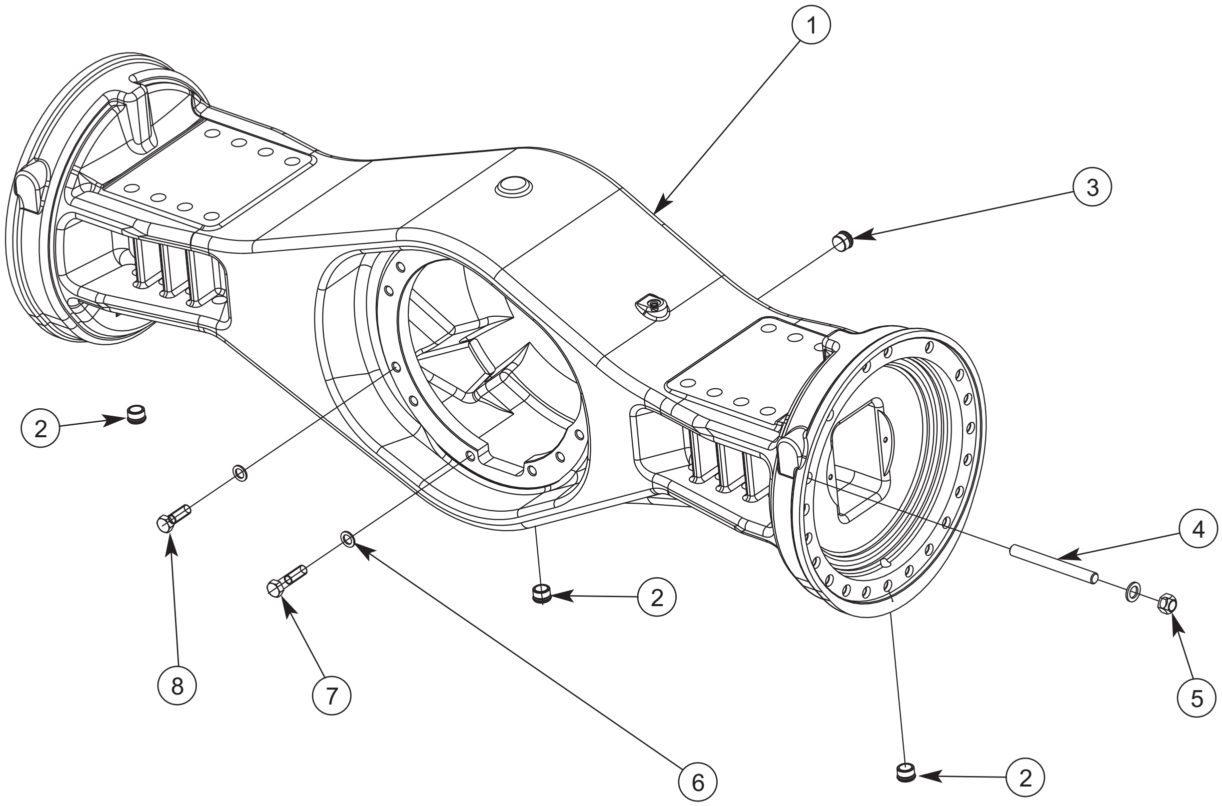
# Table of Contents

## Axle Housing Assembly With Forced Cooling Option



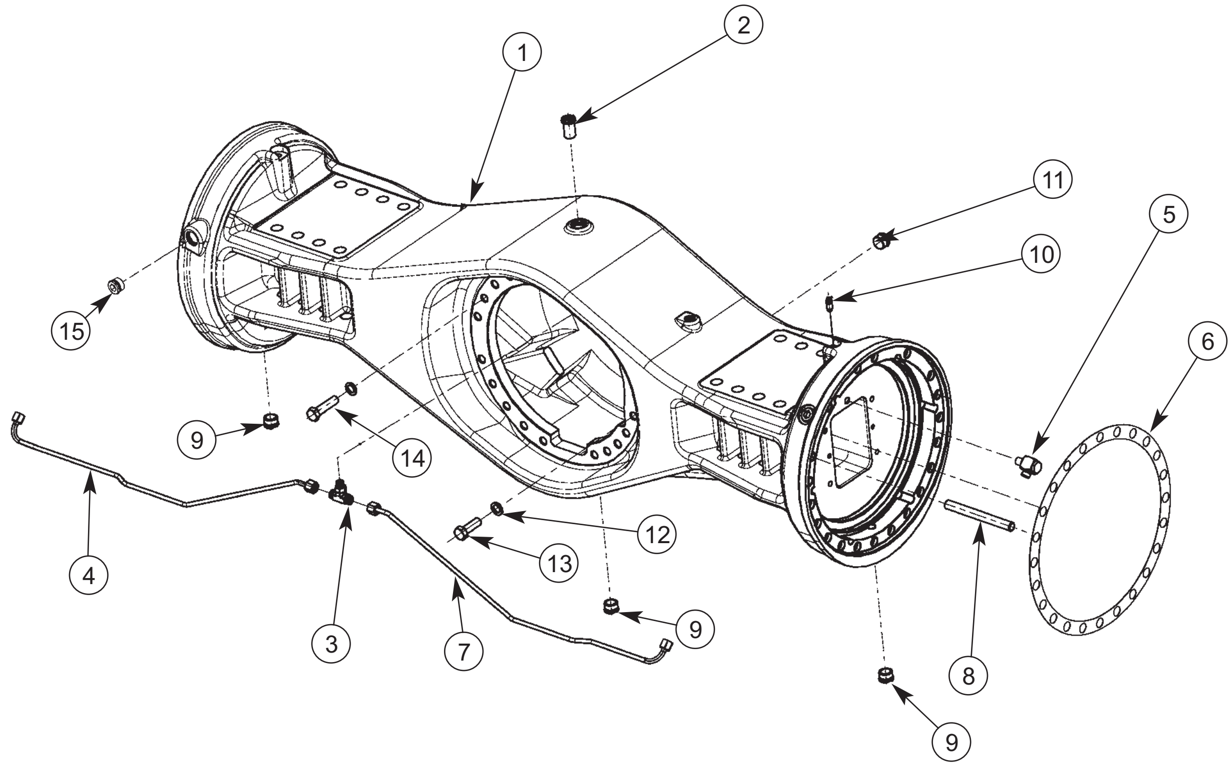

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | AXLE HOUSING | 6 | CAPSCREW |
| 2 | MAGNETIC PLUG | 7 | BLEEDER SCREW |
| 2A | MAGNETIC PLUG- FORCE COOLING OUTLET PORT | 8 | BREATHER ASSEMBLY |
| 3 | FILL PLUG | 9 | SHIM |
| 3A | FILL PLUG - FORCE COOLING INLET PORT | 10 | STUD |
| 4 | HARDENED WASHER | 11 | BRAKE ACTUATION PORT FITTING |
| 5 | CAPSCREW | | |

## Axle Housing Assembly – Heavy Housing Using Recessed Carrier Mounting



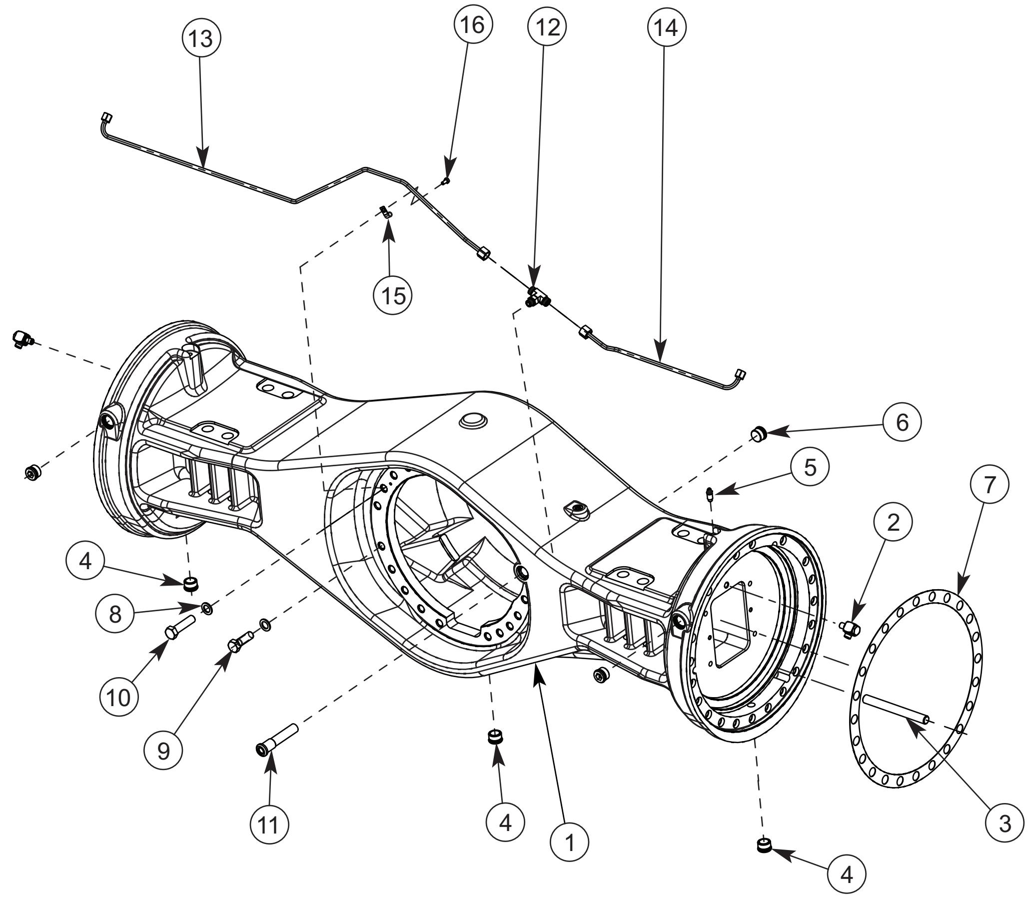

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | AXLE HOUSING | 5 | LOCK NUT |
| 2 | MAGNETIC PLUG | 6 | HARDENED WASHER |
| 3 | FILL PLUG | 7 | CAPSCREW |
| 4 | STUD | 8 | CAPSCREW |

# Heavy Axle Housing With Central Actuation Service Brake – Top Inlet Port




| Item | Description | Item | Description |
|---|---|---|---|
| 1 | AXLE HOUSING | 9 | MAGNETIC PLUG |
| 2 | TOP INLET PORT CENTRAL ACTUATION | 10 | BLEEDER SCREW |
| 3 | HYDRAULIC TEE FITTING | 11 | FILL PLUG |
| 4 | TUBING ASSEMBLY | 12 | HARDENED WASHER |
| 5 | CONNECTOR FITTING ASSEMBLY | 13 | CAPSCREW |
| 6 | SHIM | 14 | CAPSCREW |
| 7 | TUBE ASSEMBLY | 15 | WET DISC BRAKE INSPECTION PORT PLUG |
| 8 | STUD | | |

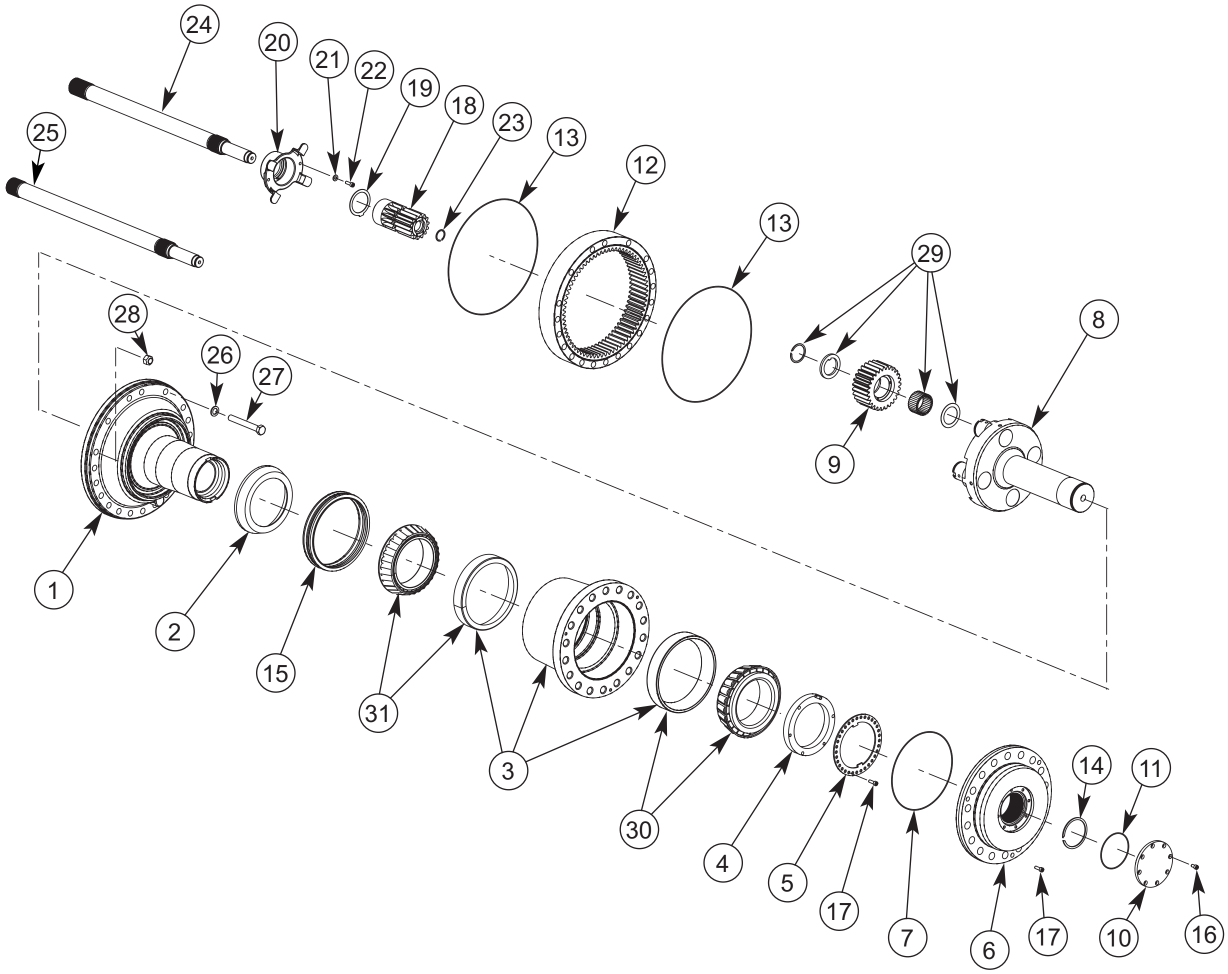
## Heavy Axle Housing With Central Actuation Service Brake – Front Inlet Port




| Item | Description | Item | Description |
|---|---|---|---|
| 1 | AXLE HOUSING | 9 | CAPSCREW |
| 2 | CONNECTOR FITTING ASSEMBLY | 10 | CAPSCREW |
| 3 | STUD | 11 | CENTRAL ACTUATION FRONT INLET PORT |
| 4 | MAGNETIC PLUG | 12 | HYDRAULIC TEE FITTING |
| 5 | BLEEDER SCREW | 13 | TUBE ASSEMBLY |
| 6 | FILL PLUG | 14 | TUBE ASSEMBLY |
| 7 | SHIM | 15 | CLIP, BRAKE TUBE |
| 8 | HARDENED WASHER | 16 | CAPSCREW |

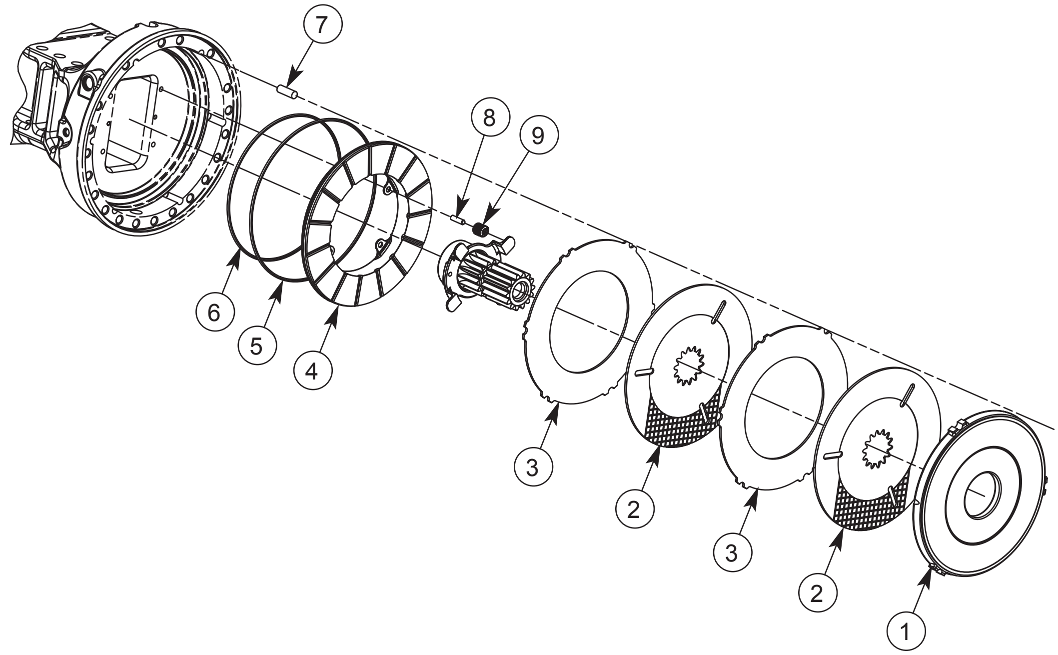
## Exploded View

### Planetary Wheel End Components




| Item | Description | Item | Description |
|---|---|---|---|
| 1 | SPINDLE | 17 | SOCKET HEAD CAPSCREW |
| 2 | WHEEL BEARING SPACER | 18 | PLANETARY SUN GEAR |
| 3 | HUB AND CUP ASSEMBLY | 19 | THRUST WASHER |
| 4 | WHEEL BEARING NUT | 20 | SPRING HOUSING |
| 5 | LOCK PLATE | 21 | HARDENED WASHER |
| 6 | DRIVE FLANGE | 22 | SOCKET HEAD CAPSCREW |
| 7 | O-RING | 23 | SNAP RING |
| 8 | PLANETARY SPIDER ASSEMBLY | 24 | AXLE SHAFT |
| 9 | PLANETARY PINION | 25 | AXLE SHAFT |
| 10 | COVER | 26 | HARDENED WASHER |
| 11 | O-RING | 27 | CAPSCREW |
| 12 | PLANETARY RING GEAR | 28 | LOCK NUT |
| 13 | O-RING | 29 | PLANETARY PINION BEARING KIT |
| 14 | SNAP RING | 30 | BEARING KIT |
| 15 | TRS FACE SEAL ASSEMBLY | 31 | BEARING KIT |
| 16 | SOCKET HEAD CAPSCREW | | |

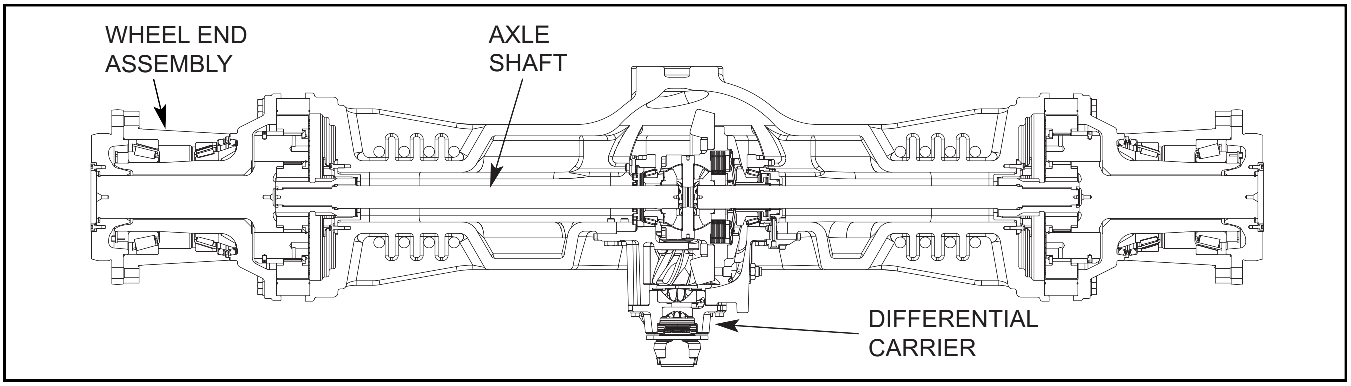
## W3H Shaft Speed Wet Disc Service
## Two Friction Disc Brake



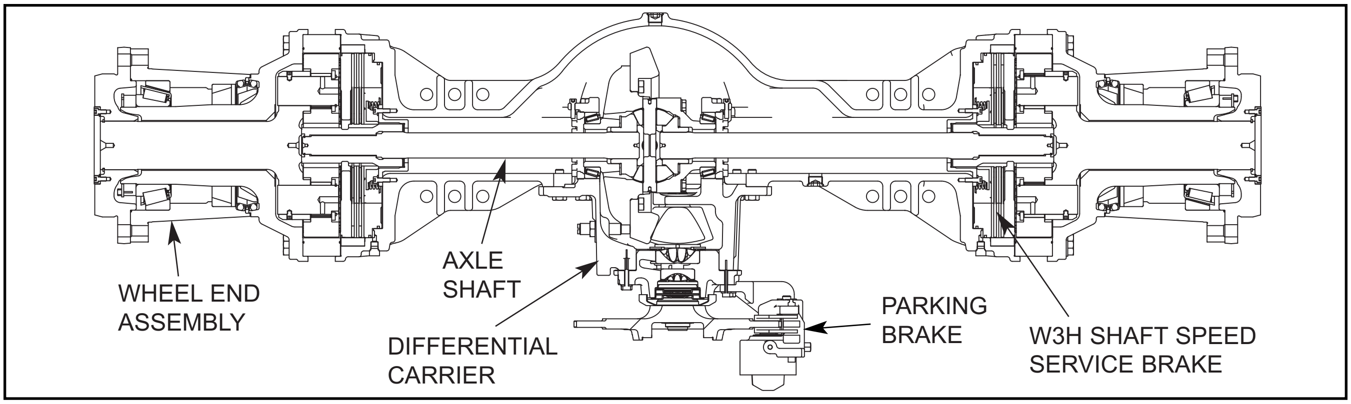

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | BACKING PLATE | 6 | D-RING PISTON SEAL |
| 2 | FRICTION DISC (ROTATING) | 7 | STATIONARY DISC DOWEL |
| 3 | STATIONARY DISC | 8 | SPRING GUIDE DOWEL |
| 4 | PISTON | 9 | RETURN SPRING |
| 5 | D-RING PISTON SEAL | | |

# Axle Cross-Section Views

## Rigid Mount Axle — No Brake




## Rigid Mount Axle — with Service Brake and Parking Brake



## Description

The AxleTech PROC2715 and PRC2715 axle family is a single speed planetary axle series. Key features in this axle family are:

- Hypoid ring and pinion gearing in the carrier assembly.
- Carrier assembly available with standard differential or a hydraulically actuated differential lock (HDL) option.
- Carrier available with trunnion feature option or standard differential.
- Thrust screw standard in carrier shell.
- Axle with a “trunnion” feature option.
- Internal large diameter Wet Disc Brake for service braking.
- Standard cast housing or heavier cast housing.
- Axle housing has wet brake inspection port standard when wet brakes are fitted.
- Internal brake actuation lines standard in the heavy axles with wet disc service brake.
- A planetary system with 3 or 4 planetary pinions per wheel end assembly.
- A common lubrication sump throughout the axle.
- O-ring drain/fill/breather port plugs standard.
- Force cooling inlet and return ports are standard on basic axle housing.
- Park/Emergency brake on carrier input is optional on axles without trunnion option.

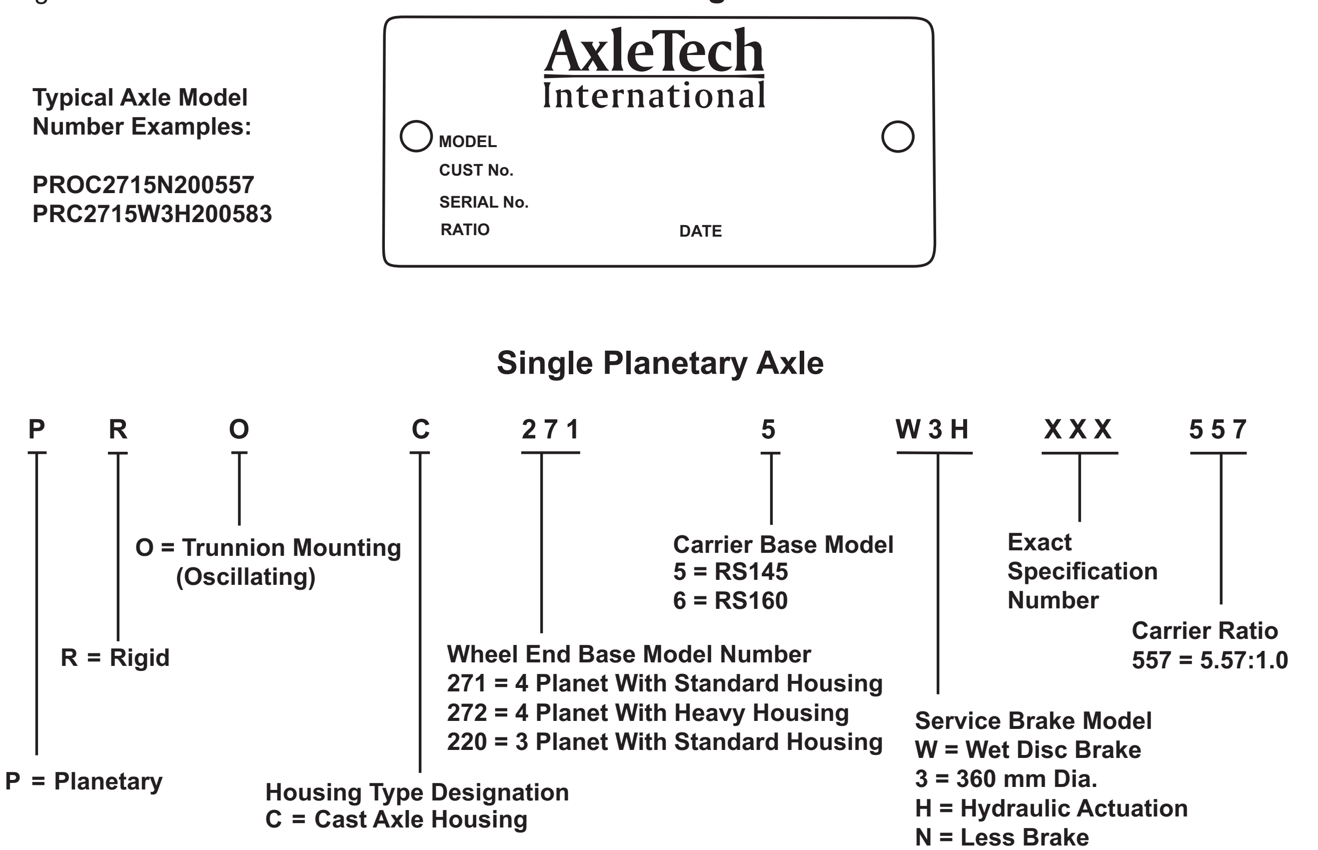
This manual covers the servicing of this axle family. The carrier is covered separately in AxleTech maintenance manual 5.4. Refer to the “How to Order” section to obtain copies of these maintenance manuals. Optional parking brake on carrier input is covered separately in AxleTech maintenance manual 4A.

## Identification

To determine the exact axle model specification, refer to the identification tag fastened to the main housing. **Figure 1.1.**

Figure 1.1

**Axle Tag**



## Removal and Disassembly from the Vehicle

### WARNING

**To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.**

**Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.**

**Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.**

**NOTE:** Any pre-cleaning on vehicle to remove dirt/grease or corrosive material should be per vehicle manufacturer recommendations. Care should be taken to cover the axle breather to limit additional contamination during pre-cleaning process.

1. Park the vehicle on a level surface and block the wheels to prevent the vehicle from moving.
2. Raise the vehicle so that the area you will service is off of the ground. Support the vehicle with safety stands. Refer to the vehicle maintenance manual for instructions on raising the vehicle.
3. Remove and plug any hydraulic differential lock actuation line and any connection to the axle with integral wet brakes by following the OEM vehicle manufactures instructions to close hydraulic valves and plug lines and safe draining of fluids as required. Also disconnect any supplement greasing lines should the trunnion carrier design require servicing per OEM vehicle manufacturers recommendation.

**NOTE:** Dispose of all collected fluids and grease in an environmentally friendly approved practice.

4. Remove the magnetic oil drain plugs from the axle housing bowl (1.06"-12) and each axle housing flange to drain the lubricant into a suitable container. Note amount of metal on the magnetic drain plug and clean drain plug. **Figure 2.2 and 2.3.**
5. Disconnect the vehicle propshaft from the axle input yoke per vehicle manufacturer recommendations. Care should be taken so personal injury does not occur.

### WARNING

**Take care when using lifting devices. When you use a lifting strap, inspect the strap for damage before you use it. Do not use a lifting strap to shock load or drop load a component. Serious personal injury and damage to components can result.**

Figure 2.2 **Rigid Mount Axle Assembly Less Wet Brake**

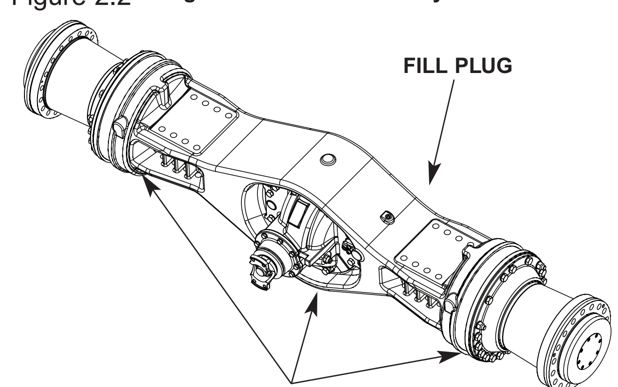
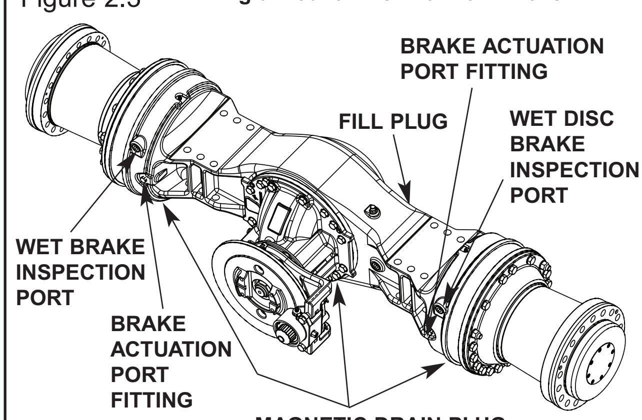



Figure 2.3 **Rigid Mount Axle With Park Brake**

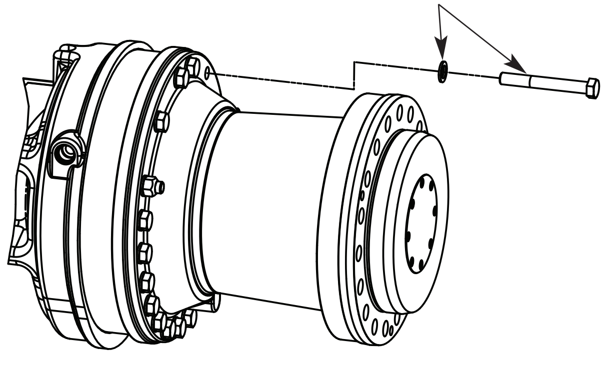


## Wheel End Disassembly Procedure

**NOTE:** There may be some small quantity of oil remaining within the planetary wheel end reduction when the planetary assembly is opened. Care should be taken to capture this small amount of oil for safe and recommended disposal practices.

1. Remove the M18 capscrews and washers from the spindle to axle housing joint. **Figure 2.7.**

Figure 2.7



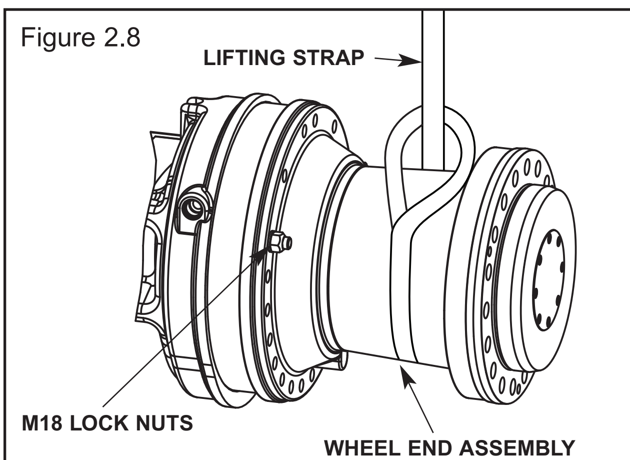

**NOTE:** These capscrews had medium strength thread locker added at original axle assembly.

### WARNING

**Take care when using lifting devices. When you use a lifting strap, inspect the strap for damage before you use it. Do not use a lifting strap to shock load or drop load a component. Serious personal injury and damage to components can result. Figure 2.8.**

2. Support the wheel end to be serviced with a lifting device.
3. Loosen without removing the M18 lock nuts and washers at the studs at the spindle to axle housing joint. **Figure 2.8.**

Figure 2.8

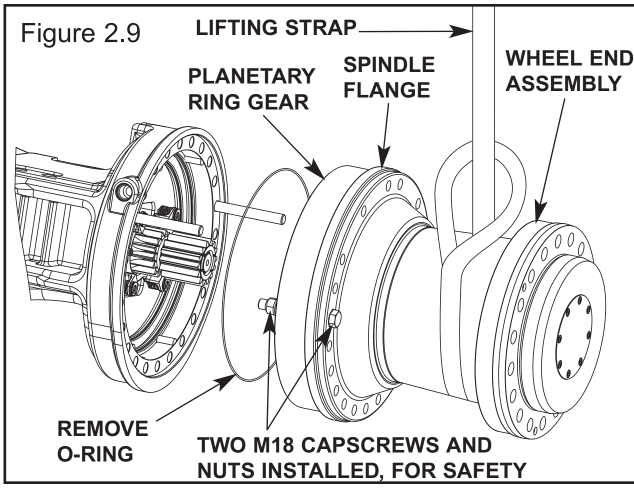



### CAUTION

**Do <u>Not</u> remove the studs as they support the planetary ring gear and spindle assembly on the axle housing. Use care to keep planetary ring gear from falling off spindle flange.**

4. Use a brass or leather mallet to hit spindle flange and loosen wheel end assembly from the axle housing. **Figure 2.9.**
5. Remove O-Ring from inner side of ring gear. For safety, remove M18 lock nuts while wheel end is still supported by studs, assemble (2) M18 cap-screws with washers through spindle flange and planetary ring gear mounting holes and assemble (2) nuts with washers onto capscrew threads so the ring gear cannot fall off the spindle flange. **Figure 2.9.**
6. Remove the wheel end assembly from the axle housing assembly and place safely on a work bench. Where further wheel end disassembly can be completed. **Figure 2.9.**

Figure 2.9

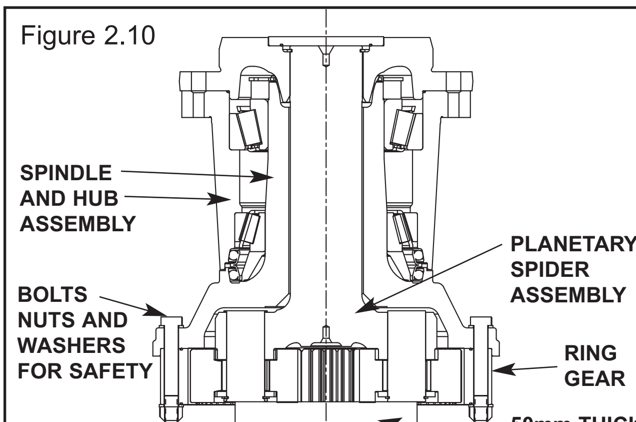



**NOTE:** If the axle to be serviced does not require the planetary wheel end assembly to be further disassembled, please go to required section for specific area of disassembly required.

**NOTE:** To further disassemble the planetary wheel end assembly and to service all the internal wheel end components, the following procedure is recommended:

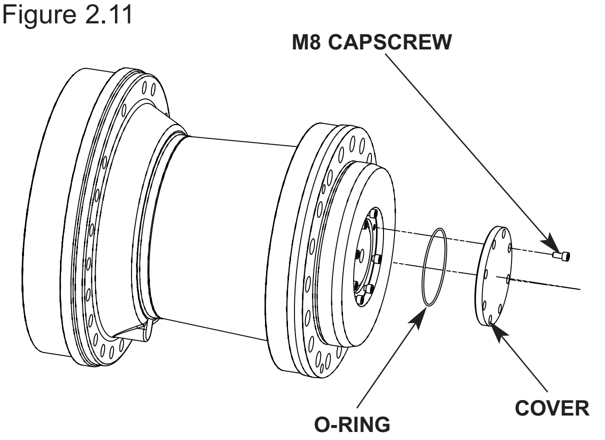
1. For further disassembly set with planetary pin facing downward with planet pins on a 50mm thick spacer whose O.D. is smaller than ring gear's I.D. **Figure 2.10.**

Figure 2.10



2. Remove the socket head M8 capscrews from the cover on the planetary wheel end. **Figure 2.11.**

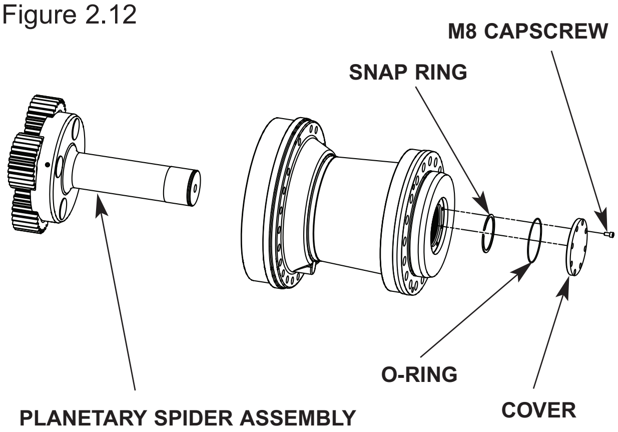
Figure 2.11




**NOTE:** These capscrews had a medium strength thread locker applied at original production assembly.

3. Remove the cover and O-ring from the driver. **Figure 2.12.**

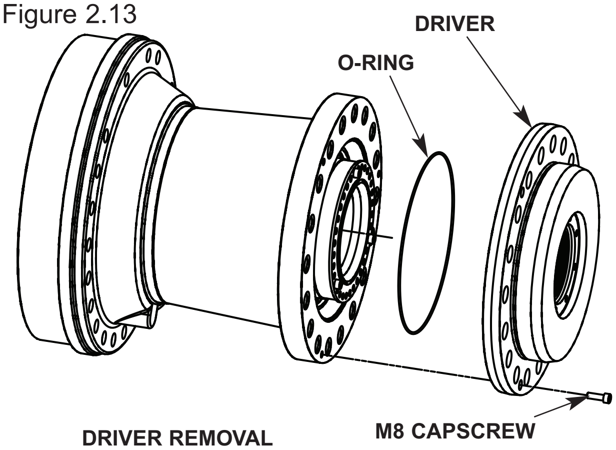
Figure 2.12




4. Remove the snap ring from the planetary spider. The snap ring removal will now permit the wheel end spindle and hub assembly to be carefully removed as a sub assembly from the planetary spider assembly. **Figure 2.12.**

5. Remove the (3) M8 socket head capscrews that retain the driver to wheel hub. **Figure 2.13.**

Figure 2.13

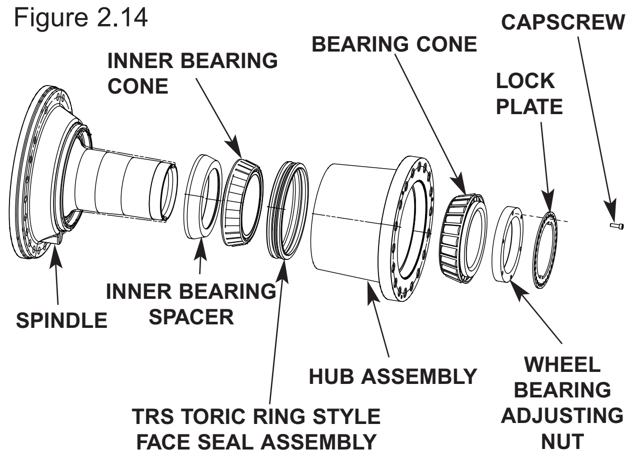



**NOTE:** These capscrews had medium strength thread locker applied at original assembly.

6. Remove the driver and larger O-ring from the wheel hub.

7. Remove the (3) M8 socket head capscrews from the lockplate that retains the wheel bearing adjusting nut. **Figure 2.14.**

Figure 2.14




**NOTE:** These capscrews had medium strength thread locker applied at original assembly.

8. Remove the wheel bearing adjusting nut. Early design nut was hexagonal. Later design is round nut shown. A special tool (860901008T) is available that fits both nuts. (See Special Tool Section for description).

**NOTE**: The bearing cups stay with the wheel hub and the outer bearing cone will be loose while being disassembled from spindle. The inner bearing cone will be removed with the wheel hub assembly and will not stay on the spindle during hub assembly removal. Half of the TRS toric ring face seal will be removed as part of the planetary hub assembly when removed.

9. Remove both the inner and outer bearing cones, planetary hub assembly, and TRS toric ring metal face seal half from the spindle. Wrap the inner and outer bearing cones to prevent contamination and set aside for later cleaning, inspection and re-assembly.

**CAUTION**

**Care should be taken to store the (2) halves of the face seal to protect them from damage and saved for reassembly later when required.**

10. Remove the loose TRS face seal from the spindle. Please use the face seal tool as shown in the special tools section during later reassembly. If removed, store the (2) face seal halves together and wrapped in a manner to prevent contamination or damage to the metal seal surfaces.
11. If required, use a suitable bearing cup puller to remove both the cups from the planetary hub assembly. Wrap both the bearing cups to prevent contamination. If bearing cups are not to be removed, please proceed to the next step.
12. Remove the inner bearing spacer from the spindle only if required. This spacer has had Loctite 680 or equivalent applied at original production assembly and should not be removed unless damaged.

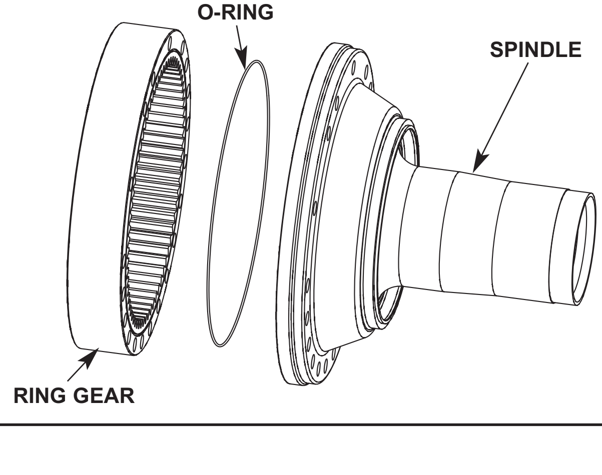
**WARNING**

**Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.**

**NOTE:** Should the planetary spider and gearsets need to be disassembled, please go to the specific section for disassembly required.

13. Remove the planetary ring gear and O-ring from the spindle flange, if required, separate the ring gear and O-ring from the spindle.Set aside these components for later inspection and reassembly. **Figure 2.15.**

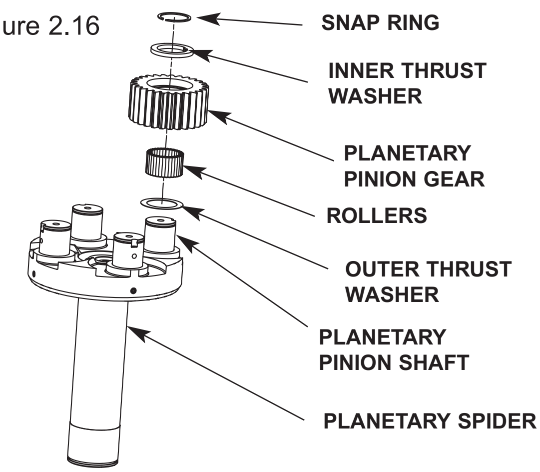
Figure 2.15




## Disassembly of the Planetary Spider Assembly

1. Place the planetary spider assembly safely in a vertical position with the planetary gears facing upwards. **Figure 2.16.**

Figure 2.16




**NOTE:** Using a grease pencil, mark each planet pinion shaft/planetary pinion gear with same number to identify which pinion shaft and gear were originally pre-assembled together for later re-assembly.

2. Mark each planet pinion shaft and its planetary pinion gear with matching numbers.
3. Remove the snap ring from the groove near end of each planetary pinion shaft.
4. Remove the inner washer from each planetary pinion shaft. During removal, mark the washer with the pinion shaft number to retain with same original planetary shaft/gear assembly or place in numbered plastic bags.

**NOTE:** The (33) needle rollers/planetary gear assembly should also be placed in separate bags as removed from each planetary pinion /shaft assembly and marked to keep the rollers with the same planet gear/shaft for later inspection and re-assembly.

5. Carefully lift the planet pinion gear, full complement of needle rollers, and outer thrust washer as an assembly. It may be easier to slide a thin shim stock under the thrust washer or planetary pinion gear as it is lifted to capture all the loose needle rollers. The needle rollers should be retained or replaced, if required, as a set for each planetary pinion and pinion shaft.
6. Using the grease pencil, label the outer washer with the same number as marked for the planetary gear/needle roller assembly.

**NOTE:** Repeat above for each planet gear to be removed.

## Do Not Remove the Planetary Pinion Shafts from the Planet Spider

**NOTE:** The planetary pinion shafts are not serviceable items. Be careful not to bump or damage the pinion shafts.

**CAUTION**

**The planetary pinion shafts are not serviceable items and must not be pressed out of the planetary spider shaft.**

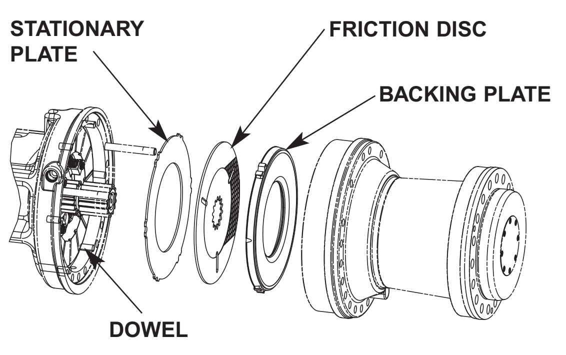
The planetary pinion shafts are precisely "fixture located" in the spider by a heavy press fit. Removal and reassembly of the pinion shafts can change the precision pinion shaft locations relative to each other.

## Disassembly of the Wet Brake Assembly

If the axle being serviced has a wet disc brake, use the following recommended service procedure. **Figure 2.17.** Set aside each component as removed for later inspection and reassembly in the correct order with mating surfaces together. Should the axle being serviced be less wet brake, move to the next section **Disassembly of the Axle Shaft, Snap Ring, Sun Gear Assembly.**

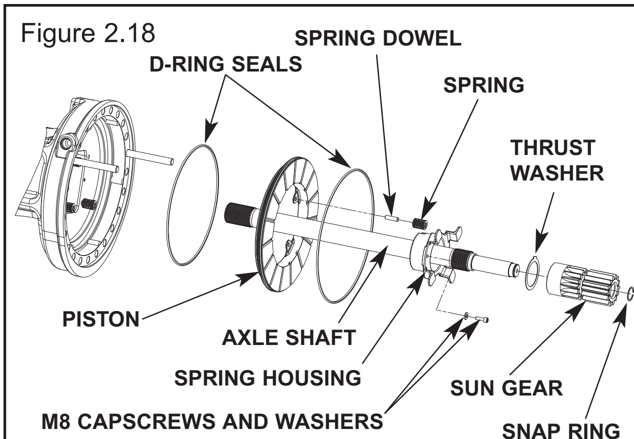
**NOTE:** Number or stack in order of removal the friction discs and stationary plates as a reference during later reassembly.

Figure 2.17




1. The backing plate may now be removed by sliding the backing plate off the dowels located in the axle housing flange.
2. Friction disc can be removed by sliding off the sun gear teeth.
3. The brake stationary plate can be removed by sliding along the axle housing dowels.

Figure 2.18




**NOTE:** Capscrews in spring housing had a medium strength thread locker applied at original production assembly.

**NOTE:** These capscrews also compress the brake return springs on the spring dowels within the brake assembly. **Figure 2.18.**

4. Loosen the (2) M8 spring housing to axle housing capscrews and washers that retain the wet brake piston assembly.
5. Remove the axle shaft, sun gear, snap ring, and thrust washer assembly from the axle housing. The thrust washer may come out with the axle shaft assembly or may stay within the spring housing. Should the thrust washer stay within the spring housing, remove separately after the axle shaft is removed.
6. Remove the spring housing capscrews, washers and return springs from the spring dowels with the spring housing from the axle.
7. Remove the wet brake piston and (2) D-Rings attached.
8. Remove the (2) D-Rings from the wet brake piston for later inspection and reassembly.

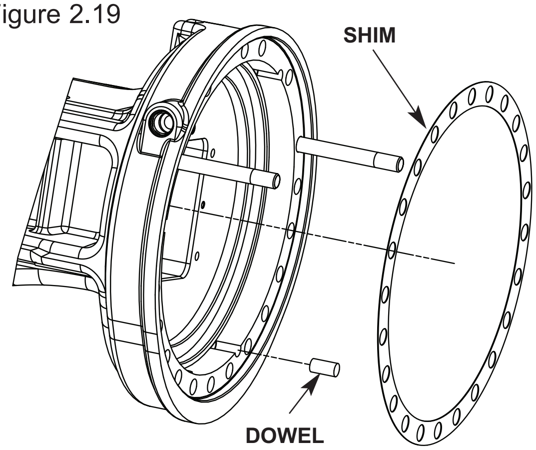
**NOTE:** Dowels might have a light press into the axle housing. If being removed, care should be taken not to damage the dowels to be reused in later reassembly.

9. Remove the (2) wet brake spring dowels from axle housing, only if required.

**CAUTION**

**Follow recommended glue manufacturers recommendations for safe usage and to avoid potential irritation to skin, eyes, etc.**

Figure 2.19




10. Remove the shim that is glued onto the axle housing flange face, only if required, by using a suitable glue dissolving agent. Removal of this shim is only required, if the removal of any of the (6) dowels fixed into the axle housing flange is required. During removal, the shim could be destroyed, so replacement with a new shim is recommended. **Figure 2.19.**
11. Remove the (6) dowels from the half rounds in the axle housing flange, only if required. If being removed, care should be taken not to damage the dowels to be reused in later reassembly.

## Disassembly of the Axle Shaft, Snap Ring, Sun Gear Assembly

To complete disassembly of the axle shaft, sun gear, snap ring sub assembly, use the following recommended procedure. **Figure 2.18.**

1. Remove the axle shaft, sun gear, snap ring and thrust washer assembly from the axle housing, if not already removed. (Axle being serviced is less wet disc brake).The thrust washer may stay within the spring housing when the axle shaft is removed. Should the thrust washer stay within the spring housing, remove the thrust washer separately after the axle shaft is removed.
2. Remove the snap ring retaining the sun gear on the axle shaft.
3. Remove the sun gear from the axle shaft.
4. Remove the thrust washer from the axle shaft.

With the axle shafts removed, the carrier assembly removal, as well as servicing the internal hydraulic brake tubing assemblies if equipped with the wet brake option, is now possible.

**NOTE:** For recommended carrier removal procedure, the AxleTech carrier maintenance manual 5.4 should be used for recommended disassembly, inspection, and reassembly procedures.

## Disassembly of Wet Brake Actuation Tubing Assembly

If the axle being serviced has a wet disc brake with central actuation, then there will be internal wet brake actuation tubing assemblies in the axle housing assembly. These tubing assemblies will be accessible for service when the carrier assembly, axle shaft and planetary wheel ends are removed. “The following service procedure is recommended to disassemble the brake tubing assemblies, if required.

1. Loosen both the (2) M14 hydraulic nuts fitted to the tee near the carrier bowl of the axle housing.
2. Loosen the hydraulic nut in the axle housing flange ends that retains the opposite end of each tube assembly. Mark tubing for later reassembly in same locations.
3. The complete hydraulic tube assembly can now be removed separately from the axle housing from each of the housing flange ends.
4. The hydraulic tee can now be unscrewed from the axle housing carrier bowl area.

**NOTE:** This inlet port had high strength thread locker applied at original production assembly.

5. The M22 hydraulic inlet port can be removed, only if required, from the axle housing.

**NOTE:** For the axle equipped with the wet brakes, there are O-ring oil fill/drain plugs. The lower (3) plugs are magnetic plugs. These plugs must be removed and cleaned.

**WARNING**

**To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.**

**Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, and emulsion-type and petroleum-base cleaners. Read the manufacturer's instructions before using a solvent cleaner, then carefully follow the instructions. Also follow the procedures below.**

- **Wear safe eye protection.**
- **Wear clothing that protects your skin.**
- **Work in a well-ventilated area.**
- **Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.**
- **You must use hot solution tanks or alkaline solutions correctly. Read the manufacturer's instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.**
- **Remove gasket material from parts. Take care not to damage ground surfaces.**
- **Do NOT clean ground or polished parts in a hot solution tank, water, steam or alkaline solution.**

**Take care when you use Loctite® adhesive to avoid serious personal injury. Read the manufacturer's instructions before using this product. Follow the instructions carefully to prevent irritation to the eyes and skin.**

## Clean Rough Parts

1. Clean rough parts with the same method as cleaning ground and polished parts.
2. Rough parts can be cleaned in hot solution tanks with a weak or diluted alkaline solution.
3. Parts must remain in hot solution tanks until heated and completely cleaned.
4. Parts must be washed with water until all traces of the alkaline solution are removed.

## Clean Ground and Polished Parts

1. Use a cleaning solvent to clean ground or polished parts or surfaces. Kerosene or diesel fuel oil can be used for this purpose. Do not use gasoline.
2. Use a tool with a flat blade if required, to remove sealant material from parts. Be careful not to damage polished or surfaces.

**CAUTION**
**Do not use hot solution tanks or water and alkaline solutions to clean ground or polished parts. Damage to parts can result.**

3. Do not clean ground or polished parts with water or steam. Do not immerse ground or polished parts in a hot solution tank or use strong alkaline solutions for cleaning, or the smooth sealing surface may be damaged.

## Cleaning the Axle Housing Assembly

**NOTE:** Refer to manual 5.4 to Clean and Inspect the Carrier. Follow all recommended procedures and comments with all Warnings and Cautions noted.

- An axle housing may be steam cleaned on the outside to remove dirt. If cleaning only outside of housing, cover over all openings in the axle assembly. Examples of openings are breathers (unless breathers are remote mounted).
- The axle housing may be steam cleaned internally when all components and plugs are removed. Cover over all openings in the axle assembly. Examples of openings are breathers (unless breathers are remote mounted).
- The axle housing should be inspected for any signs of housing cracks or other wear damage. All threaded holes should be reviewed to assure threads are not damaged for re-assembly. Threaded holes may be repaired by thread metric taps, if possible.
- Remove all metallic particles from all the magnetic drain plugs.
- After cleaning, check behind the internal flange in carrier area for contaminants. Also, check housing arms for contaminants. Remove any contaminants prior to reassembling.

## Dry Parts After Cleaning

1. Parts must be dried immediately after cleaning and washing.
2. Dry the parts using soft, clean paper or cloth rags.

**CAUTION**
**Damage to bearings can result when they are rotated and dried with compressed air.**

3. Except for bearings, parts can be dried with compressed air.

## Prevent Corrosion On Cleaned Parts

1. Apply axle lubricant to cleaned and dried parts that are not damaged and are to be re-assembled.
2. To store parts, apply a special material that prevents corrosion to all surfaces. Wrap cleaned parts in a special paper that will protect the parts from moisture and prevent corrosion.

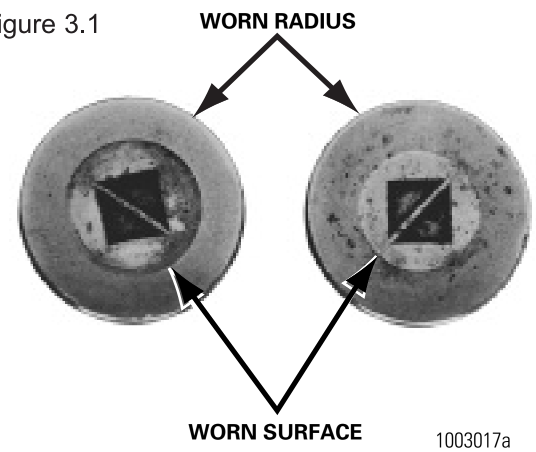
## Inspect Parts

### Tapered Bearing

It is very important to inspect all parts carefully and completely before the axle assembly is assembled. Check all parts for wear and replace damaged parts. Replacement of damaged or worn parts will prevent breakdown of assembly later. Inspect the cup, cone, rollers and cage of all tapered roller bearings in the assembly. If any of the following conditions exist, replace the bearing.

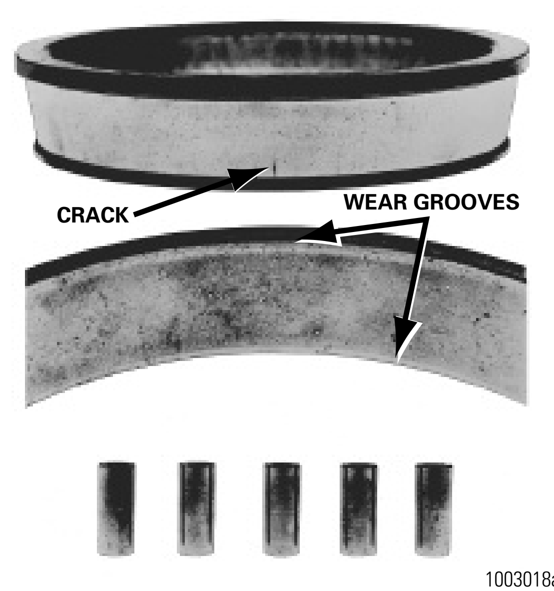
- The large-diameter end of the rollers is worn level with or below the center surface. **Figure 3.1.**

Figure 3.1




- The radius at the large-diameter end of the rollers is worn to a sharp edge. **Figure 3.1.**
- There is a visible roller groove in the cup or cone inner race surfaces. The groove can be seen at the small- or large-diameter end of both parts. **Figure 3.2.**

Figure 3.2

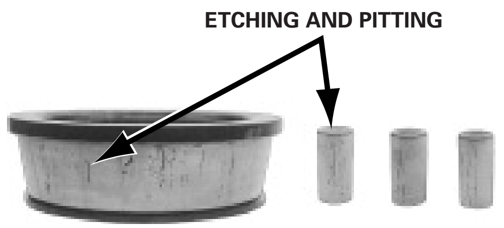



- There are deep cracks or breaks in the cup, cone inner race or roller surfaces. **Figure 3.2.**
- There are bright wear marks on the outer surface of the roller cage. **Figure 3.3.**

Figure 3.3

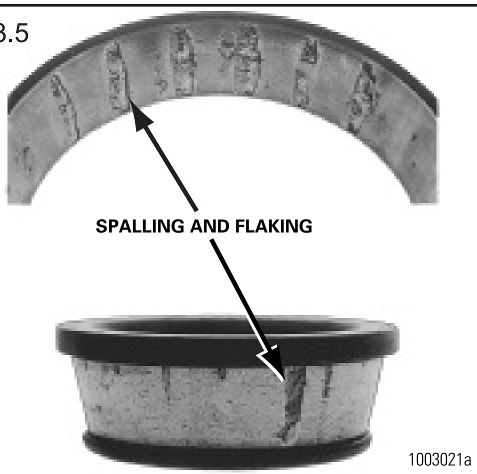
- There is damage on the rollers and on the surfaces of the cup and cone inner race that touch the rollers. **Figure 3.4.**

Figure 3.4




- There is damage on the cup and cone inner race surfaces that touch the rollers. **Figure 3.5.**

Figure 3.5



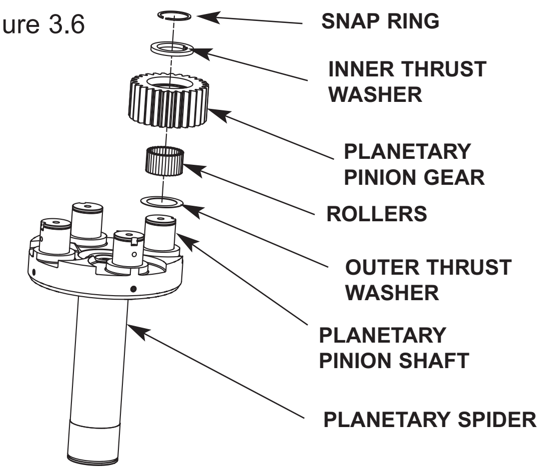

- There is any sign of cracks or damage to the roller cage assembly that retain the individual taper rollers.

## Planetary Wheel End Gearing

**CAUTION**
**The planetary sun gear, planetary gears and ring gear work together similar to a matched set. Damage to the sun gear or planet gears can also damage the planetary ring gear. It is strongly recommended that when any noted damage to any of these gears might occur, the complete set in a planetary wheel end should be changed.**

- All gears should be inspected for cracks, chipping of the teeth, scoring, pitch line damage, or heavy teeth wear.
- The planetary pinion gears should also be checked for any signs of wear or smoothness damage to the pinion gear bores.
- The planetary ring gear should be checked for signs of heavy wear, teeth chipping or scoring or deep scratches around the O-ring groove diameters.
- The planetary sun gear should be checked for any signs of wear on the gear teeth, scoring, chipping of gear teeth, signs of wear or burrs on the wet brake splines on the sun gear, and internal spline wear, burrs, or other spline damage. **Figure 3.6.**

Figure 3.6




**CAUTION**
**The planetary pinion shafts are not serviceable items and must not be pressed out of the planetary spider shaft. Also take care to maintain the matched set markings on planet pinion shafts during cleaning process.**

## Needle Roller Bearings

**CAUTION**
**Any damage to these rollers can damage the planetary pinion shaft or pinion gear bore. The needle rollers should also be inspected for end wear on the individual needle rollers.**

All the planetary pinion gears have a “full complement” of needle roller bearings. Keep (33) needle roller bearings grouped with their planet gear. These needle rollers should be inspected for roughness, pitting, or any signs of wear to the individual roller outer diameter surface.

## Planetary Wheel End Thrust Washers

**WARNING**
**Any wear will cause metallic debris and early component failures.**

The planetary thrust washers should be examined for any signs of wear on the flat thrust surfaces from either the needle rollers or the planetary pinions rubbing against this surface.

## Planetary Spider Shaft

Inspect the planetary spider shaft for any signs of wear, burrs, scratches or other damage to the planetary pinion shafts. Inspect the splines where the driver is mounted for signs of wear and the snap ring groove for wear or burrs.

## Wheel End Spindle

Inspect the planetary spindle for any damage or scratches to the bearing journals. The face seal bore should be inspected to review for scratches to the seal bore. Light clean up is allowed with emery cloth, fine file, India stone, or crocus cloth. The spindle bore and threads should be checked for wear or any damage for the nut locking system. The spindle should also be reviewed in the lock plate mating tang interfaces for any burrs, signs of damage or wear. The spindle thread for the wheel bearing adjusting nut should be reviewed for any damage to the threads that will not allow the spindle adjusting nut to assemble. Minor repair is allowed to this thread by using a metric thread die or file to repair a damaged thread.

## Driver

The driver should be inspected for any signs of wear, burrs, or damage to the internal splines that attach to the planetary spider shaft. Burrs may be removed by use of a light file. Look for any rubbing marks indicating contact with end of spindle. Any interference should be removed by grinding spindle's tapered inside diameter.

## Planetary Nut Lock System

Inspect the wheel bearing adjusting nut, lock plate, and capscrews for any signs of wear or damage. The capscrew thread should have the previously applied thread-locker removed during cleaning, prior inspection. The capscrews should be replaced if any damage is noted on the threads. Inspect the tangs on the lock plate for any signs of wear or damage to the lock plate capscrew holes.

## Planetary Assembly O-Rings

Inspect each O-Ring for any signs of wear, being torn, pinched, cut, nicked, or swelling. Replace if damage is noted.

## Axle Shafts

Inspect axle shafts for wear and cracks at the shaft and splines. Replace the axle shafts, if required. Inspect axle shaft snap ring groove for burrs. Clean up is permitted by using a light file.

## Axle Housing

Inspect the axle housing for any signs of cracks, or damage from service usage, or stripped threaded holes.

**WARNING**

**Repair of axle housings by bending or straightening can cause poor or unsafe vehicle operation and axle failure. Any axle housing bending or straightening is Not allowed. Serious personal injury and damage to components can result.**

The housing material for PRC2715, PRC2725, PRC2726, PROC2715 and PROC2725 axle families is not suitable for welding. Do not attempt to repair weld a drive axle. All threads should be cleaned to remove previously applied thread-locker for later reassembly.

## Wet Brake Assembly Components

Inspect the wet brake components per the following recommended procedures:

1. Inspect the friction and stationary brake discs for flatness and wear. The friction disc lining should be inspected to check for unusual wear. Measure the thickness of the discs. Overall thickness should not

be less than that shown in Table 1. Replace the entire disc pack if one disc needs replacing.

**Table 1.**

| Minimum Brake Disc Thickness | | |
|---|---|---|
| **Disc Type** | **Part Number** | **Minimum Thickness** |
| Friction | A3281L1260 | 0.192 Inch (4.87 mm) |
| Stationary | 3281M1261 | 0.167 Inch (4.24 mm) |

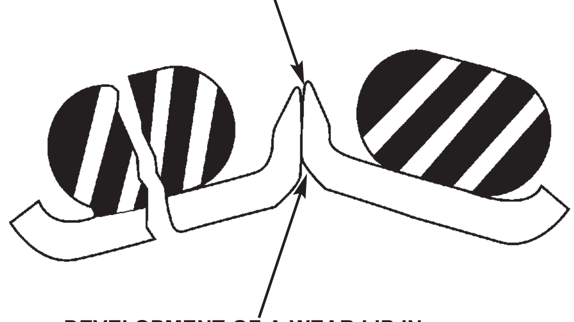
2. The splines on the friction disc should be reviewed for wear or cracks evident on the spline teeth. The backing plate and stationary disc should be inspected for scratches on the mating surface to the friction disc. Scratches may be removed with emery cloth, India stone, or crocus cloth. The tangs on the stationary disc(s) should be inspected for wear.
3. Inspect the backing plate for scratches on mating surfaces to the friction plate. Scratches may be removed with emery cloth, India stone, or crocus cloth. The tangs should be inspected for wear.
4. Inspect the wet brake piston for any signs of wear or light scratches. The piston's 2 seal grooves need to be inspected for any wear or burrs. Burrs and light scratches may be removed with emery cloth, India stone, or crocus cloth. Inspect the housing's piston bores for wear or rough spots. Polish out rough spots with fine crocus cloth.
5. Inspect the D-Ring seals for nicks, cuts, torn material, swelling, or evidence that the seal is damaged or worn. If any damage is noted, these D-Ring seals should be replaced with new components.
6. Inspect the wet brake piston return springs and dowels for damage or wear. Scratches on the dowels, may be removed with emery cloth, India stone, or crocus cloth.
7. Inspect any wet brake hydraulic tubing assemblies and the fittings for any signs of damage to the tubes, hydraulic nut faces, or fitting threads. Replacement with new components is required if any damaged is noted.
8. Inspect TRS Toric Ring face seals as follows:

### CAUTION

**Install face seal halves in the same positions where they were located prior to disassembly. Mixing up face seal halves can cause component damage.**

- Look for obvious signs of damage. Replace any damaged face seal or O-ring. Replace any O-ring that is stuck to the seal or brake housing or any that has taken a "set" or cannot be pulled and "snapped" into position on the seal ring retaining lip.
- Toric Ring formed face seals are more flexible than cast ring seals and, as a result, produce a wear pattern different than cast ring designs. Typically, formed seals wear in an axial rather than radial direction, as depicted below, due to their increased flexibility. **Figure 3.7.**

Figure 3.7




- The total thickness of the flange is the usable wear material on the formed seal rings, and good seal performance can generally be expected until the flange is completely worn away. Estimate the remaining service life of the seal ring by measuring the ring flange thickness and comparing that measurement to those listed in **Table 2.** The minimum flange thickness required for seal ring usability is 1.27 mm (0.050 in.).
- With formed seal rings, the measured parameter used to check the remaining seal ring life is the flange thickness at the outer edge. Measure carefully, since the shoulder is only 1.52 mm (0.060 in.) from the edge of the flange.

**Table 2. Formed Seal Wear Chart**

| Flange Thickness mm (inch) | Seal Wear % Worn |
|---|---|
| 1.91 (0.075) | 0 |
| 1.59 (0.062) | 25 |
| 1.27 (0.050) | 50 |
| 0.95 (0.038)* | 75 |
| 0.64 (0.025)* | 100 |
| 0.32 (0.012)* | 125 |
| 0.00 (0.000)* | 150 |

*Seal ring not usable. Replace seal ring.

## Repairing or Replacing Parts

Replace worn or damaged parts of an axle assembly. The following are some examples to check for repair and possible replacement:

- Replace any fastener if corners of the head are worn.
- Replace washers if damaged.
- Replace oil seals or grease seals at the time of axle repair.
- Clean parts and apply new liquid gasket material where required when the axle is assembled.
- Remove nicks, marks and burrs from parts having machined or ground surfaces including axle shaft splines. Use a fine file, India stone, emery cloth or crocus cloth for this purpose.

**CAUTION**

**Threads must be without damage and clean so that accurate adjustment and correct torque values can be applied to fasteners and parts.**

- Clean and repair threads of fasteners and holes. Use a thread die or tap of the correct size or a fine file for this purpose.
- Tighten all fasteners to correct torque values.

## Removing Dri-Loc Fasteners

If it is difficult to remove fasteners from components, the strength of Dri-Loc, adhesive or medium and high strength thread-locking compound can be decreased by heating. Refer to the following procedure.

**CAUTION**

**Do not exceed 177° C (350° F) maximum. Heating must be done slowly to prevent thermal stresses in the other components.**

1. Heat the fastener for three to five seconds only. Try to loosen the fastener with a wrench. Do not use an impact wrench to loosen the fastener or hit the fastener with a hammer.
2. Repeat Step 1 until you remove the fastener.

## Preparing Surfaces, Threaded Holes and Fasteners for Later Assembly.

1. Clean the oil and dirt from threaded holes. Use a wire brush.
2. Remove all the old gasket material from both surfaces.
3. Clean the surfaces where silicone gasket material will be applied. Remove all the oil, grease, dirt and moisture without damaging the mating surfaces.
4. Dry both surfaces.

## Flush Lube from the Axle

The entire rigid mount axle housing assembly shares the same oil. Lubricant contamination of the wheel end or housing bowl can spread to all areas of the axle. Flush the lubricant from the entire axle housing before you assemble the axle.

1. Reminder note that there are (3) magnetic plugs in an axle assembly , (1) in the carrier bowl bottom and (1) each in the axle housing flange bottom. These must be removed and cleaned of any metallic debris before axle reassembly.
2. The oil fill plug located in back of axle housing bowl is non-magnetic. This plug can also be removed during axle cleaning.
3. For axles that have internal wet brake option: there are (2) wet brake inspection plugs that are located (1) in each axle housing flange. These plugs are also non- magnetic.
4. Clean any debris from behind internal flange in housing bowl area.
5. Verify all contaminants in housing leg areas have been removed.

## Axle Assembly

General comments to be applied to the Axle Assembly Procedures and Recommendations:

1. Clean and dry all surfaces to which sealant or adhesive will be applied.
2. Clean and dry all threads of capscrews or holes to which thread locker will be applied.
3. Apply thread locker to capscrew threads in through holes, and into tapped holes when blind holes.
4. All fastener torques and recommended thread locker types are located in a table listed in the “Torque Table” in section 6 in this manual by thread size and location.
5. Torquing of all capscrews is to be done in a crossing pattern for even clamping.
6. Taper bearing cones and cups must be from the same bearing vendor. Do Not mix cups and cones in mating assemblies or same axle wheel ends.
7. Needle bearings must be from the same bearing vendor, if being replaced from disassembly, and not mixed in re-assembly. Variations in different bearing vendors can adversely impact needle bearing life.
8. After pressing a bearing cone/cup into an assembly, use a 0.025mm (0.001”) feeler gauge to verify assembly is properly installed against bearing cone/cup shoulder.
9. Mating surfaces between 2 components must be free of “positive” indentations (with material above surface). Minor “negative” indentations are permitted.
10. Functional critical surfaces must be free from defects:
    Friction faces on the wet brake /Hydraulic differential lock stationary discs and reaction plates.
    Piston bores of the wet brake and Hydraulic differential lock components.
    Seal races or seat, O-Ring sealing surfaces.
    Planet pinion bore, planet pinion shaft.
11. Use of the correct assembly tools are recommended to assure a quality rework on these axle components. A listing of the recommended assembly tools is indicated in the “Special Tools” section and are available upon request. Use of incorrect assembly tools may cause damage to component being installed and other components associated with component being assembled.
12. All friction discs must be pre-soaked for at least 12 hours in axle oil after rotating wheel end prior to vehicle use.
13. Following the final axle assembly, there are 4 axle tests that should be performed to help assure a quality re-assembly. (Information on each of these tests are located in the assembly section as the axle group is assembled or in the carrier manual 5.4 for the carrier test if done separately prior axle re-installation).
    a. Carrier Hydraulic Differential Functional and Leak Test (if HDL differential equipped).
    b. Wet Disc Brake Functional and Leak test. (if equipped).
    c. Axle Air Leak Test.
    d. Axle Spin Test.

**NOTE:** Refer to AxleTech manual 5.4 to follow the differential carrier assembly recommended procedures.

**Thread Locker’s, Adhesives, Sealants**
AxleTech STF specs for organic materials are called out across the text. Use table below to identify approved compounds.

| AXLETECH STF SPEC | DESCRIPTION | APPROVED COMPOUND | WHERE USED |
|---|---|---|---|
| STF 02-452 | Retaining compound, anaerobic | Loctite 680 | Diff. case bearing cup<br>Wheel bearing spacer<br>Planetary ring gear shim |
| STF 02-435 | Sealant, anaerobic flexible | Loctite 518 | Pinion cage shim pack |
| STF 02-458 | Retaining compound, anaerobic | Loctite 635 | Diff. case bearing cup<br>Wheel bearing spacer<br>Planetary ring gear shim |
| STF 02-437 | Sealant, RTV non-corrosive | Loctite 5699<br>Permatex 82194<br>Three Bond 1216<br>Three Bond 1216E | Input yoke spline<br>HDL inlet port<br>Ring gear thrust screw<br>Housing, carrier face<br>Housing, trunnion adapter face |

## Assembly of the Axle Housing Components with Central Actuation Wet Disc Brake Feature Option

**WARNING**

**Use straps to lift axle housing into safe axle work-stand with lifting straps. Care should be taken to secure the axle housing so personal injury or component damage does not occur.**

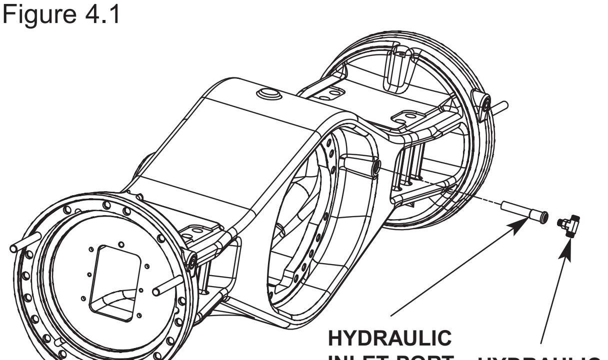
**WARNING**

**Take care when using lifting devices. When you use a lifting strap, inspect the strap for damage before you use it. Do not use a lifting strap to shock load or drop load a component. Serious personal injury and damage to components can result.**

1. Using lifting straps ,safely lift the clean axle housing and place in axle stand with carrier bowl opening facing forward to assemble brake tubing components if axle has the central actuation wet brake option. If the axle is without central actuation wet brakes, skip to **"Install Carrier into Axle Housing Assembly"** section.

If the axle being assembled has the wet disc brake central actuation port option, follow the recommended assembly procedure. Should the axle being assembled not have a central actuation wet disc brake option, skip to the next section. **Figure 4.1.**

Figure 4.1




1. If the central actuation hydraulic inlet port was previously removed from the axle housing, apply high strength thread-locker to M22 threads of hydraulic inlet port and insert into the top or front of the axle housing near the carrier area.

**NOTE:** The internal hydraulic tee-fitting (see page 5) may be used to install the hydraulic inlet port by applying oil to the tee threads and screwing the tee fitting into the flange side of the port using it to turn in the hydraulic inlet port until hydraulic port is fully installed. Refer to "Torque Table" in section 6.

**NOTE:** It is recommended that before removing the hydraulic tee-fitting or special tool to wait at least 15 minutes to allow the thread locker to become effective.

2. Apply oil on the thread of the tee-fitting, if using it as a temporary tool.
3. The tool should be removed from the inlet port once the port is installed, after waiting a minimum of 15 minutes.
4. Before installing the hydraulic tee-fitting into the axle housing, back off the jam nut against the shoulder and install the tee-fitting into the inlet port inside the carrier bowl by hand tightening and then slowly loosen tee to align with direction of both hydraulic brake tubes.

**NOTE:** These brake tubes will only fit correctly installed into the correct side of the axle housing. If previously marked during disassembly, this would assist in re-assembly in correct positions.

5. Insert both the brake tubes and fittings at the same time from each of the axle flange ends to optimize the fit into the axle housing.

**NOTE:** The brake tubes have threaded hydraulic nuts on each end.

6. Hand -tighten each brake tube assembly to the hydraulic tee.
7. Hand tighten each brake tube assembly on the banjo fittings aligning with the ports in the axle housing.

**NOTE:** Care should be taken to not exceed the recommended torque value and over stress the other connections in the tubing assemblies.

8. Tighten the M12 banjo fittings by holding the banjo stationary while using a wrench to tighten its bolt per “Torque Table” in section 6. T
9. Tighten the tee-fitting to inlet port nut, refer to “Torque Table” in section 6. T
10. Tighten the banjo-fitting to hydraulic brake tube nuts (11/16”), per “Torque Table” in section 6. T
11. Install any internally mounted brake tube clips over the tube.

## Install Carrier into Axle Housing Assembly

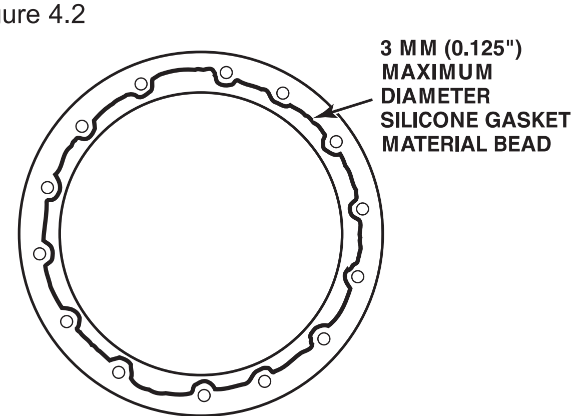
1. Using the lifting straps, lift the axle housing assembly and rotate the axle housing to have the carrier bowl opening facing upwards and safely secure the axle housing so no personal injury or component damage can occur.

### WARNING

**When you apply some silicone gasket materials, a small amount of acid vapor is present. To prevent serious personal injury, ensure that the work area is well-ventilated. Read the manufacturer’s instructions before using a silicone gasket material, then carefully follow the instructions. If a silicone gasket material gets into your eyes, follow the manufacturer’s emergency procedures. Have your eyes checked by a physician as soon as possible.**

- Apply 3.0 mm (0.12 inch) bead of sealant STF 02-437 to the axle housing where the carrier assembly will be assembled. **Figure 4.2.**

Figure 4.2

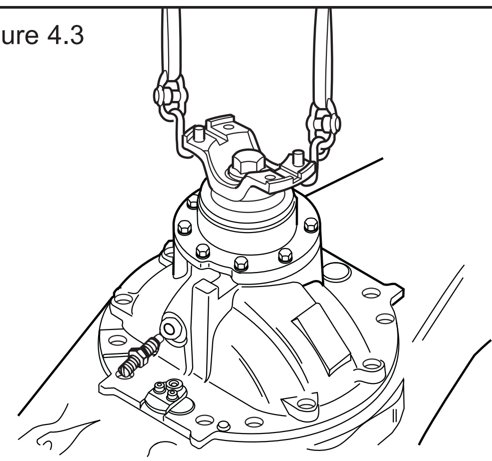



### CAUTION

**Take care when using lifting devices. When you use a lifting strap, inspect the strap for damage before you use it. Do not use a lifting strap to shock load or drop load a component. Serious personal injury and damage to components can result.**

- Using the lifting straps to safely lift the carrier assembly and install into the axle housing. **Figure 4.3.**

Figure 4.3



2. Apply high strength thread locker to each of the capscrew threads and install the M16 hex head carrier to axle housing capscrews and hardened washers and tighten per “Torque Table” in section 6. T

## Axle Housing Plugs Assembled

Figure 4.5 **Rigid Mount Axle Assembly Less Wet Brake**

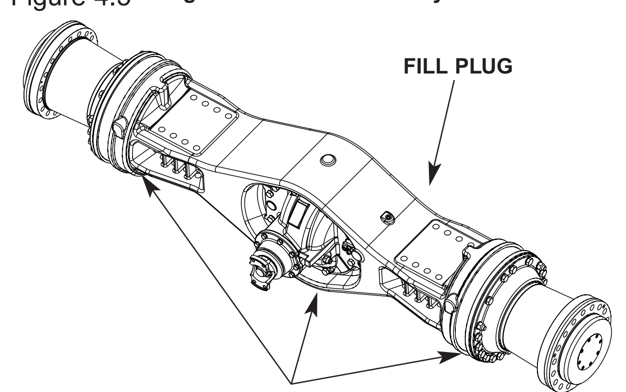
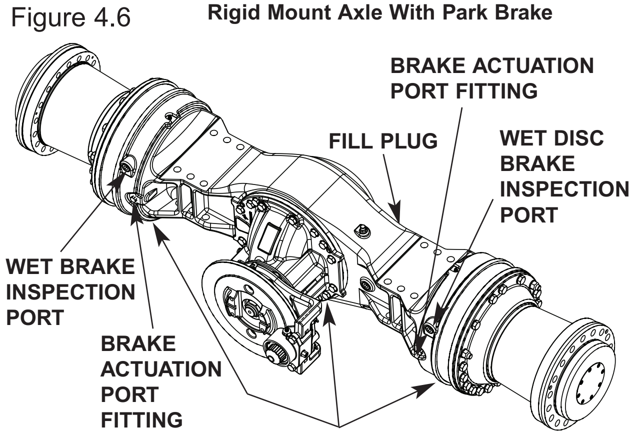



Figure 4.6 **Rigid Mount Axle With Park Brake**




1. Install the (1.06”) non-magnetic oil fill plug with O-ring assembly into the upper carrier bowl area of the axle housing. Tighten per “Torque Table” in section 6. T
2. Install the (3) (1.06”) axle magnetic drain plugs with O-ring assemblies into the axle housing in the bottom of the carrier bowl and at the bottom of each axle flange. Tighten per “Torque Table” in section 6. T
3. Install axle breather in the 3/8-18 NPSF port.

If the axle being assembled has the wet brake feature, need to include the following additional steps:

1. Install the (2) (1.06”) wet brake inspection port non-magnetic plugs with O-rings assembled, if this axle has wet brake option. Tighten per “Torque Table” in section 6. T
2. Install the (7/16”) wet brake bleeder on the top of each axle housing flange, if this axle has the wet brake option. Tighten per “Torque Table” in section 6. T

## Axle Without Wet Disc Brake Assembly

**CAUTION**

**Take care when using lifting devices. When you use a lifting strap, inspect the strap for damage before you use it. Do not use a lifting strap to shock load or drop load a component. Serious personal injury and damage to components can result.**

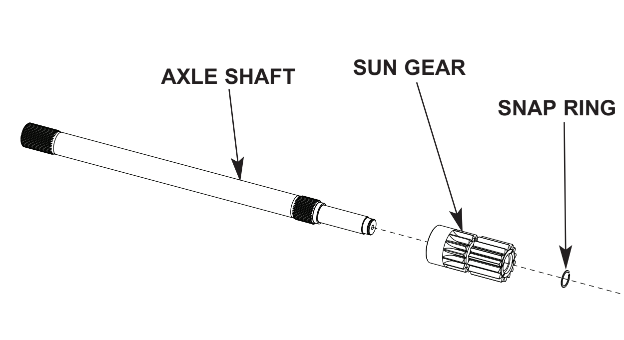
If the axle being assembled is less wet brake, the following assembly procedure is recommended. (All steps are to be done to each axle housing flange end). Should the axle be with wet brake, skip to next section.

1. Using lifting straps, rotate the axle housing so the carrier is facing forward and secure the axle assembly so no personal injury or component damage can occur.
2. Apply medium strength thread locker into the (2) holes that will be used for the M18 studs. Install the studs at 2:00 and 10:00 positions and tighten per “Torque Table” in section 6. T
3. Add a few drops of medium strength thread locker into each of the (2) threaded holes in the axle housing flange for the M8 capscrews to be installed soon.
4. If the axle being assembled is less wet brake, install the spring housing to axle housing with (2) washers and (2) M8 capscrews into the threaded holes in the axle housing flange and tighten per “Torque Table” in section 6. T

## Axle Shaft, Thrust Washer, Snap Ring, Sun Gear Assembly

Complete this assembly for each axle shaft to be assembled. Note there are a long and short axle shaft to be assembled. **Figure 4.7.**

Figure 4.7




1. Slide the planetary sun gear on the axle shaft planetary splines.

**NOTE:** The snap ring should rotate freely in the snap ring groove, if properly installed. This should be checked to assure snap ring is seated.

2. Install the snap ring in the snap ring groove of the axle shaft.
3. Install the thrust washer into the spring housing.
4. Slide the correct length axle shaft assembly through the thrust washer, spring housing, into the axle housing and engage the carrier side gear splines.

## Wet Brake Assembly in the Axle Housing

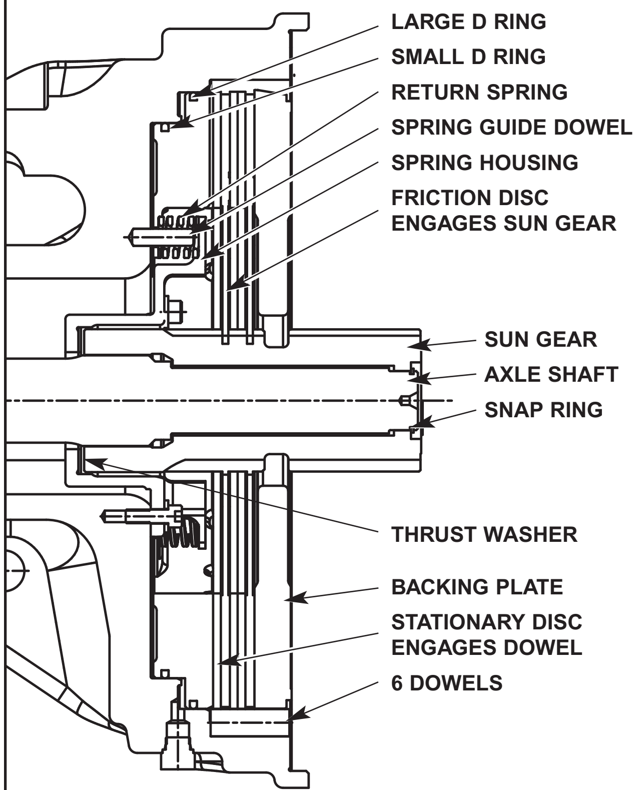
### CAUTION

**Take care when using lifting devices. When you use a lifting strap, inspect the strap for damage before you use it. Do not use a lifting strap to shock load or drop load a component. Serious personal injury and damage to components can result.**

If the axle has the wet brake being assembled, the following procedure is recommended. (All steps are to be done to each axle housing end).

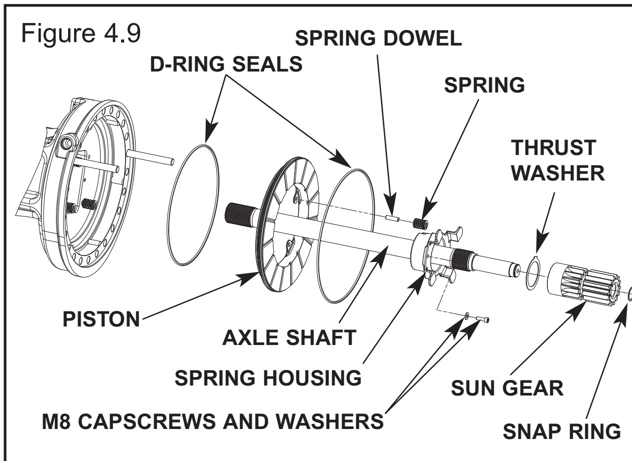
1. Using lifting straps, rotate the axle housing so the carrier is facing forward and secure the axle assembly so no personal injury or component damage can occur.
2. Install the (6) stationary disc dowels, if were removed during disassembly, into the half rounds in the axle housing flange. These dowels will guide the wet brake stationary disc and backing plate. **Figure 4.8.**

Figure 4.8




3. Assemble the (2) D-Rings on the outer diameter of the wet brake piston and add a thin coat of oil to the outer surface of both D-Rings. Care should be taken not to twist or damage the D-Rings during this assembly. Also see brake exploded views in front of manual. **Figure 4.9.**

Figure 4.9




4. Add a few drops of medium strength thread locker into each of the (2) threaded holes in the axle housing flange for the M8 capscrews to be installed soon.

5. Apply a thin coat of oil to the wet brake piston bore and install the wet brake piston and D-Ring assemblies into the axle housing flange bore, including the lead-in chamfer area.
6. Place the piston and D-Rings assembly against the lead chamfer in the piston housing.
7. Oscillate the piston 15-20 degrees easily by hand. Easy movement indicates good fit and piston is well centered and seated against the lead chamfer in the axle housing flange.

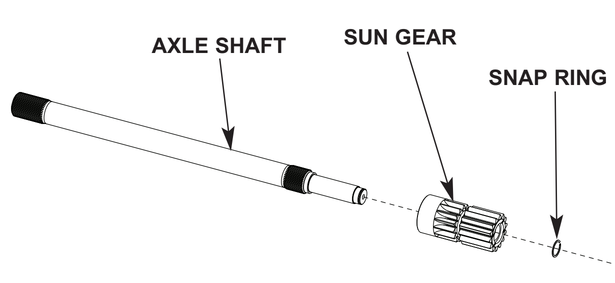
**NOTE:** If excess effort is required to manually press the piston into the axle housing flange, it may mean the piston is cocking and not being pressed parallel. If cocking occurs, the piston may bind and scratch the critical seal surfaces.

8. Install the (4) wet brake spring guide dowels, if were removed during disassembly, through the piston and into each axle housing flange bore.
9. Press the piston by hand into the piston housing of the axle housing flange.
10. Slide the (4) return springs over the spring guide dowels.
11. Place the spring housing against the return springs.
12. Install the spring housing to axle housing with the (2) M8 capscrews into the threaded holes in the axle housing flange, compressing the (4) return springs, and tighten per “Torque Table” in section 6. T

## Axle Shaft, Thrust Washer, Snap Ring, Sun Gear Assembly

Complete this assembly for each axle shaft to be assembled. Note there are a long and short axle shaft to be assembled. **Figure 4.10.**

Figure 4.10




1. Slide the planetary sun gear on the axle shaft planetary splines.

**NOTE:** The snap ring should rotate freely in the snap ring groove, if properly installed. This should be checked to assure snap ring is seated.

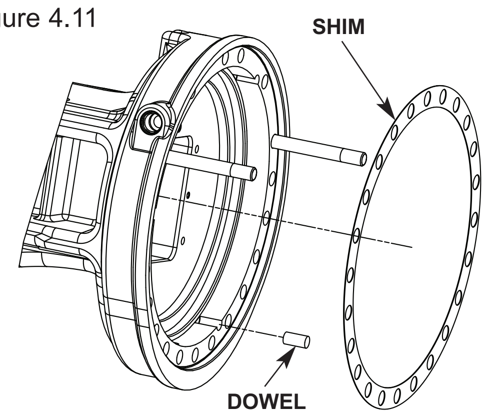
2. Install the snap ring in the snap ring groove of the axle shaft.
3. Install the thrust washer into the spring housing.
4. Slide the correct length axle shaft assembly through the thrust washer, spring housing, into the axle housing and engage the carrier side gear splines.

## Install the Wet Brake Disc Components into the Axle Housing

Install the wet brake disc components, if this axle has the wet brake feature, in the reverse sequence of the order that they were removed and set aside for reassembly.

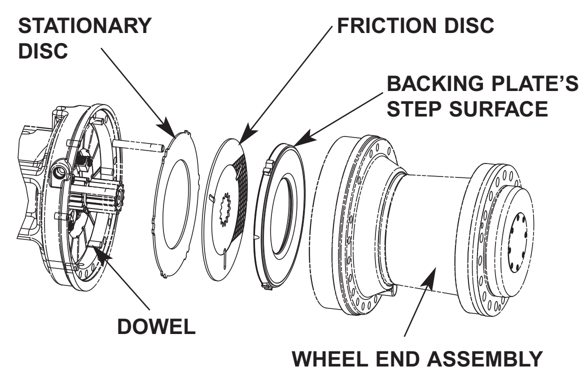
1. Use rubbing alcohol to clean the surface of the shim prior applying adhesive and apply #Q58 adhesive to the shim that mounts to the axle housing face and align the hole pattern as attach the shim to the axle housing flange surface. **Figure 4.11.**

Figure 4.11




If assembly has one friction disc, refer to **Figure 4.12** for sequence of discs.

Figure 4.12



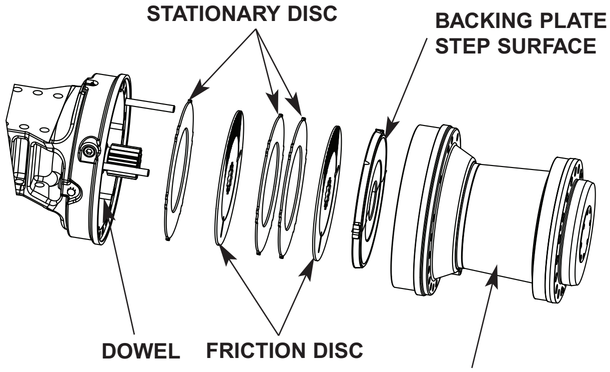

2. Install a stationary disc against the piston into the axle housing flange aligning the slots in the disc with the (6) axle housing flange dowels.
3. Install the friction disc on the planetary sun gear aligning the splines.

**NOTE:** The backing plate’s step surface is to be installed away from the friction disc towards the wheel end planetary assembly.

4. Install the backing plate with flat surface toward friction disc, into the axle housing flange, aligning the slots in the plate with the (6) dowels.

If assembly has two friction discs, refer to **Figure 4.13** for sequence of discs.

Figure 4.13




2. Install a stationary disc against the piston into the axle housing flange aligning the slots in the disc with the (6) axle housing flange dowels.
3. Install the friction disc on the planetary sun gear aligning the splines.
4. Install (2) more stationary discs against the first friction disc, aligning the slots with the (6) axle housing flange dowels.
5. Install the second friction disc on the planetary sun gear aligning the splines.
6. Install the backing plate into the axle housing flange with flat surface toward friction disc, aligning the slots in the plate with the (6) dowels.

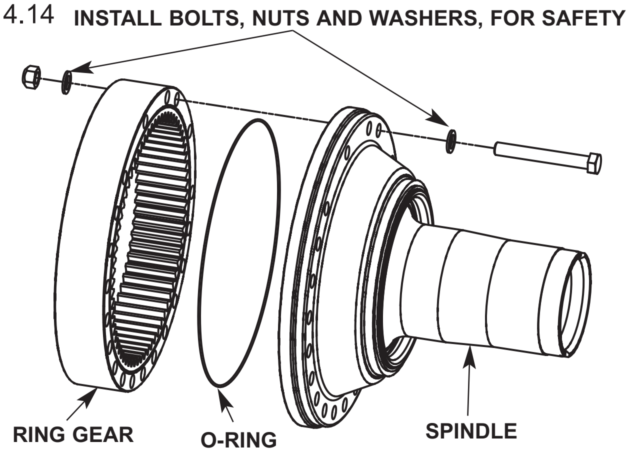
## Wet Disc Brake Actuation and Functional Test

1. Install a fixture or the planetary ring gear against the shim to limit piston travel.
2. Bolt this fixture into the tapped M18 holes in the axle housing flange by using (3) M18 capscrews with washers stacked as necessary under capscrew heads.
3. Install a pressure gauge into the inlet port for accurately measuring 690kPa (6.9 Bar, 100 psi).
4. Connect hydraulic pressure line with a shut off valve using a maximum hydraulic pressure of 690kPa (6.9 Bar, 100 psi) actuation pressure.
5. Actuate the piston 5 times to 690kPa (6.9 Bar, 100 psi) checking that the piston extends freely and returns to starting position when hydraulic pressure is released.
6. Actuate piston again, lock in pressure and hold at maximum 690kPa (6.9 Bar, 100 psi). The gauge should read a limit 34kPa (0.34 Bar, 50 psi) maximum drop after 1 minute.
7. Should the assembly not pass this test, The piston should be removed and D-Rings inspected and the axle housing bores checked for surface scratches, repaired and re-assembled and the test procedure rerun, until passing test.

## Spindle and Planetary Ring Gear Sub-Assembly

The planetary ring gear assembles between the spindle and axle housing. The ring gear can first be reassembled onto the axle housing or onto the spindle. In either case, the final assembly requires O-rings installed in the grooves on both sides of the ring gear. If the planetary ring gear was disassembled from the spindle earlier, the following (2) assembly procedures are recommended to reassemble the ring gear and spindle. **Figure 4.14.**

4.14




If this method is selected for assembly,

### CAUTION

**Care should be taken not to press directly on the spindle threads as damage to these threads may occur. Use of 3 steel bars assembled to allow the press to push on the spindle flange directly and not on the spindle threads is recommended.**

1. Apply light coat of grease to the O-Ring.
2. Install the O-Ring into the groove on the planetary ring gear face. Care should be taken not to twist or damage the O-Ring during assembly.
3. Align the capscrew holes in the ring gear when you are pressing the ring gear into the spindle. The hole alignment must be done prior actually pressing ring gear into spindle.

4. A piece of thin shim stock ~0.0254mm (0.001”) is to be inserted in several places around the diameter to check the ring gear is properly seated.
5. Install (2) bolts, nuts and washers, for safety.

An optional assembly method is as follows if a press is not used:

1. Apply a light coat of grease to the O-Ring.
2. Install the O-Ring into the groove of the planetary ring gear face. Care should be taken not to twist or damage the O-Ring during assembly.
3. Apply a light coat of oil to the outer diameter edge of the planetary ring gear that will be pressed into the spindle flange bore.
4. Set the spindle over the planetary ring gear and O-Ring already assembled and align the holes in the spindle flange with the planetary ring gear spacing by using 1 or 2 temporary guide pins that fit the M18 holes.

**CAUTION**

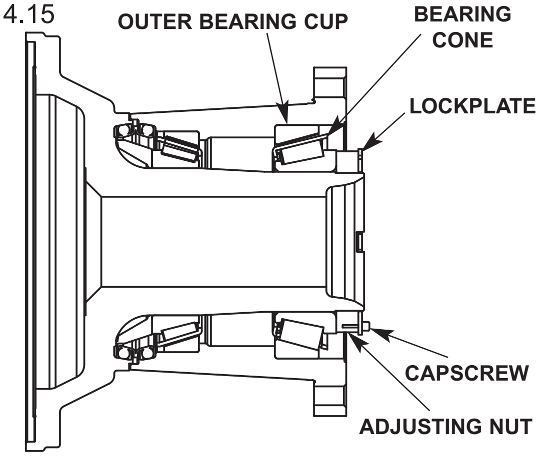
**Do not use a steel hammer, use a rubber or rawhide mallet.**

5. Using a rubber or rawhide mallet, Not Steel hammer,tap the spindle over the planetary ring gear by hitting around the spindle flange several times until ring gear is seated.
6. Remove the temporary guide pins.
7. A piece of thin shim stock ~0.0254mm (0.001”) is to be inserted in several places around the diameter to check the ring gear is properly seated.

## Wheel Hub, Inner Bearing Spacer, Wheel Bearings, Seal, and Spindle Sub-Assembly

If the wheel hub,spindle, and bearings were disassembled during disassembly, the following procedure is recommended. **Figure 4.15.**

Figure 4.15

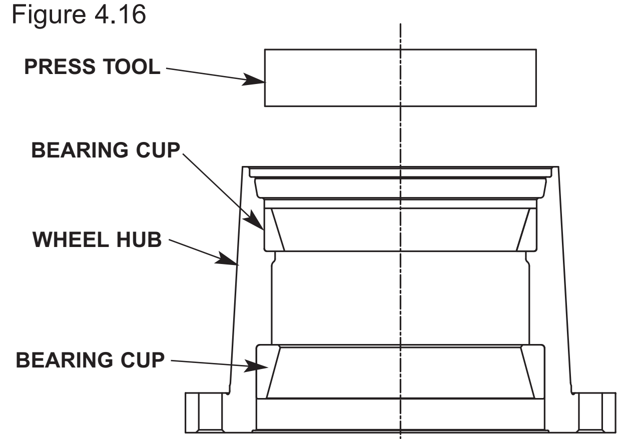



**WARNING**

**Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.**

1. Place the wheel hub upright in a press to install the bearing cups. **Figure 4.16.**

Figure 4.16

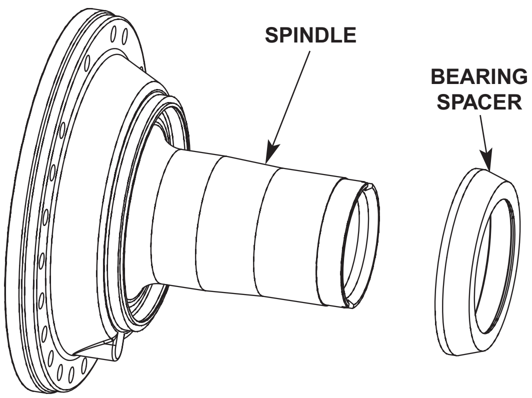



2. Press each bearing cup into the wheel hub against the shoulder in the wheel hub by using the appropriate bearing cup drivers, tool number 2 and 3 (see Special Tool Section).
3. A piece of thin shim stock ~0.0254mm (0.001”) is to be inserted in several places around the diameter to check the bearing cups are properly seated.
4. Remove the wheel hub from the press and place on suitable workbench for further safe assembly.

**NOTE:** The inner bearing cone must be installed in the wheel hub and not on the spindle bearing diameter because the Duo Cone seal, once installed in the wheel hub assembly will not fit over the bearing cone assembly.

5. Apply a light coat of oil to the inner bearing cone rollers and install in the wheel hub assembly.
6. If the wheel bearing spacer was previously removed, apply Adhesive #Q58-Grade -226 or #Q44 to the spindle face of the bearing spacer. **Figure 4.17.**

Figure 4.17




7. Slide the spacer over the spindle and against the spindle shoulder tapping with a brass rod to properly seat the wheel bearing spacer. Alternatively, a large, thin-wall tube (tool number 1, see Special Tool Section) for installing the inner bearing onto the spindle during hub assembly, could be used to push the bearing spacer onto the spindle.

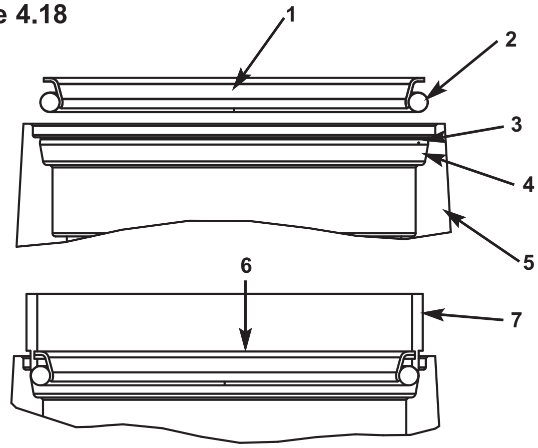
## Toric Ring Face Seal into Hub and into Spindle

**CAUTION**

**Install face seal halves in the same positions where they were located prior to disassembly. Mixing up face seal halves can cause component damage.**

The TRS Toric Ring face seal halves must be installed in the spindle and in the hub before the hub can be assembled to the spindle. **Figure 4.18.** Install the Toric Ring face seal halves in the spindle and in the hub as follows:

**Figure 4.18**




| | |
|---|---|
| 1. Seal Ring | 5. Seal Ring Housing |
| 2. Toric Ring | 6. Seal Ring Face |
| 3. Housing Retainer Lip | 7. Installation Tool (TC-79461) |
| 4. Housing Ramp | |

**WARNING**

**Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-base cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's instructions and these procedures:**

- **Wear safe eye protection.**
- **Wear clothing that protects your skin.**
- **Work in a well-ventilated area.**
- **Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.**
- **You must use hot solution tanks or alkaline solutions correctly. Carefully follow the manufacturer's instructions.**

**CAUTION**

**Check for solvent residue on all seating surfaces. Solvents that leave a residue on the Toric Ring, metal face seal or on housing seal seating surface can cause the Toric Ring to roll into the seal, rather than slide. Damage to the seal can result.**

1. Make sure the formed seal ring, Toric Ring and wheel hub are clean and free of any oil or other contaminants. If required, use a solvent like isopropyl alcohol, that evaporates quickly, leaves no residue, and is compatible with the Toric Ring.

**CAUTION**

**Install the Toric Ring into the seal ring and make sure it is flat. Do not twist the Toric Ring when installing onto the seal ring. A twisted Toric Ring will not seal correctly, allowing leakage of lubricant and pumping of debris past the ring. Damage to components can result.**

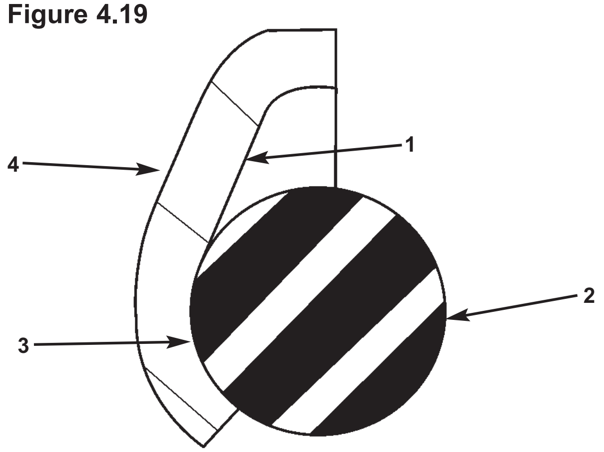
2. Install the Toric Ring onto the formed seal ring so that it rests in the radius of the tail of the seal ring and is not twisted. Install the Toric Ring onto the seal ring as follows:

**CAUTION**

**Do not use Stanosol® or any other liquid that leaves an oily film and does not evaporate quickly, since this may result in incorrect seating of the Toric Ring in the housing, resulting in seal leakage.**

A. Wet the rubber Toric Ring with isopropyl alcohol and install it onto the formed seal ring so that it is seated at the bottom of the seal ring ramp and against the retaining lip. **Figure 4.19.**

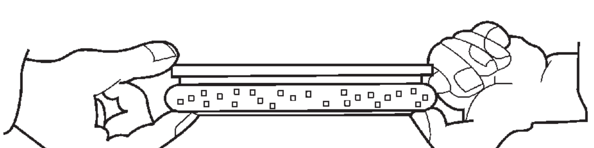
**Figure 4.19**




| | |
|---|---|
| 1. Seal Ring Ramp | 3. Seal Ring Retaining Lip |
| 2. Rubber Toric Ring | 4. Seal Ring |

B. Make sure the Toric Ring is not twisted by rapidly pulling it away from the seal ring and letting it snap back. Do this in a number of places until the seal is correctly seated. Be careful not to nick or cut the Toric Ring seal, as this will cause leaks. **Figure 4.20.**

**Figure 4.20**

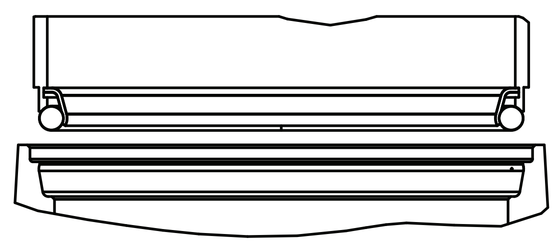


**CAUTION**

**Do not use Stanosol® or any other liquid that leaves an oily film and does not evaporate quickly, since this may result in incorrect seating of the O-ring in the housing, resulting in seal leakage.**

3. Coat the Toric Ring with isopropyl alcohol so that it slides easily past the retainer lip in the wheel hub and installs correctly on the spindle ramp. **Figure 4.21.**
4. Place installation tool part number TC-79461 (see Special Tool Section) around the metal seal ring and Toric Ring. Installation tools are available from AxleTech International at in North America 1-877-547-3907, in Europe 33-477-92-8868 or at www.axletech.com/aftermarket.htm.
5. Wipe the O-ring with a lint-free towel or clean foam brush saturated with isopropyl alcohol.
6. Shake excess lubricant from the assembly. Immediately install (“pop”) the seal into the wheel hub with a firm push of the installation tool. **Figure 4.21.**

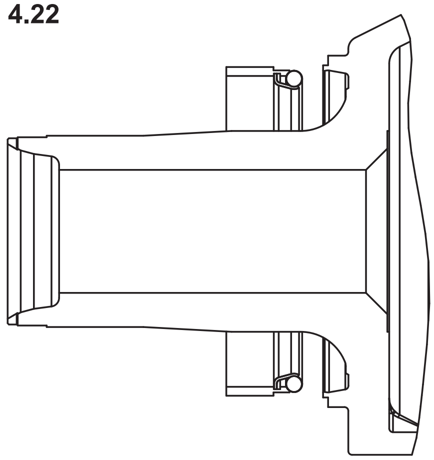
**Figure 4.21**



7. Remove the installation tool.

8. Follow the same procedure to install the other half of the face seal assembly onto the wheel spindle. **Figure 4.22.**

**Figure 4.22**

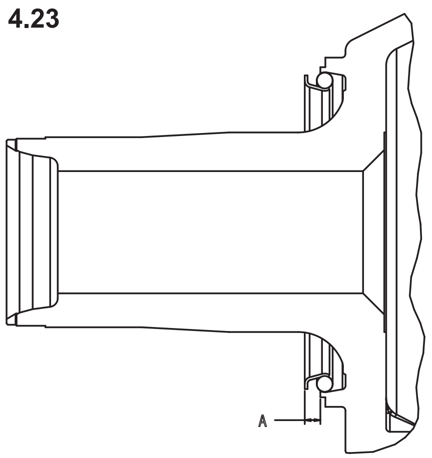


## Check for Correct Installation of the TRS Toric Ring Seal

Check the spindle and wheel hub for correct installation of the TRS Toric Ring face seal before the hub can be installed onto the spindle.

1. Check assembled height variation (A) in at least four places, 90 degrees apart, using a caliper, toolmaker's rule, or other accurately calibrated measuring device. The difference in height around the ring must not be more than 0.5 mm (0.02 inch). **Figure 4.23.**

**Figure 4.23**




2. If required, adjust the seal standout height by using the following methods.

- **If the standout height cannot be brought into specification:** Remove the seal and repeat the installation procedure.

### CAUTION

**Push or pull the Toric Ring and face seal only. Do not push or pull directly on the seal ring. This can cause component damage.**

A. Use the installation tool to push down on the Toric Ring and face seal.

B. With your fingers, pull up uniformly on the Toric Ring and face seal.

### CAUTION

**Apply isopropyl alcohol to the Toric Ring. Check the retaining lip of the seal seating area for burrs or fins, which can cause a seal to leak. Damage to components can result.**

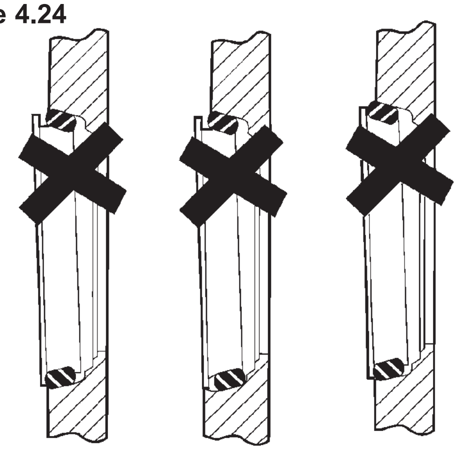
3. Apply isopropyl alcohol as a lubricant to the Toric Ring and place in the seating area. If installation does not appear smooth, flat and correct, remove the seal from the spindle and repeat the process.

### CAUTION

**To prevent slippage of the Toric Ring, allow sufficient evaporation time for the assembly lubricant before proceeding with further assembly. Damage to components can result.**

4. Seat Toric Ring correctly. Once correctly in place, the Toric Ring must roll on ramp only. See **Figure 4.24** for examples of incorrect installation.

**Figure 4.24**



## Wheel Hub to Spindle Assembly

**NOTE:** Complete the assembly of the wheel hub to the spindle. Before installing the wheel hub onto the spindle, however, keep the following points in mind to ensure correct sealing between the faces of the Toric Ring:

1. Check both sealing faces carefully to make sure they are clean and free of any dirt, debris, lint, and even human hair.

**CAUTION**

**Bring the housings together slowly. High impact can result in component damage. Remove protective pad from the spindle's seal journal.**

2. Remove the protective pad from the spindle's seal journal.

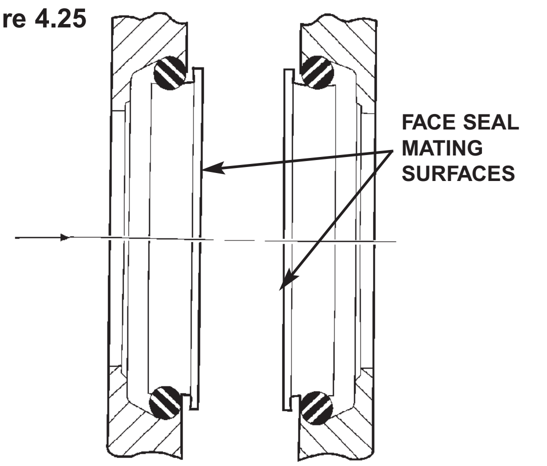
**CAUTION**

**Do not apply lubricant to the Toric Ring. The Toric Ring can leak. Damage to components can result.**

3. Apply a light coating of Dow Corning GN molybdenum assembly paste lubricant to the two mating surfaces of the face seal's steel rings only. Do not allow this lubricant to contact the Toric Ring. The Toric Ring can leak. **Figure 4.25.**

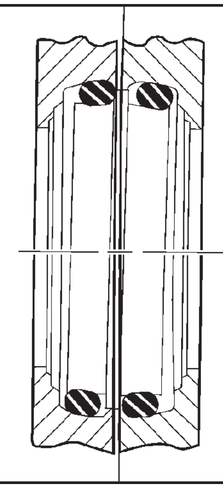
- When installing the hub onto the spindle, both seal housings must be aligned correctly.
- Slowly bring the hub and spindle assembly together as the spindle bearing adjustment nut is tightened. **Figure 4.25.**

**Figure 4.25**




- **If the seals are not aligned correctly:** The seals will move. Any wobbling motion of the seals is an indication of incorrectly positioned (cocked) seals. Dirt can enter past the Toric Ring.
- Shown in **Figure 4.26,** the Toric Rings have slipped, instead of rolling on the left-hand side of the seal. Note how the top Toric Ring is to the right and the bottom Toric Ring is to the left. The same seals are also shown after the bottom half is rotated 90 degrees.

**Figure 4.26**

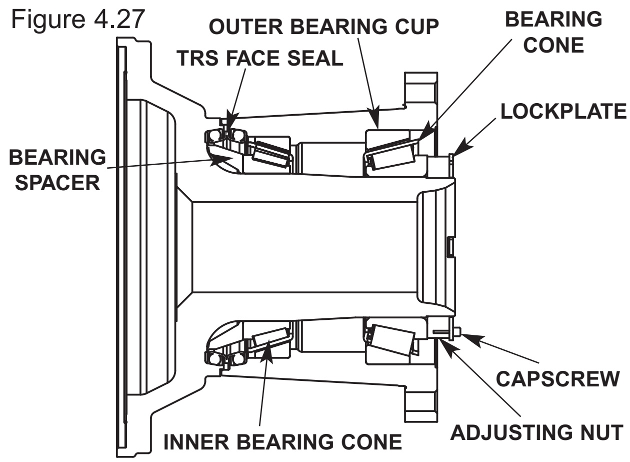


- **If the Toric Ring slips at any location,** it will twist, causing the formed seal rings to seat incorrectly (cock).

4. Install the hub. Use a large thin-wall tube (tool number 1, see Special Tool Section), to push the inner bearing onto spindle while installing hub onto spindle.

5. Apply a light coat of oil to the bearing cone rollers and install the outer bearing cone onto the spindle. **Figure 4.27.**

Figure 4.27




**NOTE:** The (3) M8 threaded holes in the wheel bearing adjusting nut should be facing outward as the nut is assembled against the wheel bearing cone. Rotate the wheel hub by hand while tightening adjusting nut in order to seat the wheel bearings and seal assembly.

6. Install the wheel bearing adjusting nut using the wheel bearing adjusting nut tool 860901009T per the special tools section, or equivalent. Tighten the nut to 500 lb-ft (678 N•m). T
7. Rotate the hub three to five revolutions in both directions.
8. Tighten the nut to 500 lb-ft (678 N•m) again. T
9. Rotate the hub three to five revolutions in each direction again.
10. Repeat above steps until nut torque level stabilizes.
11. Install the wheel bearing lock plate over the wheel bearing adjusting nut and align the tabs on lock plate with slots in the spindle.
12. Review the alignment of the holes in the lock plate and holes in the spindle nut. Review amount the spindle bearing nut must be loosened to make the holes align with lock plate.
13. Repeat steps 11 & 12 with lock plate indexed 180 degrees and review the hole alignment in the lock plate and wheel bearing adjusting nut.
14. Choose between the (2) lock plate positions that requires the “least loosening” of the wheel nut.The maximum recommendation is no more than 5.5 degrees “loosening” of the adjusting nut.

**NOTE:** Do not further tighten the wheel nut to align the capscrew holes.

15. Add a few drops of medium strength thread locker to each capscrew threads to install the (3) lock plate M8 capscrews and tighten per “Torque Table” in section 6. Safely set the planetary wheel hub, planetary ring gear, and spindle assembly on a workbench. T

## Planetary Spider Sub-Assembly

The planetary pinion shafts are not serviceable items and should not have been disassembled from the planetary spider.

Further sub-assembly of the planetary pinion gears, needle rollers, and thrust washers is as follows if the planetary spider gears had been removed.

### Re-Use Components

If the re-assembly of the planetary spider will re-use the components that were previously dis-assembled and inspected:

1. Open each bag containing the previously removed planet gear, snap ring, thrust washers, and needle bearing components that were marked and match to the planetary pinion shaft from which they were removed. Keep these parts matched to their planetary pinion shaft during assembly.

### New Components

If new components are to be assembled on the planetary pinion shafts, please follow the identical recommended procedure:

Repeat the following steps for each planetary pinion shaft /gear assembly.

1. Place the planetary spider with the (4) planetary pinion shafts pointing upward in a safe workbench orientation so the planetary spider assembly will not roll or fall off the work bench and cause personal injury or component damage.
2. Apply a light coating of oil or grease to the base of planetary spider where the outer thrust washer will be placed and the planetary pinion shaft,outer thrust washer faces and slide the outer washer over the pinion shaft and against the spider.

**CAUTION**

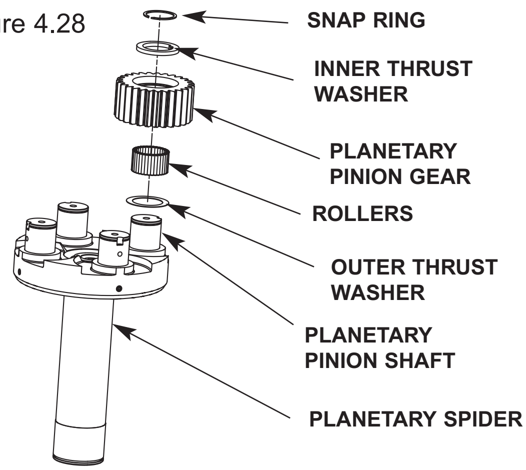
**Never mix new and old needle rollers, nor needle rollers from different manufacturers, on the same planetary pinion shaft and gear assembly. Component damage can occur.**

Two optional methods of assembling the planetary gears with needle rollers to each planetary pinion shaft are recommended:

**Method 1:**

3. Apply a light coat of grease to the planetary pinion gear bore and assemble the (33) needle rollers into the planet gear bore until there is no further space to add additional needle rollers. **Figure 4.28.** If new needle rollers are being used in the planetary gear assembly, they must be from the same vendor, and belong to the same tolerance group (0.002mm).

Figure 4.28




4. Carefully, lift the planet gear with needle rollers assembled and place on the planetary pinion shaft. It is recommended to use a pointed tool to stick between the needle rollers to help align the needle rollers and verify there is no gap large enough to insert an extra roller.

**Method 2:**

3. Apply a light coat of grease to the planetary gear bore and install the gear over the planetary pinion shaft. **Figure 4.28.**

**NOTE:** Oscillating the planetary pinion gear will help in seating the needle rollers during assembly. Use of a pointed tool to stick between the needle rollers may be required until all rollers are aligned and installed with no gap large enough for an additional roller.

4. Individually add each needle roller to the gear assembly until all (33) rollers are installed.

5. Add light coat of oil or grease to the faces of the inner thrust washer and slide over the planetary pinion shaft and insert the locking tab into the planetary pinion shaft to eliminate the thrust washer rotation.

**NOTE:** The snap ring should rotate freely in the groove on the planetary pinion shaft when properly seated.

6. Install the snap ring into the planetary pinion shaft groove to retain the planetary gear assembly on the planetary spider assembly.

**NOTE:** If the gear does not rotate smoothly or if excessive axial end play is noted, the outer thrust washer may have been omitted and this gear assembly should be removed and checked that all components were assembled.

7. After each planetary pinion gear,needle rollers, thrust washers and snap ring are assembled on each pinion shaft, a check should be done to assure the planetary gear rotates smoothly and has little axial endplay ( ~ < 0.07mm or 0.003”) .

8. Safely set the assembled planetary spider shaft on a work bench for later assembly into the planetary wheel end.

## Planetary Spider Assembly, Spindle & Planetary Ring Gear Assembly, and Wheel Hub Assembly

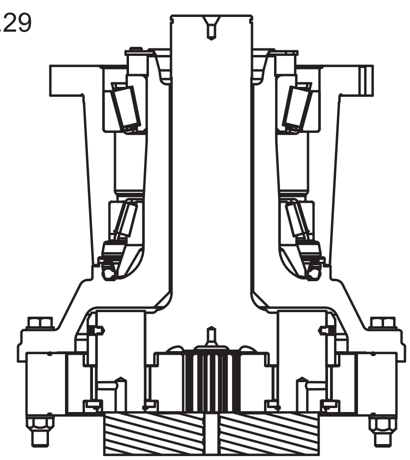
To assemble the planetary wheel end using the above sub-assemblies, the following procedure is recommended:

**CAUTION**

**Take care when using lifting devices. When you use a lifting strap, inspect the strap for damage before you use it. Do not use a lifting strap to shock load or drop load a component. Serious personal injury and damage to components can result.**

1. Using a lifting strap to secure the planetary spider assembly, place the assembly with the planet pins setting on a 50 mm thick spacer whose O.D. is smaller than ring gear’s I.D. **Figure 4.29.**

Figure 4.29

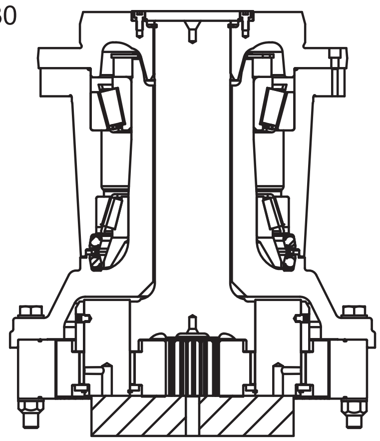


2. Using a lifting strap to secure the spindle, wheel hub and planetary ring gear assembly, safely lower this assembly onto the the planetary spider allow-ing the planetary spider shaft to pass through the spindle bore and then mesh the planetary gears into the planetary ring gear teeth as the subassembly is slowly and safely lowered together.

**NOTE:** Use care not to damage or twist the O-ring during assembly.

3. Apply a light coat of grease to the O-ring that will be fitted onto the driver pilot diameter and install O-ring onto the driver against the flange. Care should be taken to not twist or damage the O-ring during this assembly. **Figure 4.30.**

Figure 4.30



4. Slide the driver and O-ring assembly onto the planetary spider shaft splines. Fit the driver pilot diameter in the wheel hub pilot bore, aligning the (3) M8 capscrew mounting holes.
5. Add medium strength thread locker to the (3) M8 Allen head capscrew threads and tighten the capscrews per "Torque Table" in section 6. T

**NOTE:** The snap ring should rotate freely in the snap ring groove, if properly seated.

6. Install the snap ring into the groove of the planetary spider shaft, locking it against the driver.
7. Apply a light coat of grease to the O-ring and add O-ring to the cover groove. Care should be taken not to twist or damage the O-ring during assembly on the cover groove.
8. Place the cover against the wheel driver and the end of the planetary spider.
9. Add medium strength thread locker to each of the (8) holes in the wheel driver and install the (8) M8 Allen head capscrews and tighten per "Torque Table" in section 6. T

## Install the Planetary Wheel End Assembly On the Axle Housing

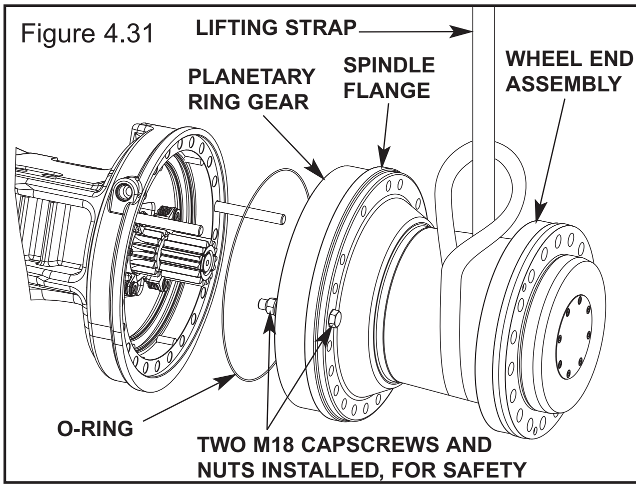
### CAUTION

**Take care when using lifting devices. When you use a lifting strap, inspect the strap for damage before you use it. Do not use a lifting strap to shock load or drop load a component. Serious personal injury and damage to components can result.**

To continue with this axle assembly, the axle housing should have carrier input horizontal. All instructions provided are per axle housing end and must be repeated on the opposite housing end for a complete axle assembly.

1. If (2) studs are not already installed in the axle housing flanges, then add a few drops of medium strength thread locker into (2) threaded holes at 10:00 and 2:00 positions in the axle housing flange and add (2) M18 studs. Tighten per "Torque Table" in section 6. **Figure 4.31.** T

Figure 4.31

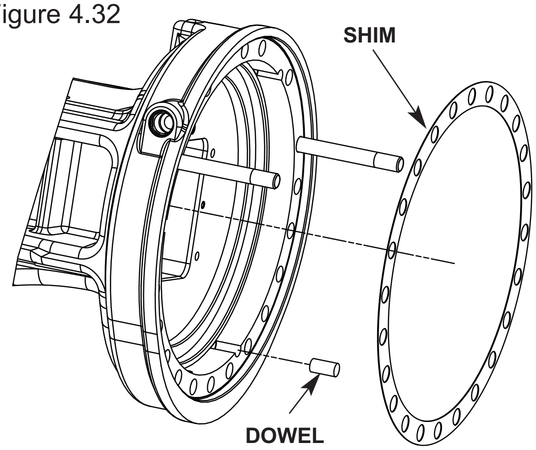



**NOTE:** The following 2 steps apply to the wet brake axle only at this point of assembly. Should the axle being assembled not have the wet brake option, skip to step 4.

### WARNING

**Take care when you use adhesives, thread locking compounds, silicone gasket materials or any sealants to avoid serious personal injury. Follow the manufacturer's instructions to prevent irritations to the eyes and skin. Figure 4.32.**

Figure 4.32




2. If the axle uses wet disc brakes and if a shim is not installed against axle housing flange face, then apply a thin uniform coat of adhesive #Q58-grade-226 on one side of the ring gear shim.
3. Carefully install the (0.8 mm thick) shim with the adhesive side against the axle housing flange face while guided on the wheel end studs. Apply pressure around the shim surface to make sure the shim will be bonded to the entire axle flange diameter surface.
4. Apply a thin coat of grease to the O-ring that will be assembled to the planetary ring gear face. (Reference line art in step 1)
5. Install the O-ring into the groove on the face of the planetary ring gear with care not to twist or damage the O-ring during installation.
6. Using the lifting strap, carefully lift the pre-assembled planetary wheel end assembly and slide the assembly along the (2) wheel end studs that were installed in the axle housing flange. Remove the (2) M18 safety bolts, nuts and washers, if installed through spindle flange and ring gear.
7. Make the final wheel end assembly by turning the axle input yoke to turn the planetary sun gear so the sun gear teeth will align with each of the planet pinion gears.
8. Verify that O-rings have not fallen out of grooves on both sides of ring gear.
9. Add medium strength thread locker to the (18) M18 axle housing flange threads. Install the (18) M18 cap-screw and washers to the axle housing flange/wheel end assembly. Torque to torque chart value.

**NOTE:** Thread locker is Not required as these (2) nuts are lock nuts. Torque to torque chart value.

9. Install the (2) nuts and washers on the (2) studs.

## Axle Air Leak Test

Place axle in a safe test stand mounted with carrier input pinion horizontal for this assembly test.

1. Install a pressure gauge that will clearly read up to 140 kPa (1.4 Bars, 20 psi) into the axle housing breather port (7/16”-20 UNF).
2. Connect an air line with a shut off valve.
3. Apply 55 kPa(0.55 Bars, 8 psi) and lock pressure on.
4. Monitor for air pressure drop maximum allowed is 2.1 kPa (0.3 P.S.I)after 30 seconds. If a greater drop is noted, the axle assembly must be reviewed for location of air leak by wetting axle surfaces with soapy water and looking for expanding bubbles at an air leak. Once air leak is found and repaired, this test should be repeated.
5. Open shut off valve, bleed the air from the system, and remove the pressure gauge, and re-install the breather, or plug, if a remote breather is fitted.

## Axle Spin Test

Place axle in a safe test stand mounted with carrier input pinion horizontal for this assembly test.

1. Fill the axle with oil to the correct level.
2. Using a compatible input connection on a safely supported drive motor, connect to the axle input yoke.
3. Run the axle at ~ 50 RPM at the wheels for 90 seconds in the forward direction.
4. If the axle has the wet brake option, slightly actuate each of the wet brakes separately to equalize speed to both wheels.If the axle is less the wet brake feature, just monitor in forward direction and reverse direction for items in step #5.
5. Monitor for noises, leaks, signs of overheating, unbalanced speeds.
6. Repeat for reverse input direction.
7. Drain the axle oil through a screen and observe the oil screen for any abnormal particles.

**NOTE:** If this oil is to be disposed, recommend in accordance with environmentally accepted practices.

8. Remove all (3) magnetic drain plugs and inspect for abnormal particles.
9. Replace all (3) magnetic drain plugs and tighten per “Torque Table” in section 6. T

## Re-Installation into Vehicle

Please follow the vehicle OEM recommendations to re-install the axle into the vehicle chassis. Once the axle has been re-installed safely within the vehicle chassis, the following steps to re-connect the axle is recommended (if they do not conflict with OEM assembly instructions):

1. Reconnect the hydraulic differential lock actuation line and torque inlet fitting to OEM recommended value.
2. Replace any OEM vehicle guard, if previously removed, that protects this inlet line from in service damage, if required.

**NOTE:** Follow the OEM installation instructions to assure grease has been forced through the grease lines into both the trunnion brackets.

3. If the axle has the trunnion feature, verify shimming of rear trunnion bracket assembly to correct clearance per vehicle OEM recommendation and connect the grease lines to the front and rear trunnion brackets.
4. Re-connect any remote axle breather if axle breather on axle housing is not used.
5. If this axle has the wet brake feature, re-connect the hydraulic brake line and torque to OEM recommended value. T

**NOTE:** Axles with wet disc brakes require oil level to be verified and all friction discs must be presoaked for at least 12 hours in axle oil, after rotating wheel end prior to placing vehicle into service.

6. Re-open all previously closed shut off valves and bleed each line to assure all air has been removed from each system.

**NOTE:** The wet brake axle has a bleeder located on the top of each axle housing flange and each must be opened and bled separately. Re-torque the wet brake bleeders to recommended values.

7. Re-check to assure the axle has been filled to correct oil level by checking the oil level plug located on the upper area of the rear axle housing carrier bowl. Correct oil level description is located in the lubrication section of this axle manual.
8. To re-connect the axle drive shaft and wheel mounting, use the OEM vehicle manufacturers recommendations before removing the vehicle from the service area.

## LUBRICATION

### Breather

**CAUTION**

**Cover the breather when steam cleaning the axle housing to prevent water from entering the axle housing and contaminating the oil. Damage to components will result. Breathers release pressure and vacuum condensation to help maximize oil and component life.**

### Seals

**CAUTION**

**Always use the correct tools and procedures when replacing seals to prevent incorrect installation and leaking seals. Seals keep lubrication in and dirt out of a component. When they are worn or damaged, seals leak and produce damaging low lubricant levels that will damage components.**

### Oil Level

#### Check and Adjust:

Correct procedure to check oil level in the axle assembly:

1. Park the vehicle on a level surface. Place blocks in front and back of the rear axle wheels to keep the vehicle from moving.
2. Clean the area around the fill plug in the axle housing. Remove the plug from the axle housing assembly. The oil level must be level with the bottom of the fill plug hole.
   - If the oil flows from the hole when you loosen the plug: the oil level is high. Drain the oil to the correct level.

**NOTE:** Follow the vehicle manufacturer's recommendation of disposal of the oil drained from the axle housing assembly to assure disposal is in an environmentally friendly procedure.

**NOTE:** Oil level too high may cause damage to the seals and other components. It is essential the correct oil level be maintained for component damage not to occur.

- If the oil level is below the bottom of the fill plug: Add the specified oil according to the following procedure: Fill the axle housing assembly with the specified oil through the fill plug hole. Wait a few minutes to allow the oil to flow through the entire axle housing assembly. Check the oil level and fill to the correct level, if necessary.

**NOTE:** Too low an oil level could cause component damage as proper lubrication may not be available to protect against component damage.

3. Install and tighten the fill plug to the correct torque specification. Refer to "Torque Table" in Section 6.

### Approved Oil Listings

Specific oils other than those listed should have approval prior use in this assembly as damage may occur to components in axle assembly. Reference AxleTech International oil and grease base specifications STC 05-000 for descriptions of oils and STC 05-200 FOR greases that meet the AxleTech specifications and approval criterion.

This specification includes use of Petroleum, Semi-Synthetic and Full Synthetic oils. This specification should be reviewed when questions relating to Oil Compatibility, Use of Synthetic oils, and Seal Compatibility are being considered.

See attached chart for recommended lubricant cross reference (Viscosity) and Temperature Chart to provide recommendations of oil viscosities recommended based on ambient temperature range in vehicle service.

### Approved Grease

Recommendations for Axle Trunnion Assembly

**Grease:** Multipurpose Grease (1)

**Specification:** Per AxleTech International grease specification STC 05-201 (NLGI Grade 1) for Lithium 12 Hydroxy Stearate or Lithium Complex.

(1) AxleTech recognizes that industry trends are moving towards selection and usage of synthetic based greases in vehicle maintenance. However, some seals are known to expand when in contact with synthetic grease. The original assembly has been done with above recommended grease used and recommendation is to continue with similar grease in service.

Off-Highway Operation Intervals*

Recommended Check Petroleum Initial Oil Change Oil Level Oil Change 50-100 Operating hrs. for initial oil change.

Check oil every 200-250 Operating hrs.

Typical 1,000 hrs. or twice a year, whichever comes first*

**Reference oil capacities:**

PROC 2714W3H=67 Quarts (63.5 Liters)for complete axle assembly.

PRC2715N= 70 Quarts (66.4 Liters) for complete axle assembly.

## Lubrication Specification

The axles covered by this manual all have a hypoid gear set in the carrier assembly that requires extreme pressure EP type lubricant in the GL5 oil classification.

The planetary wheel end's oil and the wet disc brakes' coolant oil, if equipped with wet disc brakes, have a common sump with the carrier's oil. Any oil added to the axle's common sump, whether added at the wheel end or at the carrier center fill plug locations, must be the GL-5 type hypoid gearset oil. See Table C for Lubricant Specification.

**Table C:** Lubricant Cross Reference (Viscosity) and Temperature Chart

| Lubricant Specification | Description | Cross Reference | Minimum Outside Temperature | Maximum Outside Temperature |
|---|---|---|---|---|
| | | | | |
| | | | | |
| STC 05-003 | Hypoid Gear Oil | GL-5, S.A.E. 80W/90 | –15°F (–26.1°C) | - - -* |
| | | | | |
| | | | | |
| | | | | |

*There is no upper limit on these outside temperatures, but the axle sump temperature must never exceed 250°F (+121°C).

## Brake Actuation Fluid

**WARNING:**

**DO NOT USE DOT 3 or DOT 5 Automotive Brake Fluid for actuating the Wet Disc Service Brakes or for actuating the Parking/Emergency Brake, if axle is equipped with these brakes. DOT3 and DOT5 fluids are Glycol based fluids.**

Optional service brakes are 360 mm wet disc brakes that use petroleum based fluid for brake actuation. An optional Parking/Emergency Brake can be mounted at the carrier input yoke. The optional Parking/Emergency Brake also uses petroleum based fluid for brake actuation.

Hydraulic Fluid or Tractor Oil Universal (TOU) are suitable oils for actuating the wet disc brake and for actuating the Parking/Emergency Brake. Follow vehicle OEM fluid specifications and use only fluids specified by vehicle OEM.

# TORQUE TABLE

| THREAD SPEC | TYPE | LOCATION | THREAD COMPOUND [1] | TORQUE N•m (lb-ft) | |
|---|---|---|---|---|---|
| | | | | nominal | range |
| **FASTENERS** | | | | | |
| M8x1.25 | capscrew L16 Allen-head | Wheel Sup: Cover-Wheel Driver | medium-strength | 38.3 (28.2) | 33.5 (24.7) – 43.1 (31.8) |
| | capscrew L25 Allen-head | Wheel Sup: Lock Plate-Wheel Nut | medium-strength | 38.3 (28.2) | 33.5 (24.7) – 43.1 (31.8) |
| | | Wheel Sup: Wheel Driver-Wheel Hub | | | |
| | | Planet: Spring Hsg-Axle Hsg | | | |
| | | HDL: Inlet Port-Carrier Hsg | | | |
| | capscrew L30 Allen Head | Carrier: Bearing Cap (Adj. Ring Lock) | medium strength | 33.0 (24.3) | 28 (20.7) - 38(28) |
| M10x1.5 | setscrew L16 socket-head | Planet: Pinion Shaft-Spider | medium-strength | 27.0 (19.9) | 23.0 (16.9) - 31.0 (22.9) |
| M12x1.75 | capscrew L45 hex-head | Carrier Pinion Cage-Carrier Hsg | medium-strength | 132 (97.4) | 119 (87.7) - 145 (107) |
| | capscrew L70 hex-head | Carrier: Diff. Case-Diff. Case | STF 02-452 | 143 (105.5) | 130 (96) - 155 (114) |
| | capscrew L80 Allen-head | Trunnion: Adapter-Axle Hsg | 0il | 119 (87.8) | 107 (78.9) - 131 (96.6) |
| | | Trunnion: Bracket-Trunnion Shaft | | | |
| M16x2 | capscrew L50 hex-head | Carrier: Carrier Hsg-Axle Hsg | high-strength | 328 (241.9) | 295 (217.6) - 361 (266.3) |
| | capscrew L65 hex-head | | | | |
| M16x1.5 | capscrew L62 hex-head | Carrier: Hypoid Gear-Diff. Case | medium-strength | 350 (258) | 315 (232) - 385 (284) |
| M18x1.5 | capscrew L140 hex-head | Wheel Sup: Spindle-Axle Hsg | medium-strength | 509 (375.4) | 458 (337.8) - 560 (413.1) |
| | stud L170 | Wheel Sup: Spindle-Axle Hsg | medium-strength | engage all threads | |
| | nut | Wheel Sup: Spindle-Axle Hsg | oil | 412 (303.9) | 371 (273.6) - 453 (334.1) |
| M20x2.5 | capscrew L120 hex-head | Carrier: Bearing Cap-Carrier Hsg | oil | 485 (358) | 430 (317) - 540 (398) |
| M22x1.5 | nut-jam | Carrier: Hypoid Gear Thrust Screw | none | 204 (150.5) | 136 (100.3) - 272 (200.6) |
| M39x1.5 | nut | Carrier: Yoke-Hypoid Pinion | oil | 1,393 (1,027.5) | 1,250 (922) - 1,535 (1132.2) |
| M150x2 | nut | Wheel Sup: Wheel Brg-Spindle | oil | 678 (500) | 610 (449.9) - 746 (550.2) |
| | | | | | |
| **PLUGS, FITTINGS** | | | | | |
| M12x1.5 | fitting-Banjo | WDB:Banjo Fitting-Axle Hsg | oil | 47.3 (34.9) | 45.0 (33.2) - 49.5 (36.5) |
| M14x1.5 | nut-fitting | WDB: Banjo Fitting-Tube | oil | finger tight + 1.5 turn | |
| M22x1.5 | port-inlet | WDB: Inlet Port-Axle Hsg | STF 02-452 | 37.8 (27.9) | 34.0 (25.1) - 41.6 (30.7) |
| 7/16”-20 | screw-bleeder | WDB:Bleeder Screw-Axle Hsg | oil | 23.5 (17) | 20 (15) - 27 (20) |
| 9/16”-18 | fitting-Tee | WDB: Tee Fitting-Inlet Port | oil | 35.7 (26.3) | 34.0 (25.1) - 37.4 (27.6) |
| 11/16”-16 | nut-fitting | WDB: Tee Fitting-Tube | oil | 42.0 (30.9) | 40.0 (29.5) - 44.0 (32.5) |
| 1 1/16”-12 | plug-fill | Hsg: Fill Plug | oil | 93 (68.6) | 79 (58.3) - 107 (78.9) |
| | plug-drain | Hsg: Drain Plug | | | |
| 3/8-18 NPSF | breather | Top of Housing Breather | sealant-RTV or Permatex #51 | 28 Minimum | |

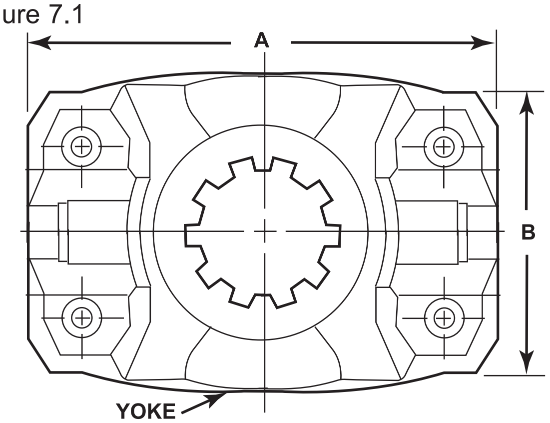
[1] Thread compounds = Medium-strength: Loctite #241/242/243, Three Bond #1334
High-strength: Loctite #271/273, Three Bond #1305
STF 02-452: Loctite 680
Sealants: Loctite Ultra Grey RTV, Permatex #51

Torque conversion factors 1N•m = 0.7376 lb-ft
1N•m = 10.20 kgf.cm

## How to Make a Yoke Bar

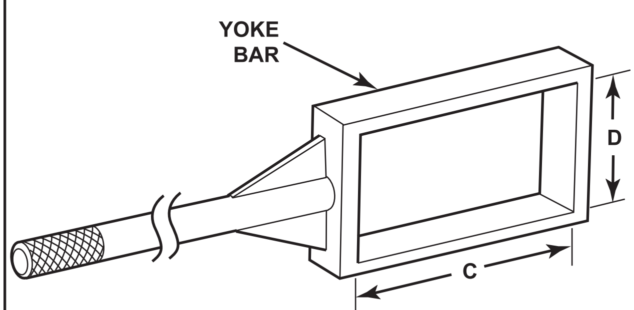
1. Measure dimensions A and B of the yoke you are servicing. **Figure 7.1.**

Figure 7.1




2. Calculate dimensions C and D of the yoke bar by adding 0.125-0.250-inch to dimensions **A** and **B** of the yoke. **Figure 7.2.**

Figure 7.2




### WARNING

**Wear safe clothing and eye protection when you use welding equipment. Welding equipment can burn you and cause serious personal injury. Follow the operating instructions and safety procedures recommended by the welding equipment manufacturer.**

3. To make the box section, cut and weld 1.0-inch x 2.0-inch mild steel square stock according to dimensions **C** and **D**. **Figure 7.2.**
4. Cut a 4.0-foot x 1.25-inch piece of mild steel round stock to make the yoke bar handle. Center weld this piece to the box section. **Figure 7.2.**
   - **To increase yoke bar rigidity:** Weld two angle pieces onto the handle. **Figure 7.2.**

Figure 7.3

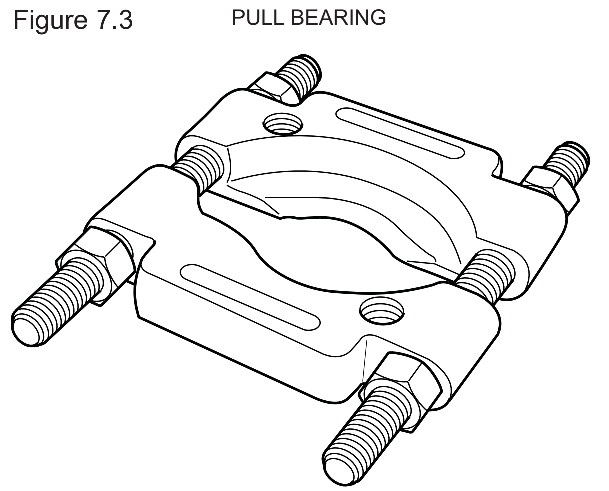



Figure 7.4

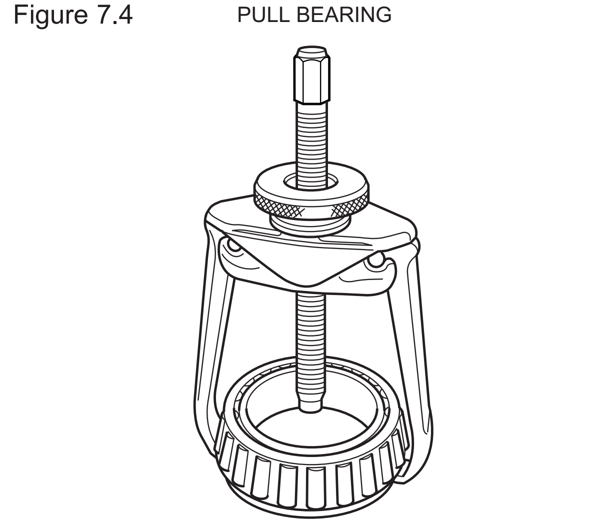


Figure 7.5
TOOL 1

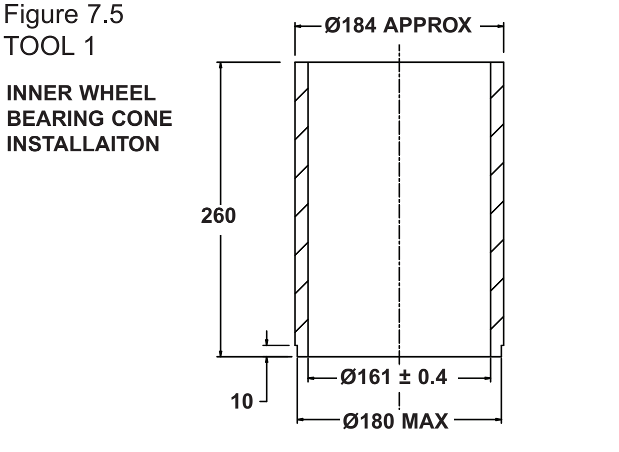



Figure 7.8
TOOL 5

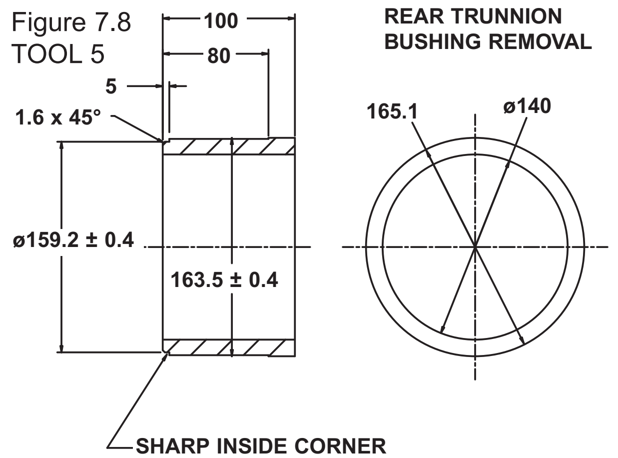



Figure 7.6
TOOL 2 AND 3

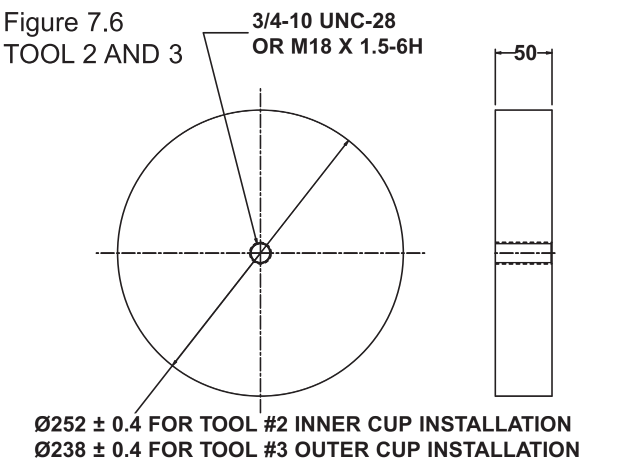



Figure 7.9
TOOL 6

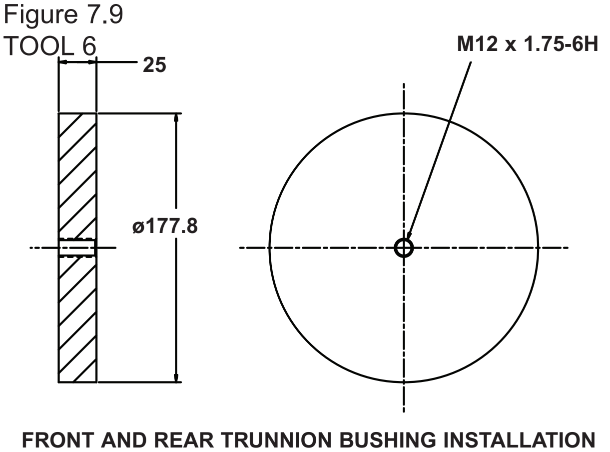



Figure 7.7
TOOL 4

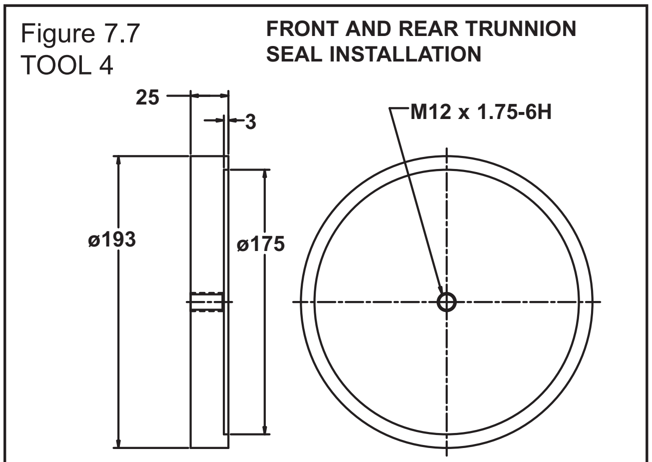



Figure 7.10
TOOL 7

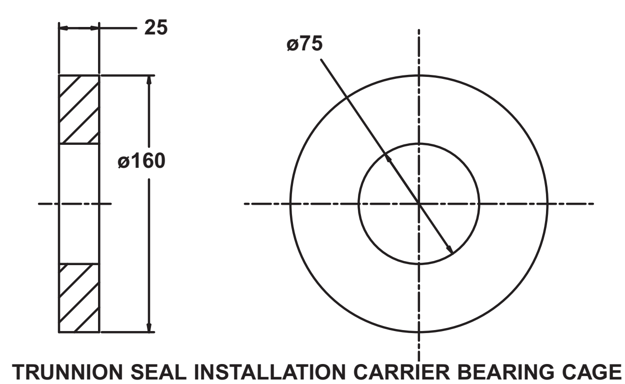
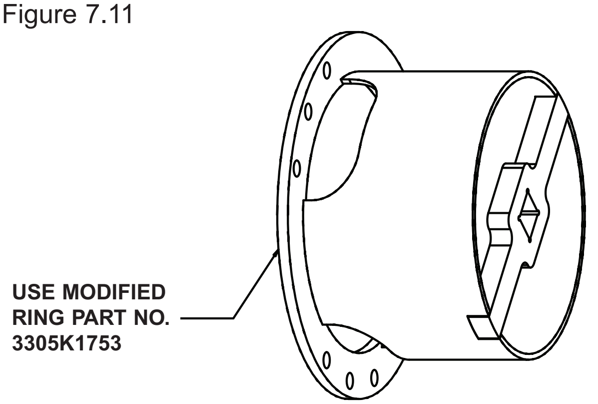
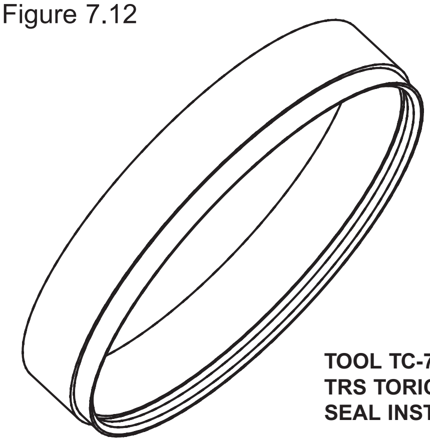


Figure 7.11




TOOL 860901008T WHEEL BEARING NUT ADJUSTMENT

Figure 7.12



TOOL TC-79461
TRS TORIC RING FACE
SEAL INSTALLATION

# Challenger®

## Terra Gator 3244 Chassis

# SERVICE MANUAL
## 627333-A

# 05 - Cabin

## Contents

# Contents

# CAB

## CAB

Cab has a Roll Over Protection Structure (ROPS).

**CAUTION: Roll Over Protection Structure (ROPS) is manufactured to meet strict safety standards. No attempt should be made to alter ROPS in any manner (i.e. welding, drilling, etc.)**

Cab has been designed for operator safety, comfort and convenience.

Cab is control center of Terra Gator. Operator can easily monitor and adjust Terra Gator functions using conveniently located controls.

*NOTE: Put identification marks on all hoses, on all hose assemblies, on all wires on all hose assemblies, on all wires, and on all tube assemblies for installation purposes. Plug all hose assemblies and all tube assemblies. This helps to prevent fluid loss, and helps keep contaminants from entering the system.*

*IMPORTANT: Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.*

**WARNING: Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.**

**WARNING: Personal injury can result from contact with refrigerant.**

**Contact with refrigerant can cause frost bite. Keep face and hands away to help prevent injury.**

**Protective goggles must always be worn when refrigerant lines are opened, even if the gauges indicate the system in empty of refrigerant.**

**Always use precaution when a fitting is removed. Slowly loosen the fitting. If the system is still under pressure, release it slowly in a well ventilated area.**

**Personal injury or death can result from inhaling refrigerant through a lit cigarette.**

**Inhaling air conditioner refrigerant gas through a lit cigarette or other smoking method or inhaling fumes released from a flame contacting air conditioner refrigerant gas, can cause bodily harm or death.**

**Do not smoke when servicing air conditioners or wherever refr0igerant gas may be present.**

**Use a certified recovery and recycling cart to properly remove the refrigerant from the air conditioning system.**

## CAB FILTRATION

### General Information

**CAUTION: Chemical residue may be present in dirt on filter elements. Wear protective gear while servicing filter elements.**

Cab is pressurized. Primary and recirculation filter purify cab's internal air.

*NOTE: Key must be in OFF position before servicing cab filters.*

**FIG. 1:** Location of cab air filters.

1. Primary fresh air filter;
2. Secondary fresh air filter;
3. Recirculation filter.

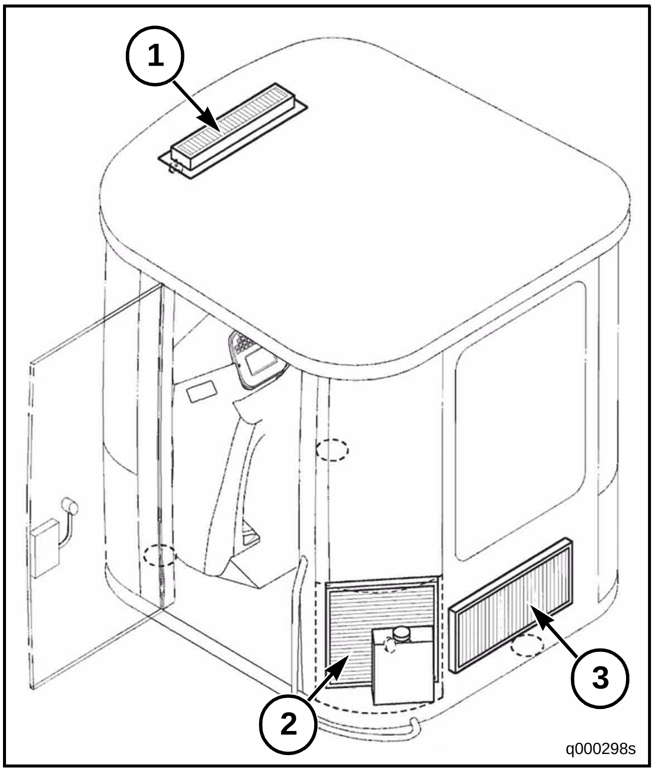



**FIG. 1**

### Filter Maintenance

Inspect cab air filter every 250 hours of operation, clean or replace if necessary. Replace cab air filter every 1000 hours or once a year, whichever comes first.

*IMPORTANT: Periodic sweeping and/or vacuuming of cab interior is recommended. Headliners and cowlings should be wiped clean or vacuumed periodically. The unit's exterior should be washed down to reduce potential contact with hazardous material. Disposal of wash water, cloths and vacuumed material should be handled according to published regulations and pesticide label instructions.*

*IMPORTANT: Become familiar with Chemical Safety before machine operation.*

#### Cleaning Cab Air Filter Element

1. Hold filter and tap on flat surface with dirty side down. Dust will fall off. Tapping too hard can cause damage.
2. Compressed air can also be used, below air through element in opposite direction of normal airflow.

**FIG. 2:**

*IMPORTANT: Keep nozzle a minimum of 25.4 mm (1 inch) from surface. Excessive air pressure causes damage.*

*NOTE: Cab air filter is partially cleaned each time cab door is closed when back pressure flushes primary air filter.*

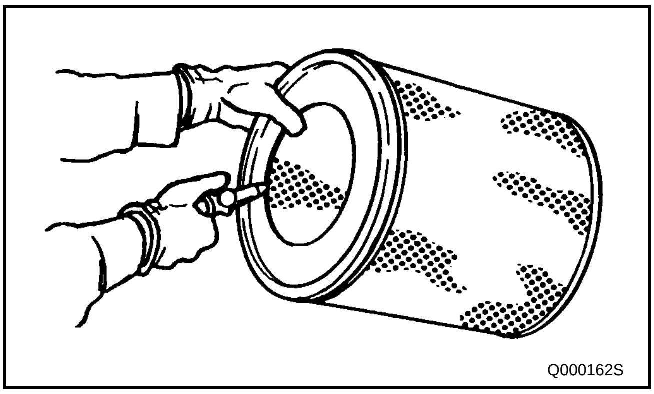



**FIG. 2**

### Primary Fresh Air Filter

Primary fresh air filter is located in roof overhang in front of the cab.

Filter removes dust particles drawn into air system and is partially cleaned each time cab door is closed, when back pressure flushes primary air filter. Before removing filter, close all windows and door. Back pressure from cab helps dislodge loose dirt on underside of filter.

**WARNING: Inadequate sealing may cause filter malfunction and personal injury could result. Isoamyl Acetate, which has a banana-like odor, may be used to check seal. Periodically inspect door gasket for damage.**

*IMPORTANT: Once filter is removed from its protective packaging, immediate installation must follow. Exposure to the environment reduces validity of filter.*

*NOTE: Store replacement filters, in original packaging, in a clean dry area away from exposure to any chemicals. If stored in cab, floor should be free of any foreign material.*

Remove Secondary (Vapor Particulate) Fresh Air Filter, clean or replace.

*NOTE: Vapor absorption or carbon section of filters, cannot be cleaned. Replace filter if odor, taste or other indication of contamination is detected.*

### Recirculation Filter

Recirculation filter purifies air for HVAC pressurization fan and draws air from inside cab. Filter must be in place or pressurization fan motor will fail prematurely. Recirculation filter in the only filter for pressurization fan.

*NOTE: Optional charcoal filters are available from your local dealer.*

*NOTE: Any chemical contaminants allowed into cab while door is open will be filtered.*

**WARNING: Charcoal filter is used to lower levels of contamination in cab during spraying operations. It does not replace or eliminate need for personal protective devices. Follow all recommendations of chemical manufacturer regarding personal protection, handling and disposal of chemicals.**

Filter life is affected by environmental conditions and should be replaced when odor, taste or other symptom of contamination is detected.

**WARNING: Inadequate sealing may cause filter malfunction. Personal injury could result. Isoamyl acetate, which has a banana-like odor, may be used to check seal. Periodically inspect door gasket for damage.**

*NOTE: Store replacement filters in original packaging in a clean dry area away from exposure to any chemicals. If stored in cab, floor areas should be kept clean from any foreign material.*

*IMPORTANT: Once filter is removed from its protective packaging, immediate installation must follow. Exposure to environment reduces validity of filter.*

*NOTE: The vapor absorption (carbon) section of these filters cannot be cleaned. Replace filter if odor, taste or other indication of contamination is detected.*

# CAB SEAT

## DELUXE SEAT

Seat is a self-contained air ride seat with its own air compressor under seat base to provide air for air spring. Seat is mounted on top of HVAC cabinet.

**CAUTION: Turn off engine and remove key from ignition.**

### Removal

**FIG. 1:** Remove two bolts (1) holding shift console to right-hand side of seat. Lower shift console to floor.

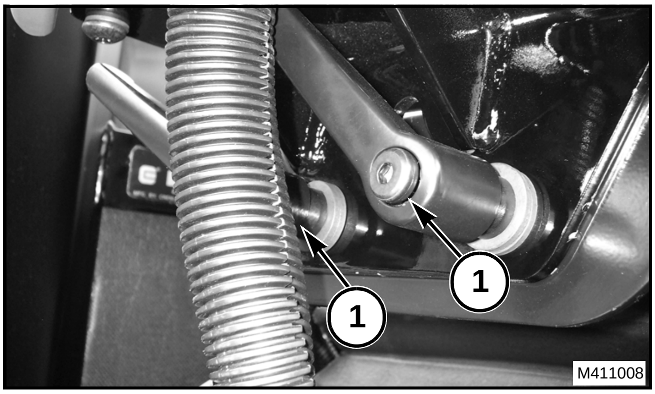



**FIG. 1**

**FIG. 2:** Using tilt control lever (1), raise steering column up to a vertical position to allow seat removal.

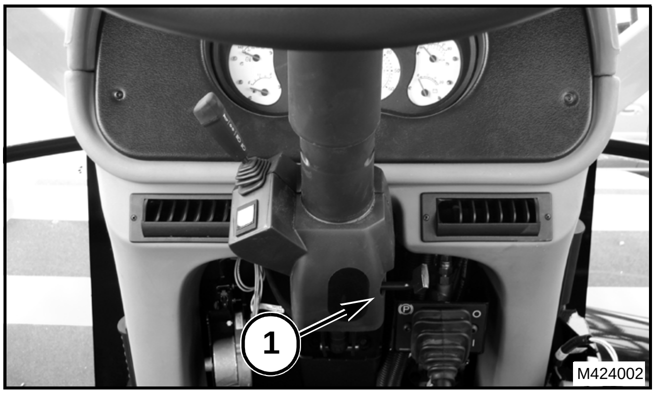



**FIG. 2**

**FIG. 3:** Loosen and remove two bolts (1) on right-hand side of base plate.

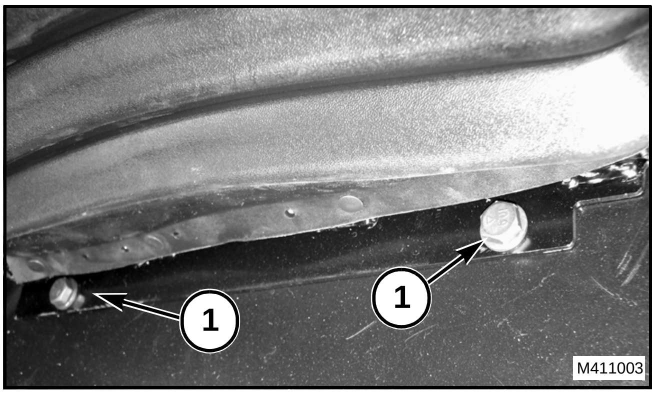



**FIG. 3**

**FIG. 4:** Loosen and remove two bolts (1) on left-hand side of base plate.

**FIG. 4**

**FIG. 5:** With height adjustment button (1) air to the seat suspension to the highest position to aid in removal.

*NOTE: If the seat is not in highest position while lift the seat of the mounting plate. The suspension of the seat will travel out before come of the mounting plate.*

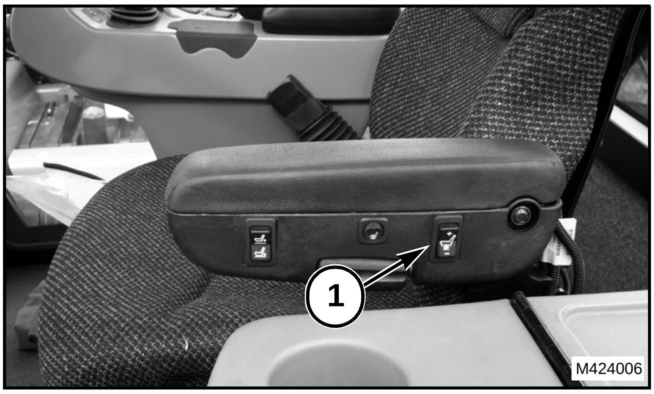


**FIG. 5**

**FIG. 6:** Disconnect pigtail electrical connector (1) on lower right-hand rear corner of seat. Pigtail coming from harness is labeled SEAT.

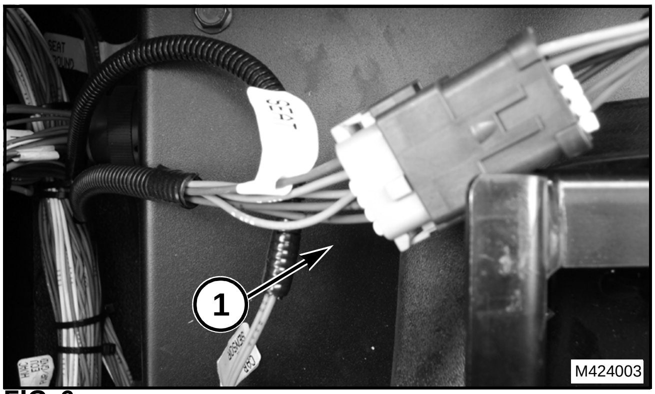


**FIG. 6**

**FIG. 7:** Use backrest recline adjustment lever (1) to fold back of seat forward.

**CAUTION: Use caution as seat is extremely heavy.**

Lift seat assembly from HVAC cabinet and remove from cab. Cushions, suspension, air compressor and base plate are removed as a unit.

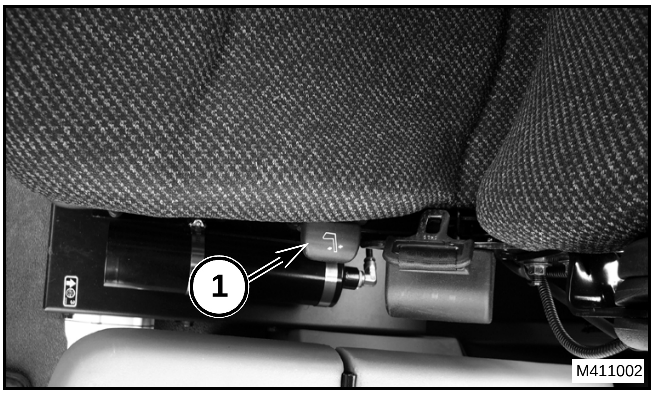


**FIG. 7**

## Installation

Lift seat into cab and place on HVAC cabinet.

**CAUTION: Use caution as seat is extremely heavy.**

*NOTE: Align bolts with holes on HVAC cabinet.*

**FIG. 8:** Turn the ignition key to the Accessory position or ON position. With height adjustment button (1) lift seat up to its highest position to aid in installation.


**FIG. 8**

**FIG. 9:** Install two bolts (1) on right-hand side and tighten.

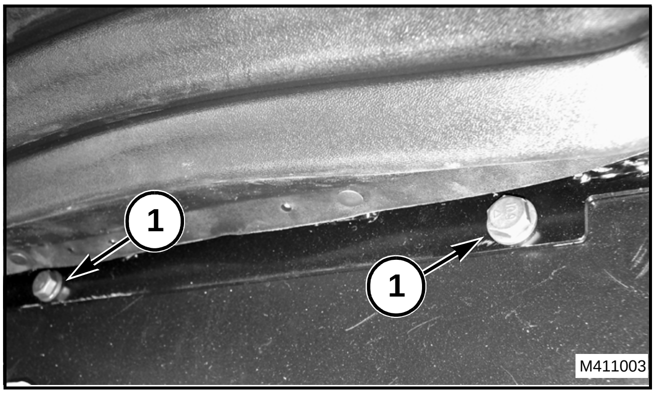



**FIG. 9**

**FIG. 10:** Install two bolts (1) on left-hand side and tighten.

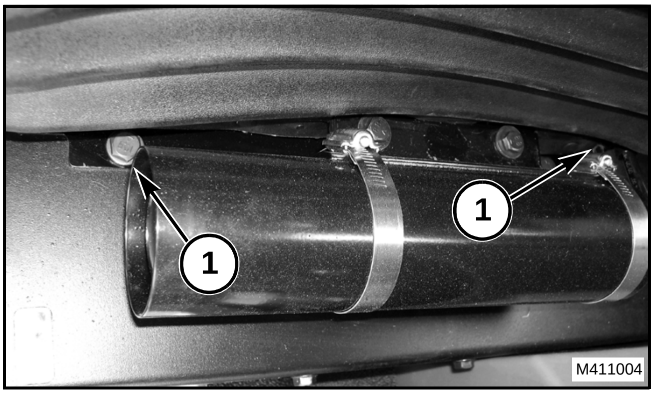



**FIG. 10**

**FIG. 11:** Connect pigtail electrical connector (1) on lower right-hand rear corner of seat. Pigtail from harness is labeled SEAT.

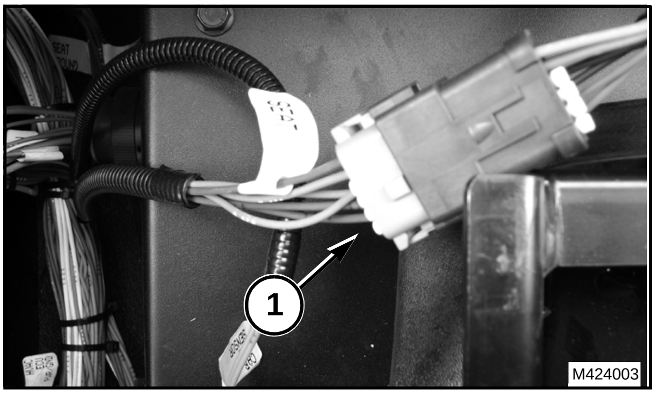



**FIG. 11**

**FIG. 12:** Lift shift console back into position, install bolts (1) and tighten.

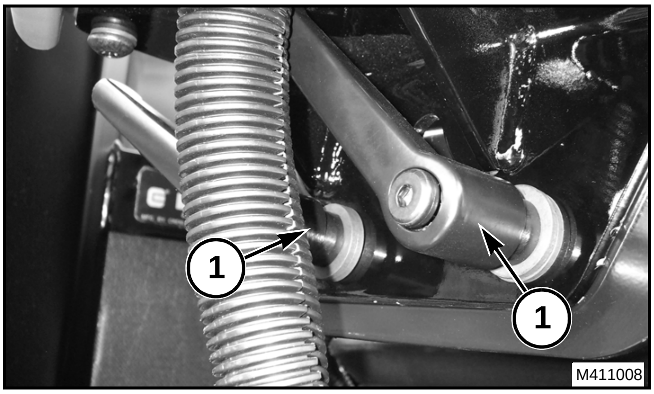



**FIG. 12**

**FIG. 13:** With backrest recline adjustment lever (1) lift seat back into normal operating position.

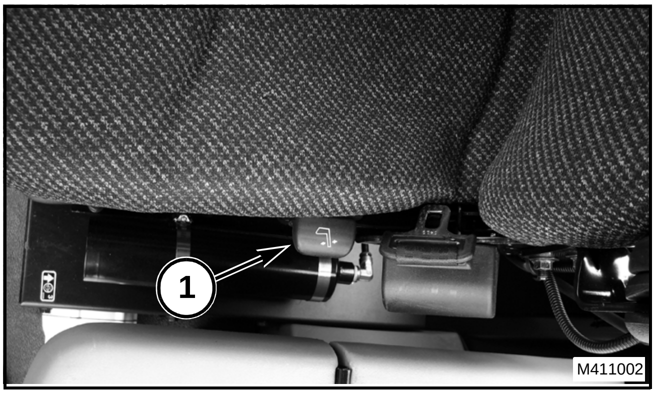



**FIG. 13**

## DIAGNOSTICS

It is possible to read the diagnostic of the seat.

Inside the suspension of the seat there is an electronic controller box with a LED at the front, pointing to the left side of the seat.

The LED flashing at different frequents. Every different frequency has is own specification.

| Flashing Frequency | Description | Correction |
|---|---|---|
| Continuous | No damper connection or bad damper coil. | Check connection / Replace damper. |
| + 4Hz | The controller is bad should be replaced. | Replace controller. |
| 4 Hz | Ride mode switch is set in “Firm” setting and system is operating properly. | - |
| 2 Hz | Ride mode switch is set in “Medium” setting and system is operating properly. | - |
| 1 Hz | Ride mode switch is set in “Soft” setting and system is operating properly. | - |

## TROUBLESHOOTING

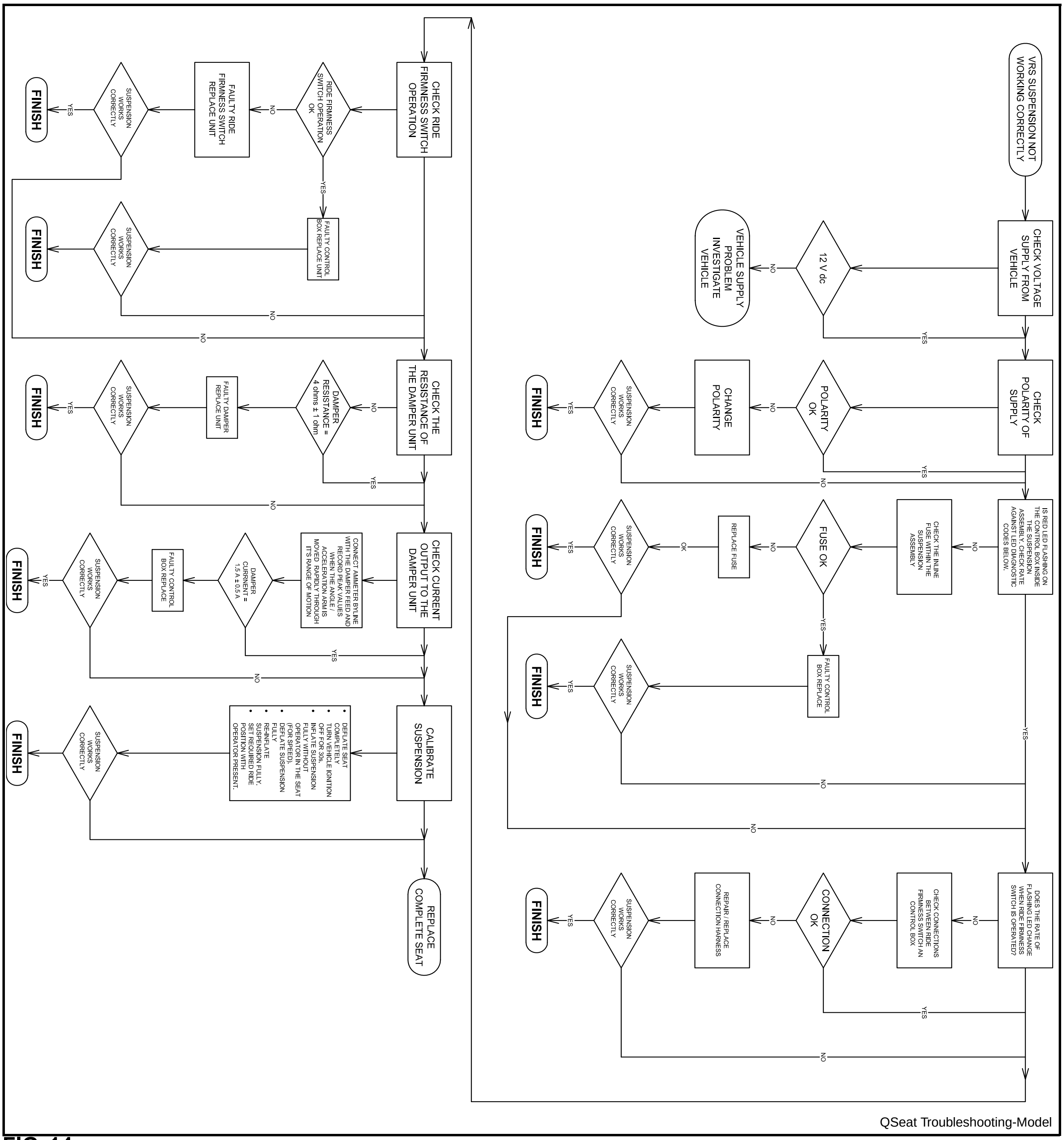



FIG. 14

# HVAC

## GENERAL INFORMATION

Heating, Ventilation and Air Conditioning (HVAC) along with components and schematics are covered in this section.

## THEORY OF OPERATION

The compressor is the central part of the A/C system. The compressor has a suction and discharge side, or a low and high side. On the high side of compressor, marked “dis” on compressor head, refrigerant is discharged from compressor. In condenser, during sub cooling process, refrigerant changes from a gas to a liquid. Liquid refrigerant leaves condenser and enters receiver-dryer where desiccant inside drier filters liquid refrigerant. Liquid refrigerant leaves drier and moves onto TXV, which meters or controls amount of refrigerant flowing into evaporator. As liquid refrigerant is pulled through evaporator liquid refrigerant changes state in superheat process from a liquid mist to a low temperature, low pressure gas. Now refrigerant is fully on suction and low side of A/C system, refrigerant is then pulled into compressor as a low temp, low pressure gas, since liquid refrigerant cannot be compressed. At this point the process begins again.

## BASICS OF REFRIGERATION

Air conditioning is based on the process of heat transfer. When a warmer object is placed next to a colder object, the warmer object loses heat and becomes cooler and the colder object absorbs heat and becomes warmer. An air conditioning system removes heat from cab and releases the heat to outside air.

Intensity of heat is measured with a thermometer in degrees Celsius or Fahrenheit. Quantity of heat is measured in calories or British Thermal Units (BTUs). BTU is amount of heat needed to raise one pound of water one degree Fahrenheit. A calorie is similar to a BTU but is measured in metric units.

When enough BTUs are added to or subtracted from a liquid, the liquid turns into a vapor or a solid, called change of state.

For example, a pound of water at 100 °C (212 °F) must have 1023 kJ (970 BTUs) added to change to a vapor at the same temperature. As a substance changes state, it absorbs or releases large amounts of heat without changing temperatures.

Liquids absorb the greatest amount of heat when boiled. Therefore, boiling point of a liquid refrigerant needs to be lower than temperature of area it is supposed to cool. Refrigerant R134a is used in most air conditioning systems because it has a very low boiling point -30 °C (-22 °F).

As R134a boils, heat from the tractor is absorbed until cab is cooled, this is the basis of an air conditioning system.

## AIR CONDITIONING PROCESS

**FIG. 1:** Refrigerant is drawn into compressor as a cool/cold low-pressure vapor, is compressed and then moves out as a hot, high-pressure vapor to condenser.

As hot, high-pressure vapor passes through condenser core, it gives off heat to cooler outside air being drawn across condenser core by engine fan.

Hot vapor is cooled and condensed to a liquid and moves to receiver/drier under high pressure.

Cooled high-pressure liquid is stored in receiver/drier until it is released to evaporator by expansion valve.

Liquid refrigerant passes through a metered orifice in expansion valve and into evaporator core. As refrigerant passes through orifice in expansion valve, refrigerant changes from a cooled, high-pressure liquid to a cold, low-pressure atomized liquid. Then, when the refrigerant reaches evaporator coils, it begins to warm by absorbing heat from air blown across evaporator coils and fins by blower fan.

Refrigerant now changes from a cold low-pressure atomized liquid to a cool/cold low-pressure vapor and leaves evaporator outlet moving back to suction (low-pressure) side of compressor to repeat cycle.

Amount of temperature increase of atomized liquid in evaporator is dependent on ambient/outside temperature.

As heat loss is taking place, moisture (humidity) in air condenses on outside of evaporator and drains off as water through drain hoses attached to evaporator drain pan, reducing humidity level of cab. Also, dust or pollen not removed by cab filters collect on wet evaporator fins and coils and are washed off with condensed moisture.

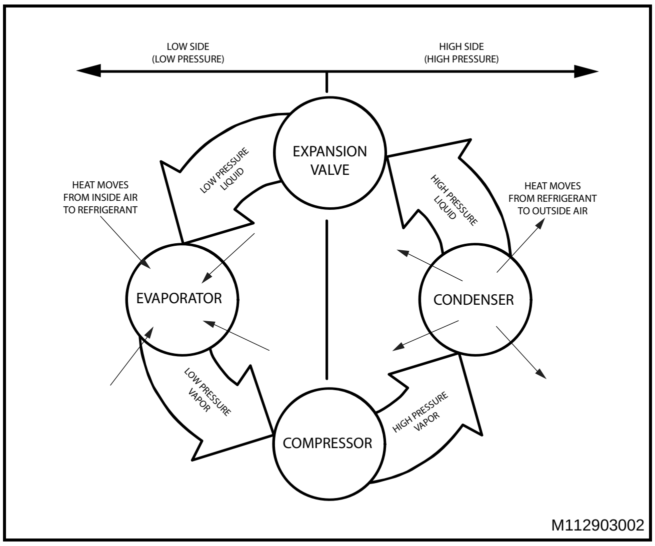


**FIG. 1**

## HVAC SYSTEM

**FIG. 2:** HVAC system is located under operator seat.

HVAC unit (1) contains components of heating, ventilation and air conditioning systems:

- Electronic controls
- Cab pressurization
- Cab airflow moisture removal (defrost)
- Cab airflow circulation
- Cab airflow heating
- Cab airflow cooling

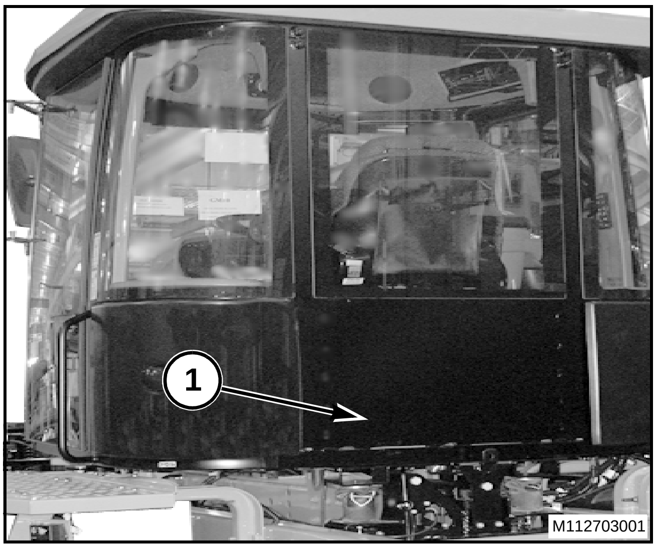


**FIG. 2**

### Electronic HVAC Controls

Unit is equipped with an electronic control using a control module to provide:

- Automatic temperature control
- Automatic fan control
- LED display
- On-board diagnostics
- Start-up memory
- Display for outside air temperature

### Pressurizing Cab

HVAC is used to provide positive air pressure in cab to prevent unfiltered air from entering.

### Removing Moisture from Cab Airflow

HVAC system uses air conditioning to condense moisture in air. If necessary, air temperature can be changed by heating system. Moisture condensed is collected as a liquid and drained.

### Circulation of Cab Airflow

HVAC needs airflow to work properly, with operator controlling direction and amount of airflow.

### Heating Cab Airflow

Air circulates by heater core to heat cab air and coolant is circulated through core.

### Cooling Cab Airflow

Air circulates by evaporator core to cool cab air. Evaporator is cooled by refrigerant, circulated in air conditioning system located in HVAC unit.

Air conditioning system is a closed loop circuit using pressure changes of refrigerant to cool cab.

## AUTOMATIC TEMPERATURE CONTROL

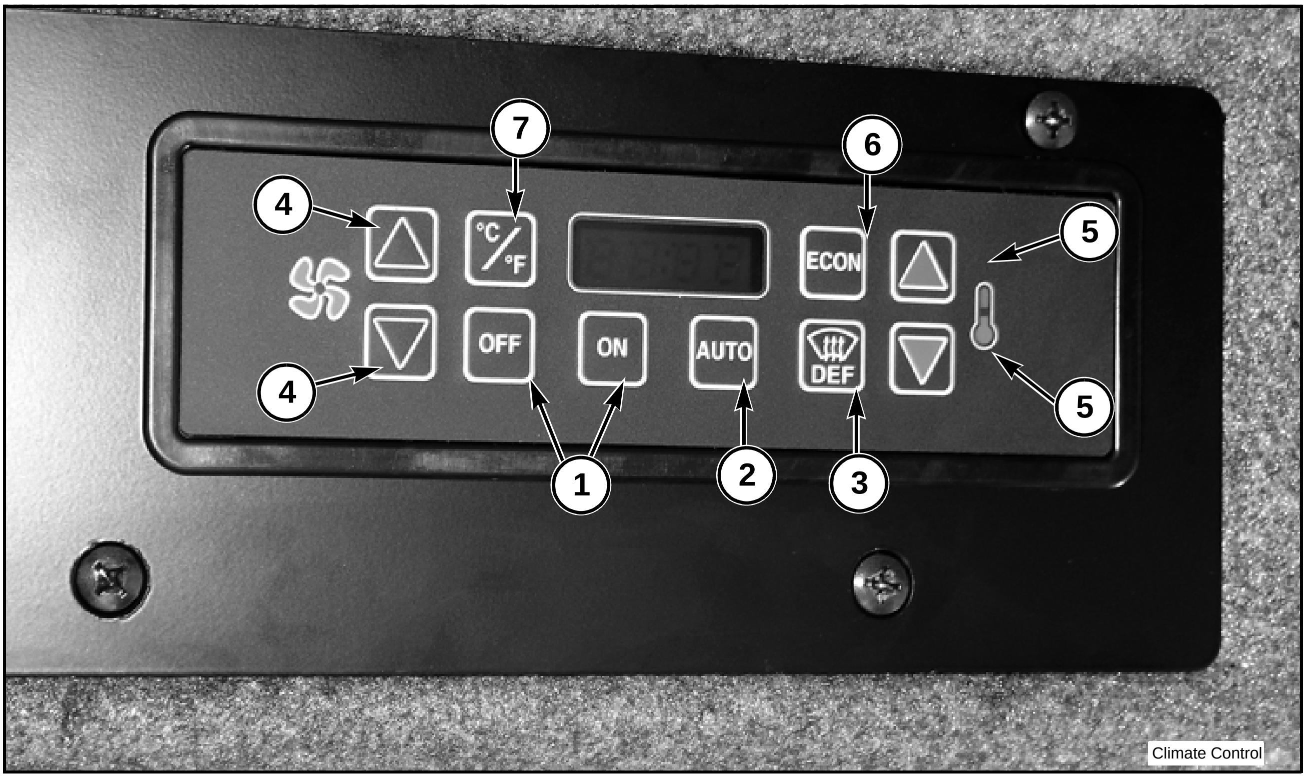



**FIG. 3**

### Description

The Automatic Temperature Control (ATC) allows for true interior cab temperature control and continuously variable blower fan speed through the use of advanced microprocessor and sensor technology.

1. **ON / OFF** - Powers vehicle Heater-A/C control system on or off. The LED numeric display is illuminated when the unit is turned on. The display will show the current set point temperature.
2. **AUTO** - Places the system in a fully automatic temperature control mode including automatic fan speed control. A panel light indicates when this mode is active. The system will adjust the blower fan speed to the lowest setting necessary to maintain the cab temperature at the displayed set point temperature.
3. **DEF (Defrost icon)** - Energizes the A/C system to allow for rapid de-humidification of the cab. The A/C will be enabled even if the set point temperature requires heat. A panel light indicates when this modes is active.
4. **FAN UP / DOWN** - Overrides the automatic fan speed control feature. Increments fan speed up or down in eleven steps. The digital display indicates the fan speed setting as a percentage or “HI” when maximum fan speed is reached or “LO” when minimum fan speed is reached then returns to normal display five seconds after either key is depressed. The set point fan speed is maintained until it is changed or if the AUTO key is depressed.
5. **TEMPERATURE UP / DOWN** - Increments the set point temperature up or down. The system will control the electronic water valve and/or the A/C compressor clutch to hold the cab temperature as closely as possible to set point temperature.
6. **ECON (Economy Mode)** - When depressed, locks out the A/C function. The control uses only fresh air, fan speed, and water valve control to maintain the set point temperature. Depressing the ECON key will return the system back to normal operation. A panel light indicates when this mode is active.
7. **C / F** - Switch between Fahrenheit and Celsius.

## Troubleshooting

To display diagnostics, depress key three times. Digital display shows any active fault codes. Repeatedly pressing key scrolls through active codes. Each code displayed should be addressed until No Faults code E00 is displayed.

### Fault Codes

| Cause | Display Reads |
|---|---|
| No Faults Detected | EO |
| Cab Sensor Shorted | E1 |
| Cab Sensor Open | E2 |
| Evap Probe Shorted | E3 |
| Evap Probe Open | E4 |
| Water Valve Shorted | E9 |
| Water Valve Open | E10 |
| No Communications w/ ECU | E17 |

For all fault codes is the possible solution check the wiring and connectors.

### No Display

- Press control panel on key.
- Make sure display illuminates.
- Verify control panel is plugged into wire harness.
- Check if wire harness is wired into vehicle properly.

### No Fan

- Turn up fan with fan up key.
- Make sure fan is plugged into wire harness.
- Verify circuit breakers or fuses are intact.
- If all other functions work properly, replace electronic control unit (ECU).

### No Heat

- Turn up heat with temperature up key. Use the advanced diagnostics to verify that the water valve is commanded open.
- Inspect and verify all wiring connections.
- Verify that any coolant shut off valves on the engine are open.
- Verify that warn coolant is flowing into the heater core by testing the heater hoses.
- Inspect and replace the electronic water valve if necessary.
- Inspect and replace ECU if necessary.

### No Cooling

- Turn down heat with temperature down key and enable defrost mode. Use the advanced diagnostics to verify that the A/C clutch is requested ON.
- Verify that the system is fully charged with refrigerant.
- Verify correct voltage is present at clutch relay on wire harness.
- Inspect and verify all wiring connections.
- Inspect and replace clutch relay if necessary.
- Inspect and replace refrigerant high pressure and/or low pressure cut out switches if necessary.
- Inspect compressor and clutch assembly and clutch assembly and replace clutch if necessary.

**The system is not controlling the cab temperature properly.**

- Inspect the Cab Air Temperature sensor.
- Verify that the recirculation vent inlet not obstructed.
- Inspect and replace recirculation vent air filter if necessary.
- Change the setpoint temperature in small increments.
- Verify that the water valve is working properly (see No Heat).
- Verify that the compressor clutch is working properly (see No Cooling).

**The evaporator core is icing up and restricting airflow.**

- Inspect the Evaporator Core Probe.
- Verify that the probe is making good contact with the evaporator fins and is not loosely inserted.
- Reposition the probe and check the core temperature during operation using the advanced diagnostics.
- Replace the evaporator core if necessary.

**System is putting out cool air when heat is needed.**

- Reposition cab temperature sensor as required.
- Verify compressor clutch is working properly (see No Heat).

**System is putting out hot air when cooling is needed.**

- Reposition cab temperature sensor as required.
- Verify compressor clutch is working properly (See No Cooling).

## Air Conditioning System

### Refrigerant Compressor

**FIG. 4:** Refrigerant Compressor (1)

Belt-driven and located on engine's left front, magnetic clutch is used to engage compressor. Compressor separates the low and high pressure sides of system and is basically a pump with two functions:

- Raising refrigerant temperature and pressures by compression.
- Functioning as a pump to circulate required volume of refrigerant and refrigerant oil around system.

See Systems Operation/Testing and Adjusting, Refrigerant Compressor for additional information.

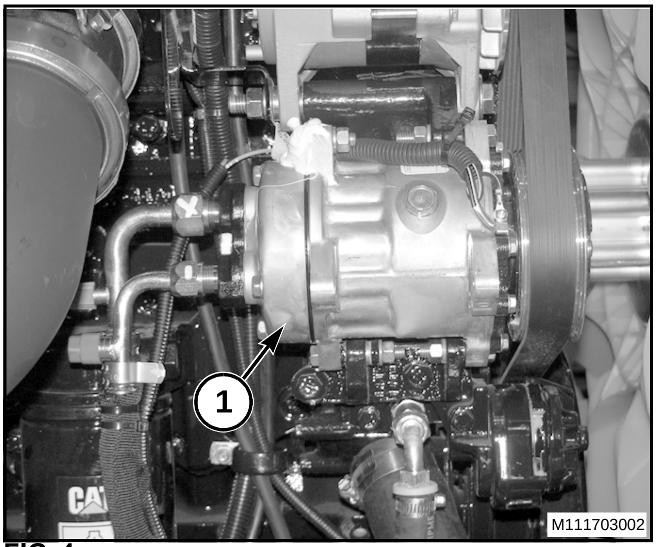


**FIG. 4**

### Refrigerant Condenser

**FIG. 5:** Condenser Operation

Condenser (1)

Refrigerant from Compressor (2)

Refrigerant to Orifice Tube (3)

Condenser Fan (4)

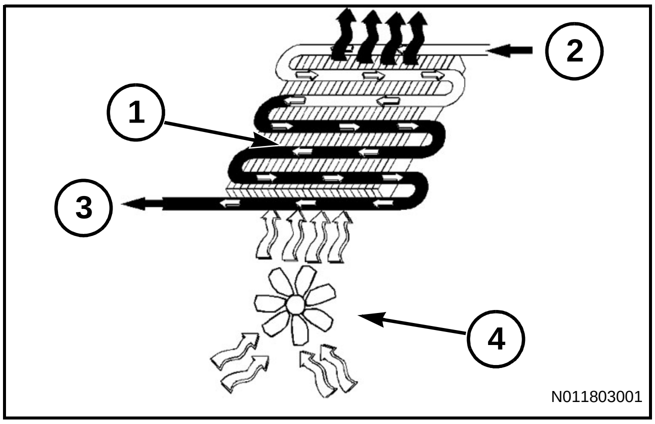


**FIG. 5**

**FIG. 6:** Refrigerant Condenser (1)

Located in front of radiator.

Heat is transferred from refrigerant to outside air in condenser. Transfer is in opposite direction as transfer in evaporator coil. Fins on outside surface of condenser are for efficient heat transfer. If refrigerant is not cooled enough, air inside cab at evaporator coil is not cooled sufficiently. To prevent this, good ventilation must be provided. This makes cooling refrigerant more efficient.

Condenser consists of a number of turns of continuous coil mounted in a series of thin cooling fins to provide maximum heat transfer in a contained amount of space.

Condenser receives hot, high-pressure refrigerant vapor from compressor. The hot vapor passes through condenser coils. Outside air is pulled through condenser by engine fan. Heat moves from hot refrigerant vapor into cooler outside air flowing across condenser coils and fins.

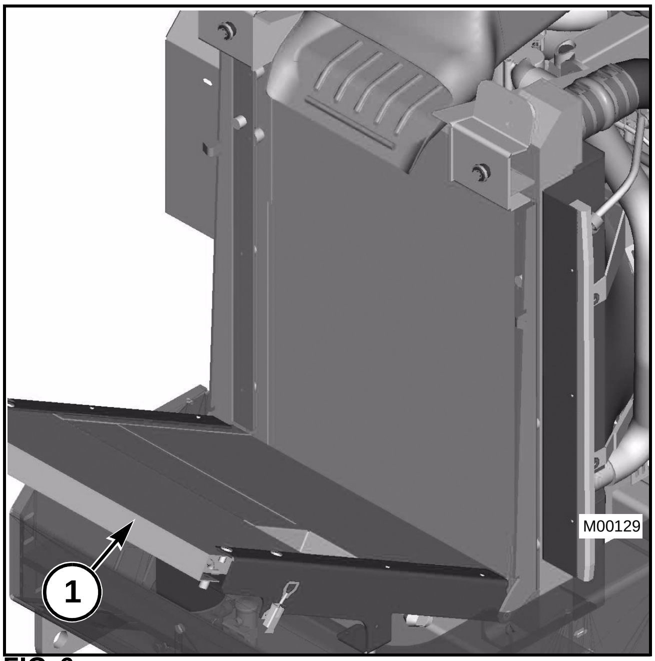


**FIG. 6**

Then refrigerant vapor reaches pressure and temperature that induces a change of state, a large quantity of heat is transferred to outside air and refrigerant changes to a high-pressure cool liquid and moves to receiver/drier.

See Systems Operation/Testing and Adjusting, Refrigerant Condenser for additional information.

### Receiver/Drier

**FIG. 7:** Receiver/drier (1) stores liquid refrigerant to ensure a steady flow to thermostatic expansion valve is maintained under widely different operating conditions.

Receiver/drier consists of several components:

The drier section contains a desiccant to absorb any moisture within system and a filter to prevent entry of foreign particles.

A high-pressure relief valve, mounted on outside of receiver/drier, provides protection for system in case of extremely high pressure spikes.

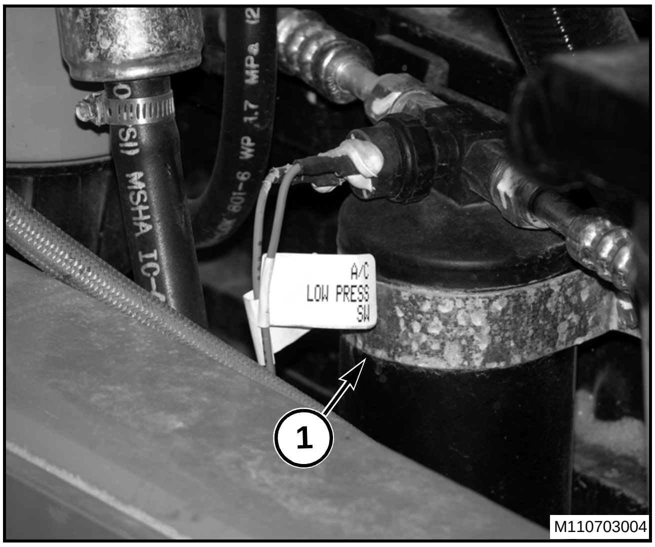



**FIG. 7**

## A/C and Heating System Schematic

Two sensors monitor refrigerant pressure:

- Pressure sensor for side of high pressure
- Pressure sensor for side of low pressure

Pressure sensor on side of high pressure ensures pressure does not go too high or too low. If either occurs, compressor shuts off to protect system.

Pressure sensor on side of low pressure ensures pressure does not go too low. If this occurs, compressor shuts off to protect system.

## Compressor Clutch

### Clutch Operation

**FIG. 8:** Components

Magnetic Clutch and Pulley Assembly (1)

Drive Plate (2)

Bearing (3)

Shaft (4)

Coil Assembly (5)

Compressor is driven clockwise by engine. A belt connects engine to clutch and pulley assembly located on clutch. Drive plate is fastened to shaft of compressor. Clutch and pulley assembly turn on a bearing and is not connected to shaft. Electric current from thermostat controls a magnetic field in coil assembly, pulling drive plate against clutch and pulley assembly, turning shaft and operating compressor. When current to coil assembly is stopped, magnetic field is removed allowing drive plate to move away from clutch and pulley assembly, moving freely on bearing. Sequence of connecting and disconnecting pulley to compressor shaft is called compressor cycling and is controlled by thermostat. Used to monitor temperature of evaporator coil.

### Control for Clutch

See Systems Operation/Testing and Adjusting, Control Module for more information regarding control of compressor clutch.

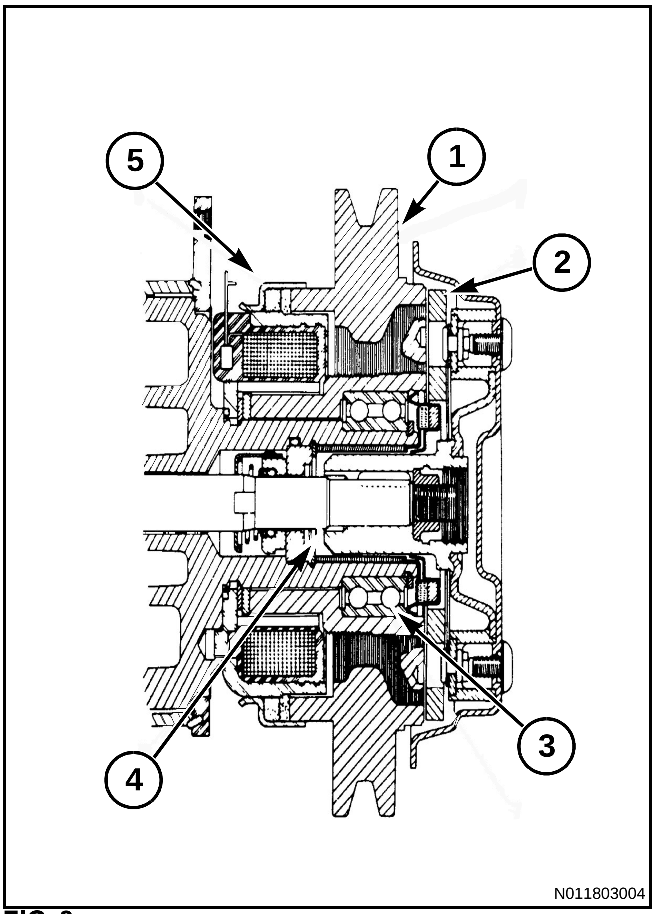



**FIG. 8**

## Suction (Suction Side)

Suction lowers refrigerant pressure in evaporator. Metered restriction, provided by orifice tube, allows high pressure liquid to be reduced to a low pressure liquid, helping with evaporation of refrigerant, leading to continuous cooling.

## Pumping

Pumping circulates refrigerant in air conditioning system, leading to continuous cooling.

## Compression (Discharge Side)

As pressure increases so does temperature of saturation. Compressor changes refrigerant from a low to a high pressure vapor. Change must occur for latent heat of condensation to be produced when refrigerant is sent through condenser.

## Operation of Compressor

**FIG. 9:** Compressor Operation

Intake Valve (1)

Exhaust Valve (2)

Intake Valve (3)

Exhaust Valve (4)

Intake Stroke (5)

Compression Stroke (6)

Compressor uses reed valves to control entry and exit of refrigerant gas.

As piston moves down, reed valve opens on suction side and closes on discharge side. Low pressure refrigerant gas has weight due to a heat transfer characteristic and is drawn from evaporator into compressor. As piston moves up, compressor pressurizes gas which increases heat.

Since temperature is a measurement of heat intensity, temperature of gas increases. Gas is high pressure and temperature. Gas closes reed valve on suction side and opens on discharge side. Gas is forced through a hose to condenser.

Pressure increase is accomplished by adding a restriction in high pressure side of system caused by an orifice tube.

See Systems Operation/Testing and Adjusting, Orifice Tube for additional information.

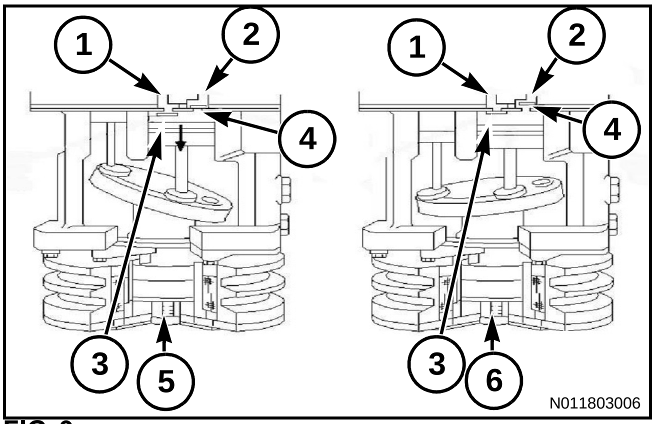


FIG. 9

## REFRIGERANT RELIEF VALVE

**FIG. 10:** Relief Valve

Relief valve is located on compressor at high pressure outlet and protects system by discharging refrigerant into atmosphere when high pressure reaches a preset amount to prevent failure.

Body (1)

Packing (2)

Valve (3)

Spring (4)

Relief Valve (5)

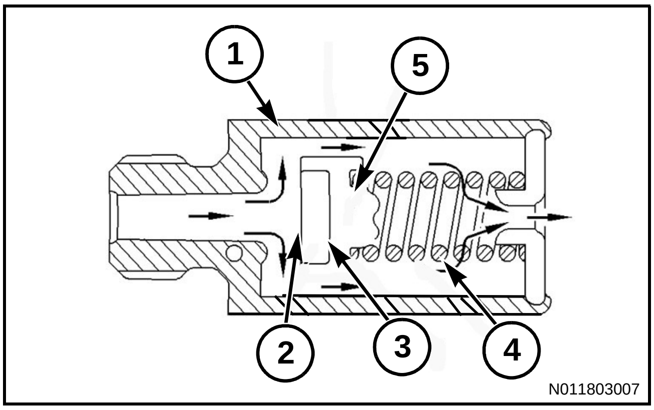


FIG. 10

## TEMPERATURE SENSORS

Temperature sensors are used for automatic temperature control system:

- Cab airflow temperature
- Outside temperature
- Ventilation duct temperature
- Probe for evaporator core

## Temperature in Cab

Temperature of inside cab airflow is measured by temperature sensor in HVAC unit. Cab airflow is drawn through recirculation filter and passed sensor.

## Outside Temperature

Outside temperature is measured by sensor located near drive motor for rear window wiper.

## Temperature of Ventilation Duct

Temperature of cooled or heated air in ventilation duct is measured by a sensor (5) located in blower fan housing.

## Probe for Evaporator Coil

**FIG. 11:** Probe (1) is inserted into evaporator coil to monitor temperature. Probe limits control signal of clutch for refrigerant compressor. Control signal for clutch is interrupted when temperature of evaporator coil is below 0 °C (32 °F), preventing evaporator coil from freezing. Moisture in airflow condenses and freezes below 0 °C (32 °F). Frozen moisture inhibits airflow through evaporator coil.

If the air flow coming out of the vents gates is about 7°C / 8°C (44,6°F / 46,4°F). The airco is working good.

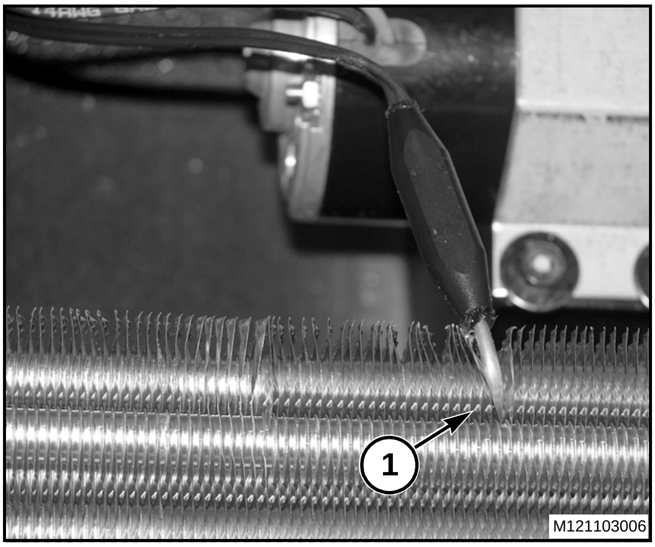



**FIG. 11**

## EVAPORATOR COIL

**FIG. 12:** Evaporator Operation

Evaporator (1) is located in HVAC unit in front of heater coil.

Evaporator transfers heat in cab to refrigerant.

Evaporator receives liquid refrigerant, with low pressure and temperature. Since pressure of liquid refrigerant is low, temperature of saturation of refrigerant is low. As temperature of saturation changes, refrigerant changes from liquid to vapor.

Blower fan exposes evaporator coil to air inside cab. Heat from air inside cab is absorbed by evaporator transferring heat to refrigerant, at which time it reaches temperature of saturation and changes from a liquid to a vapor. The amount of heat required to reach temperature of saturation is called latent heat of vaporization. Vaporized refrigerant leaves evaporator and carries heat away from cab. Vaporized refrigerant returns to compressor when refrigerant leaves evaporator. This process is repeated continuously.

Temperature of evaporator coil is monitored by a temperature sensor inserted into evaporator coil.

See Systems Operation/Testing and Adjusting, Temperature Sensors for additional information.

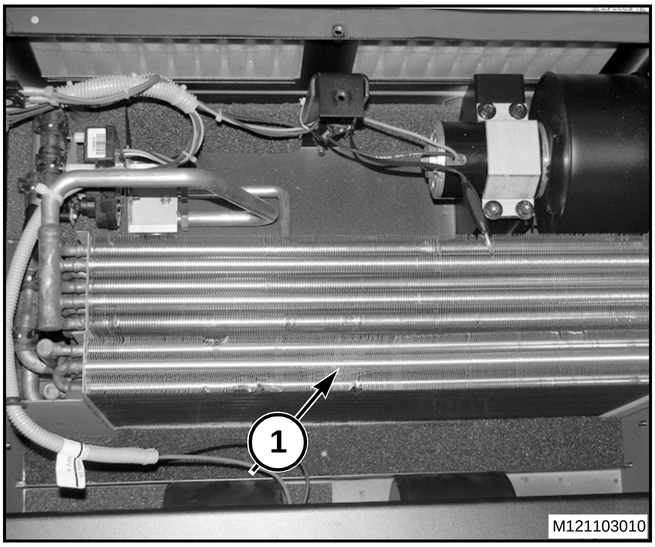



**FIG. 12**

## HEATER CORE (CAB)

**FIG. 13:** Heater core (1) is located in HVAC unit.

Airflow is forced past heater core to gain heat from engine coolant. Engine coolant is circulated through heater core. Airflow is created by blower fan in HVAC unit.

Heater core is constructed of copper and aluminum as these metals are excellent heat conductors. Heater core and water valve are connected with a heater hose. These connections are critical and should be checked periodically for leaks.

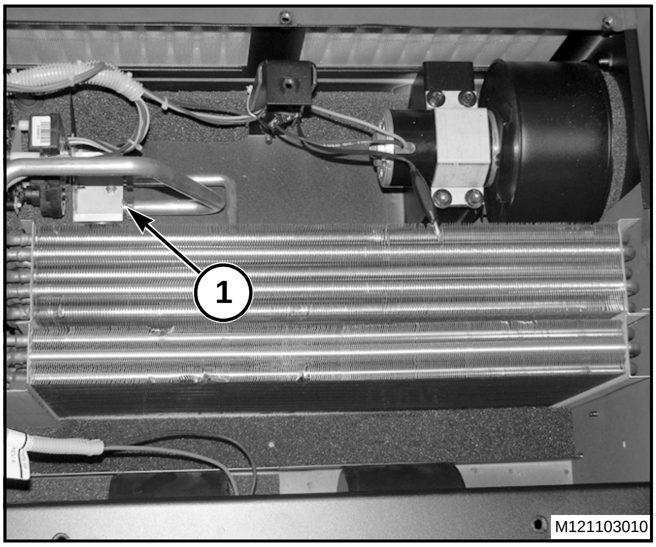



**FIG. 13**

## ACTUATOR MOTOR (WATER VALVE)

**FIG. 14:** Water Valve with Actuator Motor

Water valve (1) controls amount of water flowing into heater core. Foreign matter on outside surface of heater core can cause a poor exchange of heat. Heating system loses capability to heat when heater core gets dirty. Clean outside surface of heater core when system is checked.

Valve actuator is used to control water valve with sixteen positions available and is dependent on amount of heat required. Position of water valve changes as selected temperature changes. A potentiometer detects position of water valve and feeds information back to control module.

**FIG. 15:** Water Valve Schematic

Inside actuator (A)

6-Pin Actuator (B)

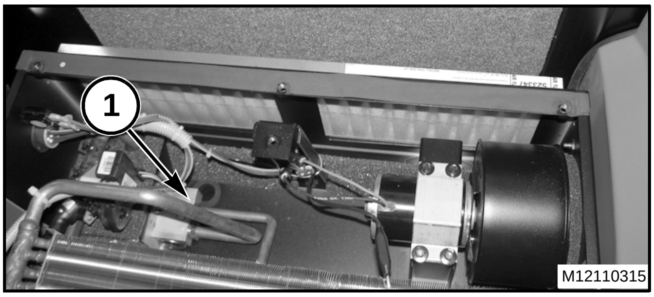



**FIG. 14**

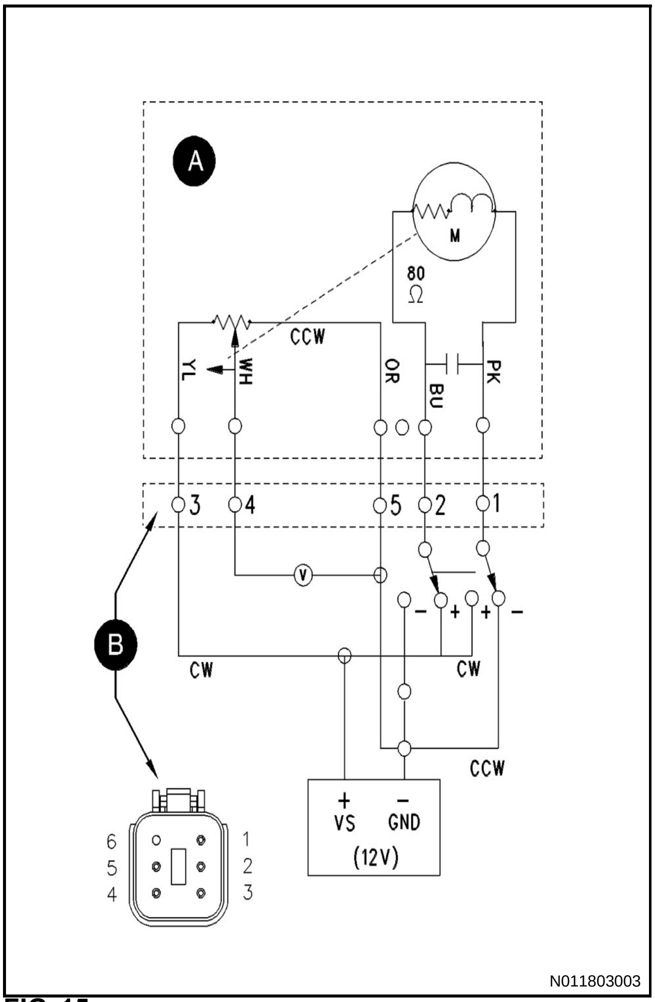



**FIG. 15**

# AIRFLOW

## Components for Airflow

Airflow Components

HVAC Unit

Air Filter (Fresh Air)

Air Filter (Recirculation)

Damper Control (Deluxe Cab)

Inlet for Recirculated Air

Inlet for Fresh Air

Blower Fan

Sealing Area

## Blower Fan

**FIG. 16:** Internal components with rear cover removed

Blower (1) is located in HVAC unit and has:

- Inlet for fresh air and inlet for recirculated air.
- Outlet for vents on left side of the cab.
- Outlet for vents on front console.
- Outlet for vents on right side of cab.

Motor drives blower.

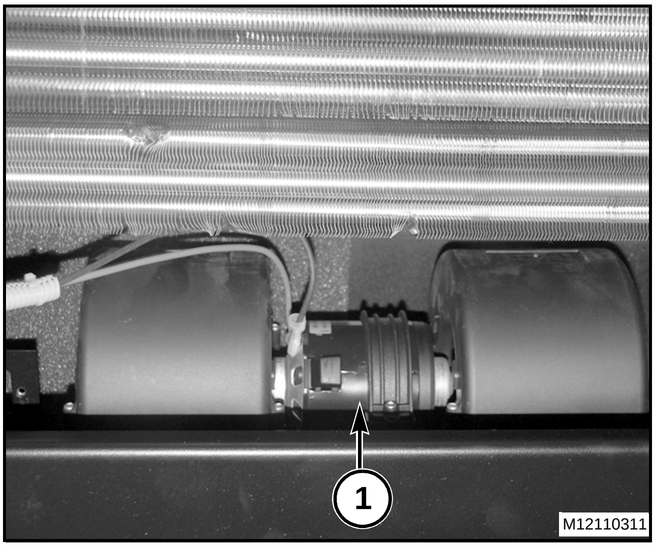



**FIG. 16**

## Intake For Airflow

HVAC unit draws air from fresh air inlet and recirculates in cab. HVAC unit is designed to draw 20% fresh air from outside and 80% interior air, this is not adjustable.

## Fresh Air

**FIG. 17:** Fresh air flow

The fresh air flow comes from the blower which is located underneath the seat. The air flow goes underneath the cab floor mat to the dashboard console. Inside the dashboard goes the air flow through the air gates into the cab.

The arrows in the figure shows the air flow.

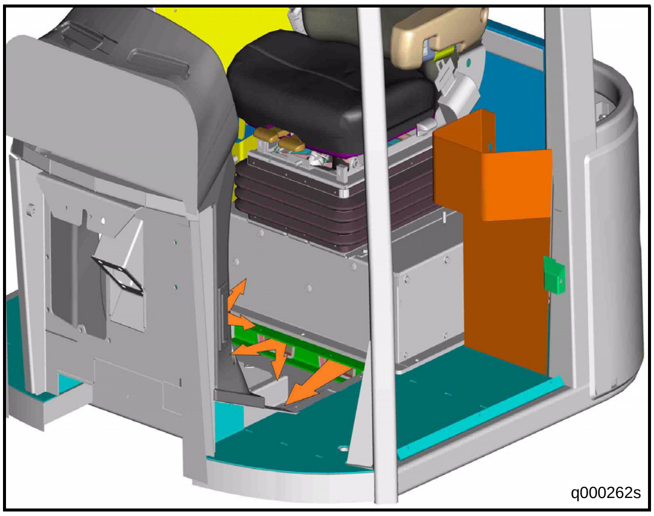



**FIG. 17**

### Fresh Air Filter

**FIG. 18:** Fresh Air Filter

Fresh air is drawn through cab filter (1) located above windshield. Filter collects dust particles from air, then travels down rear cab supports to HVAC unit.

Maintenance for Air Filter (Cab)

### Maintenance for Cab Air Filter

If necessary, filter should be cleaned or replaced. Ensure tight seal on filter so dust is not drawn into system.

Refer to Operation and Maintenance Manual, Air Filter (Cab) - Clean/Replace for additional information about inspecting and cleaning filter.

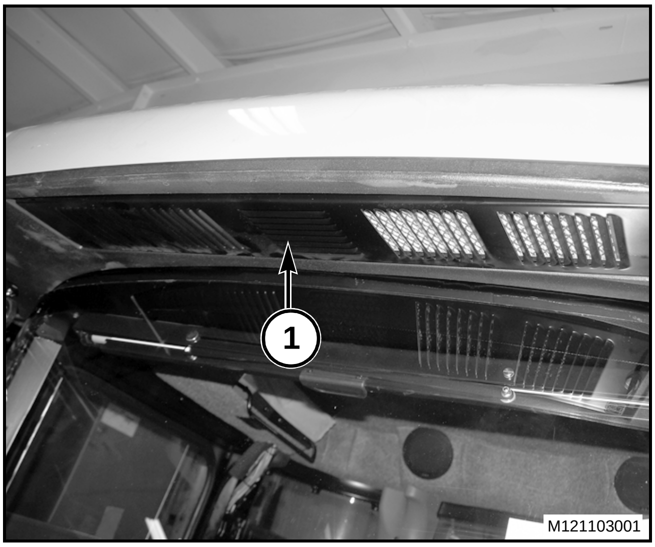



**FIG. 18**

## Recirculation

### Recirculated Air Filter

**FIG. 19:** Recirculated Air Filter

Recirculated air is drawn through recirculation cab filter (1) located behind operator seat. Filter collects dust particles from air. HVAC unit is directly behind filter.

If necessary, filter should be cleaned, inspected or replaced.

Refer to the Operation and Maintenance Manual, Air Filter (Cab Recirculation) - Clean/Replace for additional information about inspecting and cleaning filter.

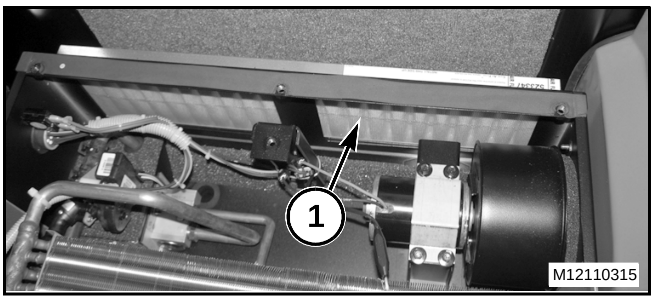



**FIG. 19**

### Charcoal Air Filter

**FIG. 20:** Charcoal Air Filter

*IMPORTANT: To maintain proper cab pressurization, baffle must be in the fully raised position when used with charcoal filter. When used with a standard cab filter, baffle must be in fully lowered.*

Charcoal filter (1) is used in conjunction with a baffle on cab air filter cover.

Life of filter is affected by environmental conditions and should be replaced when odor, taste or other symptoms of contamination are detected. Replace the filter at least every 1000 hours / annully

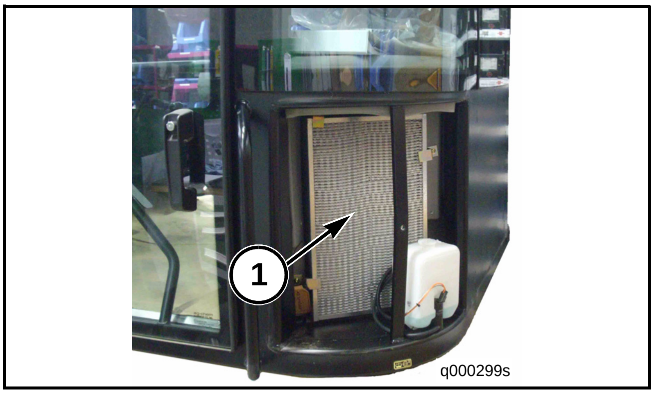


FIG. 20

## Head, Foot and Defrost

**FIG. 21:** Airflow to Vents

Vents on front console direct cab airflow toward operator's top, sides and feet.

Rear posts for ROPS are incorporated with air ducting.

Operator has control of all vents, however, a motorized damper controls airflow for front console. Damper is automatically controlled by control module.

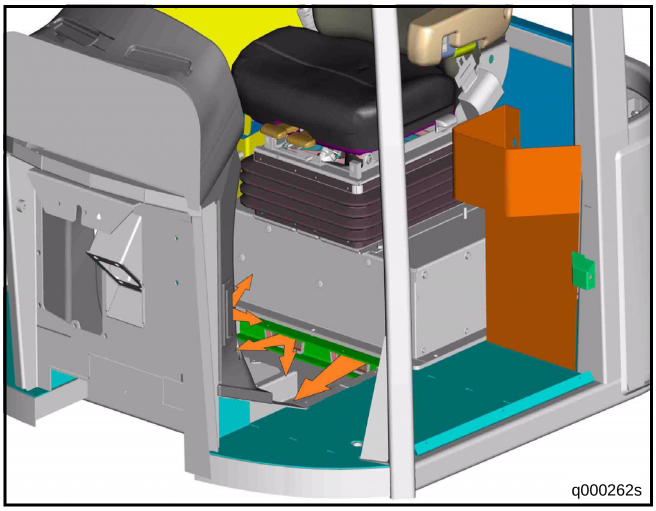


FIG. 21

## MOTOR (AIR CONDITIONING BLOWER)

**FIG. 22:** Blower Components

Fan (1) is used to circulate air for HVAC system and is located in HVAC unit (3). Motor (2) drives fan.

Rotation of motor is clockwise.

## Overpressure blower

Inside the cab of Terra Gator is always a overpressure to keep the air inside the cab clean. The blower which prevent the overpressure is located underneath the operator's seat.

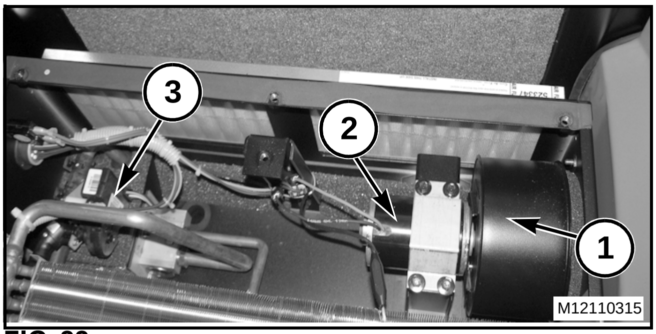


FIG. 22

## Automatic Temperature Control (Fan)

### Auto Mode

Fan speed is system determined based on difference between setpoint and actual cab temperature. A large difference in temperature results with faster fan speed.

Heating or cooling occurs if cab is too hot or cold. Fan speed is held at a minimum when cab is heating or cooling quickly and overshoots setpoint temperature.

In automatic mode, fan speed is limited by temperature of outlet duct. If temperature of duct is less than 22 degrees C (72 degrees F), fan speed is limited to low speed. Fan speed gradually increases as temperature of duct increases. This continues until temperature of duct reaches 35 degrees C (95 degrees F). This limit is disabled if a duct temperature sensor error occurs. In automatic mode, all changes in fan speed are gradual.

### Manual Mode

Fan speed directly corresponds to fan speed control. Control is a potentiometer allowing infinite adjustment. Initial fan speed on start-up gradually increases to desired fan speed.

## Manual Fan Control

Manual fan speed switch provides operator with five speed selections, including off. Fan speed is independent.

# SPEED CONTROL

## Automatic Fan Speed Control

Speed controller consists of control panel and main control module. Fan speed rotary control must be in auto to allow automatic control of fan.

Speed controller for fan regulates amount of voltage supplied to blower motor and operates in a linear mode on ground side of blower motor.

Speed controller for fan also provides thermal protection if there is a short circuit. This protection is also provided for a stalled motor or any other condition causing excessive temperature in heat sink. Limit of output current is proportional to sensed output voltage causing current to feedback if there is a stalled motor or a short circuit to Vbatt. Output faults cause temperature in heat sink to rise. Insufficient airflow also causes temperature in heat sink to rise. Thermal protection is a two-stage process. When temperature in heat sink is greater than approximately 70 degrees C (158 degrees F), thermal protection causes output to attempt maximum output voltage. If temperature in heat sink continues to rise above approximately 105 degrees C (221 degrees F), output turns off. Output turns on when temperature in heat sink lowers to approximately 70 degrees C (158 degrees F).

## Manual Mode Fan Speed Control

Fan speed directly corresponds to fan speed control. In automatic or manual mode, initial fan speed on start-up gradually increases to desired speed.

## ACTUATOR MOTOR (DAMPER)

**FIG. 23:** Actuator Motor Schematic

Actuator Motor (1)

Inside Actuator (2)

2-Pin Connector (3)

Actuator motor is used in one position on HVAC system to control a damper for airflow of defrost for front window.

*NOTE: Refer to table in Systems Operation, Control Module for details on operation of actuators.*

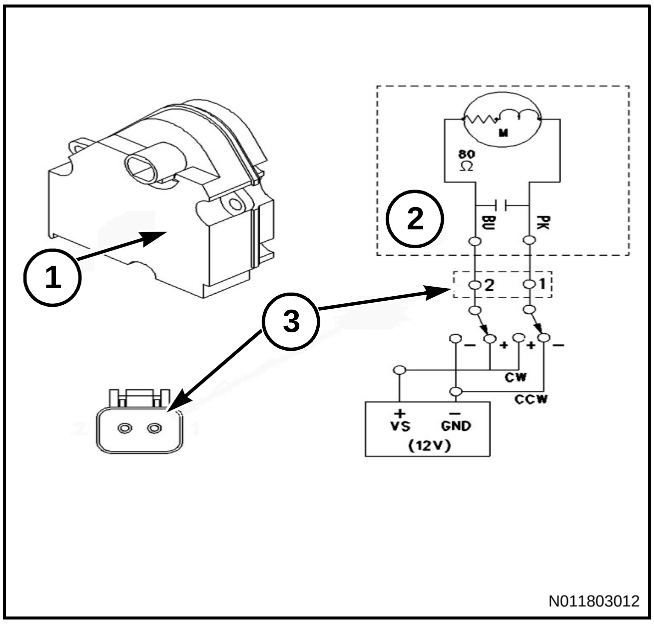



**FIG. 23**

## GLOSSARY OF TERMS

accumulator - a refrigerant storage and filtering component used in place of a receiver-drier in CCOT air conditioner systems

activated alumina - chemical agent used in receiver-driers as a desiccant

air block - an assembly used to direct air pressure to control devices

air conditioning - control of air movement, humidity and temperature by mechanical or other means in a vehicle

air operated water valve - a valve in vehicle cooling (heater) system controlled by air pressure

altitude - a measured height above sea level (where atmospheric pressure is lower than at sea level)

ambient air temperature - air temperature outside vehicle

atmospheric pressure - pressure of air at a given altitude with normal pressure reference point of 14.7 pounds per square inch at sea level

axial compressor - type of compressor containing pistons located in an axial design

back seat - an AC service valve position which closes off service port and allows free flow of refrigerant in system

bellows - a chamber used as a control device in an air conditioning system which expands and contracts, much like an accordion

bi-level system - a cab HVAC system where AC output is diverted to both upper (defrost) and lower air outlets

bimetallic - two dissimilar metals joined together to function as a thermostat

Binary switch - a two function pressure activated switch used to prevent compressor damage when pressure is too high or refrigerant is lost from AC system.

blends - a refrigerant containing less chlorine than R-12. Proposed as a replacement for R-12, but not a simple substitute

blower wheel - wheel used to blow air through evaporator or heater core causing air to circulate in cab

boiling point - point at which liquid changes to vapor

BTU - an abbreviation for British Thermal Unit, a unit of measure of heat quantity equal to amount of heat energy required to raise a pound of water one degree Fahrenheit

bulk charge - a large container of refrigerant used in air conditioning system servicing, containing 20 or more pounds of refrigerant

CTC (constant temperature control) - an electro-mechanical device used to maintain preselected air temperature

capacity - a measure of unit performance in BTUs per hour, tons, watts or other unit of measure

capillary tube - a gas-filled tube extending from thermostat and some expansion valves, senses temperature to close thermostat (clutch) circuit or open expansion valve orifice

Celsius - a temperature scale where zero degrees Celsius equals 32 degrees Fahrenheit (freezing) and 100 degrees Celsius equals 212 degrees Fahrenheit (boiling point of water)

centigrade - another name for Celsius

change of state - reorganization of matter which allows a solid to change to a liquid or gas, a liquid to a solid or gas, or a gas to a solid or liquid

charge - term used to describe what happens when refrigerant is added to an air conditioning system

charging hose - a hose connected to a port on a manifold gauge set, used to conduct refrigerant into AC system from refrigerant source

chlorofluorocarbon (CFC) - a family of chemicals which includes R-12 and other chemicals. Usage is being phased out under federal law

clutch - a mechanical device which serves to take torque in a driving force and transfer it to another force to be driven - used to drive compressor or engine fan

clutch cycling switch - an electrical switch used to turn compressor clutch on or off according to temperature or pressure demands (one example: thermostat)

compressor - pump (often referred to as the heat) of an air conditioning system which pumps refrigerant through system and raises vapor pressure of refrigerant

compressor head pressure - pressure of refrigerant as it leaves compressor through discharge port

compressor shaft seal - a seal located on output end of compressor shaft which serves to keep refrigerant oil and refrigerant inside system

condensate - water that collects on surfaces like evaporator fins and other cold surfaces when air conditioning system is operating

condensation - process by which gas or vapor changes to a liquid

condenser - a finned tube device (heat exchanger) in which refrigerant loses heat and changes from hot vapor (or gas) to a warm liquid in system

conduction - ability of a substance to convey heat from one point to another within the substance (heat movement in refrigerant)

contaminant - any foreign substance (particularly moisture, dirt or air) which enters an air conditioner system and must be removed

convection - transmitting or moving heat within a liquid or gas by moving heated parts

cutoff switch - a switch on compressor which cuts compressor out of system when full throttle is applied to engine cycling clutch orifice tube (CCOT) system - a system using an expansion tube (fixed orifice tube) and an accumulator in place of expansion valve and receiver-drier

cycling clutch system - a temperature control system which monitors operation of compressor clutch

dehumidify - to remove moisture (humidity) from air in the cab or defog windshield

density - ratio of mass to it’s volume

desiccant - an agent used in an air conditioning system to dry or remove moisture by absorption; found in receiver-drier or accumulator

desiccant bag - container found inside some receiver-driers and accumulators for desiccant

diaphragm - a device which acts as a bellows or piston to divide chambers of a control device

dichlorodifluoromethane - chemical name for Refrigerant R-12

discharge - in an air conditioning system, refers to bleeding or releasing all refrigerant in a system

discharge line - line carrying refrigerant from compressor outlet to condenser inlet connection

discharge pressure - high side pressure (refrigerant vapor) leaving compressor

discharge switch (compressor) - switch on compressor which turns compressor off when low pressure of refrigerant is sensed

discharge valve - same as high side service valve

drain tube - in an AC system a tube positioned to drain condensation out of vehicle

drier - normally a part of receiver-drier, used to absorb moisture in system using a desiccant as a drying agent

drive pulley - pulley that drives compressor clutch

drying agent - same as desiccant

electronic lead detector - a device designed to sense leaks in an air conditioning system with extreme accuracy

electronic sight glass - a device using ultra-sonic principals to sense refrigerant inside an AC system and provide audible signals when AC system has proper amount of refrigerant

equalizer line - used to control valves in an air conditioning system to equalize pressure or temperature

ester - a type of lubricant that may be found in R-134a systems

evacuate -process of removing all moisture or air in a system by creating a vacuum in system

evaporation - process by which a liquid changes it’s state to become a vapor or gas

evaporator - a device with coils and fins through which liquid refrigerant flows, removing heat energy from air, and changing to a vapor

expansion tube - also called a fixed orifice tube (CCOT system), replaces expansion valve and meters refrigerant to evaporator

expansion valve - same as thermostatic expansion valve (TXV)

external equalizer - same as equalizer line

Fahrenheit - a scale used to measure temperature (heat intensity - how hot something is) and calibrated at 32 degrees Fahrenheit where water freezes and 212 degrees Fahrenheit where water boils

fan clutch - a variable speed or on-off clutch which acts as a coupler (fluid, air or electrical), between engine and engine cooling fan

filter - a portion of receiver-drier used to remove solid contaminants from system

flush - process of removing all foreign matter from a system by means of pressurized air, refrigerant or dry nitrogen

foaming - when observed in sight glass indicates low level of refrigerant in system

foot-pound - a measurement of energy required to raise one pound one foot. In relationship to torque, it is a force that acts upon a body (such as a bolt or nut) to produce rotation

freeze-up - freezing of water or moisture in expansion valve orifice or on fins and coil of evaporator

freezing point - point at which a liquid becomes a solid

Freon - Dupont registered trademark name of refrigerant R-12

front seat - an AC service valve position which isolates compressor from system by closing valve (turning valve stem all the way to the right)

gauge set - two gauges (sometimes three) installed on a manifold to test and measure conditions inside AC system

‘H’ valve - a water valve which returns excess coolant from heater inlet back to engine cooling system

Halide leak detector - a propane gas device used to determine location and severity of an R-12 lead in system

head pressure - pressure of refrigerant from where it originates at discharge valve of compressor, through all lines and components to orifice in expansion valve

heat energy - heat in action; movement of a quantity of heat measured in BTUs (example, in a change of state)

heat exchanger - a device which enables fluid at one temperature (higher) to move heat to another fluid at a lower temperature

heat intensity - temperature of a substance or material as measured by a thermometer

heat load - amount of heat contained in a given situation

heat quantity - amount of heat measured in BTUs (British Thermal Units)

heater - an apparatus providing heat

heater core - an assembly of metal tubing and fins used to exchange heat from engine coolant to cab air

Hg - symbol for mercury in Periodic Table of Elements

HVAC - heating, ventilation and air conditioning

high load condition - circumstance when air conditioning system is operating at maximum capacity to cool a given environment

high pressure cutout switch - a switch which cuts out compressor clutch if pressure in system rises above a pre-set level

high pressure lines - lines carrying high pressure refrigerant gas and liquid between compressor, condenser, receiver-drier and expansion valve

high side - high pressure side of system (gas or liquid) from compressor outlet to expansion valve orifice

high side low pressure cutout switch - a switch (on high pressure line) which cuts out compressor clutch if pressure in system drops below a preset level

low side - low pressure side of a system, from expansion valve orifice to compressor inlet

low side service valve - a valve on compressor used to service low pressure side of system and permit it to be checked

lubricant - refrigeration oil specially formulated to be free of all contaminants and moisture. Note: different from R-12 and R-134a

magnetic clutch - an electronically operated device used to cycle compressor on and off

manifold - part of manifold gauge device designed to control refrigerant flow

manifold gauge hoses - hoses connected to manifold gauge set used to test, evacuate, recover and charge air conditioning system

manifold gauge set - a system measuring device containing two (sometimes three) gauges and three or more service connections

melting point - temperature at which a solid turns into a liquid

mercury - used to indicate amount of vacuum (a perfect vacuum is 29.92 inches of mercury at sea level)

molecular sieve - a drying agent used in receiver-drier to absorb moisture and filter contaminants out of refrigerant

natures laws - principals of conduct in natural process or function in nature

PAG - a polyalkylene glycol lubricant used in many R-134a systems

parallel flow - a coil design where refrigerant flows through both upper and lower tubing simultaneously

phosgene - a poison gas produced when R-12 comes in contact with an open flame

POA valve - a suction throttling valve used in some systems

pressure drop - pressure lost while passing through a component, difference between pressure in and pressure out

pressure range - a measured spread between a high and low pressure

pressure switch - a pressure sensitive electrical switch mounted at receiver-drier, on some accumulators or in suction lines to activate or interrupt electrical current cycling compressor clutch

propane - a flammable gas used in Halide leak detector

PSI - abbreviation for “pounds per square inch”

PSIg - abbreviation for “pounds per square inch gauge”

purge - to remove refrigerant from an AC system and hoses by opening system or using pressure to eliminate contents

R-12 - common name of refrigerant used in vehicle air conditioner systems to move heat energy

R-134a - new refrigerant that does not harm atmosphere

radial compressor - a compressor with pistons in a radial design

radiation - heat waves (heat energy) passing through air

radiator shutter - a metal vane assembly on some truck radiators where vanes can be opened or closed to allow or exclude ram air flow to radiator, radiator mounted condenser and engine

ram air through which a vehicle passes increasing in orifice as speed of vehicle increases

receiver-drier - a container which receives, stores and removes moisture from refrigerant

reciprocating compressor - a compressor having pistons that move back and forth in cylinders

reclaim - process of restoring refrigerant to new product specifications

recovery - process of removing refrigerant from an AC system

recycle - process of removing contaminants (moisture, acid, particulate matter) from a refrigerant

reed valve - suction and discharge valves located in valve plate of compressor

refrigerant - a substance used in HVAC systems to control heat energy

refrigerant cycle - one complete revolution of refrigerant through system which includes changes of state of refrigerant from liquid to vapor or gas and back to liquid

refrigeration oil - a specially manufactured oil free from moisture and all contaminants

relative humidity - amount of moisture in air as compared to total amount air can hold at a given temperature and altitude

resistor - a voltage dropping device, usually wire wound, which provides a means of controlling fan or blower speed

retrofitting - reconditioning an R-12 AC system to use R-134a rotary vane compressor - a type of compressor which uses internal vanes rather than pistons to operate and pump refrigerant through system

rotating coil clutch - an old type clutch where magnetic coil is part of clutch pulley - now replaced universally by stationary coil design where coil is bolted to compressor body

Schrader valve - a spring loaded valve inside some service fittings, similar to a tire valve; also found on some accumulators

serpentine - a condenser coil formed from one piece of extruded aluminum tubing

service port - a fitting on control devices and service valves allowing connection of manifold gauge hoses

service valve - see “low side service valve” and “high side service valve”

shaft seal - see “compressor shaft seal”

sight glass - a window usually in top of receiver-drier for observing condition of refrigerant

silica gel - a type of desiccant which removes moisture from refrigerant

solenoid valve - an electromagnetic valve controlled by electrical current energizing and de-energizing a coil to open or close valve

specific heat - amount of heat required to change temperature of one pound of a substance 1 degree Fahrenheit

stationery coil clutch - magnetic clutch used to drive compressor

stem-type valve - a service valve with a threaded valve stem for three position adjustment, back-seated, mid position and front-seated

suction line connecting evaporator outlet to compressor inlet; low pressure lines

suction service valve - see “low side service valve”

suction side - low pressure portion of system, from expansion valve orifice to compressor inlet

sump - portion of a compressor where oil is contained, waiting to be circulated

superheat - heat added to a gas after evaporation from a liquid state (approximate temperature rise across evaporator coil)

SUVA - Dupont trademark for R-134a

superheat switch - a switch mounted on compressor and connected to a thermal limiter and fuse, used in some systems to sense low refrigerant and protect compressor

temperature range - a measured spread between high and low temperature

thermal limiter - a protective device with a fuse and used with a superheat switch to stop compressor when low pressure is sensed by superheat switch

thermistor - a very sensitive electronic temperature sensor

thermostat - a temperature sensitive switch used to control system temperature by cycling compressor on and off

thermostatic expansion valve - a valve which senses evaporator outlet tube temperature and pressure to regulate flow of refrigerant into evaporator

Trinary switch - a three function switch, first two functions protect the compressor from operating as follows: 1) abnormally low refrigerant or loss of refrigerant, 2) extremely high head pressure. The third function can open radiator shutter and/or cycle an air or electric operated fan clutch when system requires more air flow through condenser

tube and fin - aluminum or copper tubing inserted through individual pieces of fin material

vacuum - expressed in inches of mercury or Hg, a vacuum is a state in which air pressure is below atmospheric pressure

vacuum pump - a pump attached to a sealed system or enclosure (an air conditioning system) to evacuate air and moisture from system

valves-in-receiver - a receiver-drier which contains an expansion valve and a POA valve in one unit

Wankel compressor - a type of compressor which uses a triangular gear driven rotor inside a figure eight shaped cavity to operate and pump refrigerant through AC system

water valve - a mechanical, vacuum or air operated valve used to control flow of coolant to heater core

## NOTES

# HVAC SPECIFICATION

## REFRIGERANT COMPRESSOR

### Compressor

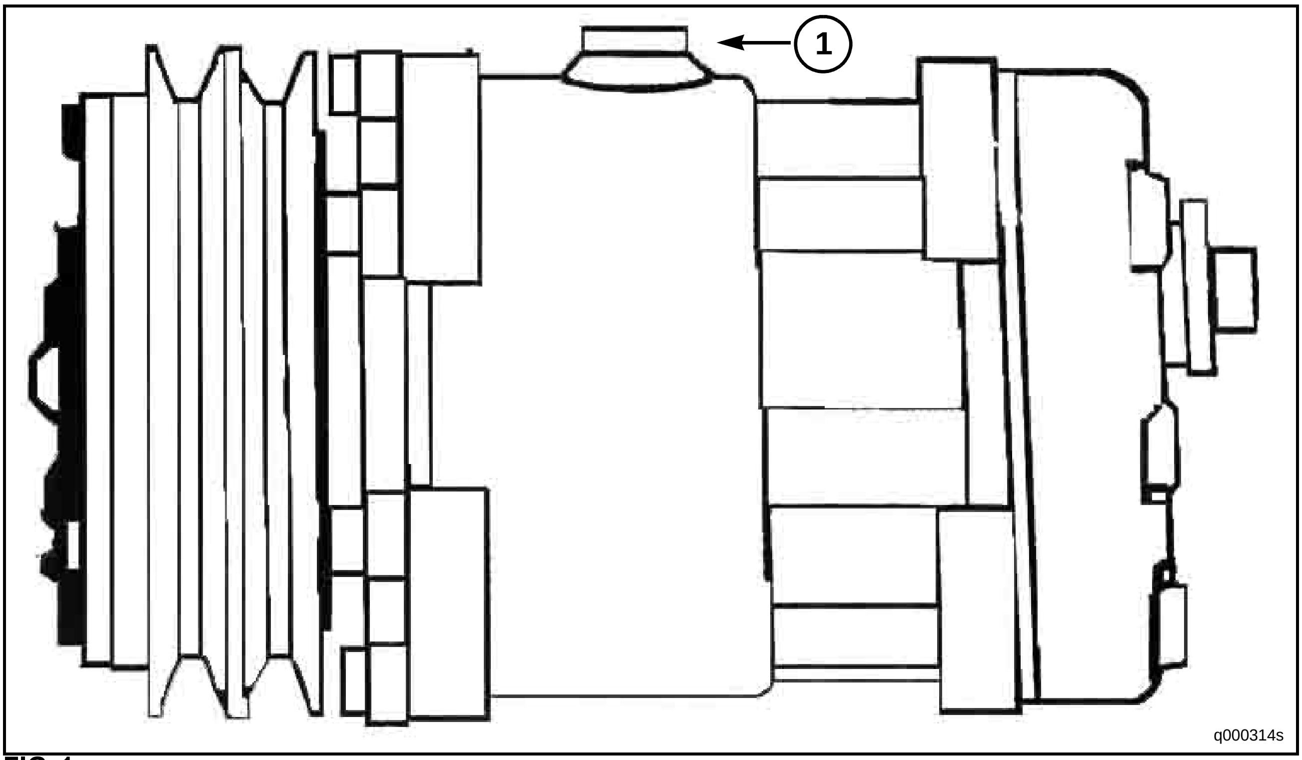



FIG. 1

**FIG. 1:**

Torque for oil plug (1) 8 to 12 Nm (71 to 107 lbf in)

*NOTE: Oil plug is pressurized*

| | |
|---|---|
| Type of compressor | Sanden International 4872-6000 |
| Type of 4C-2959 Air Conditioner Lubricant | SP-15 |
| Oil capacity of compressor | 199,92 mL (6,76 fl oz) |
| Type of refrigerant | R134a |
| Filling | 1800 gram (3,97 lb) |
| Type of compression | 7 swing cylinders |
| Capacity of cylinders | 155,7 cc/rev (9,5 in3/rev) |
| Power consumption | 49W |
| Rotation | Clockwise |
| Maximum allowable continuous RPM | 6000 |

### Clutch

| | |
|---|---|
| Rotation | Clockwise |
| Voltage of magnetic clutch | 12 VDC |

### Relief Valve

| | |
|---|---|
| Final installation torque | 18 to 32 Nm (158 to 282 lbf in) |
| Opening pressure of relief valve | 4137 kPa (600 PSI) |

## Belt

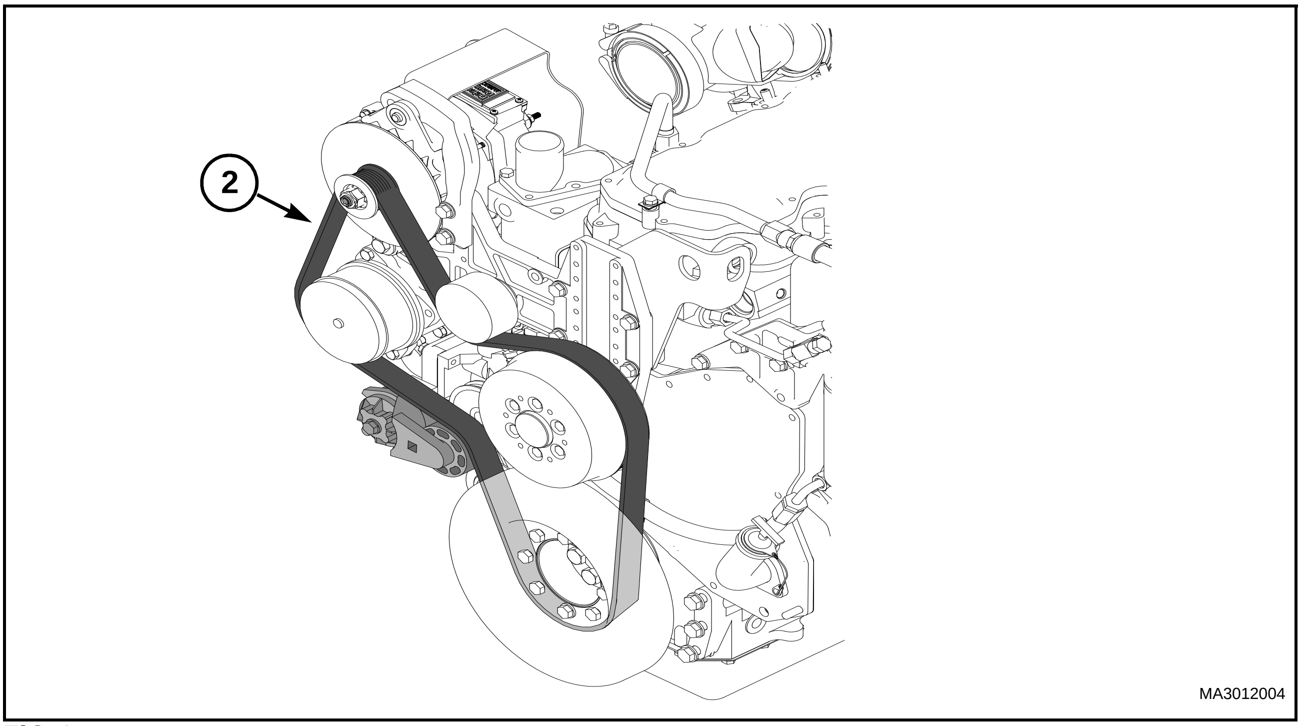



**FIG. 2**

**FIG. 2:**

Belt (2)....................................................................................................................................................PV10

135-2151 Belt Tightener spring force at 25 degrees ...................................... 12.4 to 15.8 Nm (9.1 to 11.7 lbf ft)

# HVAC TESTING AND ADJUSTING

## TROUBLESHOOTING MACHINE PREPARATION

**WARNING: Personal injury can result from contact with refrigerant.**

**System is always under pressure, even if engine is not running. Never apply heat to a charged system.**

**Refrigerant contact can cause frostbite. Keep face and hands away to prevent injury.**

**Even if gauges indicate no refrigerant in system, protective goggles must always be worn when refrigerant lines are opened.**

**Always use caution when removing a fitting and always loosen fittings slowly. If system is still under pressure, evacuate and recover refrigerant before removing fitting.**

**Personal injury or death can result from inhaling refrigerant through a lit cigarette or other smoking method.**

**Inhaling fumes released from a flame, contacting with air conditioner refrigerant gas, can cause bodily harm or death.**

**Do not smoke when servicing air conditioners or anytime refrigerant gas may be present.**

**Before checking air conditioning and heating system, move machine to a level surface and lower all implements to the ground. Ensure transmission is in neutral or park and parking brake is engaged. Keep all other personnel away from unit or where they are visible.**

Before any problem solving procedures are performed, refer to Testing and Adjusting, Visual Inspection. Make a visual inspection of the complete air conditioning and heating system.

- All charging and leak testing must be done in a well-ventilated area.
- Avoid any physical contact with refrigerant as contact can cause frostbite.
- Always wear goggles when working on or testing any part of the air conditioning system.
- Place a clean cloth over any open valve or connection.
- Never weld, solder or steam clean any charged components.
- Do not smoke when recovering or recycling refrigerant, charging, performing a leak test or flushing the system.
- Do not carry refrigerant drums in cab or expose them to direct sunlight.
- Dispose of any opened, but unused, oil that is poly alkaline glycol (PAG). Moisture will contaminate unused oil and the air conditioning system.

## GENERAL TROUBLESHOOTING INFORMATION

- Low refrigerant charge causes losses of cooling and lubrication in compressor, results in failed compressor.
- Overcharge of refrigerant causes a loss of cooling ability. An overcharged system contains excess liquid refrigerant that can severely damage compressor. An overcharged system fails at a rate of twice an undercharged compressor.
- Too much oil in system contributes to a low refrigerant charge.
- A small amount of moisture will penetrate the hoses used in R134a systems. Change accumulator, desiccant, and filter annually. Moisture causes sludge resulting in a plugged system and can also cause the formation of ice at the orifice of the tube assembly.
- When outside temperature is above 32 degrees C (90 degrees F) or if the humidity is high, gauge readings for an undercharged R134a system appear as symptoms of overcharge. Incorrect gauge readings lead to a loss of cooling ability and compressor failure.
- Removed refrigerant cannot be weighed accurately. A 20 to 30 percent error can occur as a result of inaccuracies of devices used for recovery.
- Check scale for accuracy after every 30 days or every 30 uses.
- If system pressure rises above 0 kPa (0 PSI) within five minutes of recovering a system, recover again until pressure does not increase. Recovering system again empties accumulator of refrigerant.
- Presence of frost on accumulator is normal, the thickness of frost depends on outside temperature and humidity.
- Perform regular maintenance on refrigerant service units and change vacuum pump oil.
- Secure lines and wires to prevent damage.
- The formation of black sludge deposits in the system is caused by moisture in R134a systems and by mixing charges of R134a and R12.
- The presence of white foam during recovery is normal, it is caused by mixing oil and refrigerant.
- R134a system charges must be within 0.03 kg (1oz) to .06 kg (2oz) of specified charge for unit.

A loss of cooling ability or failure of compressor may be caused by one or more of the following conditions.

- Low charge
- Overcharge
- Too much oil
- Dirty or plugged filter
- Dirty or plugged condenser
- Dirty or plugged evaporator
- Dirty or plugged orifice tube

## VISUAL INSPECTION

Before a performance check of the air conditioning system, check the following:

1. Check condenser and evaporator.
   a. Check for any restriction obstructing air flow such as dirt, insects, plastic bags, etc.
2. Clean fresh air and recirculation filters.
3. Check for a loose belt on compressor.
4. Check drain tube on evaporator for obstruction.
5. Start unit and set air conditioner on HIGH. Place hand on accumulator, a properly charged system should feel cool or cold to the touch.

## TROUBLESHOOTING FAULTS WITH SERVICE CODES (ACTIVE)

The active diagnostics displays information on the control panel. This information will assist in servicing HVAC unit.

### Service Codes

| ERROR CODE | PROBLEM |
|---|---|
| E0 | No faults detected |
| E1 | Cab sensor shorted |
| E2 | Cab sensor disconnected |
| E3 | Evaporator probe shorted |
| E4 | Evaporator probe disconnected |
| E5 | Outlet duct sensor shorted |
| E6 | Outlet duct sensor disconnected |
| E7 | Ambient sensor shorted |
| E8 | Ambient sensor disconnected |
| E9 | Water valve shorted |
| E10 | Water valve disconnected |
| E13 | Water valve failed, stuck or not responding* |
| E14 | Mode door stuck, actuator disconnected, failed or not responding* |
| E17 | ECU module underpowerd, failed, or disconnected or serial communication wires disconnected or damaged. |

* Cycle ignition power to clear error.

For all fault codes is the possible solution check the wiring and connectors.

### Entering Active Troubleshooting

1. Turn on control panel.
2. Press button for outside temperature three times in succession to view stored error codes.
3. Press and hold button for outside temperature for five seconds to view active diagnostics.
4. LED should display CAB. Temperature measured by cab temperature sensor will be displayed on LED.

*NOTE: Display continuously updates information.*

5. Press button for outside temperature to scroll through available information.

The following diagnostics can be displayed:

| Definition of DISPLAY | |
|---|---|
| **Display** | **Definition** |
| CAB | Cab Airflow Temperature |
| DUCT | Air in Duct Temperature |
| EUAP | Evaporator Core Temperature |
| A-C | Compressor Clutch (On/Off) |
| HEAT | Water Valve Position (0-100%t open) |
| PRES | Pressure Cut Out Switch (On/Off)* |
| SUN | Sunlight Value (0-100)** |
| FAN | Blower Fan Duty Cycle (0-100)*** |
| DOOR | Mode Door Actuator Feedback Position (0-100% of travel) |
| * Off position is caused by exceeding pressure limit 7 PSI. | |
| ** 100 is maximum value | |
| *** 100 is maximum speed | |

Control panel can be operated in all functions while displaying active diagnostics. Operator is able to change set point temperature, vent mode and blower fan speed.

To return system to normal operation, turn unit off and on again.

## Troubleshooting Using Active Diagnostics

Several systems can be checked with active diagnostics.

## Checking Temperature Sensors

Use following procedure to verify temperature sensor readings:

- CAB - Cab air temperature
- DUCT - Duct air temperature
- EUAP - Evaporator core temperature (Switch)
- DOOR - Mode Door Actuator Feedback Position

1. Measure temperature near sensor being checked.
2. Enter active troubleshooting. Refer to Entering Active Troubleshooting for instructions about active troubleshooting.
3. CAB is first code displayed, continue to sensor being verified. Displayed temperature should be near reading of thermometer.
4. If temperatures are not similar, verify the following:
    - Accuracy of thermometer.
    - Wiring connections for temperature sensors in cab.
    - Check displayed temperature for other modes to verify control module is not faulty.
    - If all temperature sensors display –54 degrees C (–65 degrees F), replace HVAC control module.
    - Check power to control module.
    - Check serial communications between control panel and control module for damage.
    - Check for poor wire connections.
5. Probable Solutions
    - Repair faulty wire connections.
    - Replace temperature sensor and verify proper operation.
    - Replace control module and verify proper operation.

## Checking Compressor Clutch

Use the following to verify operation of compressor clutch:

*NOTE: Test should be performed in air temperatures greater than 21 degrees C (70 degrees F), clutch may not engage below that temperature. If necessary, use a heat source to warm outside air temperature.*

1. Move mode control switch to DEFROST.
2. Enter active troubleshooting. Refer to Entering Active Troubleshooting for instructions on active troubleshooting.
3. CAB is first code displayed. Continue to switch being verified. Display should be A-C for compressor clutch.
4. Compressor clutch should be engaged in defrost mode and LED display should display ON. This indicates compressor clutch is on.

*NOTE: Test should be performed in air temperatures greater than 21 degrees C (70 degrees F), clutch may not engage below that temperature. If necessary, use a heat source to warm outside air temperature.*

5. If LED display shows OFF verify the following:
    - Outside temperature is at least 21 degrees C (70 degrees F).
    - Verify refrigerant charge present in A/C system.
    - Verify connections to refrigerant pressure switches, refer to Checking Refrigerant Pressure Switches for additional information.
    - Verify all wire connections.
6. If no other problems can be found and display shows OFF, replace control module.
7. If LED shows ON, but clutch does not engage, verify:
    - Check voltage supplied to compressor clutch.
    - Verify wire connection at compressor clutch.
    - Verify wire connection at relay in HVAC unit.
8. If display shows ON and compressor clutch is not receiving 12 volts, replace control module.
9. If proper voltage is being supplied to compressor clutch but compressor clutch does not engage, replace compressor clutch.

## Checking Refrigerant Pressure Switches

Use the following to verify operation of refrigerant pressure switches:

*NOTE: Test should be performed in air temperatures greater than 21 degrees C (70 degrees F), clutch may not engage below that temperature. If necessary, use a heat source to warm outside air temperature.*

1. Turn rotary switch to Head-Foot position.
2. Set temperature control to maximum heat.
3. Enter active troubleshooting, refer to Entering Active Troubleshooting for instructions on active troubleshooting.
4. CAB is first code displayed, continue to switch being verified. PRES for refrigerant pressure switches will be displayed.
5. Display shows ON, indicating sufficient, but not excessive pressure in system.
6. If display shows OFF, verify air conditioning system has appropriate charge of refrigerant. SS 2.1 kg (4.65 lb). MT800 2.3 kg (5 lb).
7. If refrigerant charge is correct, verify:
   - Inspect high and low pressure switches for damage.
   - Verify wire connections.
   - Check wire harness for damage or poor terminal connections.
8. If items in step 6 are correct, replace pressure switches and check for normal information.
9. If system does not operate normally, replace control module and check again for normal operation.

## Checking Actuator for Water Valve

Use the following to verify water valve actuator operation:

1. Verify engine coolant system is full of coolant.
2. Turn switch to Head-Foot position.
3. Enter active troubleshooting, refer to Entering Active Troubleshooting for instructions about active troubleshooting.
4. CAB is first code displayed, continue to sensor being verified. HEAT for check water valve actuator will be displayed.
5. Engine coolant must be near operating temperature.
6. Set temperature control to maximum heat, display should increase to 100. When a high number is displayed, heated air should be felt from vents.
7. Set temperature control to maximum cooling. Display should decrease to zero and air should become cooler.
8. If displayed number does not change in steps 6 and 7 or if number does not reach 0 or 100, check the following:
    - Inspect wire connections for water valve actuator.
    - Check for damage on wire harness.
9. Replace water valve and check for normal operation.

*NOTE: If debris is found in the coolant system, flush coolant system and determine source of debris.*

10. If the problem continues, replace control module.

## Checking Blower Fan

Verifying operation of blower fan:

*NOTE: Problems with blower fan are normally obvious, however, checking the output control of the control module to blower motor may be necessary.*

1. Enter active troubleshooting, refer to Entering Active Troubleshooting for instructions about active troubleshooting.
2. CAB is first code displayed, continue to sensor being verified. FAN will be displayed, check signal being sent to fan from control module.
3. Display will show pulse width modulation sent to blower motor. Value will range from 27-100. Vary blower fan speed and verify pulse width modulation changes.

*NOTE: In AUTO mode, fan speed may not reach lowest possible speed due to logic of control module.*

4. If speed does not change, replace control panel.

## Checking Mode Door Actuator

Use the following to verify mode door actuator operation:

1. Enter active troubleshooting, refer to Entering Active Troubleshooting for instructions about active troubleshooting.
2. CAB is first code displayed, continue to sensor being verified. DOOR will be displayed, check signal being sent to actuator from control module.
3. Value displayed will show current position of actuator, from 0-100.

*NOTE: Extremes of these values are not normally reached as door stops prevent extreme movements of actuator.*

4. Use rotary switch to change position of actuator and verify displayed value changes.
5. If displayed value does not change, inspect following items:
    - Wire connections.
    - Check for wiring harness damage.
6. Replace actuator and check for normal operation.
7. If problem continues, replace control panel and check for normal operation
8. If problem continues, replace control module and check for normal operation.

## TROUBLESHOOTING AIR CONDITIONER CONTROL

### Problem List

Problems listed below are discussed in more detail.

- No display
- No blower fan
- No heat
- No cooling
- System is putting out hot air when cooling is needed.
- No HVAC system function
- No fan or erratic fan
- Electric actuator for airflow is not moving or working properly.

### Probable Causes

The following offers problems and a probable solution:

#### No Display

1. Turn control panel on with mode switch.
2. Check display for illumination.
3. Verify control panel is connected properly.
4. Check connection of wire harness to unit.
5. Verify control panel is receiving 12 volts of power.
6. Verify control panel is properly grounded.

#### Probable Solution

1. Replace control panel.

#### No Blower Fan

1. Turn blower fan to high.
2. Ensure blower fan is connected properly.
3. Verify circuit breakers and fuses are in tact.
4. Verify HVAC unit is receiving 12 volts of power.
5. Verify blower motor is receiving 12 volts of power.
6. Verify blower motor is properly grounded.

#### Probable solution

1. Replace fuse or circuit breaker.
2. Replace blower motor.
3. Replace electronic control module.

#### No Heat

1. Turn up heat with control button.
2. Verify warm coolant is flowing into heater core by testing heater hoses.
3. Verify water valve is working correctly.
4. Inspect water valve for jammed components.

#### Probable Solution

1. Replace water valve.

#### No Cooling

1. Turn down heat with control button.
2. Turn mode switch to enable defrost.
3. Verify refrigerant compressor has voltage at clutch.
4. Verify circuit breakers and/or fuses are intact.
5. Verify relay for clutch on wire harness has voltage.
6. Verify system is fully charged with refrigerant.
7. Verify heater valve is closed

#### Probable Solution

1. Inspect relay for clutch. If necessary, replace relay.
2. Replace heater valve.

#### System is putting out cool air when heat needed

1. Verify temperature sensor for cab airflow is connected correctly.
2. Verify water valve is working properly. refer to No Heat for additional information.

#### Probable Solutions

1. Replace temperature sensor for cab airflow.
2. Replace control module.

#### System is putting out hot air when cooling needed.

1. Verify temperature sensor for cab airflow is connected correctly.
2. Verify water valve is working properly and water valve is not stuck open.
3. Verify compressor clutch is working properly, refer to No Cooling for additional information.

#### Probable Solution

1. Replace temperature sensor for cab airflow.
2. Replace control module.

#### No Fan or Erratic Fan

1. Set rotary control for blower fan to maximum.
2. Ensure blower fan is connected properly.
3. Verify circuit breakers or fuses are intact.
4. Verify HVAC unit as 12 volts of power.
5. Verify blower motor has 12 volts when rotary control is at maximum.

#### Probable Solutions

1. Replace blower motor.
2. Replace control module.

### Nothing Works

None of the following components work:

- Fan
- Compressor clutch
- Water control valve

1. Check for error code 17.

   See Systems Operation/Testing And Adjusting, Troubleshooting Faults With Service Codes for information on checking error codes.

2. Verify control module is receiving 12 volts of power.

*NOTE: Use a voltmeter to check voltage. This can be verified by disconnecting and connecting DT connector (four pin) on control module. A faint click in module indicates electrical power is energizing an internal relay.*

3. Verify serial communication ports are not damaged.
4. Verify control panel is connected properly.
5. Verify wire harness is connected to unit properly.
6. Verify pin 17 and 18 are connected securely into DT connector (40 pin) on control module and are making good contact.

### Probable Solution

1. Replace control module.

### Electric Actuator for Mode of Airflow is not Moving or Working Properly

1. Verify control module is receiving electrical power.
2. Verify there are no error codes.
3. Verify component for electric actuator is not jammed.
4. Inspect wire harness and connections.

### Probable Solutions

1. Replace electric actuator for mode of airflow.

## REFRIGERANT COMPRESSOR OIL - CHECK

### General

A special refrigerant oil is used in the air conditioning system, the oil mixes completely with refrigerant so all components receive lubrication. A check of the refrigerant oil in the compressor will give an indication of the amount of oil in the system.

*NOTE: Generally, when there is a major loss of oil, check compressor oil.*

Following is a list of other causes for oil loss:

- Broken refrigerant hose
- Hose fitting (leaks)
- Badly leaking compressor seal
- Component damage

### Complete Check of Compressor Oil

When replacement of a component is necessary, follow the procedure below to determine amount of refrigerant oil (lost oil) needed in compressor.

**FIG. 1:** Compressor Components

(1) Pulley

(2) Hose (Low Pressure)

(3) Hose (High Pressure)

(4) Electrical Harness

(5) Service Valve (Low Pressure)

(6) Service Valve (High Pressure)

(7) Plug (Oil Change)

(8) Belt (Engine Driven Component)

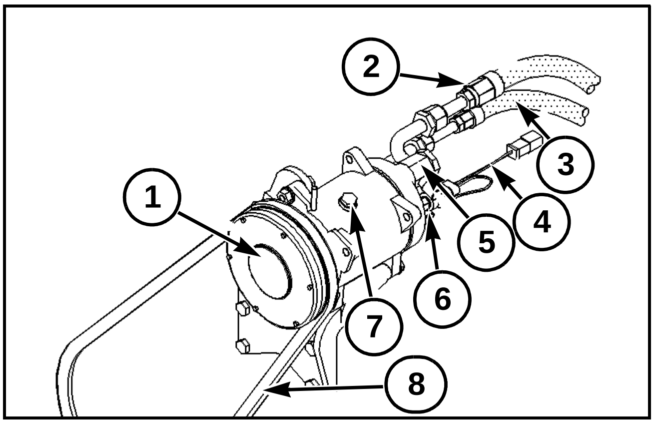


**FIG. 1**

1. Operate engine at 1000 rpm and set temperature on maximum cooling. Move fan speed switch to HIGH, system will stabilize in a minimum of ten minutes.
2. Stop engine and remove refrigerant charge from system. Install a plug in all open lines, refer to Testing and Adjusting, Refrigerant Recovery.
3. Remove compressor from machine and place protective caps on all fittings and hoses.
4. Place compressor in a horizontal position so oil plug is facing down. Remove oil plug from compressor and drain oil into a clean container. Rock compressor back and forth to remove all oil and rotate compressor shaft to drain oil from sump. Inspect oil for contaminants, metal chips, rubber particles, or any other foreign material. Dispose of oil in a suitable container. Use the following list as a guide for adding oil to compressor.
    - If the amount of oil drained from compressor is 177 mL (6 fl oz) to 237 mL (8 fl oz), replace the same amount. Never add more than 237 mL (8 fl oz) of refrigerant oil.

- If the amount of oil drained from compressor is less than 177 mL (6 fl oz), add 177 mL (6 fl oz) to 237 mL (8 fl oz) of new refrigerant oil.

If too much oil is added to system and a total of more than 325 mL (11 fl oz) of oil is in system, cooling capacity will be reduced. If too little oil has been added to system, compressor may fail due to a lack of lubrication.

If particles of metal or other foreign material are present in system, flush system, refer to Testing and Adjusting, Refrigerant System - Flush. Refer to Testing and Adjusting, Air Conditioning System Troubleshooting.

- Add oil to compressor through opening for oil plug or inject oil through ports for charging. Compressor must be positioned so refrigerant oil does not flow out of service valves. Do not rest compressor on compressor shaft. Turn compressor shaft by hand when compressor is filled. Oil will slowly flow into compressor. Only use refrigerant oil approved and recommended.
- Add oil to any components being installed.
- Inject oil into system through ports for low pressure charging.

5. After correct amount of refrigerant oil has been added, install compressor and drive belt, refer to Testing and Adjusting, Refrigerant System - Charge.

## REFRIGERANT SYSTEM - CHARGE

### Relationship Between Temperature and Pressure (R-134a Refrigerant)

Use table to determine pressure and contamination level of a refrigerant container. Table can also be used for an air conditioning system that is not operating. The system must not operate for 10 to 12 hours and must not be stored in direct sunlight to stabilize ambient temperature.

If pressure measured at any specific temperature does not match pressure given on chart, the following may exist:

- Contaminants in system
- Incorrect refrigerant

| Relationship Between Temperature and Pressure (R-134a Refrigerant) | |
|---|---|
| **Temperature Degrees C (degrees F)** | **Pressure kPa (PSI)** |
| –18 C (0.0 F) | 44 kPa (6.4 PSI) |
| –17 C (2.0 F) | 51 kPa (7.4 PSI) |
| –16 C (4.0 F) | 59 kPa (8.5 PSI) |
| –14 C (6.0 F) | 66 kPa (9.6 PSI) |
| –13 C (8.0 F) | 74 kPa (10.7 PSI) |
| –12 C (10.0 F) | 82 kPa (11.9 PSI) |
| –11 C (12.0 F) | 90 kPa (13.1 PSI) |
| –10 C (14.0 F) | 99 kPa (14.3 PSI) |
| –9 C (16.0 F) | 108 kPa (15.6 PSI) |
| –8 C (18.0 F) | 117 kPa (17.0 PSI) |
| –7 C (20.0 F) | 127 kPa (18.4 PSI) |
| –6 C (21.0 F) | 132 kPa (19.1 PSI) |
| –6 C (22.0 F) | 137 kPa (19.8 PSI) |
| –5 C (23.0 F) | 141 kPa (20.5 PSI) |
| –4 C (24.0 F) | 147 kPa (21.3 PSI) |
| –4 C (25.0 F) | 152 kPa (22.0 PSI) |
| –3 C (26.0 F) | 157 kPa (22.8 PSI) |
| –3 C (27.0 F) | 163 kPa (23.6 PSI) |
| –2 C (28.0 F) | 168 kPa (24.4 PSI) |
| –2 C (29.0 F) | 174 kPa (25.2 PSI) |
| –1 C (30.0 F) | 179 kPa (26.0 PSI) |
| –1 C (31.0 F) | 185 kPa (26.8 PSI) |
| 0 C (32.0 F) | 191 kPa (27.7 PSI) |
| 1 C (33.0 F) | 197 kPa (28.5 PSI) |
| 1 C (34.0 F) | 203 kPa (29.4 PSI) |
| 2 C (35.0 F) | 209 kPa (30.3 PSI) |
| 2 C (36.0 F) | 215 kPa (31.2 PSI) |
| 3 C (37.0 F) | 221 kPa (32.1 PSI) |
| 3 C (38.0 F) | 228 kPa (33.0 PSI) |
| 4 C (39.0 F) | 234 kPa (34.0 PSI) |
| 4 C (40.0 F) | 241 kPa (34.9 PSI) |
| 5 C (41.0 F) | 248 kPa (35.9 PSI) |
| 6 C (42.0 F) | 254 kPa (36.9 PSI) |

| Relationship Between Temperature and Pressure (R-134a Refrigerant) | |
|---|---|
| **Temperature Degrees C (degrees F)** | **Pressure kPa (PSI)** |
| 6 C (43.0 F) | 261 kPa (37.9 PSI) |
| 7 C (44.0 F) | 263 kPa (38.9 PSI) |
| 7 C (45.0 F) | 275 kPa (39.9 PSI) |
| 8 C (46.0 F) | 283 kPa (41.0 PSI) |
| 8 C (47.0 F) | 290 kPa (42.0 PSI) |
| 9 C (48.0 F) | 297 kPa (43.1 PSI) |
| 9 C (49.0 F) | 305 kPa (44.2 PSI) |
| 10 C (50.0 F) | 312 kPa (45.3 PSI) |
| 11 C (51.0 F) | 320 kPa (46.4 PSI) |
| 11 C (52.0 F) | 328 kPa (47.5 PSI) |
| 12 C (53.0 F) | 336 kPa (48.7 PSI) |
| 12 C (54.0 F) | 344 kPa (49.9 PSI) |
| 13 C (55.0 F) | 352 kPa (51.0 PSI) |
| 13 C (56.0 F) | 360 kPa (52.2 PSI) |
| 14 C (57.0 F) | 369 kPa (53.5 PSI) |
| 14 C (58.0 F) | 377 kPa (54.7 PSI) |
| 15 C (59.0 F) | 385 kPa (55.9 PSI) |
| 16 C (60.0 F) | 394 kPa (57.2 PSI) |
| 16 C (61.0 F) | 403 kPa (58.2 PSI) |
| 17 C (62.0 F) | 412 kPa (59.8 PSI) |
| 17 C (63.0 F) | 421 kPa (61.1 PSI) |
| 18 C (64.0 F) | 430 kPa (62.4 PSI) |
| 18 C (65.0 F) | 440 kPa (63.8 PSI) |
| 19 C (66.0 F) | 450 kPa (65.2 PSI) |
| 19 C (67.0 F) | 459 kPa (66.8 PSI) |
| 20 C (68.0 F) | 469 kPa (68.0 PSI) |
| 21 C (69.0 F) | 478 kPa (69.4 PSI) |
| 21 C (70.0 F) | 488 kPa (70.8 PSI) |
| 22 C (71.0 F) | 498 kPa (72.3 PSI) |
| 22 C (72.0 F) | 509 kPa (73.8 PSI) |
| 23 C (73.0 F) | 519 kPa (75.3 PSI) |
| 23 C (74.0 F) | 530 kPa (76.8 PSI) |
| 24 C (75.0 F) | 540 kPa (78.3 PSI) |
| 24 C (76.0 F) | 551 kPa (79.9 PSI) |
| 25 C (77.0 F) | 562 kPa (81.5 PSI) |
| 26 C (78.0 F) | 573 kPa (83.1 PSI) |
| 26 C (79.0 F) | 584 kPa (84.7 PSI) |

| Relationship Between Temperature and Pressure (R-134a Refrigerant) | |
|---|---|
| Temperature Degrees C (degrees F) | Pressure kPa (PSI) |
| 27 C (80.0 F) | 595 kPa (86.3 PSI) |
| 27 C (81.0 F) | 607 kPa (88.0 PSI) |
| 28 C (82.0 F) | 618 kPa (89.7 PSI) |
| 28 C (83.0 F) | 630 kPa (91.4 PSI) |
| 29 C (84.0 F) | 642 kPa (93.1 PSI) |
| 29 C (85.0 F) | 654 kPa (94.8 PSI) |
| 30 C (86.0 F) | 666 kPa (96.6 PSI) |
| 31 C (87.0 F) | 678 kPa (98.4 PSI) |
| 31 C (88.0 F) | 691 kPa (100.2 PSI) |
| 32 C (89.0 F) | 703 kPa (102.0 PSI) |
| 32 C (90.0 F) | 716 kPa (103.8 PSI) |
| 33 C (91.0 F) | 729 kPa (105.7 PSI) |
| 33 C (92.0 F) | 742 kPa (107.6 PSI) |
| 34 C (93.0 F) | 755 kPa (109.5 PSI) |
| 34 C (94.0 F) | 768 kPa (111.4 PSI) |
| 35 C (95.0 F) | 782 kPa (113.4 PSI) |
| 36 C (96.0 F) | 796 kPa (115.4 PSI) |
| 36 C (97.0 F) | 809 kPa (117.4 PSI) |
| 37 C (98.0 F) | 823 kPa (119.4 PSI) |
| 37 C (99.0 F) | 838 kPa (121.5 PSI) |
| 38 C (100.0°F) | 852 kPa (123.5 PSI) |
| 38 C (101.0 F) | 866 kPa (125.6 PSI) |
| 39 C (102.0 F) | 881 kPa (127.8 PSI) |
| 39 C (103.0 F) | 896 kPa (129.9 PSI) |
| 40 C (104.0 F) | 911 kPa (132.1 PSI) |
| 41 C (105.0 F) | 926 kPa (134.3 PSI) |
| 41 C (106.0 F) | 941 kPa (136.5 PSI) |
| 42 C (107.0 F) | 956 kPa (138.7 PSI) |
| 42 C (108.0 F) | 972 kPa (141.0 PSI) |
| 43 C (109.0 F) | 988 kPa (143.3 PSI) |
| 43 C (110.0 F) | 1004 kPa (145.6 PSI) |
| 44 C (111.0 F) | 1020 kPa (147.9 PSI) |
| 44 C (112.0 F) | 1036 kPa (150.3 PSI) |
| 45 C (113.0 F) | 1053 kPa (152.7 PSI) |
| 46 C (114.0 F) | 1069 kPa (155.1 PSI) |
| 46 C (115.0 F) | 1087 kPa (157.6 PSI) |
| 47 C (116.0 F) | 1103 kPa (160.0 PSI) |

| Relationship Between Temperature and Pressure (R-134a Refrigerant) | |
|---|---|
| Temperature Degrees C (degrees F) | Pressure kPa (PSI) |
| 47 C (117.0 F) | 1120 kPa (162.5 PSI) |
| 48 C (118.0°F) | 1138 kPa (165.1 PSI) |
| 48 C (119.0 F) | 1156 kPa (167.6 PSI) |
| 49 C (120.0 F) | 1173 kPa (170.2 PSI) |
| 49 C (121.0 F) | 1191 kPa (172.8 PSI) |
| 50 C (122.0 F) | 1209 kPa (175.4 PSI) |
| 51 C (123.0 F) | 1228 kPa (178.1 PSI) |
| 51 C (124.0 F) | 1247 kPa (180.8 PSI) |
| 52 C (125.0 F) | 1265 kPa (183.5 PSI) |
| 52 C (126.0 F) | 1285 kPa (186.3 PSI) |
| 53 C (127.0 F) | 1304 kPa (189.1 PSI) |
| 53 C (128.0 F) | 1323 kPa (191.9 PSI) |
| 54 C (129.0 F) | 1342 kPa (194.7 PSI) |
| 54 C (130.0 F) | 1362 kPa (197.6 PSI) |
| 55 C (131.0 F) | 1382 kPa (200.5 PSI) |
| 56 C (132.0 F) | 1402 kPa (203.4 PSI) |
| 56 C (133.0 F) | 1422 kPa (206.3 PSI) |
| 57 C (134.0 F) | 1443 kPa (209.3 PSI) |

## Labeling Procedure

Attach a cable strapped label to air conditioning system indicating system charge.

## Charging System

*NOTE: An accurate refrigerant charge is only determined by weight or temperature of evaporator core. Pressures can not be used to determine if air conditioning system is correctly charged. Do not add or remove part of refrigerant.*

*NOTE: Never charge liquid or gas through discharge side (high) of system when engine is in operation.*

*IMPORTANT: In an expansion valve system which uses poly alkaline glycol (PAG), sight glass is not a reliable way to determine system charge.*

*NOTE: For expansion valve systems containing PAG oil, sight glass can not be used to charge system. for a full system charge, refrigerant must be recovered and evacuated. After recovery and evacuation, charge system with correct amount of refrigerant. This is the only procedure recommended.*

*NOTE: If engine is running, charge system with refrigerant gas through low pressure side. Never charge liquid refrigerant through suction side (low) of air conditioning system. If engine is not running, charge with liquid or gas through high pressure side.*

*NOTE: Before charging system, check the following important items:*

1. Condenser and evaporator
    - Inspect condenser and evaporator for foreign material such as dirt, insects, plastic bags, etc. These things can will inhibit airflow.
    - With roof-mounted condensers, verify both fan motors are running. Check for restrictions as a clean condenser will increase compressor life.
2. Check for a loose belt on compressor.
3. Clean fresh and recirculation filters.
4. Check moisture indicator on the receiver-dryer or in-line dryer, replace if indicator is pink or white. A blue moisture indicator is normal.
5. Check condensation tube on evaporator to ensure it is not plugged and is in place.

*NOTE: Before an accurate moisture reading, a new receiver-dryer requires two to three hours of operation.*

*NOTE: Preferred method for charging air conditioning system is below:*

- Recover refrigerant.
- Evacuate system.
- Charge system with correct amount of refrigerant, measured by weight.

*NOTE: After system has been recovered and evacuated, charge with correct amount of refrigerant measured by weight.*

## COMPLETE CHARGE OF SYSTEM FROM A REFRIGERANT TANK WITH A SCALE

Use of a refrigerant tank and scale is necessary to charge system using the following procedure.

*NOTE: Engine can not be running when charging system with a liquid.*

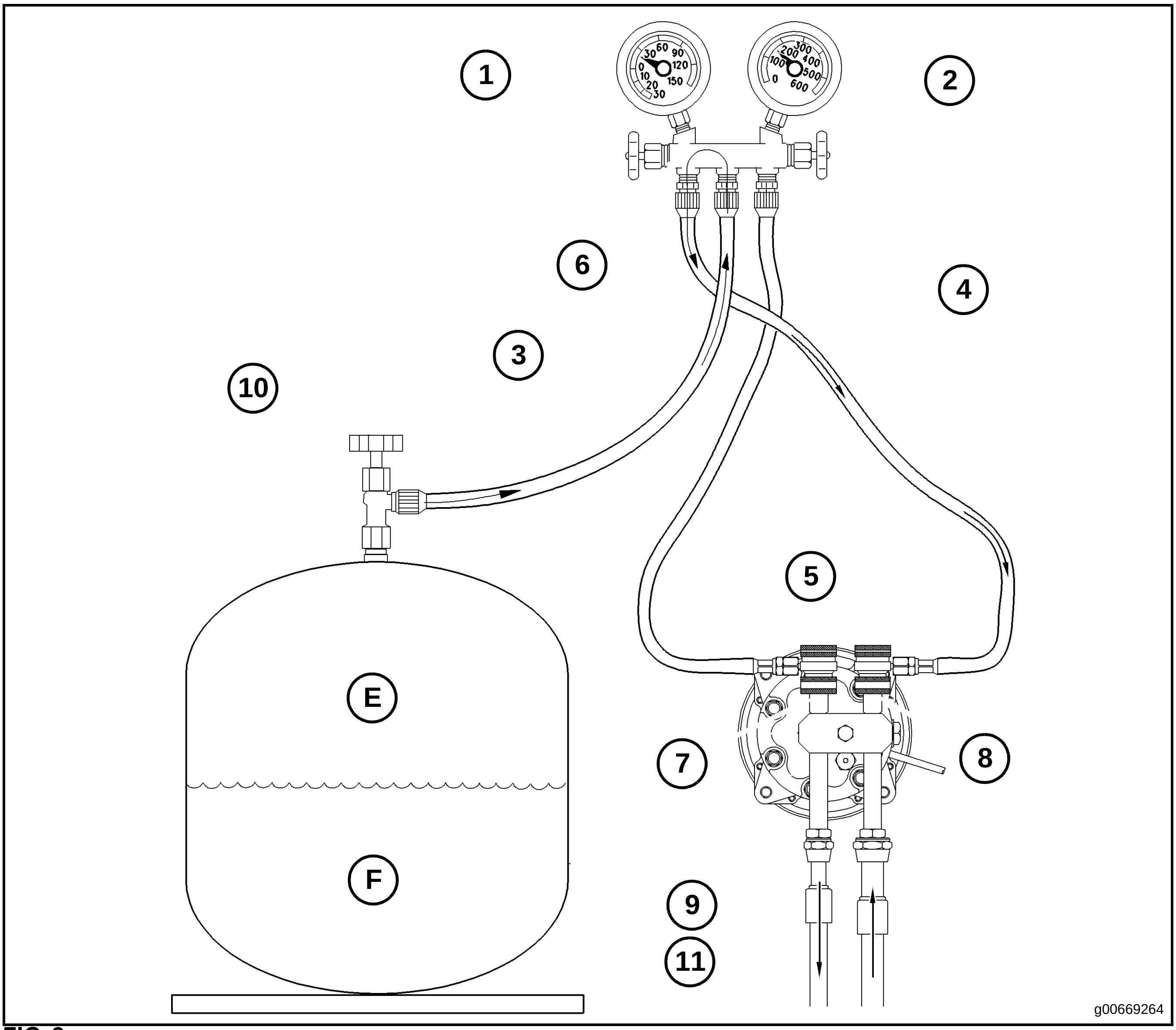



**FIG. 2**

**FIG. 2:** Charging System Components

(1) Low Pressure Valve

(2) High Pressure Valve

(3) Charging Hose

(4) Low Pressure Hose

(5) High Pressure Hose

(6) Manifold Gauge Set

(7) Service Valve (Discharge)

(8) Service Valve (Suction)

(9) Refrigerant Tank

(10) Valve on Top of Refrigerant Tank

(11) Scale

(E) Vapor

(F) Liquid

1. Find refrigerant capacity for system.
2. Install high and low pressure hoses and purge hoses, refer to Testing and Adjusting, Manifold Gauge Set (Refrigerant) - Install.
3. Hand tighten charging hose from manifold gauge set directly to valve on refrigerant tank. Open valve on top of refrigerant tank to allow the flow of refrigerant through charging hose to manifold gauge set.
4. Loosen hose at manifold gauge set for two to three seconds and tighten connection, this will purge air from line.
5. Place refrigerant tank on scale so valve is at bottom. Check weight of tank.

*NOTE: A heater blanket may be required when charging an air conditioning system with a partially full refrigerant tank.*

6. Open high pressure valve on manifold gauge set. This action allows liquid refrigerant to charge system through the high pressure side of compressor.
7. Check weight of refrigerant tank often as weight will decrease as refrigerant enters the system. When required amount of refrigerant (system capacity) has entered system, close valve and high pressure valve. Closing valves stops flow of refrigerant. For example, 1.8 kg (4 lb) of refrigerant has entered a system with 1.8 kg (4 lb) capacity.
8. For correct system operation, disconnect charging hose and conduct a performance check.

## ADDING ADDITIONAL REFRIGERANT TO AN AIR CONDITIONING SYSTEM WITH LOW CHARGE

*IMPORTANT: Failure to properly follow procedure may cause compressor failure. The following procedure is NOT the preferred method for charging an air conditioning system, the preferred method of measuring refrigerant is by weight.*

*IMPORTANT: If system has no refrigerant, evacuate system before charging. Refrigerant charge should be measured by weight.*

*NOTE: The following is only applicable if the inlet air temperature at condenser is between 21 °C (70.0 °F) and 32 °C (90.0 °F) and may be repeated a second time to achieve proper charge method.*

1. Connect manifold gauge set to discharge and service ports on compressor.
2. Ensure low and high pressure valves are closed on the manifold gauge set.
3. Turn valve on tank counterclockwise to release refrigerant to charging hose.

*NOTE: Ensure cylinder of refrigerant is upright to allow refrigerant to enter system as a gas.*

4. Loosen hose connection on charging hose at manifold gauge set for two to three seconds, then tighten connection. This action allows air to be released from charging hose.
5. Start engine and operate at 1000 rpm.
6. Move temperature control knob to MAXIMUM cool and move fan switch to HIGH.

*NOTE: Recovering refrigerant and evacuating system is preferred method for charging air conditioning system. After system has been recovered and system has been evacuated, system needs to be charged with the correct amount of refrigerant measured by weight.*

7. Open low pressure valve on manifold gauge set to release refrigerant into low pressure hose, this connects to suction service valve on the compressor. Check pressure gauge and note gauge reading, should not exceed normal operating ranges during procedure. Slowly add refrigerant until accumulator is cool. Temperature of vents inside cab should decrease during procedure.
8. After accumulator becomes cool, add 0.34 kg (0.750 lb) of refrigerant to system for reserve, measure by weight.
9. To prevent additional flow of refrigerant into compressor, close low pressure valve. Allow system to stabilize for five minutes, the inlet and outlet on accumulator should be cool.

*NOTE: If low pressure valve is opened completely, reading will appear excessively high until system becomes fully charged.*

10. Gauge reading for low pressure valve should be within normal range after system is charged. Gauge reading for high pressure valve should be within normal range after charging system. If gauge readings are within normal range, go to Step 11, if not go to Step 12.
11. If pressure on suction side or discharge pressure becomes too high, system is overcharged. Completely close valve on refrigerant tank to shut off flow of refrigerant to charging hose. Shut off engine, recover charge and evacuate system and recharge system to correct charge.
12. Move air conditioning controls to OFF and stop engine.
13. Remove manifold gauge set.

## MANIFOLD GAUGE SET (REFRIGERANT) - REMOVE

Remove charging hoses properly to prevent a low system charge. For accurate refrigerant charge, remove refrigerant from charging hoses referring to the following:

1. Allow compressor to continue operating. Close valve on high pressure side, located near charging ports. Disconnect high pressure hose from air conditioning system.
2. Open high and low pressure valves at gauge set. Refrigerant in hoses will be removed by compressor through low pressure hose.
3. Close valve on low pressure side, located near the charging ports. Disconnect low pressure hose from air conditioning system and system is now charged.

*NOTE: After manifold gauge set is removed, cap charging valves.*

## CONTROL PANEL - TEST

### Test Automatic Control Panel

**Test Result**

1. LED will briefly flash 8888.

**Speed Control for Blower Fan**

1. Turn HVAC system on.

**Test Result**

1. LED should display last setpoint selected.
2. Blower fan should be circulating air, temperature selected will determine speed of blower and should increase relative to the difference of temperature.

**Push Button for Temperature**

1. Set temperature to highest setting 32 °C (90 °F).
2. Set control for blower fan in auto.

**Test Result**

1. Speed of blower fan changes to full speed.
2. Heating system will turn on.
   a. Water valve should open.
   b. Temperature of supply line at heater core should increase as engine temperature increases.

**Push Button for Temperature**

1. Set temperature to lowest setting 15.5 °C (60 °F).
2. Set blower control to auto.

**Test Result**

1. Speed of blower fan changes to full speed.
2. Air conditioning system turns on.
   a. Clutch for refrigerant compressor engages.
   b. Temperature of supply line at evaporator coil decreases.

**Push Button for Temperature**

1. Set temperature to equal temperature of cab.
2. Set control for blower fan in auto position.

**Test Result**

1. Speed of blower fan should change to a low speed.
2. Air conditioning system will turn on.

**Control for Mode of Airflow**

1. Change control for mode of airflow.

**Test Result**

1. Airflow from vents should change to match control for airflow.

**Control for Mode of Airflow (Defrost)**

1. Change control for mode of airflow to defrost.

**Test Result**

1. Clutch for refrigerant compressor should engage.
2. Airflow should be directed to vents for defrost.

**NOTES**

# INDEX

# Challenger®

## Terra Gator 3244
## Chassis

# SERVICE MANUAL
## 627333-A

# 06 - Electrical

### Contents

NOTES

# GENERAL INFORMATION

## INTRODUCTION

The electrical system can be divided into four sections:

- Engine;
- Operator's Station;
- Electro Hydraulic;
- Lighting.

Current to electrical systems is provided by a high output alternator with a built-in voltage regulator. These high output alternators are needed because, under certain conditions, very high amperage demands are required.

The 12-volt batteries wired parallel have a double negative ground-one to engine frame and one to starter. A double connection is provided to ensure a reliable ground.

## BASIC TROUBLESHOOTING PROCEDURES

In troubleshooting electrical circuits the first step is to familiaize yourself with the components, wire routing and connections of the circuit. This can be aided by studying the wiring diagrams in the operator's or service manual. Each electrical circuit on the machine is isolated to show the wire connections and components used. Most diagrams give a visual approximation of the components to aid in identifying unfamiliar parts.

If a module or other electrical component is completely dead, first check the diagram for the correct condition, i.e., ignition switch on, clutches engaged, ect. Check for obvious failure areas like fuses, unhooked connection or broken wires. The ground circuit can also become defective because of a broken wire or poor connection to the frame. Most voltmeter probes are small enough to insert into the back side of the electrical connectors so the supply voltage to a module can be checked without disconnecting it the harness.

The greatest percentage of defective connections occur at or near the connectors themselves. Visually check to see that terminals are completely inserted into the housing (no terminal should be exposed above the surface of the connector). This difficult in some connectors below the console and may require removal of the outside cover panel. If the locking tang on the terminal is damaged and will not retain the terminal in the connector, a new terminal from the electrical service kit will need to be installed. Some terminals may just require the locking tang on the terminal be reformed so it will catch the appropriate step in the housing.

Immediately behind the connectors is another potential failure area. This is increased if the wires are flexed or sharply kinked. Moving the wires from side to side may produce intermittent contact and locate the general area of failure.

Corrosion of the terminals is possible as the machine ages. In some cases simply disconnecting and reconnecting a connector will solve a poor connection problem. Heavy corrosion of terminals may occur since the machine is exposed to or stored with fertilizer of other corrosive products. This will require replacement of the affected terminals to provide reliable connections over a long period of time.

In troubleshooting a new machine or an electrical system that has never functioned correctly, check for the possibility that wires in the connector may be crossed or that wires in the connector may be inserted in an incorrect terminal where no continuity between harnesses exists. Wire colors, functions and terminal numbers (on numbered connectors) are listed in the operator's service manual under Electrical Circuits. Wires that have been exposed to oil or sunlight may require some of the harness covering to be removed to aid in identifying the correct color.

## TOOLS

**FIG. 1:** The basic tool needed to troubleshoot the electrical system is a portable digital voltmeter-ohmmeter (otherwise known as a volt-ohm meter, DVOM, or multimeter). A volt-ohm meter is not expensive or complicated when purchasing a volt-ohm meter, it is useful to have a resistance range with scale to be able to check low values or resistance on solenoids or clutch coils. Refer to the instructions accompanying your volt-ohm meter for operating procedures.

Today's electronics will run variable voltages. Just because the machine has 12 volt batteries does not mean the system is running on 12 volts. Most machines will have 12 volt circuits, 8 volt circuits and 5 volt circuits. With different voltages being used a test light will be useless, the only way to test a circuit will be with a volt meter and ohm meter.

A volt meter should be used to do all electrical testing and troubleshooting. Remember the circuit must be fully connected and operated to get proper test results. You should be looking for voltage drops to determine where the problems are.

An Ohm meter should not be used to check a circuit unless a volt meter cannot be used for some reason. The ohm meter should only be used when checking components or circuits that have a specified resistance. An example would be a solenoid that may have specified resistance of 7 - 0 ohms. An ohm meter is the proper tool to be used.

Electrical connections and wiring are available to repair the wiring harnesses on the machines. Also available, are the connector housings to replace nearly every one used on the machine. All are sold in pairs and the molded style connections are supplied with wire leads for splicing into the existing circuits.


**FIG. 1**

## GENERAL TESTING PROCEDURES

### Visual Inspection

Carefully inspect the complete wiring harness for damage. Check for loose or broken wires. Make sure the connect terminals are fully seated and locked in the connector. Insure that the terminals are clean and not damaged.

### Continuity Check

A continuity check is a test used to find whether a circuit is complete. The circuit can be a single wire, a single component or a combination of wires and components. A circuit that has continuity is complete and current can flow through the circuit. A circuit that does not have continuity has break in the circuit that will not let current flow through the circuit. An open can be caused by a broken wire, a loose connection, dirty contacts in a switch or connector or any other condition that keeps the circuit from being complete. Visually check for these conditions before doing a continuity check for these common causes of open circuits are loose or dirty connections and broken wires.

An open that comes in contact with a ground connection such as the mainframe is called a short circuit to ground.

A continuity check is used to test a circuit that is not connected to a power supply. To check a circuit that is connected to a power supply, do a voltage check or disconnect the circuit from the power supply and do continuity check.

*NOTE: Connecting an instrument for checking continuity to a circuit that is connected to a power supply can damage the instrument.*

Hook your multimeter into the circuit and you will get an ohm reading, if the circuit is complete.

Most digital multimeters have a setting for checking continuity. This setting includes an alarm on most multimeters. When the circuit being tested has continuity (is complete) the indication will be zero and the alarm will sound. If the multimeter has this type of setting, it is best to use this setting for checking continuity. On most digital multimeters, the resistance value will not be correct when using the setting. To check resistance you must use the ohms setting.

### Voltage Check

A voltage check is a test used to measure the amount of voltage in the circuit. The voltage check also determines of a circuit has continuity.

A voltage check is used to test a circuit that is connected to a power supply. To check a circuit that is not connected to a power supply, do a continuity check.

Adjust the multimeter to indicate volts DC and, if necessary, the correct range. Connect the (+) red lead of the multimeter to the circuit and (-) black lead to ground.

If the multimeter does not indicate any voltage, there is an open in the circuit or battery is completely discharged.

If the multimeter indicates a negative (-) reading, make sure the test leads are not reversed. Also make sure the wires in the circuit being tested are connected correctly.

If the multimeter indicates voltage, compare the reading to the voltage specified in the test.

If the test specifies a reading of system voltage, the multimeter must indicate 10,8 to 16,8 volts. System voltage is the amount of voltage in the battery which is normally 13,8 volts.

*NOTE: The system voltage can be several volts different with the engine running or engine not running. Unless specified, use the system voltage for engine not running.*

If the voltage reading is not correct, check the condition of the batteries and the charging system.

### Testing for Open Circuits

Test for an open circuit by folding the harness in half so that two connectors are side by side. Test for continuity through each wire using a digital multimeter. Use wire colors or connectors pin identification numbers to identify the wires at each and of the harness. If the harness is not easily folded in half because of being strapped down, connect two pins together at one connector with a jumper wire. Test for continuity through the wires at the other connector. Repeat this process by moving the jumper wire as needed until all wires are checked.

### Finding a Break in an Open Circuit

Using a digital multimeter set to the ohms scale, connect one probe to each end of the broken wire. Move along the length of the harness, flexing the harness by hand, while watching the multimeter. Any change on the ohmmeter indicates the damaged area has been located. If the damage cannot be located, find the approximate middle of the harness length. Carefully cut the outer jacket of the harness to reach the wire to be tested. Insert a needle or pin through the wire insulation and connect the meter to the needle or pin. Test for continuity between the middle and each end of the wire.

## Testing for Short Circuits

A short circuit is defined as an unintended, low resistance current path. This means that the current is taking a shorter path than it was intended in the original circuit. This could be a result of two or more wires rubbing together (copper to copper) or a wire rubbing the system ground (copper to iron).

Disconnect the harness at both ands. Using a digital multimeter set to the ohms scale, and test for continuity between the wires. To accomplish this, at one of the harness connectors, test for continuity between pins as follows:

| | | | | |
|---|---|---|---|---|
| 1 to gnd | 2 to gnd | 3 to gnd | 4 to gnd | ect |
| 1 to 2 | 2 to 3 | 3 to 4 | 4 to 5 | ect |
| 1 to 3 | 2 to 4 | 3 to 5 | 4 to 6 | ect |
| 1 to 4 | 2 to 5 | 3 to 6 | 4 to 7 | ect |
| 1 to 5 | 2 to 6 | 3 to 7 | 4 to 8 | ect |
| ect | ect | ect | ect | ect |

By progressively moving through the pin count, no combination of two conductors is missed. Continuity should not be found between any wires or ground unless shown on the wiring schematic.

*NOTE: If continuity is found, the wires are shorted.*

## Testing for High Resistance

A high resistance circuit is defined as an unintended resistance to current flow. This means that the circuit must overcome more resistance than normally found in the circuit. This could be caused by corroded connectors or wires or a wire in the circuit that is nearly pinched to breaking. This may cause the circuit to work erratically or not at all. If the circuit may or may not indicate the proper resistance and/or voltage level. A high resistance circuit can generally only be tested when the circuit is under a load (i.e. solenoid activated, control module resetting, etc.)

To properly test for high resistance circuit, the digital multimeter (set to the volt scale) has to be used to test the complete circuit when the machine is operating. Connect the (+) lead to the wire and the (-) lead to ground to measure the voltage on the wire. If a high resistance circuit is present, the voltage recorded when operating the circuit will be lower than specifications.

## Finding a High Resistance Circuit

A digital multimeter is used (set to the volts scale) to test for a high resistance circuit. Connect the (+) lead to the wire and the (-) lead to ground to measure the voltage on the wire. The multimeter is placed in the circuit in this manner so that it becomes a parallel path for the circuit. The completed circuit voltage (as shown on the multimeter) is then checked between segments of the circuit. The problem area has been located when the voltage changes noticeably on a segment being checked.

## Fuse Testing

To test a fuse pull the fuse from the slot and visually inspect for broken pins, corroded contact and a broken connection internally. If any of the above symptoms are found, replace fuse. If none of the symptoms are found, test for continuity by connecting a multimeter (set to ohms) across the ends of the fuse. For a good fuse the reading should be zero ohms. If the reading is blank or a very high number (>5000 ohms), the fuse is bad.

## Relay Testing

To test a black cube relay pull the relay out of the slot it is located in. Visually inspect for broken pins or corroded contacts. Connect power to pin 86. A click should be heard every time you ground pin 85. The click means the relay is good and can be reused. If no click is heard, find a known good relay and test it. If it tests good, replace the old relay with a good relay.

To test a black cube relay pull the relay out of the slot it is located in. Visually inspect for broken pins or corroded contacts. Connect power to pin 1. A click should be heard every time you ground pin 2. The click means the relay is good and can be reused. If no click is heard, find a known good relay and test it. If it tests good, replace the old relay with a good relay.

## Diode Testing

Using the multimeter set to the ohm scale check the diode for continuity by placing the leads across the diode and then reverses the leads across the diode. In one direction the ohmmeter should shown an open circuit (blank display). With the leads reversed the display should indicate a 0,6 to 0,9 ohms resistance reading.

In the multimeter does not read differently, the diode is open or shorted and passes current in both directions.

Using the multimeter set to the diode scale on a good diode the meter will beep when the leads are placed across the diode. When the leads are switched, the multimeter will not beep.

*IMPORTANT: It is important that the replacement diode be installed in the same direction as the one which was removed. If not, other parts of machine may be damaged.*

## WIRE COLORS

| Color | Function |
|---|---|
| Blue | Machine Functions |
| Clear | Shielded Ground |
| Gray | Ground (Dirty Ground) |
| Gray/Black | Ground (Clean Ground) |
| Green | CAN Bus Low |
| Light Green | Communications Signals |
| Orange | AutoGuide |
| Pink | Lights |
| Purple | Hazards and Flashers (Flasher Module) |
| Red | Power (Dirty Power) |
| Red/White | Power (Clean Power - Straight From Battery) |
| Tan | Transmission |
| White | Cruise Control (Engine Inputs and Outputs) |
| Yellow | CAN Bus High (Or Sense Wire) |

**NOTES**

# ELECTRICAL SYSEM

## DESCRIPTION

Manual has been written as an aid in troubleshooting problems that may occur in machine CAN bus electrical system. Manual is arranged in order or error codes with some additional sections following for circuits that are not associated with a code.

## REQUIREMENTS

This manual is to be used by a qualified technician with basic knowledge of electrical systems.

Technician must have a multimeter and experience in using the meter.

Technician must have proper tooling and repair supplies for various connectors described throughout this manual.

*IMPORTANT: CAN bus system must be rebooted connection has been altered. This is accomplished by disconnecting battery with negative cable disconnect assembly located in battery box. Often problems are fixed by simply rebooting.*

## DEFINITION

**FIG. 1:** CAN (Controller Area Network) is a method of communication which allows a large amount of data to be transferred through two which wires. A CAN network is similar to a computer network, using a server(s) (master module), and terminals (I/O Input / Output interface modules) to communicate in a controlled and standardized binary code. Use of a CAN network allows greatly reduced amount of wiring in many electrical circuits.

Machine chassis and system will use CAN bus for following functions:

1. All lighting circuits;
2. Sensors;
    - Air Pressure;
    - Fuel Level;
    - Hydraulic Level;
    - Radar.
3. Engine;
4. Transmission;
5. Drive lever.

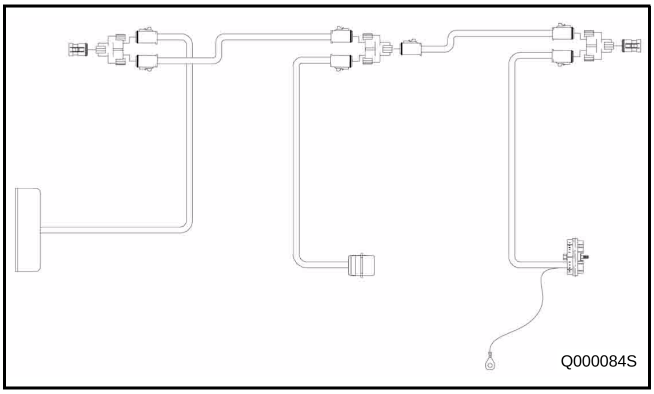



**FIG. 1**

## COMPONENT LOCATION

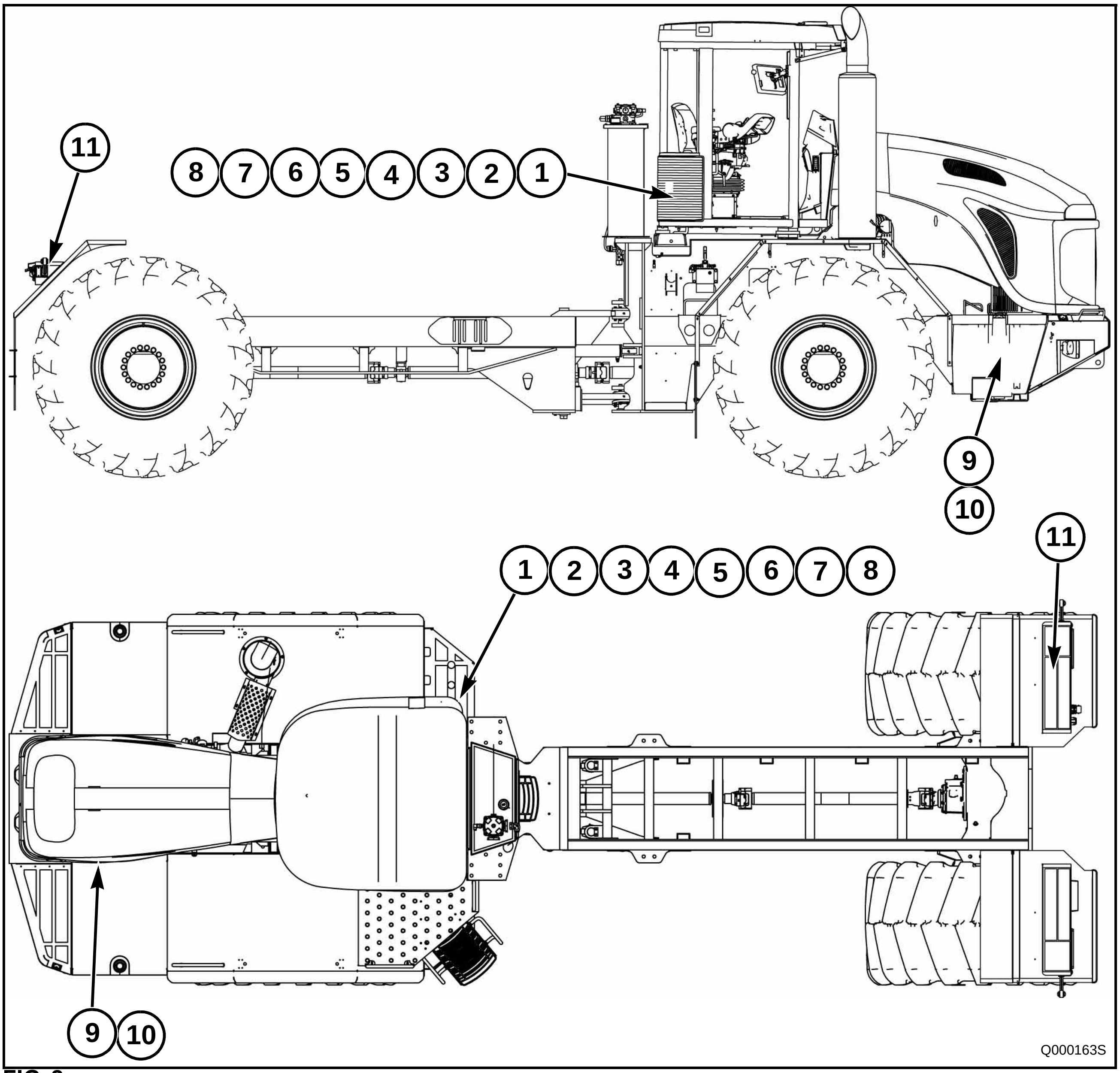



**FIG. 2**

Component layout:

1. Master Module;
2. PDM 1 (Power Distribution Modules);
3. PDM 2;
4. PDM 3;
5. 2 - Pack Relay Modules;
6. 4 - Pack Relay Modules;
7. Flasher Module;
8. Power Supply Block;
9. I/O Module 3 (underneath the engine);
10. I/O Module 5 (underneath the engine);
11. I/O Module 7.

## PRIMARY CAN BUS COMPONENTS

**FIG. 3:** Master Module

Master Module is located behind the right rear curved panel on outside of the cabin. To access panel loosen hand nut located in center of curved panel. Master module accepts signals from switches and other modules in cab, translates, and transfers those commands via a two-wire shielded harness to I/O (Input/Output) interface module. Master module also accepts inputs back from I/O interface modules and forwards those signals to proper component.

J1 Connector (1) - pins are inputs except where designated.

J2 Connector (2) - pin is output except where designated.

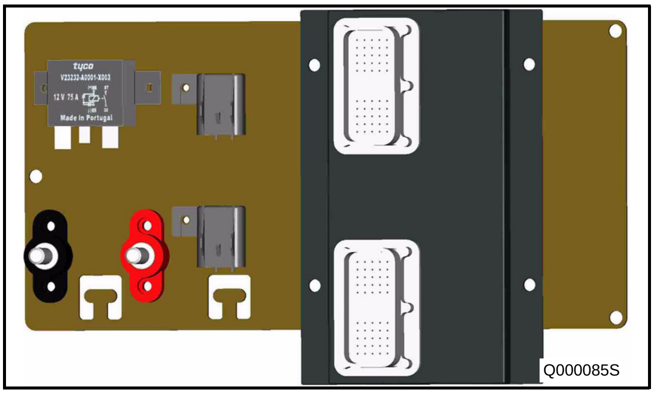



**FIG. 3**

| **Master Module** | | | |
|---|---|---|---|
| **J1** | | **J2** | |
| 1 | B+ | 1 | B+ |
| 2 | Left-Hand Foam Marker Input | 2 | Radar Output |
| 3 | Right-Hand Foam Marker Input | 3 | Left-Hand Turn Signal Output |
| 4 | Master Apply | 4 | Right-Hand Turn Signal Output |
| 5 | - | 5 | Left-Hand Amber Flashing Warning Light Out |
| 6 | - | 6 | Right-Hand Amber Flashing Warning Light Out |
| 7 | - | 7 | Low Beams Output |
| 8 | - | 8 | High Beams Output |
| 9 | - | 9 | Work Lights 1 Output |
| 10 | - | 10 | Work Lights 2 Output |
| 11 | - | 11 | - |
| 12 | - | 12 | Work Lights 4 Output |
| 13 | - | 13 | Reverse Output |
| 14 | - | 14 | Service Brake Output |
| 15 | - | 15 | Park Brake Output |
| 16 | Work Light #6 | 16 | Park Lights Output |
| 17 | - | 17 | - |
| 18 | - | 18 | - |
| 19 | Work Light #5 | 19 | - |
| 20 | Work Light #7 | 20 | - |
| 21 | Fog Light | 21 | Foam Marker On Output |
| 22 | Beacon | 22 | - |
| 23 | - | 23 | - |
| 24 | - | 24 | - |
| 25 | BCO Input | 25 | - |
| 26 | Left-Hand End Row Input | 26 | - |
| 27 | Section 1 Input | 27 | - |

| Master Module | | | |
|---|---|---|---|
| **J1** | | **J2** | |
| 28 | Section 2 Input | 28 | - |
| 29 | Section 3 Input | 29 | - |
| 30 | Section 4 Input | 30 | - |
| 31 | Section 5 Input | 31 | - |
| 32 | Right-Hand End Row Input | 32 | - |
| 33 | - | 33 | - |
| 34 | - | 34 | - |
| 35 | - | 35 | - |
| 36 | - | 36 | - |
| 37 | - | 37 | - |
| 38 | - | 38 | - |
| 39 | - | 39 | - |
| 40 | Main BSO Input | 40 | - |
| 41 | - | 41 | - |
| 42 | - | 42 | - |
| 43 | - | 43 | - |
| 44 | - | 44 | - |
| 45 | - | 45 | - |
| 46 | - | 46 | CAN A Low |
| 47 | - | 47 | CAN A High |
| 48 | - | 48 | CAN B Low |
| 49 | - | 49 | CAN B High |
| 50 | Ground | 50 | Ground |

**FIG. 4:** I/O Interface Module

I/O modules accept commands or signals from master module and activate respective component(s). I/O module also accepts signals from components outside cab and forwards them back to master module. Number of I/O modules used varies depending on application system.

J2 (gray) pin 1 is 12 volts and pin 12 ground. Power for pin 1 comes from PDM 1 F9 fuse. Same on J3 plug (black).

J2 pins 2, 3 and 4 are module identification pins. These are a combination of grounds and positive voltage pins. If pins have no wires, they are grounds. (So I/O module 0 would have no wire on pins 2, 3 and 4. Older machines did have wires on these pins. They were white 4438 and 4439 wires.)

J2 has inputs on pins 5 through 9. Pins 10 and 11 are outputs. They have an H-bridge which can be used to reverse polarity. (Example: open and close a servo).

J3 (black) pin 1 is 12 volts and pin 12 is ground. Pin 2 is CAN low and pin 3 is CAN high. Pins 4 through 11 are outputs.

Pins can be checked connector with proper spades for CAN high and low, power and ground. If there is a broken wire between J3 connector and a component, an error code will be displayed.

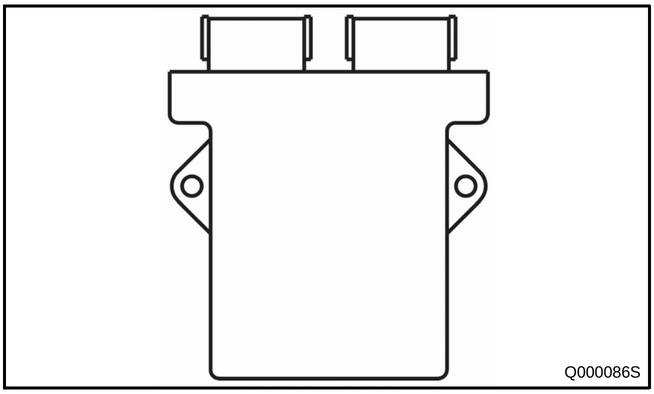



**FIG. 4**

| **I/O MODULE 5** | | | |
|---|---|---|---|
| **J2** | | **J3** | |
| 1 | B+ | 1 | B+ |
| 2 | 12 Volts | 2 | CAN Low |
| 3 | Ground | 3 | CAN High |
| 4 | 12 Volts | 4 | - |
| 5 | - | 5 | - |
| 6 | - | 6 | - |
| 7 | - | 7 | - |
| 8 | Filter 2 Input | 8 | - |
| 9 | - | 9 | - |
| 10 | - | 10 | - |
| 11 | - | 11 | - |
| 12 | Ground | 12 | Ground |

**FIG. 5:** High Current Module

J1 (1) - Power In / CAN Backbone In Pin Outs:

- Pin 1 - Switched Power Input
- Pin 2 - CAN Low
- Pin 3 - Battery Power Input
- Pin 4 - Ground
- Pin 5 - CAN Shield
- Pin 6 - CAN High

J2 (2) Pin Outs:

- Pin 1 - Output 1 (10 amps maximum)
- Pin 2 - Output 2 (10 amps maximum)
- Pin 3 - Output 3 (10 amps maximum)
- Pin 4 - Output 4 (10 amps maximum)
- Pin 5 - Output 5 (10 amps maximum)
- Pin 6 - Output 6 (10 amps maximum)
- Pin 7 - Output 7 (3 amps maximum)
- Pin 8 - Output 8 (3 amps maximum)
- Pin 9 - Input 1 (analog input 0 - 10 volts)
- Pin 10 - Input 2 (analog input 0 - 10 volts)
- Pin 11 - Input 3 (analog input 0 - 10 volts)
- Pin 12 - Input 4 (analog input 0 - 10 volts)

J3 (3) Pin Outs:

- Pin 1 - Ground for Output 1
- Pin 2 - Ground for Output 2
- Pin 3 - Ground for Output 3
- Pin 4 - Ground for Output 4
- Pin 5 - Ground for Output 5
- Pin 6 - Ground for Output 6
- Pin 7 - Ground for Output 7
- Pin 8 - Ground for Output 8
- Pin 9 - 8 VDC Output
- Pin 10 - Input 5 (analog input 0 - 10 volts)
- Pin 11 - Switched Power Bus Ground
- Pin 12 - Switch Power Bus Power

J4 (4) - CAN Backbone Out Pin Outs:

- A - CAN High
- B - CAN Low
- C - Shield

Status LEDs (5)

- Two LEDs nearest terminator are CAN signals high and low (these will be dim and flashing if comuncating).
- Bottom LED is I/O power.
- Other LEDs are for output functions.

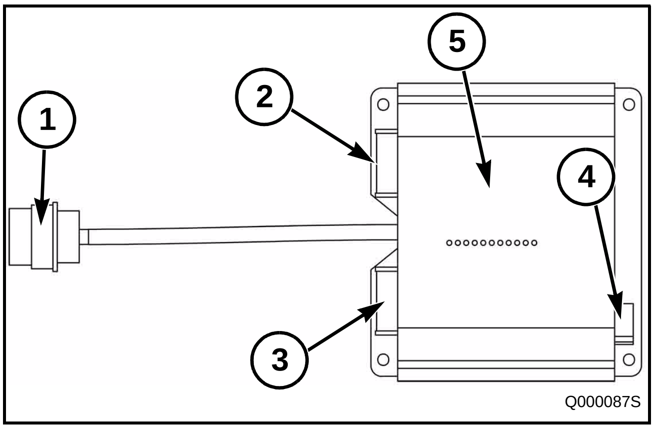



**FIG. 5**

Connectors J2 and J3 can be configured for different applications. Below are two examples:

J2 and J3 configured as I/O Module 3:

| **I/O MODULE 3** | | | |
|---|---|---|---|
| **J2** | | **J3** | |
| 1 | Low Beam | 1 | Low Beam Ground |
| 2 | High Beam | 2 | High Beam Ground |
| 3 | Work Lights 1 | 3 | Work Lights 1 Ground |
| 4 | Work Lights 2 | 4 | Work Lights 2 Ground |
| 5 | Work Lights 3 | 5 | Work Lights 3 Ground |
| 6 | Work Lights 4 | 6 | Work Lights 4 Ground |
| 7 | Left-Hand Amber Flashing Warning Light | 7 | Left-Hand Amber Flashing Warning Light Gnd |
| 8 | Right-Hand Amber Flashing Warning Light | 8 | Right-Hand Amber Flashing Warning Light Gnd |
| 9 | Fuel Level Input | 9 | 8 VDC Output (Fuel Sender Pull-Up) |
| 10 | Hydraulic Oil Temperature Input | 10 | No Connection |
| 11 | Hydraulic Oil Level Input | 11 | Switched Power Bus Ground |
| 12 | Air Pressure Input | 12 | Switched Power Bus Power |

| **I/O MODULE 7** | | | |
|---|---|---|---|
| **J2** | | **J3** | |
| 1 | Left-Hand Amber Flashing Warning Light | 1 | Left-Hand Amber Flashing Warning Light Gnd |
| 2 | Right-Hand Amber Flashing Warning Light | 2 | Right-Hand Amber Flashing Warning Light Gnd |
| 3 | Reverse Lights | 3 | Reverse Lights Ground |
| 4 | Work Lights 4 | 4 | Work Lights 4 Ground |
| 5 | Park Lights | 5 | Park Lights Ground |
| 6 | No Connection | 6 | Left Stop Ground |
| 7 | Left Stop | 7 | Right Stop Ground |
| 8 | Right Stop | 8 | No Connection |
| 9 | Radar Signal Input | 9 | Jumper to Pin 10 |
| 10 | No Connection | 10 | Jumper to Pin 9 |
| 11 | No Connection | 11 | Switched Power Bus Ground |
| 12 | No Connection | 12 | Switched Power Bus Power |

**FIG. 6:** CAN Harnesses

1. Stub Cabling
2. T-Connectors
3. Terminators
4. J1939 Backbone

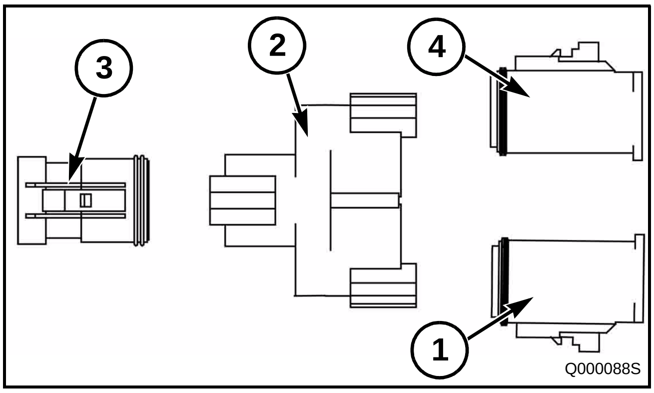



**FIG. 6**

**FIG. 7:** Back Harness Connector

Pin A to C should be 2.5 volts.

Pin B to C should be 2.3 volts.

Pin A to B should be 0.0 volts.

1. A - CAN High (yellow)
2. B - CAN low (green)
3. C - CAN shield (grey)

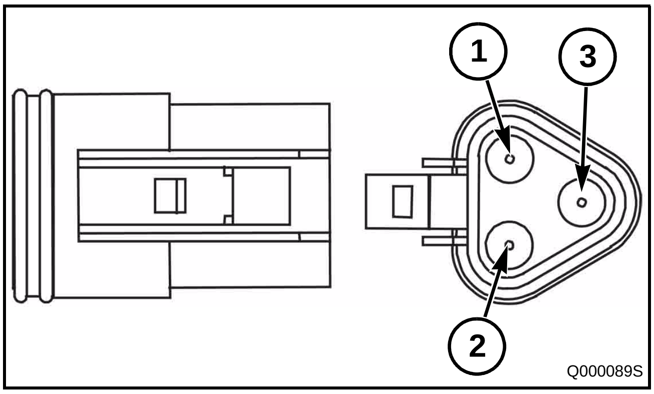



**FIG. 7**

I/O module connectors: J2 (gray) and J3 (black).

CAN backbone Harness - Gray connectors are located under right rear corner of the cab - one for chassis and one for system. Connectors can be disconnected one at a time to isolate problems down to system or chassis. Check for CAN high and CAN low on these connectors. Check for power on pin D and ground pin E. Always check pins for moisture, corrosion and loose pins.

Example: Once problem is isolated down to system or chassis, further testing can be done.

- If problem is on system side, check furthermost end of system backbone harness - taillights. Disconnect cable going into tee connector.
- If chassis starts working, problem has been isolated to taillight tee connector or cabling.
- If problem still exists, taillight system has been eliminated.
- Repeat procedure at next tee connector forward until problem is found.

Must do a battery disconnect every time when plugging or unplugging CAN network.

**FIG. 8:** Chassis CAN Bus Power Connector

| **CAN BUS POWER CONNECTOR** | | | |
|---|---|---|---|
| CAV | CABLE END | COLOR | CABLE TAG |
| A (1) | 1A | YEL | 1290 |
| B (2) | 2A | GRN | 1291 |
| C (3) | 3A | GRA/BLK | 1292 |
| D (4) | 8A | RED | 392 |
| E (5) | 9A | GRA | 397 |

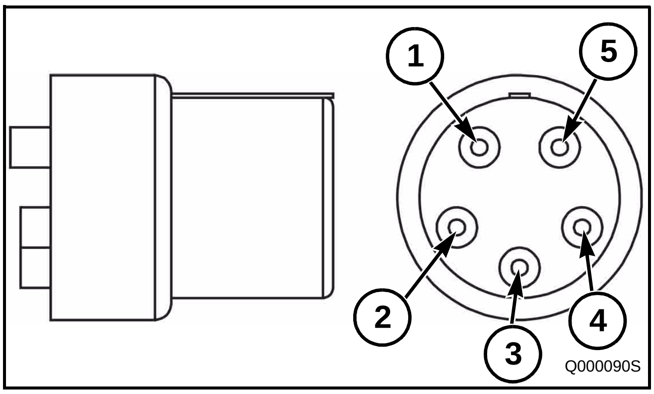



**FIG. 8**

**FIG. 9:** Power Distribution

Two panels are located behind right rear curved panel on outside of cab. To access panel loosen hand nut located in center of curved panel. Components mounted on are as follows:

1. CAN Master Module
2. PDM1
3. PDM2
4. PDM3
5. 2-Pack Relay Module (2P1 and 2P2)
6. 4-Pack Relay Module (4P1)
7. Flasher Module
8. HVAC 75 Amp Relay
9. HVAC 30 Amp Fuse
10. +10 VDC Power Terminal
11. Ground Terminal

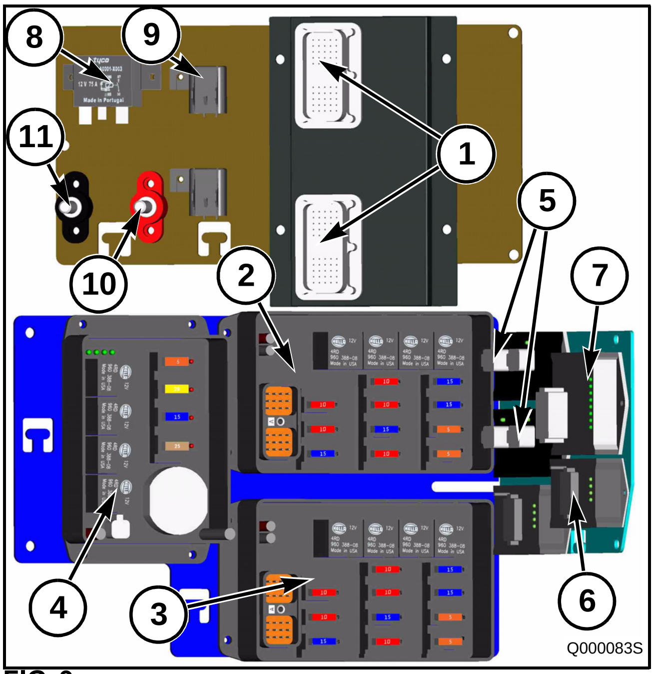



**FIG. 9**

## PDM

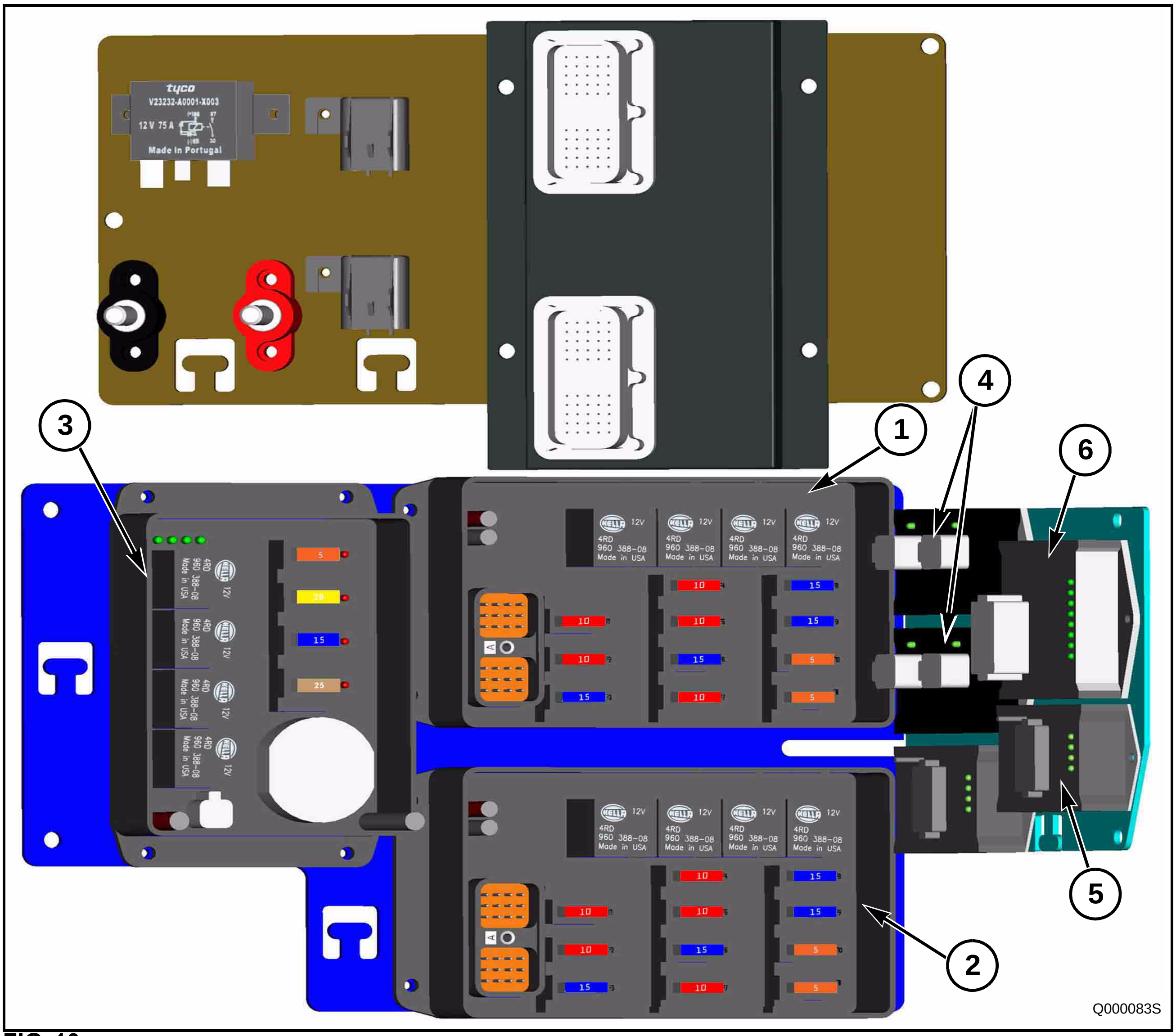



**FIG. 10**
Power Distribution Modules (PDM).

Three PDM are located on main distribution panel. All three modules contain both relays and fuses. All relays in each PDM are represented with a green LED which signals relay is active. All fuses in each PDM are represented by a red LED which indicates fuse is blown.

PDM1 and PDM2: Low current - Circuits supply up to 15 amps.

PDM1 (1) and PDM (2) have 4 relays each which supply power to 2 fuses; 8 fuses total of switched power. Both PDM's also have 3 unswitched fuses for 11 fuses total.

PDM 3 (3): High current - circuits supply from 15 to 25 amps.

2P1 and 2P2 (4): Module contains 2 relay which may supply up to 15 amps.

4P1 (5): Module contains 4 relays which may supply up to 15 amps.

Flasher module (6): Two Outputs rated at 3 amps.

## PDM1

**FIG. 11:** PDM1 - Upper Mounted Low Current Module Circuits as follows:

| FUSE | RATING | DESCRIPTION |
|---|---|---|
| F1 | 10A | ECM-UNSWITCHED |
| F2 | 10A | IGNITION SWITCH - UNSWITCHED |
| F3 | 15A | HAZARD KEY OFF - UNSWITCHED |
| F4 | 10A | ECM/REMOTE THROTTLE |
| F5 | 10A | 4P1 POWER |
| F6 | 15A | HVAC PRESSURE BLOWER |
| F7 | 10A | MASTER MODULE / SYSTEM SWITCHES |
| F8 | 15A | AIR DRYER |
| F9 | 15A | POWER BUS SYTEM |
| F10 | 5A | DASH |
| F11 | 5A | FLASHER |

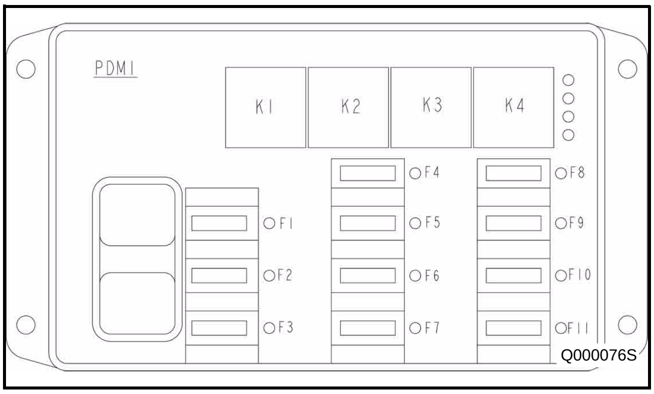



**FIG. 11**

## PDM2

**FIG. 12:** PDM2 - Lower Mounted Low Current Module Circuits as follows:

| FUSE | RATING | DESCRIPTION |
|---|---|---|
| F1 | 15A | ACC PWR OUTLET / RADIO / GPS - UNSWITCHED |
| F2 | 15A | POWER PLUGS / LIGHT SWICHTES / DOME LIGHT - UNSWITCHED |
| F3 | 10A | SWITCHED AND BACKLIGHT - UNSWITCHED |
| F4 | 10A | TCU |
| F5 | 10A | SPARE SYSTEM POWER |
| F6 | 15A | POWER BUS CHASSIS |
| F7 | 5A | BEACON (OPTIONAL) |
| F8 | 15A | A/C CLUTCH |
| F9 | 15A | WIPER / WASHER |
| F10 | 5A | REMOTE THROTTLE |
| F11 | 10A | SPARE SYSTEM POWER |

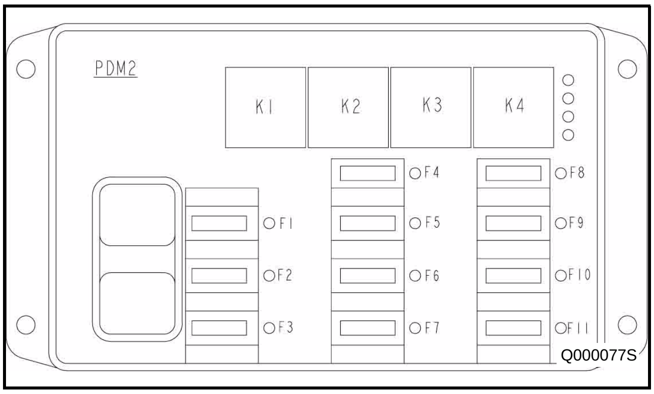



**FIG. 12**

## PDM3

**FIG. 13:** PDM3: High Current - Each circuit supplies up to 30 amps.

PDM 3 has 4 relays which each supply power to 1 fuse; meaning 4 fuses individually switched.

| FUSE | RATING | DESCRIPTION |
|---|---|---|
| F1 | 5A | ACCESSORY PLUG / RADIO / GPS |
| F2 | 20A | WORK LIGHTS 3 (OPTIONAL) |
| F3 | 15A | HVAC PRESSURE BLOWER |
| F4 | 25A | SEAT |

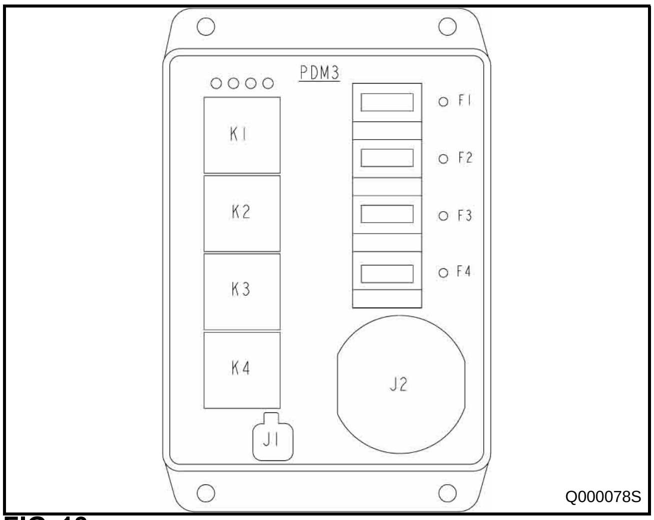



FIG. 13

## 2-Pack Relay Modules

**FIG. 14:** 2-Pack Relay Modules (2P1 and 2P2)

2-Pack relay modules contain 2 independent non-replaceable relays. Module housing contains 2 green LED's to indicate which relay are on. Each output can source a maximum of 15 amps. Relay pin out are as follows:

### J1 Connector

| PIN | RELAY | FUNCTION |
|---|---|---|
| 1 | 1 | COIL INPUT |
| 2 | 1 | NOT USED |
| 3 | 1 | COIL OUTPUT |
| 4 | 1 | N.C. OUTPUT |
| 5 | 1 | N.O. OUPUT |
| 6 | 1 | COMMON INPUT |

### J2 Connector

| PIN | RELAY | FUNCTION |
|---|---|---|
| 1 | 2 | COIL INPUT |
| 2 | 2 | NOT USED |
| 3 | 2 | COIL OUTPUT |
| 4 | 2 | N.C. OUTPUT |
| 5 | 2 | N.O. OUPUT |
| 6 | 2 | COMMON INPUT |

### Relay Module 2P1

A/C Compressor Clutch/Park Brake

### Relay Module 2P2

Work Lights #3 (Optional)

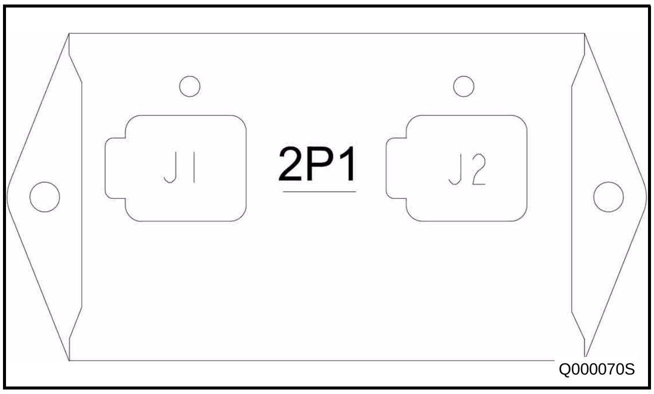



FIG. 14

## 4-Pack Relay Module

**FIG. 15:** 4-Pack Relay Module

4-Pack relay modules contain 4 independent non-replaceable relays. All relays share a common ground. Module housing contains 4 green LEDs to indicate which relays are on. Each output can source a maximum of 15 amps. Relay pin are as follows:

| PIN | RELAY | FUNCTION |
|---|---|---|
| 1 | 3 | COMMON INPUT |
| 2 | 3 | COIL INPUT |
| 3 | 4 | COIL INTPUT |
| 4 | 4 | N.O. OUTPUT |
| 5 | 3 | N.O. OUPUT |
| 6 | 4 | COMMON INPUT |
| 7 | 2 | COMMON INPUT |
| 8 | 1 | COIL INPUT |
| 9 | 2 | COIL INPUT |
| 10 | 1 | N.O. OUTPUT |
| 11 | 2 | N.O. OUTPUT |
| 12 | 1 | COMMON INPUT |

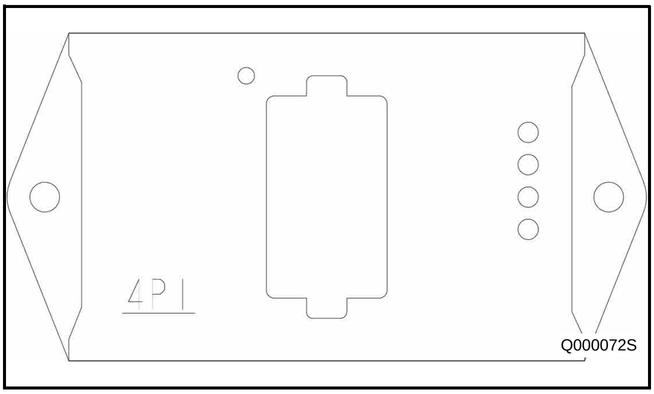



**FIG. 15**

**Relay Module 4P1**

Relay 1 - Neutral Start

Relay 2 - Remote Throttle Safety

Relay 3 - Reverse Alarm

Relay 4 - Illumiation

**Relay Module 4P2**

Relay 1 - Fog light Enable

Relay 2 - Hazard Key Off

Relay 3 - Park Brake

Relay 4 - Not Used

## Flasher Module

**FIG. 16:** Flasher Module

Flasher module is located in upper right corner of right panel next to relay modules. Flasher module accepts inputs from turn signal and hazard switches. Module then flashes corresponding lights at proper rate. Following table illustrates pinout and logic used by flasher module.

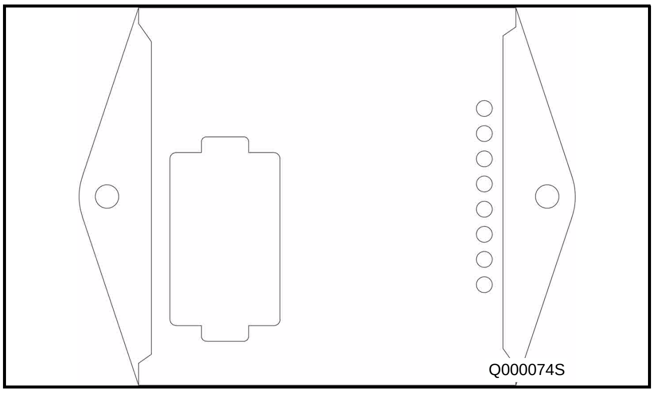



**FIG. 16**

| PIN | FUNCTION |
|---|---|
| 1 | GROUND |
| 2 | NOT USED |
| 3 | LEFT TURN INPUT |
| 4 | RIGHT TURN INPUT |
| 5 | +12 VDC INPUT |
| 6 | HAZARD INPUT |
| 7 | RIGHT B OUTPUT |
| 8 | LEFT A OUTPUT |
| 9 | NOT USED |
| 10 | NOT USED |
| 11 | RIGHT A OUTPUT |
| 12 | LEFT B OUTPUT |

FLASHER MODULE LOGIC TABLE

INPUTS

| HAZARD | IGNITION | LH TURN | RH TURN |
|---|---|---|---|
| OFF | OFF | X | X |
| OFF | ON | OFF | OFF |
| ON | OFF | X | X |
| ON | ON | OFF | OFF |
| X | ON | ON | OFF |
| X | ON | OFF | ON |
| X | ON | ON | ON |

OUTPUTS

| LH: A | RH: A | LH: A | RH: B |
|---|---|---|---|
| OFF | OFF | OFF | OFF |
| OFF | OFF | OFF | OFF |
| 65 FPM | 65 FPM | OFF | OFF |
| 65 FPM | 65 FPM | OFF | OFF |
| 90 FPM | ON | 90 FPM | OFF |
| ON | 90 FPM | OFF | 90 FPM |
| ON | ON | ON | ON |

X = CAN BE EITHER ON OR OFF

FPM = FLASHER PER MINUTE

Chassis I/O module is located on chassis frame, at the left side underneath the engine, and in front of the front axle.

## Power Supply Block

**FIG. 17:** Power Supply Block

Chassis power supply block is located on panel next to master module. This block receives power (1) from 100 amp circuit breaker in battery box next to master battery disconnect switch. Power block receives ground (2) from master battery disconnect switch in battery box. Purpose of this divider block is to split power and ground to be used by I/O module and 4-pack relay module. Power and ground are split to 12 sources.

4-Pack-relay module (3) is located on right side of interface enclosure under flasher module. Usage is as follows:

4P1 - Lower Mounted 4-Pack Module

Relay 1 - park Brake ON Ground

Relay 2 - Engine Kill

Relay 3 - B+ Backlight Switches Illumination

Relay 4 - Hazard Key OFF Power

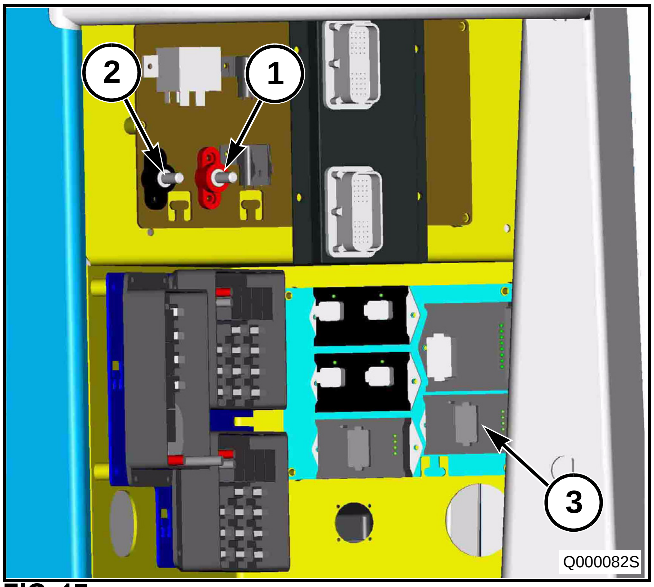



**FIG. 17**

## NOTES

# INDEX

## NOTES

# Challenger®

## Terra Gator 3244
## Chassis

# SERVICE MANUAL
## 627333-A

# 07 - Hydraulic

### Contents

NOTES

# INTRODUCTION

## HIGH-PRESSURE FLUIDS

**FIG. 1:** AVOID HIGH-PRESSURE FLUIDS

Escaping fluid under pressure can penetrate the skin causing serious injury.

The vehicle must be stopped and cooled before checking fluids. Use caution when removing radiator caps, plugs, grease fittings or pressure taps.

Never open pressure lines when they are under pressure. Release all pressure before doing maintenance or repairs on any pressure system.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

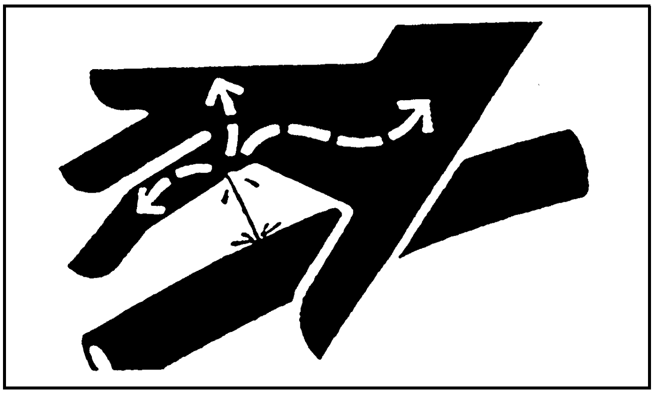


**FIG. 1**

**FIG. 2:** Search for leaks with a piece of wood or cardboard. Protect hands and body from high pressure fluids. Do not use your hands!

Never open hydraulic lines or fuel lines when they are under pressure. Hydraulic fluid or diesel fuel under pressure can cut the skin, cause bad burns, eye injury or skin irritation.

If an accident does occur, get medical help immediately if any personnel are injured by hydraulic fluid or fuel.

Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.

Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.

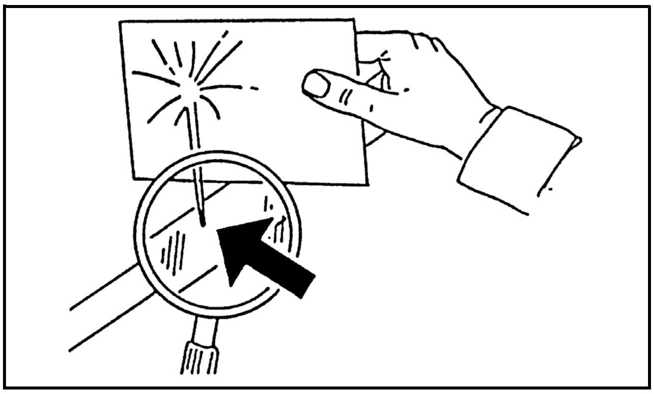


**FIG. 2**

## HYDRAULIC HOSES

*IMPORTANT: Hydraulic hoses have a limited working live. By weather influences and use under heavy conditions and normal aging the working live reduce.*

Therefore is checking of hydraulic hoses by damaging and aging important for good functioning of your machine and the safety of the user and the environment.

Replace immediately damaged and leaking hydraulic hoses.

## AVOID HEATING NEAR PRESSURIZED FLUID LINES

**FIG. 3:** Never heat by welding, soldering or using a torch near pressurized fluid lines or other flammable materials.

Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to personnel and bystanders.

**FIG. 3**

## THEORY OF OPERATION

The steering on the 3244 is hydraulically controlled. A displacement gear pump draws hydraulic oil from the reservoir. Hydraulic flow is sent directly to the priority valve mounted to the side of the right fender underneath the Cab.

The priority valve direct hydraulic flows out the Control Flow (CF) port to the steering unit. The steering unit always has priority over any other function in the hydraulic system. When the steering unit is not demanding oil flow, the priority valve shifts to send oil flow out the Excess Flow (EF) port toward the application system hydraulics.

As the steering wheel is turned a, load sense signal, along with a spring, shifts the priority to direct oil flow out the CF port toward the steering unit. The steering unit direct hydraulic oil toward one of the steering cylinders which are attached to the pivot point.

Extending and retracting the steering cylinders pivot the front chassis in the desired direction. There is one cylinder mounted to each side of the pivot point. The cylinders are plumbed so that when one cylinder retracts, the other extends.

Excess oil flow leaves the EF port of the priority valve and travels to the application system hydraulic functions.

Once the hydraulic oil is through the functions, it is returned to the reservoir through the oil cooler and the return filter.

## TOOLING LIST

For the right tools see, chapter 1; “Tooling List” in the front of this manual.

## COMPONENT LOCATION AND FUNCTION

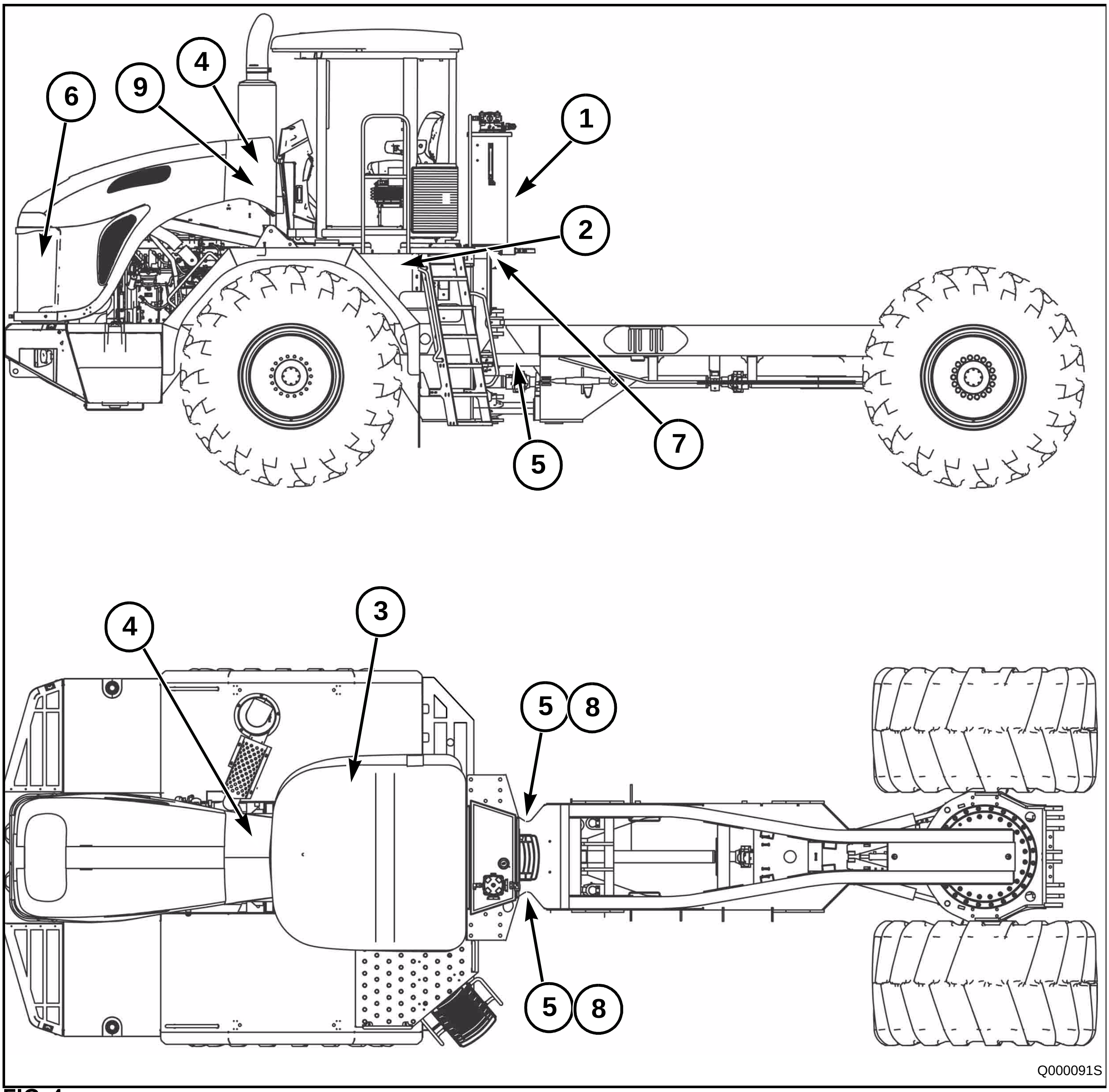



**FIG. 4**
Component layout:

1. Hydraulic Oil Tank;
2. Hydraulic Gear Pump;
3. Priority Valve;
4. Steering Unit;
5. Steering Cylinder;
6. Hydraulic Oil Cooler;
7. Application System Hydraulics;
8. Pivot Point;
9. 3 Accumulators.

**FIG. 5:** Hydraulic oil tank (1) is located behind the Cab.

The hydraulic tank is filled with 200 L (52.8 gall). Hydraulic oil is drawn out of tank by gear pump through suction strainer. Oil from application system is returned into tank through filter on top of the tank.

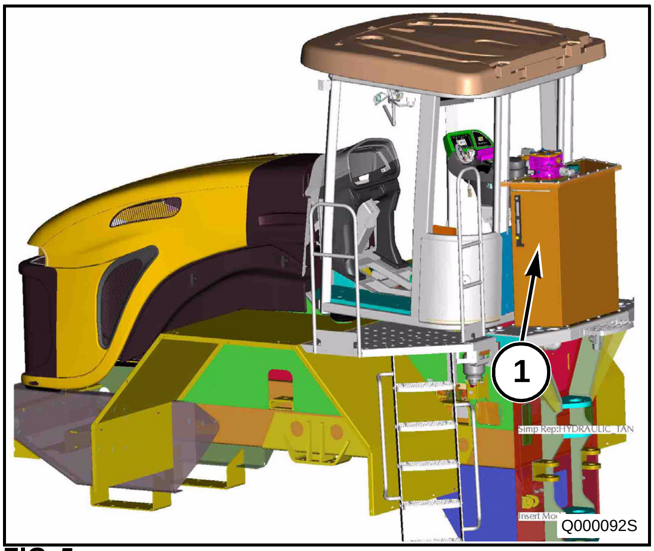



**FIG. 5**

**FIG. 6:** Hydraulic oil pump (2) is mounted on the left PTO of the gearbox.

The hydraulic pump is a displacement gear pump. The pump draws oil from the reservoir and sends oil flow to the priority valve.

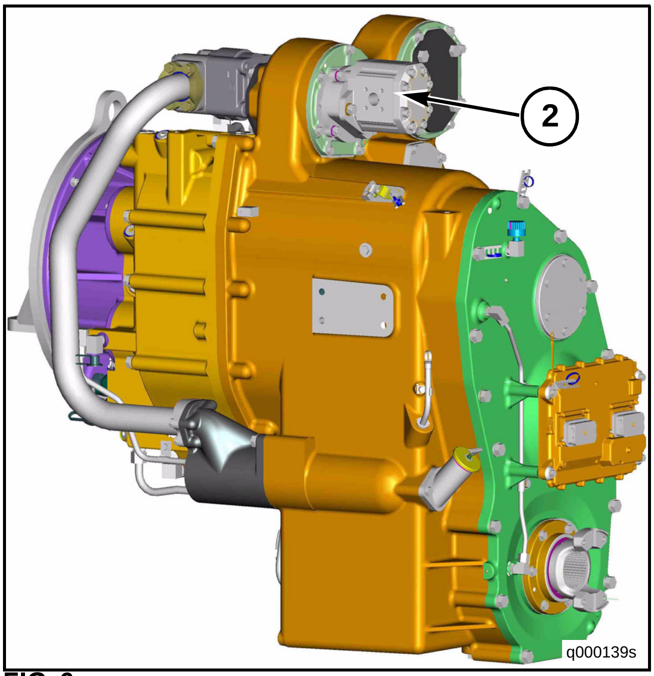



**FIG. 6**

**FIG. 7:** The priority valve (3) is mounted underneath the Cab.

The priority valve direct hydraulic flow between the steering system and the application systems, including the pressure washer if equipped. A load sense signal from the steering unit shift the valve to allow hydraulic flow to exit the control flow (CF) port. If there is no load sense signal, the priority valve shifts to allow hydraulic flow to exit the excess flow (EF) port.

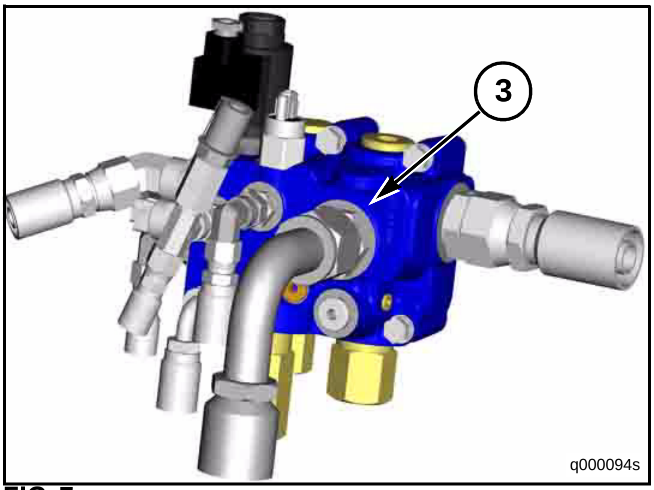



**FIG. 7**

**FIG. 8:** The steering unit (4) is mounted to the front of the cab.

The steering unit is a closed center distribution valve that is connected to the steering wheel in the Terra Gator. When the operator turns the steering wheel, the unit sends a load sense signal to the priority valve on the pump. This will send an amount of flow (CF-port) through the steering unit to the 2 steering cylinders.

The speed and/or turning angle of the steering wheel depends the amount of flow, that's send through the steering unit to the 2 steering cylinders.

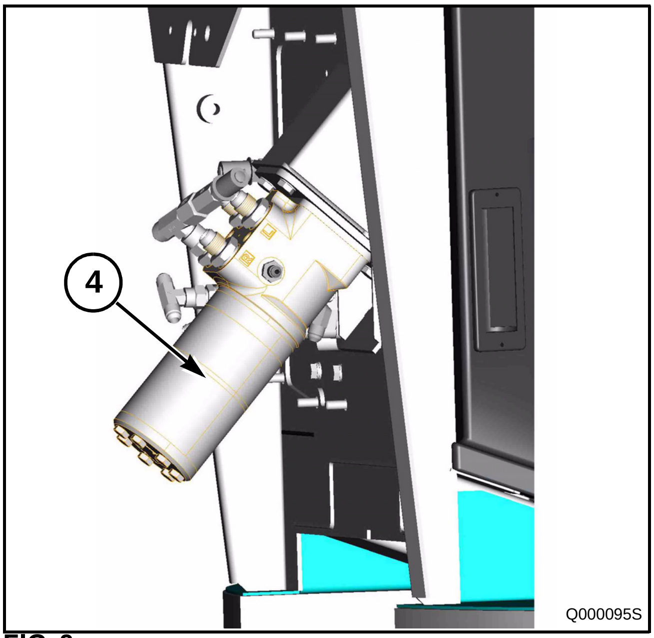



FIG. 8

**FIG. 9:** The 2 accumulators (9) are mounted to the front of the cab, underneath the Steering unit.

The accumulators make it possible, when there is a failure to the hydraulic pump. The machine still can brake 8 times.

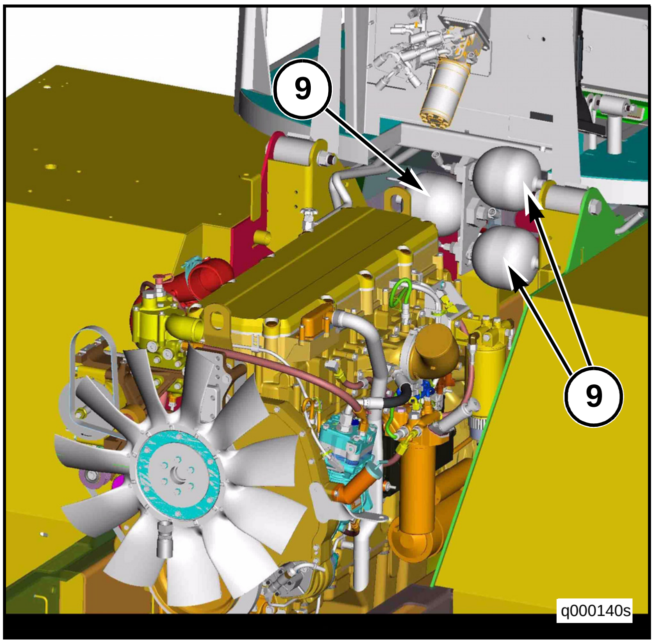



FIG. 9

**FIG. 10:** The heat exchangers

The hydraulic oil cooler is mounted to the front of the radiator assembly. The cooler cools hydraulic oil returned from the application systems hydraulic system and the pressure washer, if equipped. The cooled oil is send to the return filter and into the tank.

1. Transmission Cooler;
2. Hydraulic Cooler;
3. Air Conditioner Condenser;
4. Charge Air Cooler;
5. Engine Radiator.

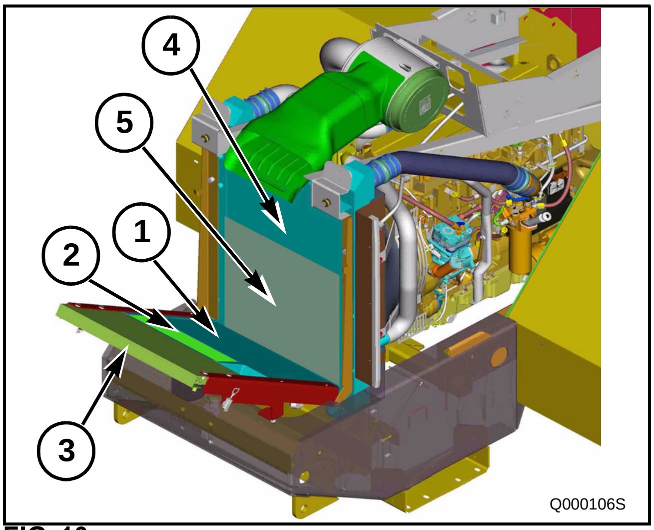



FIG. 10

**FIG. 11:**

**WARNING: The cooling system operates under pressure which is controlled by the radiator pressure cap. Removing the cap while the system is hot may allow the escape of hot coolant and steam, causing serious burns. Before you remove the radiator cap, allow the system to cool. Use a think cloth and turn the radiator cap slowly to the first stops to allow pressure to escape before fully removing the cap. Avoid contact with coolant.**

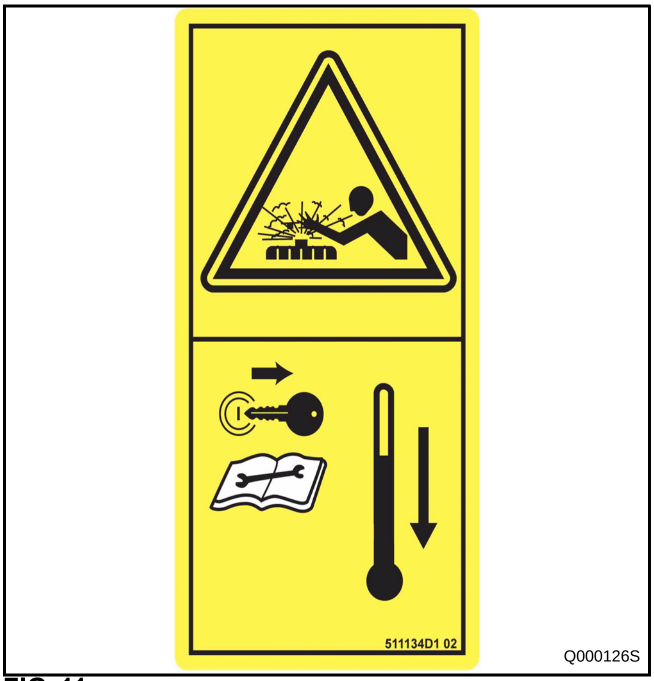



**FIG. 11**

## PRESSURE MEASUREMENT

*NOTE: Components must be clean. Before disassembly procedure, exterior of component should be thoroughly cleaned to prevent dirt from entering internal mechanism or system.*

*IMPORTANT: Ensure fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of machine. Be prepared to collect fluid with suitable containers before opening any compartment or disassembling any component containing fluids.*

*Dispose of all fluids according to local regulations and mandates.*

**WARNING: Personal injury can result from hydraulic oil pressure and hot oil.**

**Hydraulic oil pressure can remain in hydraulic system after engine has been stopped. Serious injury can be caused if this pressure is not released before any service is done on hydraulic system.**

**Ensure all implements have been lowered to ground and oil is cool before removing any components or lines. Remove oil filler cap only when engine is stopped and filler cap is cool enough to touch with bare hand.**

*NOTE: Put identification marks on all lines, hoses and tubes to ease installation. Plug all lines, hoses and tubes to prevent fluid loss and prevent contaminants from entering hydraulic system.*

### Steering System

**FIG. 12:** The test point (1) of the steering system is located on top of the Steering unit.

The pressure on the system has to be 190 bar (2756 psi).

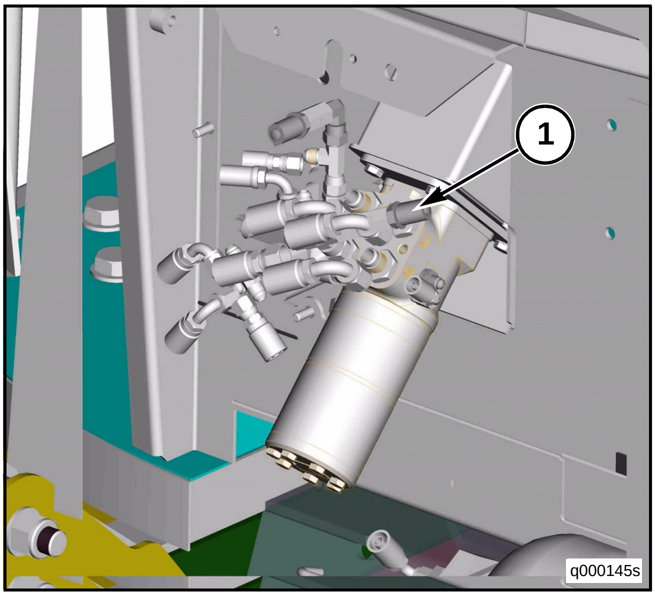



**FIG. 12**

## Braking System

### Brake Pedal

**FIG. 13:** The test point (2) of the brake pedal is located next to the Steering Unit.

The pressure on the brake pedal has be to between 0 - 40 bar (0 - 580 PSI) depends on the force which pressing the brake pedal down.

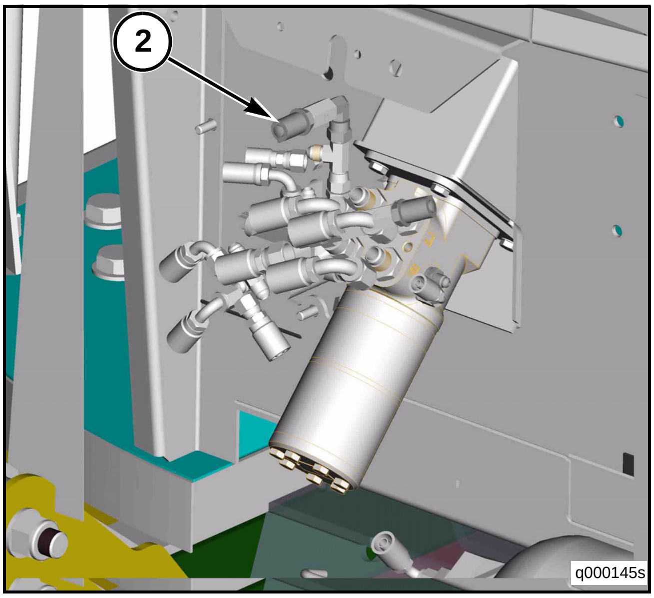



FIG. 13

### Brake Accumulators

The pressure in the accumulator has to be between 110 - 140 bar (1595 - 2030 PSI).

## Adjusting Procedure  Brake System

See below for the correct adjusting procedure of the braking system.

**FIG. 14:** Test point on the priority valve.

- Connect the pressure gauge to test point (1);
- Start the engine and measure the pressure at the gauge. The pressure shoud be around 140 bar (2030 PSI);
- Kick the brake pedal several times so the accumulators pressure decreases;
- The pressure shoud not go below 110 bar  (1595 PSI). The hydraulic pump will fill the accumulator pressure, it must rise again to 140 bar  (2030 PSI);

*NOTE: See the tooling list for the correct partnumbers of the tools.*

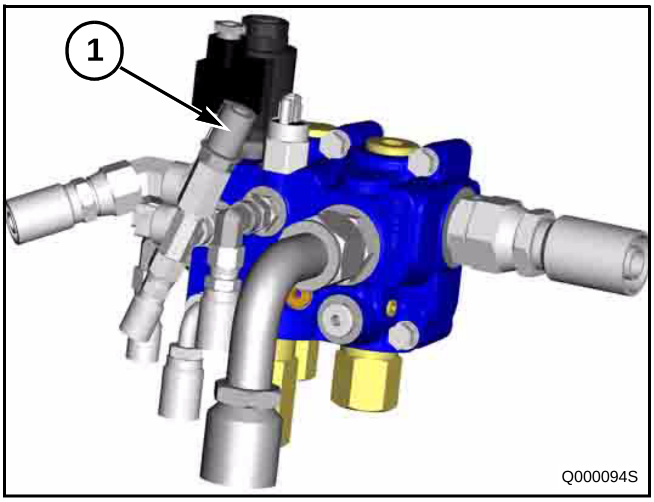



FIG. 14

**FIG. 15:**

- When pressure is incorrect at 110 bar (1595 PSI), adjust it. To adjust the pressure turn (2) clockwise to increase and turn counterclockwise to decrease.
- When the pressure decreases to 85 bar (1232 PSI), an alarm inside the cab will go off.

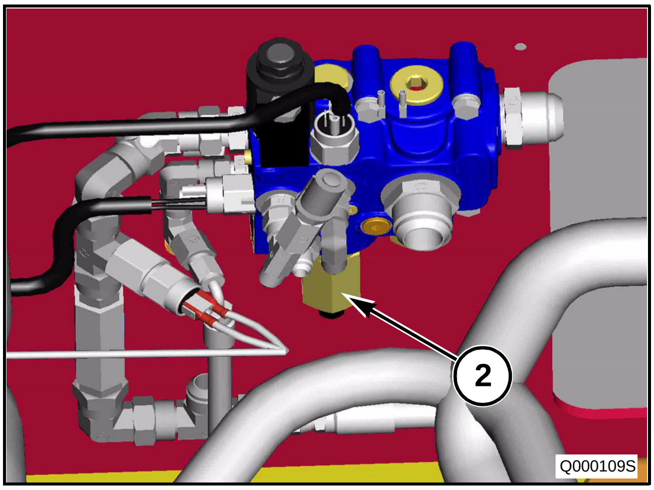



**FIG. 15**

**NOTES**

# SCHEMATIC

## HYDRAULIC SCHEMATIC

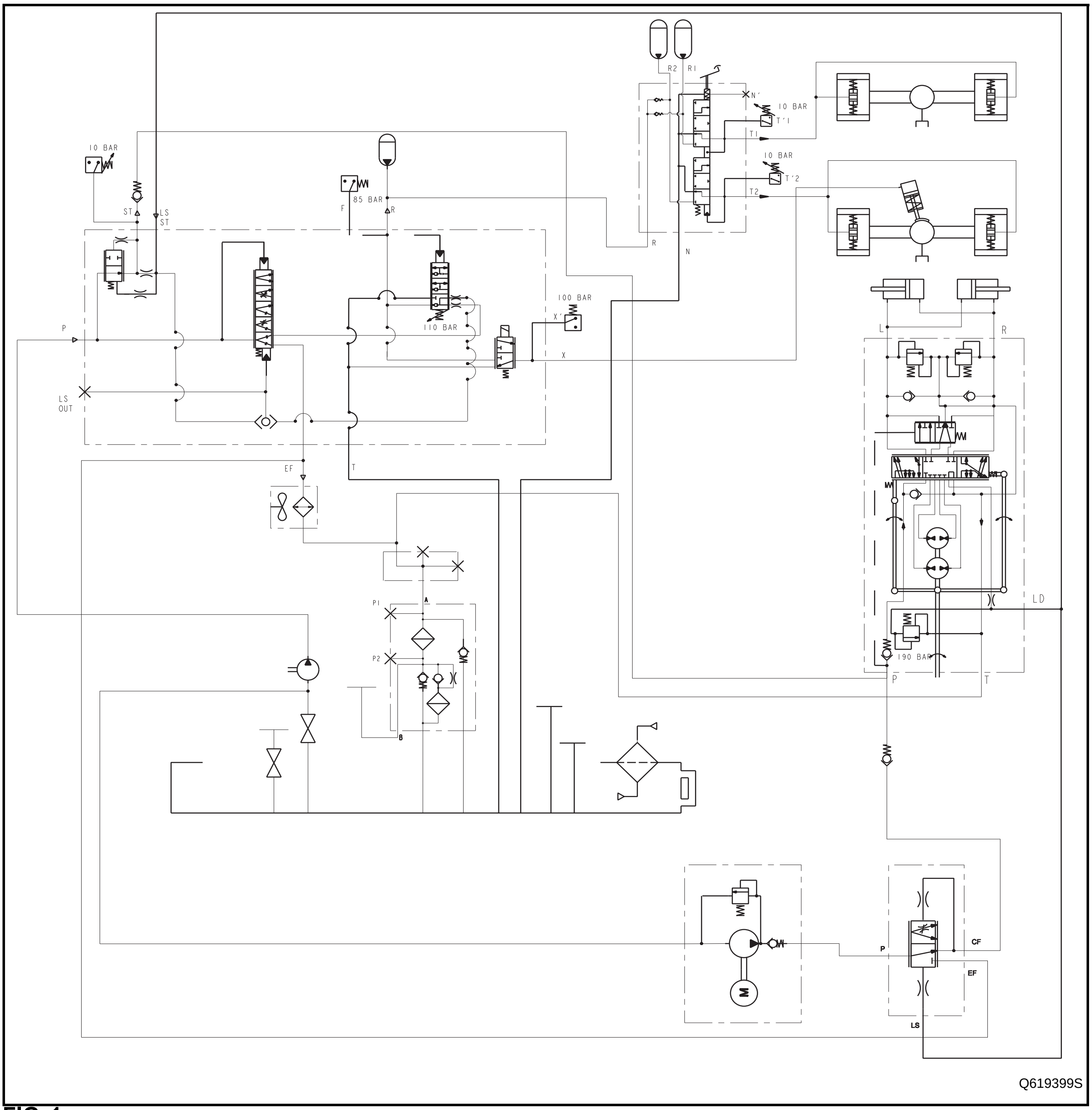



FIG. 1

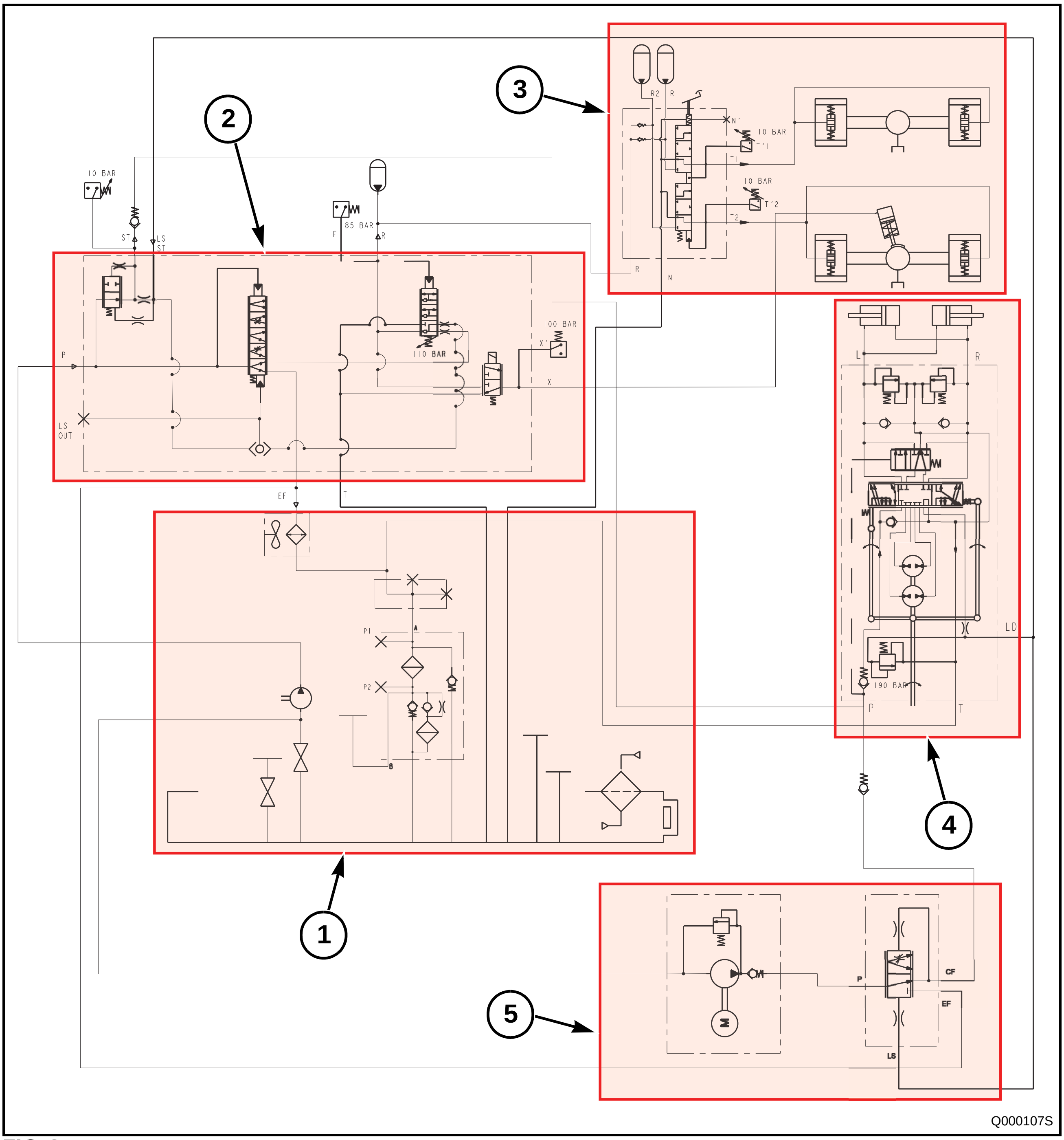



FIG. 2

1. Tank, Filter and Cooler;
2. Priority Valve;
3. Brakes;
4. Orbitrol;
5. Emergency Steering (Option)

## PRIORITY VALVE

The priority valve receives hydraulic pressure from the hydraulic pump mounted on the transmission and controls the flow to the steering system and the auxiliary hydraulic systems. The steering system maintains priority over the braking system. As the steering wheel is turned, pressure to the steering unit drops, which drops the pressure in the line and shifts the priority valve to supply more oil to the steering unit.

Priority valve has four ports and a construction hole. P-port (pressure) is incoming from hydraulic pump. LS-port (load sense) goes to steering unit. CF-port (control flow) goes to steering valve. EF-port (excess flow) goes to auxiliary hydraulic system and power washer (if equipped). PP-port is used in valve construction and is plugged.

**FIG. 3:** Priority Valve (1) right side underneath the cab.

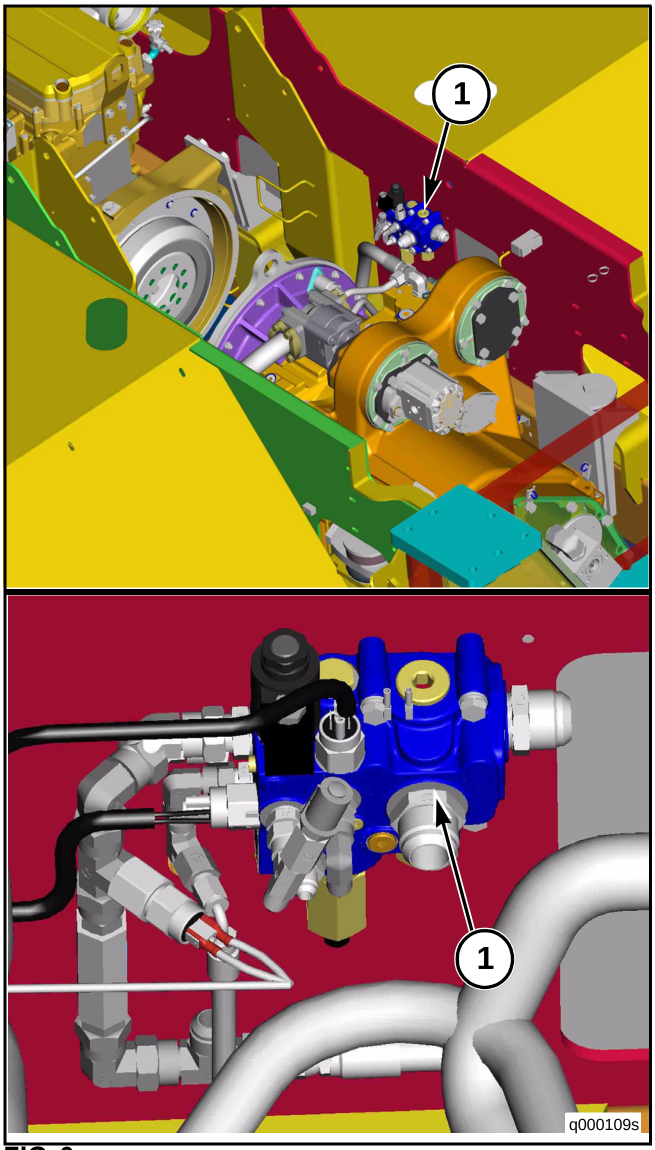



**FIG. 3**

## EMERGENCY STEERING (OPTION)

**FIG. 4:** The electric motor (1) of the emergency steering will activated when a sensor of the priority valve (2) detect a fall of the oil pressure. The oil pressure has to fall below the 10 bar. When the emergency steering is activated, a warning light (3) on the armrest will light up, and there will be an acoustic sound inside the cab.

*IMPORTANT: Never use the emergency steering longer as strictly necessary. Approximately 40 seconds.*

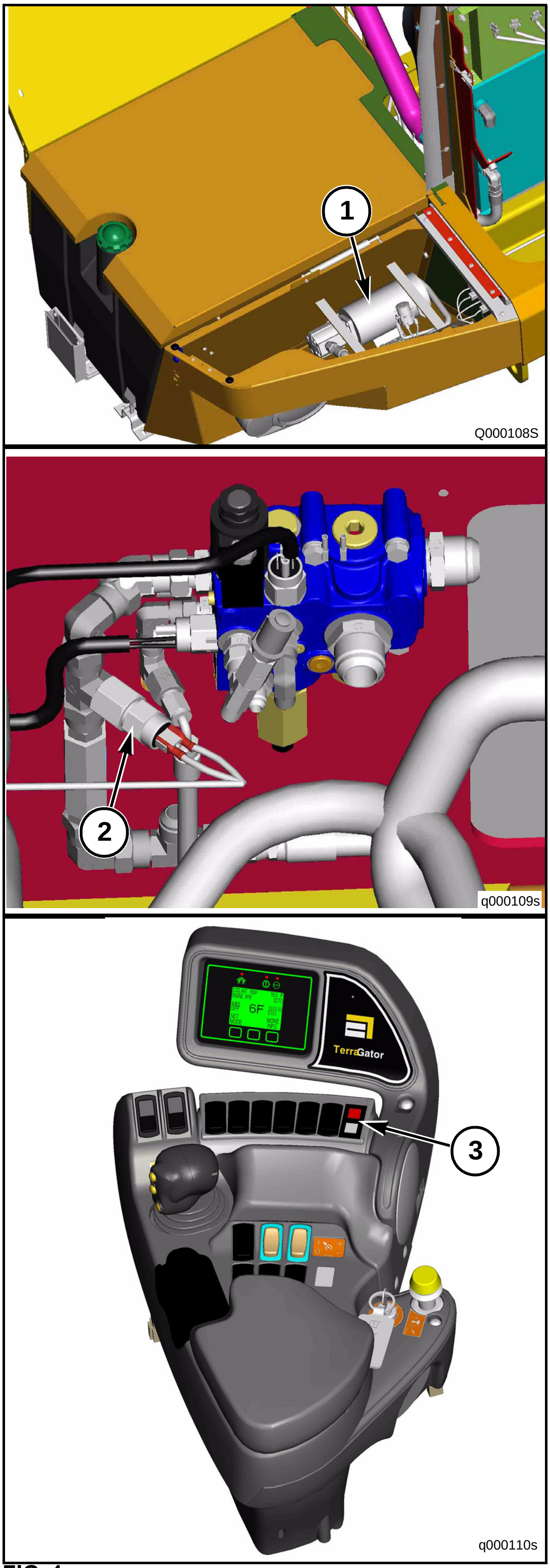



FIG. 4

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**NOTES**

# Challenger®

## Terra Gator 3244
## Chassis

# SERVICE MANUAL
## 627333-A

# 08 - Air System

## Contents

NOTES

# AIR COMPRESSOR

The chassis air system consists of an engine mounted, direct driven air compressor, an air drier and two storage tanks. The first tank is called a wet tank because most condensation occurs in this tank as the air cools from being compressed. The second tank is called a dry tank since little condensation occurs in that tank.

From the dry tank, air is sent out to the R-12 relay valve for service brakes and to the R-14 relay valve for the parking brakes. Air is sent from the dry tank to the parking brake and service brake valves in the cab to serve as “signal” air to control the relay valves.

Air is supplied to the back of the cab and goes to auxiliary functions in the cab, like the air horn and to the system requirements such as foam marker systems, product control valves, boom shut-off, etc. Air to these auxiliary functions passes through a pressure protection valve as a safety feature. In the event of a major air system malfunction (pressure drops to under 4,82 bar (70 psi)), the valve closes off to these auxiliary functions to reserve remaining air pressure for braking.

## AIR COMPRESSOR REMOVAL

**WARNING: Remove all air pressure from tanks before disconnecting any air hoses. Pressurized air can cause serious personal injury.**

**WARNING: Never open coolant system when fluid is hot. Hot fluid can cause serious personal injury.**

*NOTE: Keep all parts clean from contaminants. Contaminants may cause rapid wear and shortened component life.*

*NOTE: Contain all fluids. Be prepared to collect fluid with suitable container before opening and disassembling any component containing fluids.*

Drain coolant from coolant system.

**FIG. 1:** Disconnect high temperature braided hose going from compressor to air dryer. Mark and disconnect coolant lines going to front (1), top (2) and rear (3) of compressor. Disconnect oil line (4).

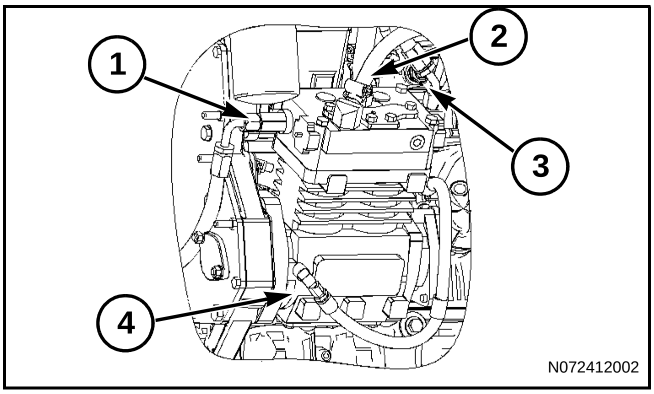


**FIG. 1**

**FIG. 2:** Remove two bolts (1) at rear of compressor holding compressor mount to engine block.

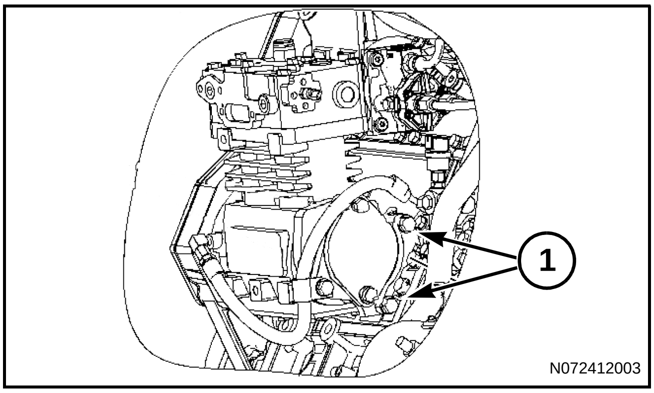


FIG. 2

**FIG. 3:** Support air compressor (1). Air compressor weighs approximately 23 kg (51 lb). Remove two bolts (2) at front of engine holding compressor to timing gear housing.

Slide compressor back to disengage gear teeth. Remove gasket with compressor.

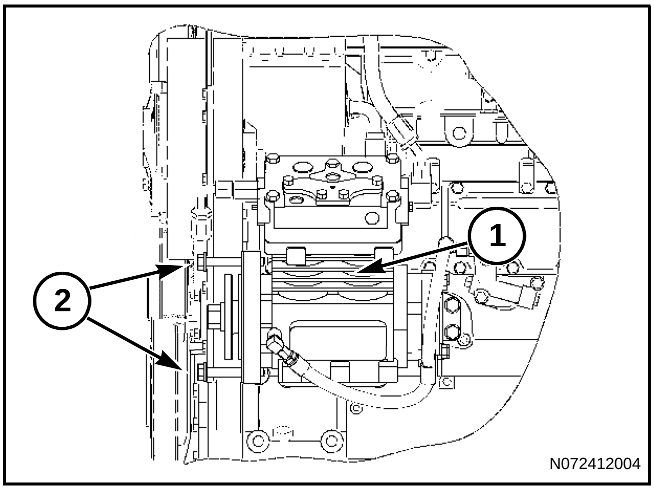


FIG. 3

## AIR COMPRESSOR INSTALLATION

*NOTE: Keep all parts clean from contaminants. Contaminants can cause rapid wear and shortened component life.*

Install mounting bracket to back of air compressor with two bolts. Inspect air compressor gasket and replace if necessary. Install gasket between air compressor and timing gear housing.

Apply thread locking compound to mounting bolts. Mount compressor to engine with four bolts, ensuring gear meshes properly in timing gear housing. Two bolts in front of housing and two through mount and into engine block.

**FIG. 4:** Torque front mounting bolts (1) to 80 to 120 Nm (60 to 90 lbf ft) and rear mounting bolts (2) to 45 to 65 Nm (33 to 47 lbf ft).

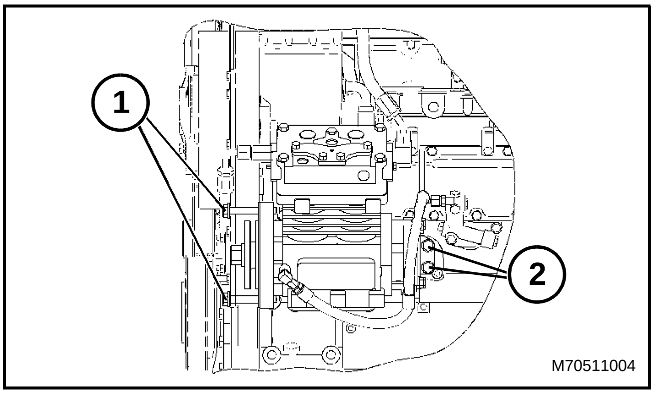


**FIG. 4**

**FIG. 5:** Connect high temperature braided hose from compressor to air dryer. Connect coolant lines going to front (1), top (2) and rear (3) of compressor. Connect oil line (4).

Refill cooling system with 50/50 water and ethylene glycol mixture coolant.

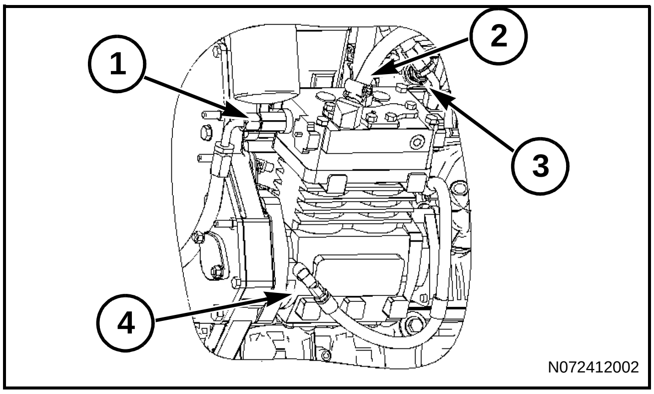


**FIG. 5**

## NOTES

# AIR TANK AND PRESSURE CONTROL CHECK VALVE

## THEORY OF OPERATION

There are two air tanks in the standard air system. The wet tank and the dry tank. The wet tank collects condensation from compression and has a drain valve to remove moisture. Compressed air flows from the wet tank to the dry tank. The dry tank supplies air to the braking and accessory systems.

There is a pressure control check valve (PCCV) mounted in the output port of the wet tank. The PCCV lets air flow from the secondary tank to the supply tank as long as system pressure remains between the cut in/out range for the governor.

*NOTE: The air which reached the wet air tank has already past the air dryer. So the term "wet tank" is a proverbial expression and means the air can be a little wet. But the practice shows there is rarely fluid in this tank.*

## AIR TANKS

*NOTE: All orientation directions are in relation to the driver's position.*

**FIG. 1:** Tanks (1) are mounted underneath the engine (2). The wet tank collects condensation that can be released by operating drain valve (3) on bottom of tank.

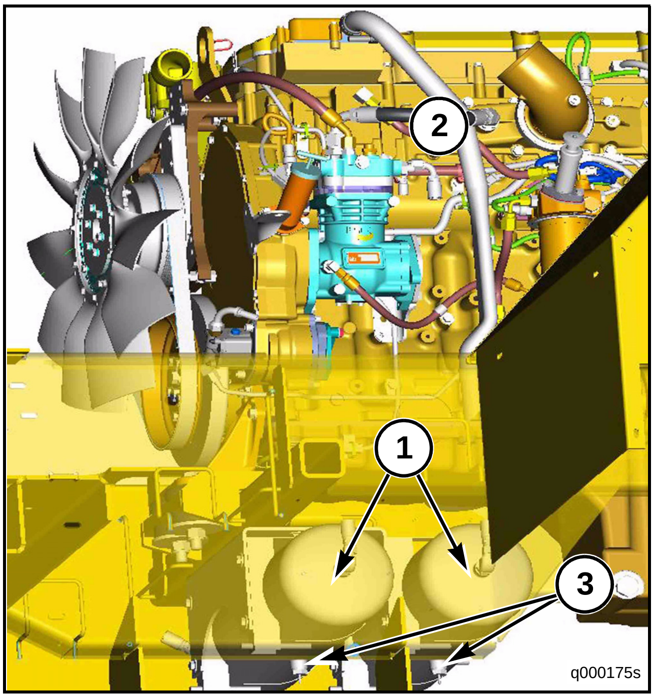

**FIG. 1**

### Air Tank Removal

*NOTE: For example we use the wet tank.*

**FIG. 2:** Mark and disconnect signal air hose (1) from wet tank (2) to air governor.

Disconnect supply hose (3) from air dryer.

Disconnect output hose (4) to dry tank (5).

**WARNING: Remove all air pressure from tanks before disconnecting any air hoses. Pressurized air can cause serious personal injury.**

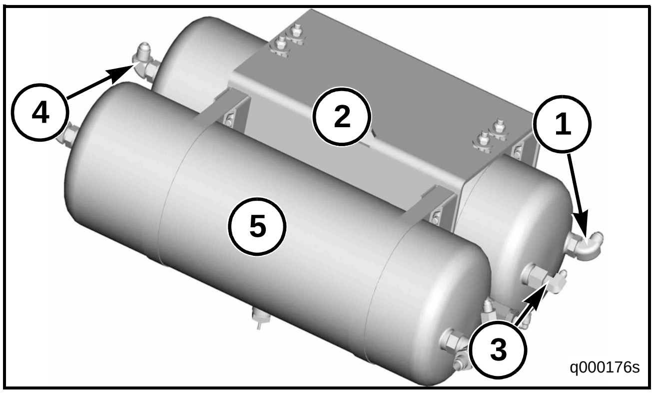

**FIG. 2**

**FIG. 3:** Remove nut holding hose support and remove support.

Remove four nuts (1) that hold clamp and tank assembly to frame brackets and remove tank assembly.

Loosen tank clamps (2) and remove clamps from tank.

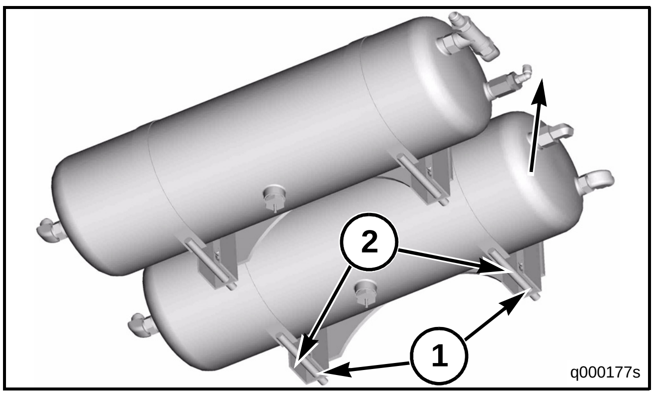

**FIG. 3**

## Air Tank Installation

*NOTE: For example ew use the wet air tank.*

*NOTE: Always use new O-rings and O-ring washers.*

*NOTE: Be sure to apply a thin film of oil to the O-rings on all fittings.*

**FIG. 4:** Install 3/4-16 MJIC straight adapter (1) into inlet port with M22 O-ring (2) and M22 trust washer (3).

Install 3/8 MNPT x 1/4 MJIC adapter (4) into a M22-1-1/2 OR x 3/8 FNPT adapter (5). Install this assembly into output port on rear of tank with M22 O-ring (6) and M22 trust washer (7).

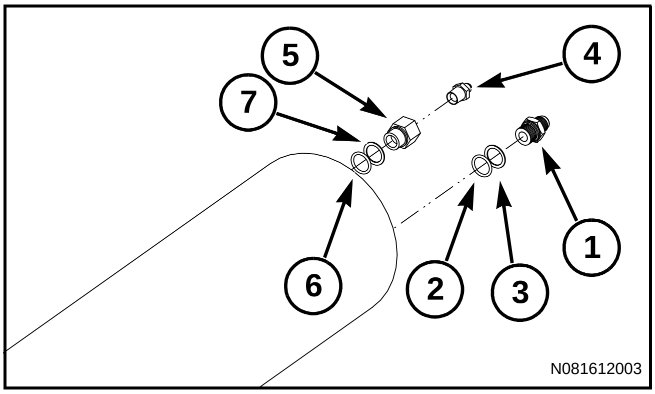


**FIG. 4**

**FIG. 5:** Install drain valve (1) into port in bottom of tank with M22 O-ring (2) and M22 trust washer (3).

Install 8 FNPT x 8 MJIC 90-degree fitting (4) onto outlet port of PCCV (5). Tighten fitting until vertical and pointing upward. Install 0.50NPT nipple (6) into inlet port of PCCV.

Install 0.50NPT adapter (7) into outlet port with M22 O-ring (8) and M22 trust washer (9).

Install PCCV assembly into outlet adapter (7). Tighten assembly until 90-degree fitting is vertical and pointing upward.

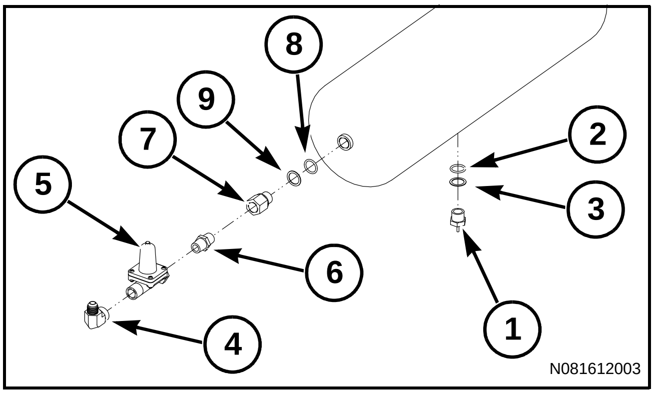


**FIG. 5**

**FIG. 6:** Bolt tank and clamp assembly (1) onto mounting brackets under frame with four nuts (2).

Mount hose support to front clamp and tighten nut.

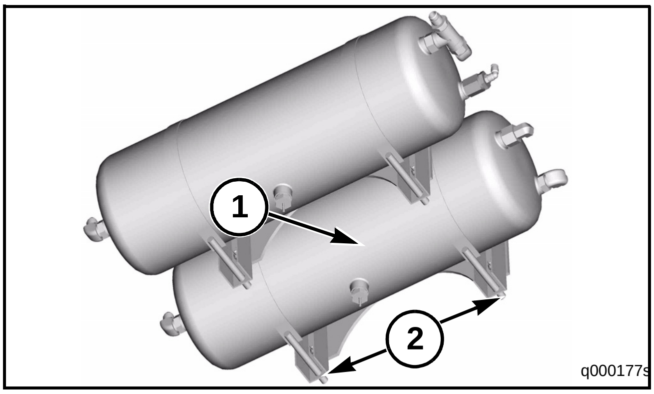


**FIG. 6**

**FIG. 7:** Attach inlet hose (1) to 0.75 fitting on rear end of tank.

Attach signal line (2) to governor to 0.25 fitting on rear end of tank.

Attach outlet hose (3) to adapter on front of tank.

Tighten clamps once tank and lines are positioned correctly.

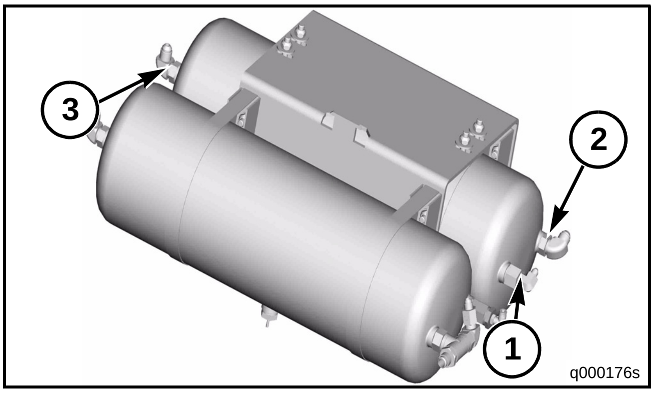


**FIG. 7**

# AIR DRYER

## DESCRIPTION

The air dryer is plumbed from the compressor to the wet tank and is mounted in front of the coolers. The dryer can be identified by a small regeneration hole in the back of the inlet port, which is visible when the fitting is removed. The dryer uses a 12-volt heater. The heater turns on at 7 degrees C (45 degrees F) and off at 30 degrees C (86 degrees F).

Minimum governor cut-out pressure is 793 kPa (115 psi). Maximum system pressure is 1034 kPa (150 psi). Minimum pressure after regeneration is 724 kPa (105 psi). Dryer includes one spin-on desiccant canister.

**FIG. 1:** Air dryer (1) located

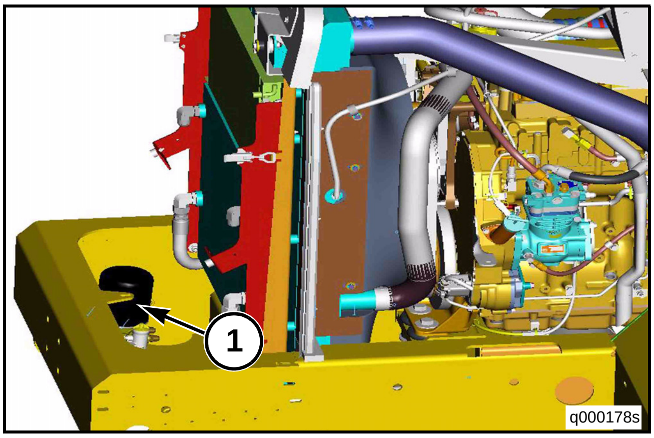


**FIG. 1**

## AIR DRYER REMOVAL

**FIG. 2:** Air dryer/Governor hose attachment.

**WARNING: To prevent serious eye injury, always wear safe eye protection when you perform machine maintenance or service. Remove all pressure from the air system before you disconnect any component, including the desiccant cartridge. Pressurized air can cause serious personal injury.**

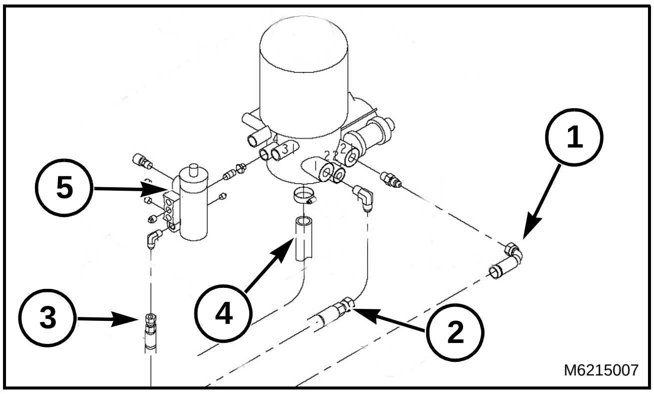


**FIG. 2**

Mark and disconnect output hose (1) to wet air tank.

Disconnect braided hose (2) from air compressor.

Disconnect signal hose (3) to governor from wet tank.

Disconnect clear vinyl hose (4) from purge valve.

Unplug wiring connector for heater.

Loosen and remove three bolts that hold air dryer to chassis and remove air dryer.

Disassemble air governor (5) from air dryer.

## AIR DRYER INSTALLATION

*NOTE: Use thread locking compound on all plugs and fittings.*

**FIG. 3:** Assemble elbow fitting (1) into inlet port. Assemble straight fitting (2) into outlet port.

Assemble governor (3) to straight fitting (4) on dryer.

Bolt dryer/governor assembly to cabinet or plate.

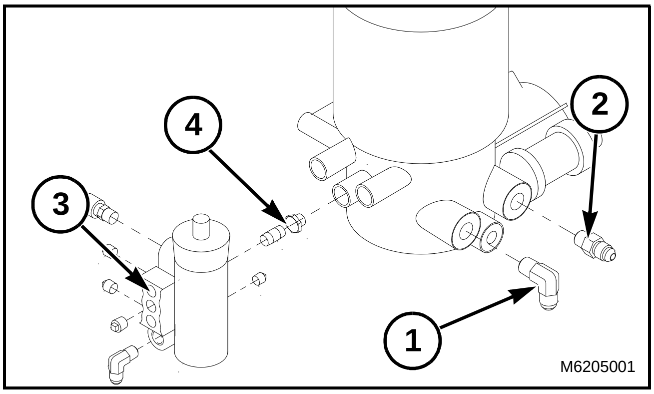


FIG. 3

**FIG. 4:** Attach supply hose (1) from compressor to elbow fitting in inlet port.

Attach air tank delivery hose (2) to straight fitting.

Attach signal hose (3) to elbow fitting on governor (4).

Plug in heater connector.

Attach clear vinyl hose (5) to purge valve.

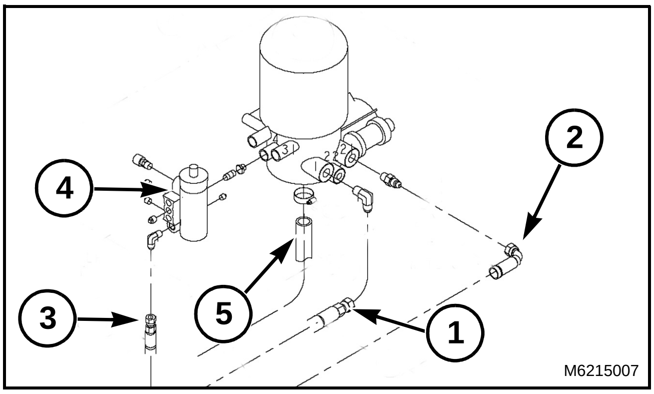


FIG. 4

## AIR DRYER COMPONENTS

**FIG. 5:** Air dryer assembly.

(1) Heater

(2) Turbo Cut-off Valve

(3) Desiccant Cartridge

(4) Outlet Check Valve

(5) Regeneration Valve

(6) Purge Valve

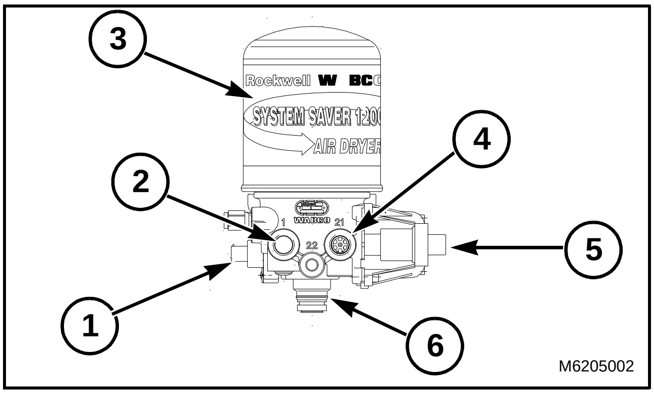


**FIG. 5**

### Heater

**FIG. 6:** Heater is located in air dryer base. Heater prevents water that collects in air dryer from freezing. The heater consists of a cylindrical resistive-type heating element and small circular thermostat. Heater is 12-volt.

To replace heater, disconnect electrical plug. Remove screws, receptacle and O-ring from base to access retainer screw. Remove entire screw and remove entire heater assembly. Install new element and thermostat in cavities. Install new retainer and screw to hold element and thermostat in place. Install new O-ring and receptacle and fasten in place with screws.

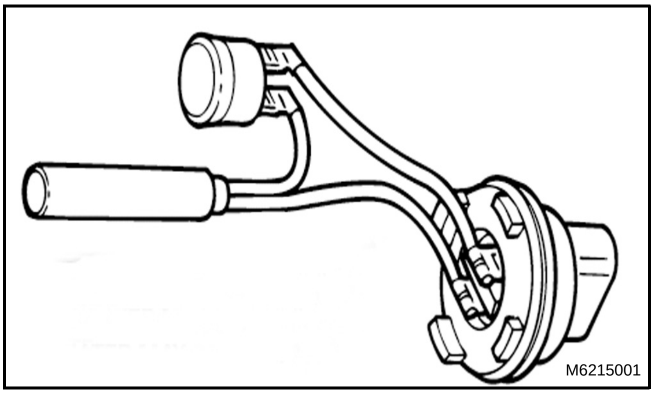


**FIG. 6**

### Turbo Cut-off Valve

**FIG. 7:** Turbo cut-off valve is located in inlet port of air dryer. The turbo cut-off valve closes path between air compressor and air dryer purge valve during compressor unload. This prevents a loss of turbocharger boost pressure during a compressor unload cycle, keeping boost pressure for maximum engine horsepower.

*IMPORTANT: There is no spring in the turbo cut-off valve assemblies used on U Series air dryers.*

To replace turbo cut-off valve, remove snap ring. Cover and spring may fall out of bore. Remove desiccant cartridge. Use a wooden stick to push piston spring and cover out if they don't fall out. Clean and inspect the valve bore. If bore is damaged so that a tight seal cannot be maintained, replace air dryer.

Install new lip seal on piston. Seal lip must face up toward top of piston. Install new O-ring on cover. Use grease supplied with kit to apply thin film to valve bore and O-ring. Install new piston with flat side toward dryer. Install new spring, cover, and snap ring to hold components in place. Install plug. Replace desiccant cartridge.

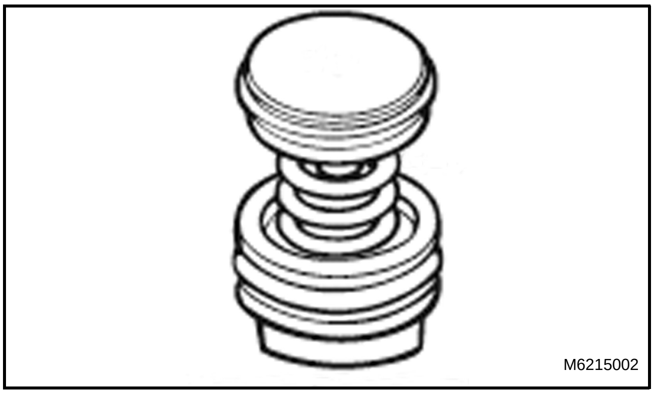


**FIG. 7**

## Desiccant Cartridge

**FIG. 8:** Desiccant cartridge is a steel housing containing filter elements needed to filter and dry system air.

**WARNING: To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service. Remove all pressure from the air system before you disconnect any component, including the desiccant cartridge. Pressurized air can cause serious personal injury.**

Replace cartridge by turning cartridge counter-clockwise to unscrew from air dryer. Screw new desiccant cartridge onto air dryer by turning clockwise until tight.

**FIG. 8**

## Outlet Check Valve

**FIG. 9:** Outlet check valve is located in outlet port. Outlet check valve prevents air from flowing back through air dryer and escaping out purge valve during compressor unload cycle.

To replace outlet check valve, remove snap ring, washer, spring, valve body, and O-ring. Clean and inspect the valve bore. If bore is damaged so that a tight seal cannot be maintained, replace air dryer.

Install new O-ring on valve body. Use greased supplied with kit to apply thin film to valve bore and O-ring. Install new valve body with its long end in bore. Install new spring with its small end around the Y-shaped fins on the valve body. Install new washer and snap ring to hold components in place.

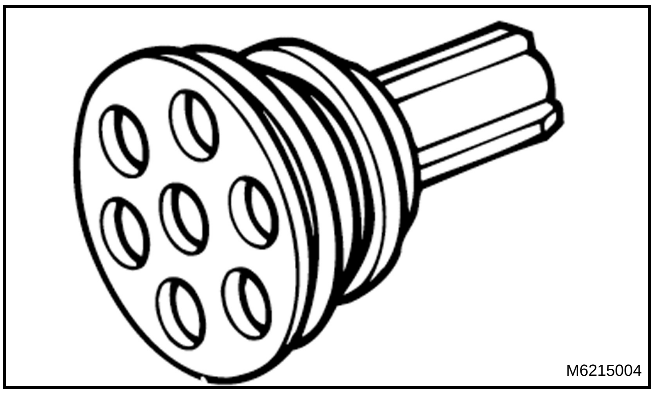

**FIG. 9**

## Regeneration Valve

**FIG. 10:** Regeneration valve controls regeneration of desiccant. Regeneration valve allows air from supply and secondary tanks to bypass outlet check valve. Air expands and backflushes moisture off of desiccant, then out through dryer purge valve.

Regeneration valve assembly kit contains two different diaphragms to service regeneration valve assembly for System Saver 1000, 1200, or 1800 air dryers. Use correct diaphragm for style of regeneration valve housing.

*IMPORTANT: Using incorrect part will result in unsatisfactory purging of desiccant cartridge and may result in excess water in air system.*

*IMPORTANT: Smooth diaphragm is used with smooth, cylindrical regeneration valve housing. The speckled/dotted diaphragm is used with finned/ribbed die cast housing. Only one diaphragm is used per assembly. DO NOT GREASE THE DIAPHRAGM.*

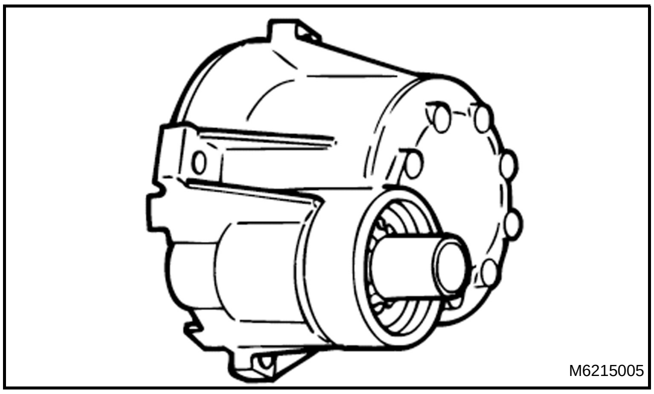

**FIG. 10**

Remove four mounting bolts and valve housing assembly. Spring and cap will fall out. Remove rubber diaphragm. Clean and inspect diaphragm lip groove. If groove is damaged so that a tight seal cannot be maintained, replace air dryer. Install new diaphragm with its lip in groove. DO NOT GREASE THE DIAPHRAGM.

Install new spring and cap with cap lip facing out. Install valve housing assembly with new lubricated O-ring and filter over orifice. Install new mounting bolts and tighten to 6 Nm (53 lbf in).

## Purge Valve

**FIG. 11:** Purge valve is located on bottom of air dryer. Purge valve remains open during a compressor unload cycle. Purge valve allows collected moisture, condensation, and contamination to be expelled from air dryer during purge cycle.

The purge opens by gouvenor when the pressure inside the tanks is to high. The pressure can be edit by adjusting the purge valve.

Use grease included with replacement kit to lubricate O-rings and seals. DO NOT grease rubber seat. If shims are included in replacement kit, they must be installed above and below spring. If they are not included, they are not needed. Remove snap ring, valve head and spring. Remove piston assembly from base. Remove washer and O-rings from base. Clean and inspect valve bore. If valve bore is damaged so that a tight seal cannot be maintained, replace air dryer. Apply a thin layer of grease to valve bore and to all O-rings. Install new washer and O-ring in dryer base and on valve head. Assemble piston assembly. Install O-ring in groove on piston head. Install piston seat in groove on piston base. Install washer on piston.

*NOTE: Lip on washer must face piston seat.*

Install spring in valve head; fit valve head assembly into bore and insert snap ring.

*NOTE: Make sure snap ring is fully seated or assembly will leak from purge valve.*

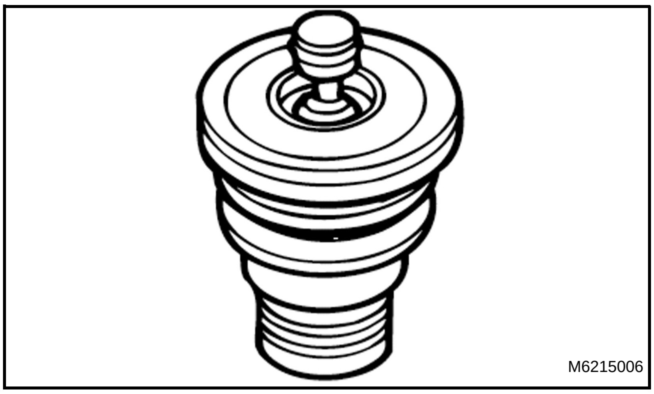


**FIG. 11**

NOTES

# AIR GOVERNOR

## THEORY OF OPERATION

The air governor is directly mounted to the air dryer and controls the opening of the purge valve when the air pressure in the tanks reaches 7,93 to 8,61 bar (115 to 125 psi). Then the purge valve should stay open until the air pressure falls to 6,55 to 7,23 bar (95 to 105 psi), when the purge valve should close to refill the tanks.

## AIR GOVERNOR REMOVAL

**WARNING: Remove all air pressure from the tanks before disconnecting any air hoses. Pressurized air can cause serious personal injury.**

**FIG. 1:** Mark and disconnect the air hose attached to elbow (1) on governor.

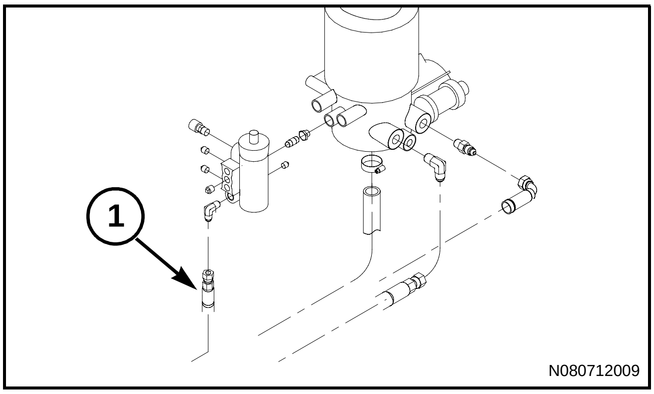


**FIG. 1**

**FIG. 2:** Unthread governor (1) from dryer (2) at coupler (3).

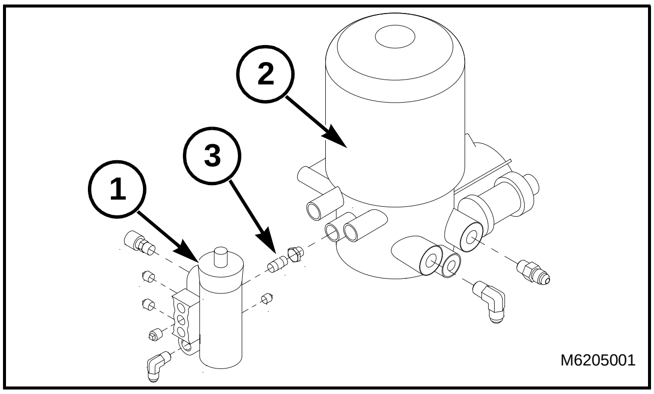


**FIG. 2**

## AIR GOVERNOR INSTALLATION

*NOTE: Use an approved thread locking compound on all plugs and fittings.*

**FIG. 3:** Install 1/8 NPT plugs in ports (B), (C), (D), and (E). Install breather in EXH port (1). Install elbow adapter in port (F).

Pressure adjusting cover (2) is on top of governor. Port-A (A) is where governor connects to air dryer.

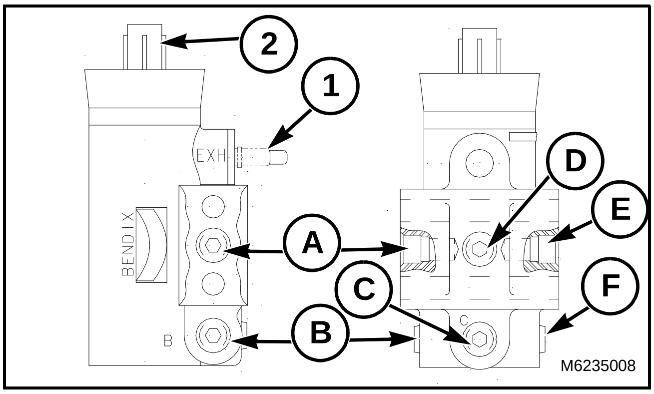


**FIG. 3**

**FIG. 4:** Install governor on to 1/8 pipe nipple (1) from port 4 on air dryer to port A with pressure adjusting cover (2) on top.

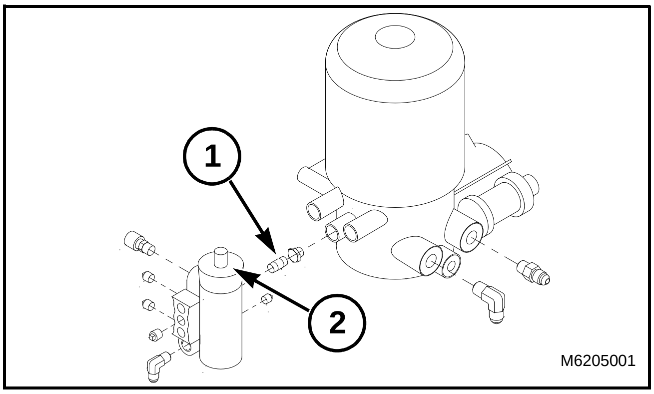


**FIG. 4**

**FIG. 5:** Mount air dryer/governor assembly in cabinet using three mounting bolts.

Reconnect air hose (1) from air tank to elbow on RES port.

Reconnect air hoses to air dryer (2).

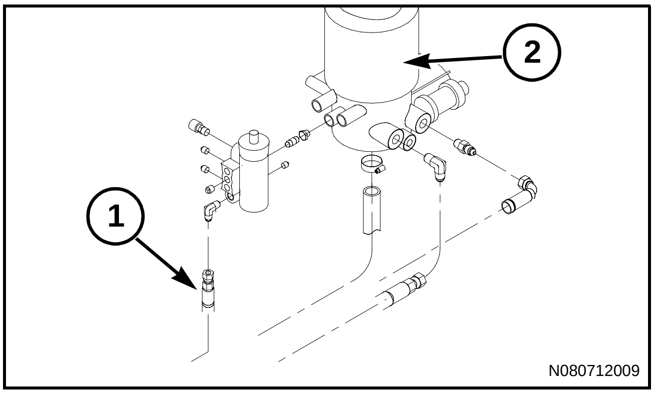


**FIG. 5**

# CAB AIR SUSPENSION

## THEORY OF OPERATION

The cab has air ride suspension. The air ride suspension has twin air bags that are filled with compressed air from the air system. A height control valve regulates the amount of air pressure in the air bags.

A lateral control rod keeps the cab located in the center of the machine while allowing the cab to move up and down. There are two shock absorbers that control the bounce of the cab.

The front of the cab is mounted in rubber bushings to allow the cab to move and pivot with the suspension.

**FIG. 1:** Cab air suspension (1) is located at the rear of the cab.

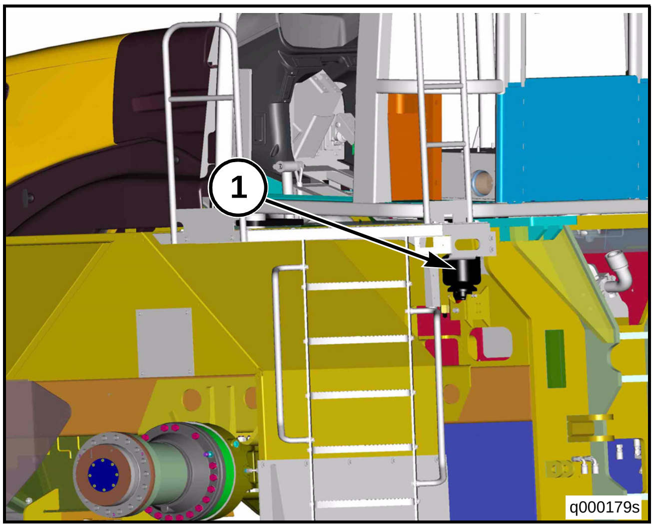


**FIG. 1**

## CAB AIR SUSPENSION REMOVAL

**FIG. 2:** Tip over the cab.

*IMPORTANT: Don't leave any loose obkects in the cabin which can cause any damage during tipping over the cabin.*

1. Remove side panels engine hood;
2. Take the lock pin with retainer out of his locking position underneath the can. And place the lock pin on the left platform, near the roatating point of the cabin;
3. Open the engine hood;

*IMPORTANT: Keep a clearence of 2 meter (80 inch) front of the vehicle.*

4. Close the knob on the handpump (CW);
5. Place pump lever in the pump and pump up the cab. While pumping up the cab suspension lock will be automatically opened for tipping over.
6. After tipping over the cab put in the lock pin with reatiner immediatly.

**DANGER: When the locking pin is not in position, nobody is allowed under the cab.**

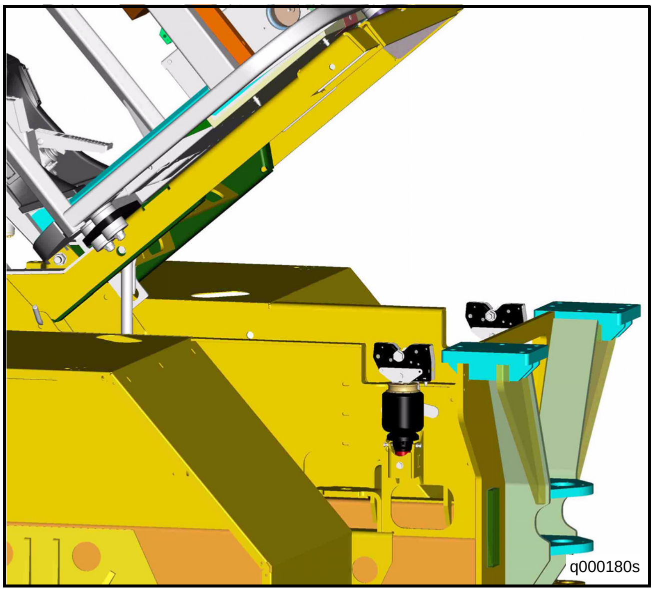


FIG. 2

**FIG. 3:** Mark and disconnect air line to height control valve.

**WARNING: Remove all air pressure from air system before disconnecting any air hoses. Pressurized air can cause serious personal injury.**

Loosen and remove the three bolts (1) holding the suspension to the chassis.

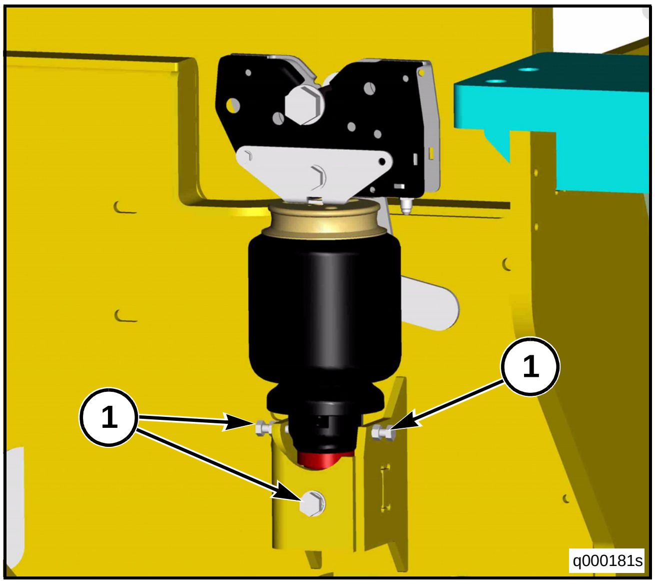


FIG. 3

## CAB AIR SUSPENSION INSTALLATION

**FIG. 4:** Place the suspension in the support on the chassis. Place and thighten the three bolts (1) holding the suspension to the chassis.

Connect air line to height control valve.

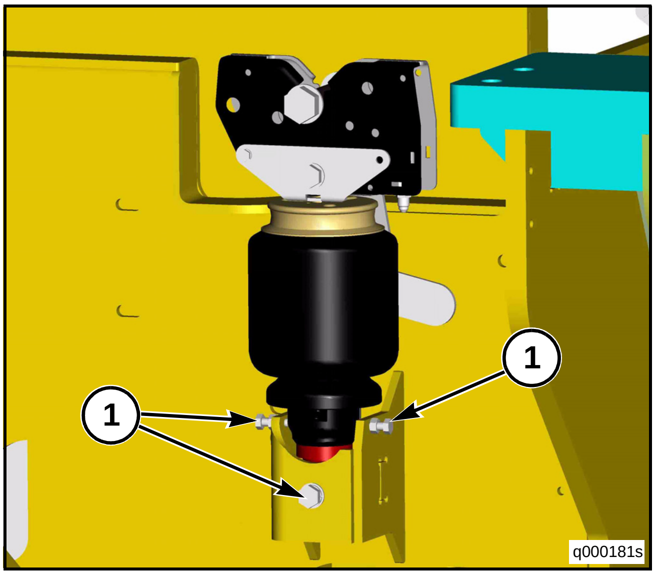


**FIG. 4**

**FIG. 5:** Lower the cab.

1. Remove the lock pin from it' locking position;

**DANGER: Make sure there's nobody under the cab.**

2. Open the knob (CCW) on the handpump, to depressurize the system. The cab will lower by its weight;

   The rear cab suspension will lock its self.

   Have the knob in the "open" position.
3. Restore the lock pin with retainer in his locking positon underneath the cab;
4. Remove the pump lever of the pump. Place the pump lever back to the storage compartment;
5. Close the engine hood;
6. Place back the side panels.

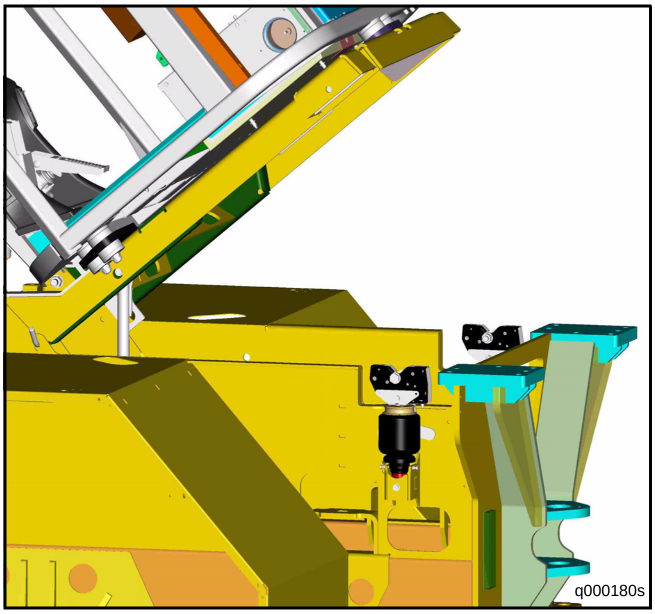


**FIG. 5**

## NOTES

# PNEUMATIC SCHEMATIC

## PNEUMATIC SCHEMATIC

This section shows the pneumatic schematic and the legend that describes the text and symbols used on the schematic.

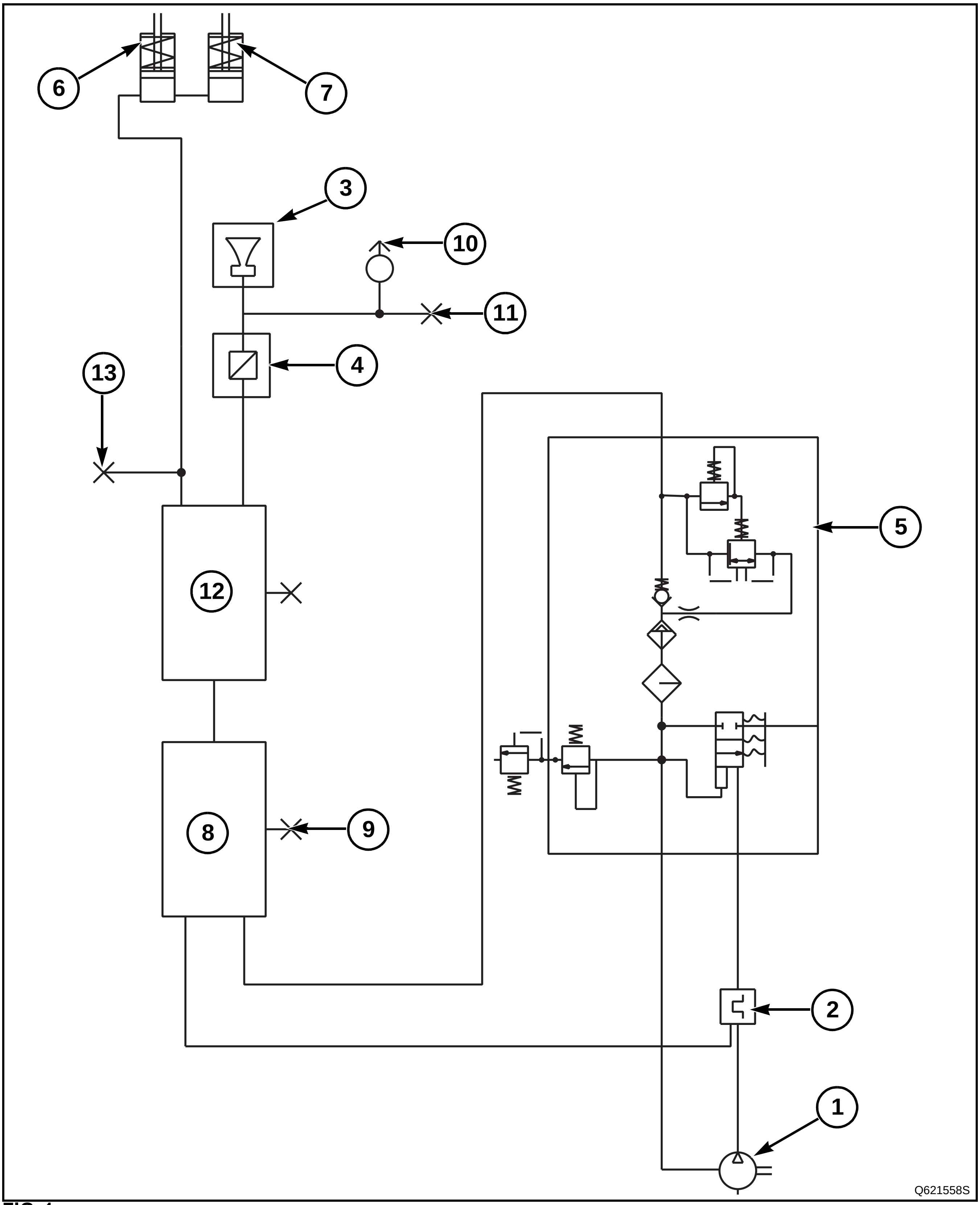


**FIG. 1**

## Pneumatic Schematic

The following callouts are indicated on the graphic.

(1) Compressor-Air;

(2) Governor-Air;

(3) Horn-Air (Europe);

(4) Valve Solenoid, 12 Volt;

(5) Dryer Air;

(6) Cylinder Cab Supension;

(7) Cylinder Cab Supension;

(8) Resevoir Air (Wet);

(9) Valve Drain;

(10) Coupler (Coupler in RH corner cab);

(11) Adapter (Stop in RH corner cab;

(12) Resevoir Air (Dry);

(13) Adapter (System Bulkhead Plate)

# INDEX

## A



## C



## D



## H



## O



## P



## R



## T



## W

**NOTES**