Rexroth
Bosch Group

Application Software Dual Path Control DPC

RE 95 325/03.04

Version 10

Electronic drive control for dual path drives

Contents

Features

The electronic dual path control system is an easily adaptable software package for the drive management of reversible dual path drives.

The dual path control system is available in three variants:

– **Variant A** for tracked vehicles (DPCA)

– **Variant B** for pavers (DPCB)

Variant B offers an automatic steering function.

– **Variant C** for pavers (DPCC)

Variant C offers additional tamper and vibration functions.

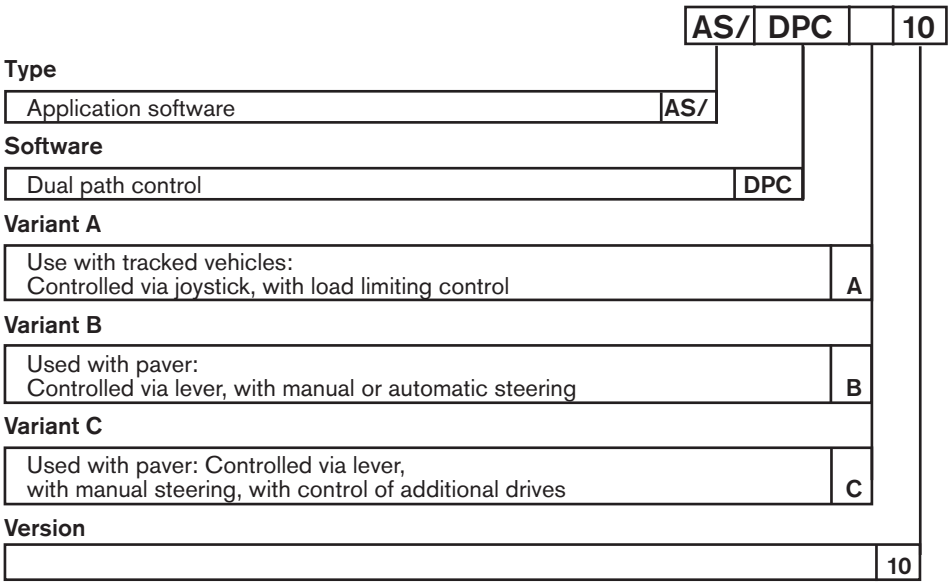
The dual path control system is designed for use with Rexroth hydraulic pumps and motors.

The dual path control system can easily be adapted by the user for different configurations of pumps, internal combustion engines, sensors or instruments, by altering the parameters.

The dual path control system is suitable for diesel engines with or without a CAN bus interface (protocol SAE J1939).

Diagnostics and parameter setting are carried out with BODEM PC software or the BB-3 control panel.

Ordering Code



Ordering Information

The application software AS/DPC must only be used with the control unit RC6-9/20 and other add-on components (variant A see page 7, variant B/C see page 16). When ordering, link the ordering codes of hardware and software with a "+" symbol.

For example: RC6-9/20+AS/DPCA10

Note

You can find a description of variant B/C on page 7.

Variant DPCA

The electronic dual path control system DPCA allows you to control the driving and steering behavior of hydraulic dual path drives of tracked vehicles.

The electronic dual path control system is designed to actuate two variable displacement pumps and two variable displacement motors in a closed circuit.

Control is based on the following hydraulic configuration:

- Two variable displacement pumps A4VG or A10VG with electro-proportional (EP) control, combined with two variable displacement motors A6VM, A6VE or A10VM with electro-proportional (EP) control

The following diesel engine configuration can be used:

- Diesel engine with or without CAN bus interface

  The dual path control system receives the actual speed from a speed sensor and the set speed from the throttle potentiometer. The DPCA variant does not evaluate the CAN bus.

Functional Description

The swivel angles of two hydraulic variable displacement pumps and two hydraulic variable displacement motors in the closed circuit with electro-proportional control are varied in order to control the driving and steering behavior.

One pump and one motor are assigned to each side of the vehicle. Steering is achieved by controlling the pumps differently.

The output torque depends on the swivel angle of the motors. At the minimum swivel angle, the speed is highest and the output torque is lowest.

A synchronization control and a load limiting control are available for controlling the driving and steering behavior.

In addition, the travel behavior can be monitored to increase safety and drive comfort.

Assignment Setpoint

A two-axis joystick is used to define the direction and speed of travel and the steering direction.

Setting is carried out redundantly:

- electronically with an analog value
- and in parallel via the CAN bus

The dual path control system checks to ensure that the values correspond. If there is too great a difference between the analog value and the value sent via the CAN bus, an error message appears.

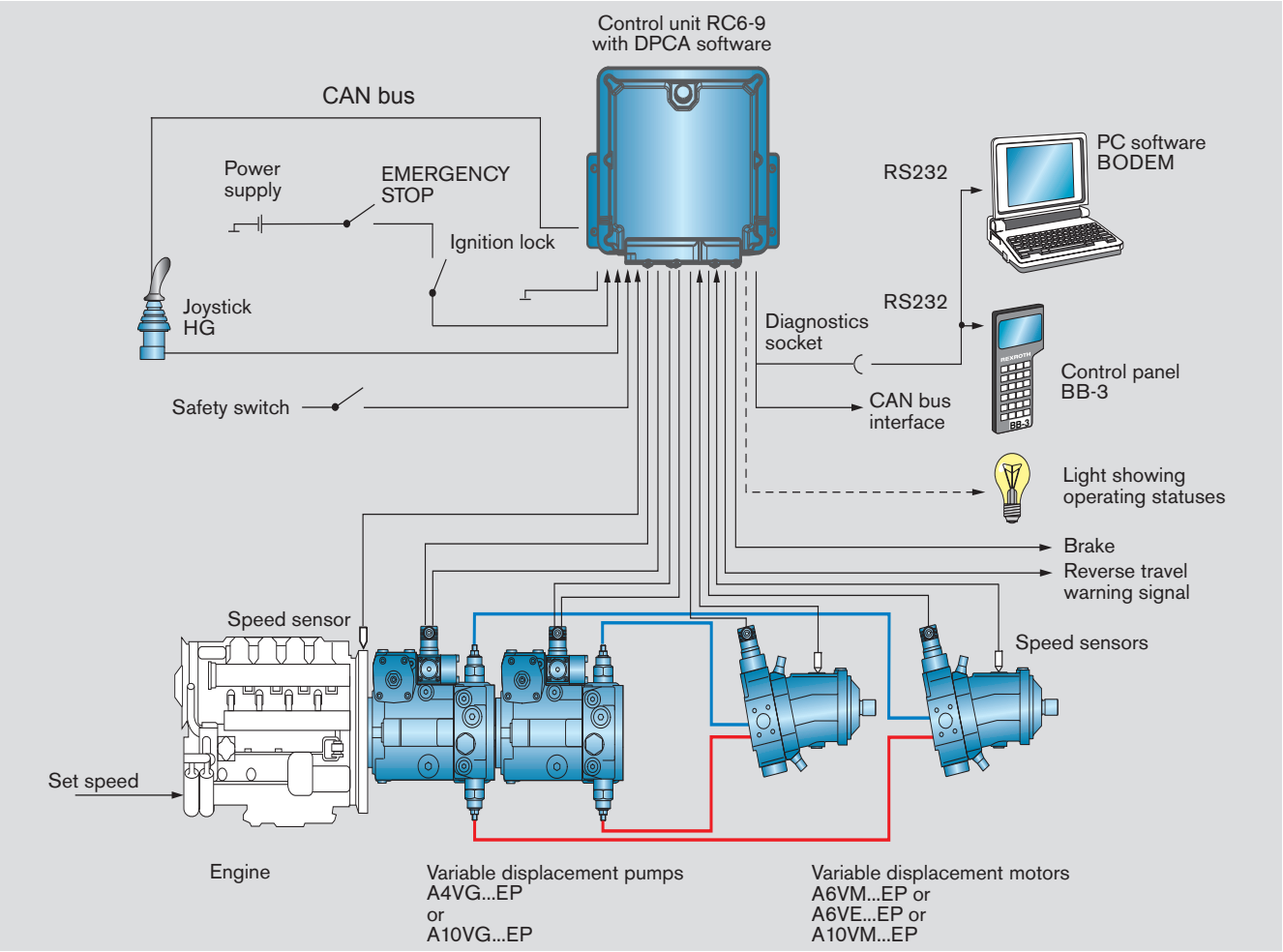


Figure 1: Typical configuration for DPCA

Travel Behavior

Travel behavior is controlled by two variables:

- The setpoint is defined with the joystick.
- The acceleration behavior is defined by time ramps. These variable time ramps determine how quickly the actuation at the PWM output is altered.

The joystick is in the neutral position in terms of travel direction (forwards or backwards) and steering direction (left or right), if it is positioned within a user-definable range around the zero position. This range is called the dead band. The dead band can be set for both deflection directions separately.

When the joystick is in the neutral position, the PWM outputs for the forwards and backwards travel directions for actuating the proportional solenoids of the left and right pumps are turned off.

If the joystick is moved forwards or backwards to a position outside the dead band, the current at the relevant PWM outputs (for forwards or backwards travel direction) increases according to the position of the joystick and the chosen time ramp. The corresponding proportional solenoids of the left and right pumps are actuated. The park brake is released.

Two pushbuttons are incorporated into the joystick. When deflecting the joystick, these pushbuttons can also be used for very fine stepwise increase or reduction of the maximum travel speed. Pressing the button changes the speed range which corresponds to full deflection of the joystick.

When the joystick is returned to the neutral position, the park brake is activated after a user-definable period.

When the travel direction is changed, the park brake is not activated. Deceleration and acceleration for the change of travel direction are determined by a common, adjustable time ramp.

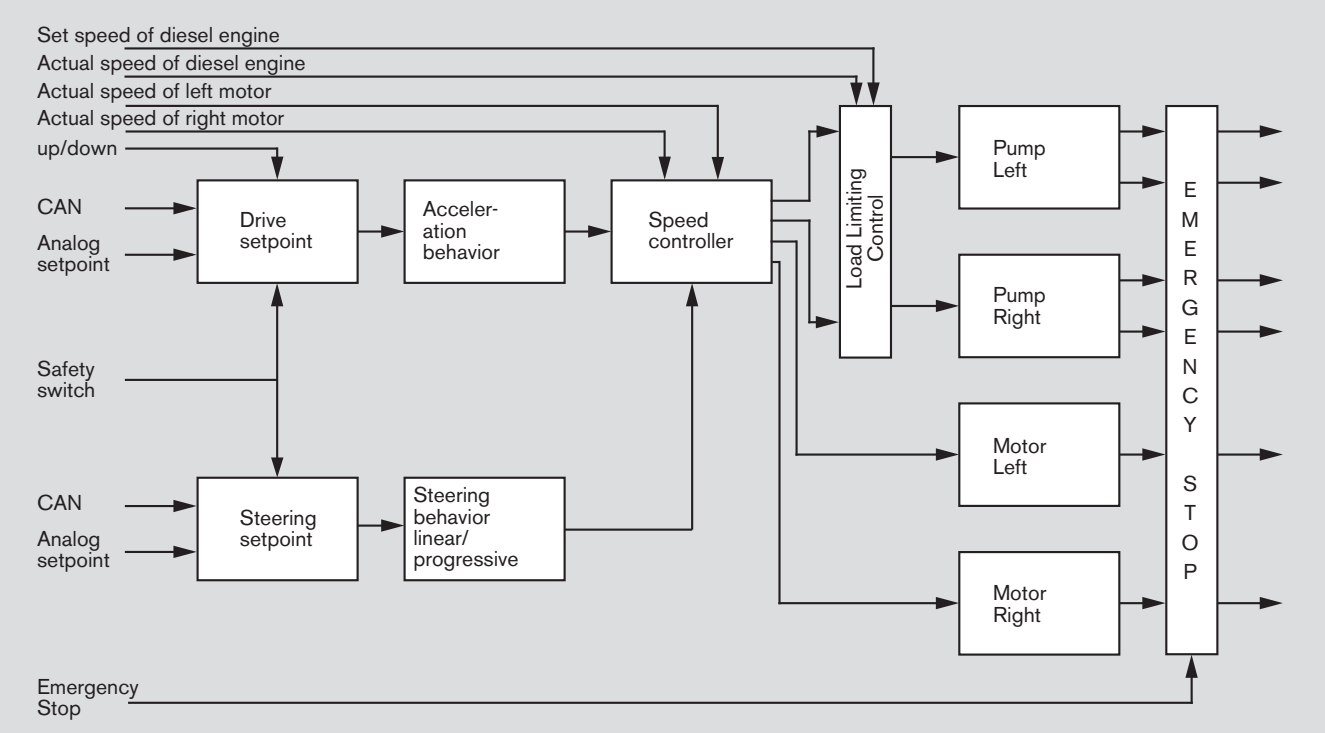


Figure 2: Dual path control DPCA: How it works

Additional Functions

During the commissioning of the vehicle, three different functions can also be activated to facilitate control of the travel behavior:

- Setpoint repeat function

  The setpoint repeat function determines the way in which the maximum travel speed is increased or reduced step by step using the pushbuttons in the joystick.

  When the setpoint repeat function is switched on, the travel setpoint is increased or reduced constantly as long as the corresponding button is pressed.

  When the setpoint repeat function is switched off, the travel setpoint is increased or reduced once every time the corresponding button is pressed.

- Load Limiting Control

  The load limiting control prevents overload of the diesel engine when the demanded hydraulic power is increased, when negotiating a steep ramp, for example.

  It does this by comparing the current speed drop of the diesel engine with a definable limit value. If this value is exceeded, the load limiting controller intervenes and reduces the demanded pump outputs.

- Synchronization control for controlled straight line driving

  The speed ratio of the left and right drives determined by the steering angle setpoint is kept constant by the synchronization control. This is achieved through the use of sensors which detect the actual speeds of the left and right hydraulic motors.

Steering Behavior

Steering behavior is controlled by two variables:

- The steering direction is determined by the joystick.
- The steering behavior, that is to say, the reaction to a change in the steering direction, is determined by the actuation of the PWM outputs and by a modifiable curve. Five curves are available, from linear to maximum progressive.

The joystick is in the neutral position in terms of travel direction (forwards or backwards) and steering direction (left or right), if it is positioned within a user-definable range around the zero position. This range is called the dead band. The dead band can be set for both deflection directions separately.

When the joystick is in the neutral position, the PWM outputs for the forwards and backwards travel directions for actuating the proportional solenoids of the left and right pumps are turned off.

If the joystick is moved sideways to a position outside the dead band, the current at the relevant PWM outputs (for forwards or backwards travel direction) changes according to the deflection direction (left or right) of the joystick and the selected curve. The corresponding proportional solenoids of the left and right pumps are actuated.

If the joystick is moved sideways beyond a point at which resistance can be felt, this causes the drives to run in opposite directions, to achieve the smallest possible turning radius. The point at which this resistance can be felt can be set for all deflection directions of the joystick separately.

The steering function has priority over the travel setpoint. Therefore, with maximum travel setpoint and simultaneous steering, the travel speed is reduced due to braking of the drive on the inside of the curve.

Safety Functions

Various options are available for monitoring travel behavior:

- Start condition and safety switch

  The start condition is used to prevent the drive from starting unintentionally.

  After the control unit is switched on (ignition switch turned on), the joystick must be in the neutral position in order for the drive to be started.

  To acknowledge faults, the joystick must be placed in the neutral position.

  An additional, external safety switch must be operated in order to travel.

- Monitoring of inputs and outputs

  The wires for the setpoint inputs and proportional solenoid outputs are monitored for cable breaks and short-circuit.

  In the event of a fault, or if the emergency stop switch is operated, the drive is turned off immediately.

  During backwards travel, a warning device is actuated via a switching output.

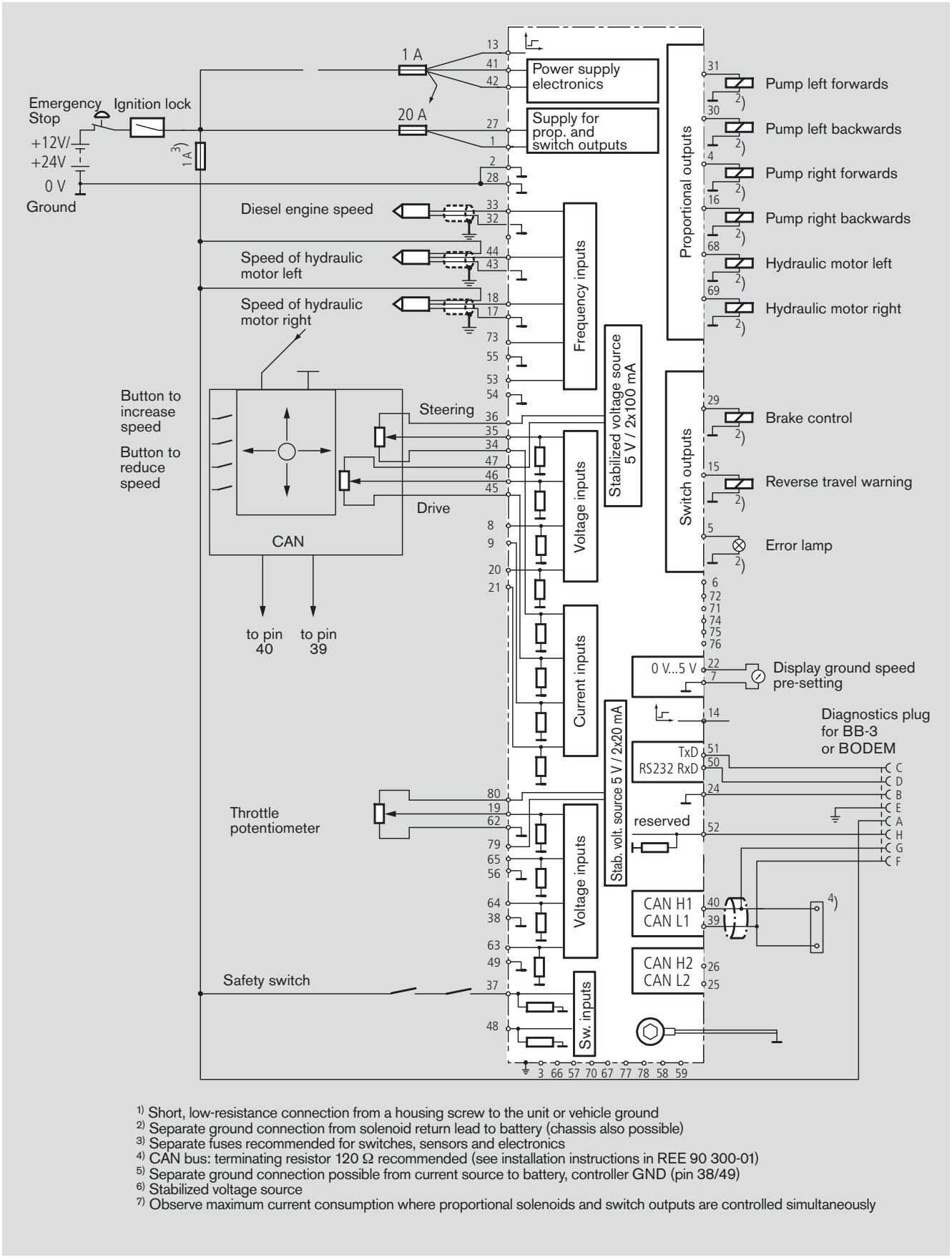
Important Features

- The setpoints for travel speed, travel direction and steering are defined by means of a joystick.
- An integrated synchronization control for controlled straight line driving keeps the speed ratio of the left and right drives constant.
- An integrated load limiting control prevents overload of the diesel engine when the hydraulic power is increased.
- There is an integral operating hours meter.
- During backwards travel, a reverse travel warning device is actuated.
- A brake control is integrated.
- The travel behavior is monitored by safety functions such as start condition and an external safety switch.
- The inputs and outputs of the control units (such as the joystick and accelerator pedal) are monitored (for cable breaks, short circuit). In the event of a fault, or if the emergency stop switch is operated, the drive is stopped immediately.
- Any faults that occur are logged in the control unit and can be read later using the BODEM diagnostic tool or BB-3 in plain text.

Main Parameters

- Diesel engine data (set speed and actual speed via sensor, number of teeth on starter ring gear)
- Potentiometer for set speed of diesel engine
- Joystick for travel direction and steering (dead band, acceleration behavior, steering behavior, braking parameters)
- Configuration (load limiting control, synchronization control, setpoint repeat function)
- Minimum and maximum magnet current for pumps forwards and backwards as well as hydraulic motors

DPCA Connection Diagram



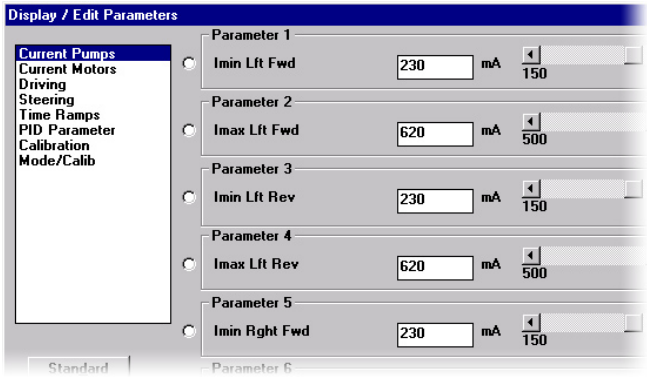
1) Short, low-resistance connection from a housing screw to the unit or vehicle ground
2) Separate ground connection from solenoid return lead to battery (chassis also possible)
3) Separate fuses recommended for switches, sensors and electronics
4) CAN bus: terminating resistor 120 Ω recommended (see installation instructions in REE 90 300-01)
5) Separate ground connection possible from current source to battery, controller GND (pin 38/49)
6) Stabilized voltage source
7) Observe maximum current consumption where proportional solenoids and switch outputs are controlled simultaneously

Figure 3: Inputs and outputs on the control unit for DPCA

Parameter Setting and Diagnostics

The parameters which have to be set for commissioning the DPCA dual path control system can easily be adjusted with the BODEM PC software.

For fault diagnosis and troubleshooting, the main process variables and error messages can be displayed with BODEM.



Instead of BODEM, you can also use the BB-3 control panel for defining parameters and diagnostics.

Components Required

The following electronic components are are required:

- RC6-9/20 control unit with mating connector (RE 95200)
- AS/DPCA software, Version 10
- HG405GF/11-S joystick
- IDR speed sensor (RE 95130) with mating connector
- HDD speed sensors (RE 95135) with mating connectors
- WS1 angle sensor (RE 95140) with mating connector
- Switch for external start release

The following hydraulic components are required:

- Variable displacement pumps with appropriate control unit
  A4VG…EP (RE 92003) or
  A10VG…EP (RE 92750)
- Variable displacement motors with appropriate control unit
  A6VM…EP (RE 91604) or
  A6VE…EP (RE 91606) or
  A10VM…EP (RE 91703)

The following items are required for commissioning and service:

- Diagnostics socket (RE 95085)
- BODEM PC software with BODEM connecting cable (RE 95085), or
- BB-3 control panel with BB-3 connecting cable (RE 29798 and RE 95080)

Variant DPCB/C

The electronic dual path control system DPCB/C allows you to control the driving and steering behavior of hydraulic dual path drives of pavers.

Variants B and **C** use the same hydraulic configuration for controlling.

Variant B:

- Two variable displacement pumps A4VG or A10VG with electro-proportional (EP) control, combined with two variable displacement motors A6VM, A6VE or A10VM with electrical two-point actuation (EZ) for the travel drive

Variant C:

- Two variable displacement pumps A4VG or A10VG with electro-proportional (EP) control, combined with two variable displacement motors A6VM, A6VE or A10VM with electrical two-point actuation (EZ) for the travel drive
- Two variable displacement pumps A4VG or A10VG with electro-proportional (EP) control for the additional functions

The following diesel engine configuration can be used:

- Diesel engine with or without CAN bus interface

  The dual path control system receives the actual speed from the speed sensors of the two hydraulic motors and the set speed from the speed potentiometer (diesel engine speed is not detected). The DPCB and DPCC variants do not evaluate the CAN bus.

Functional Description

The swivel angles of two hydraulic variable displacement pumps and two hydraulic variable displacement motors in the closed circuit are varied in order to control the driving and steering behavior.

One pump and one motor are assigned to each side of the vehicle. Steering is achieved by controlling the pumps differently.

Either transport or working speed can be selected by switching the displacement of the variable displacement motors to one of two values (minimum and maximum).

With **variant B,** the dual path control system offers automatic steering.

With **variant C**, two additional functions, tamper and vibration, are available. Two additional variable displacement pumps are actuated for this purpose.

Speed and steering regulation are available for controlling the driving and steering behavior.

Assignment Setpoint

The travel speed is defined by the deflection of the lever.

The travel direction is defined by means of direction switches (forwards and backwards). These direction switches can either be integrated into the lever or built into the vehicle as a separate switch.

The steering direction is defined separately by a steering potentiometer.

The maximum travel speed can be limited over a continuously variable range by means of a potentiometer.

Travel Behavior

Travel behavior is controlled by three variables.

- The set speed is defined by the deflection of the lever.
- The travel direction is defined by the direction switch.
- The acceleration behavior is defined by time ramps. These variable time ramps determine how quickly the actuation at the PWM output is altered.

If the lever is in the neutral position, the proportional solenoids of the pumps (left and right, for both travel directions) are not actuated by the lever. However, they can be actuated by the steering potentiometer and the slip steering switch. This allows steering on the spot.

If the lever is moved to a position outside the zero position, the current at the relevant PWM outputs increases (for travel direction forwards or backwards, depending on the direction switches) according to the position of the lever and the set time ramp. The corresponding proportional solenoids of the left and right pumps are actuated. The park brake is released.

When the lever is returned to the neutral position, the park brake is activated after a user-definable period.

When the travel direction is changed, the park brake is not activated.

Travel Behavior Modes

There are two modes of travel behavior:

- Transport mode

  The travel speed is defined only by the deflection of the lever.

  Steering and speed regulation are not active.

  The acceleration and deceleration times can be set separately for both travel directions.

- Work mode

  The travel speed is defined by the deflection of the lever and kept constant by the speed regulation.

  The maximum travel speed can be limited over a continuously variable range by means of a speed limiting potentiometer.

  The vehicle can be halted with the stop/go switch, without changing the deflection of the lever. In that way, after the halt, travel can continue at the same speed.

A switch on the vehicle is used to switch between the two travel behavior modes.

Switching between the modes causes the motor displacement to change. This is only possible with the vehicle at a standstill.

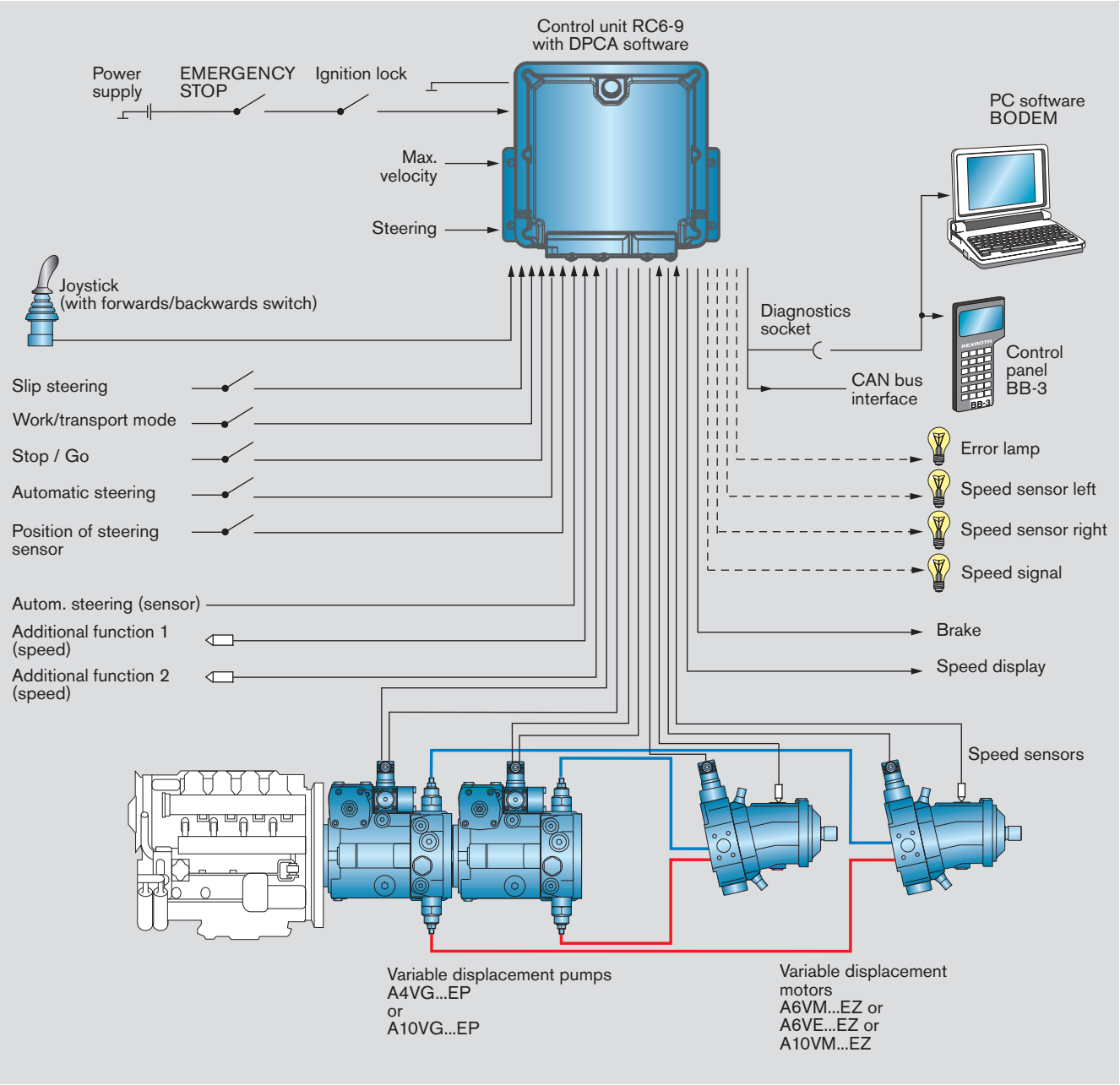


Figure 4: Typical configuration for DPCB

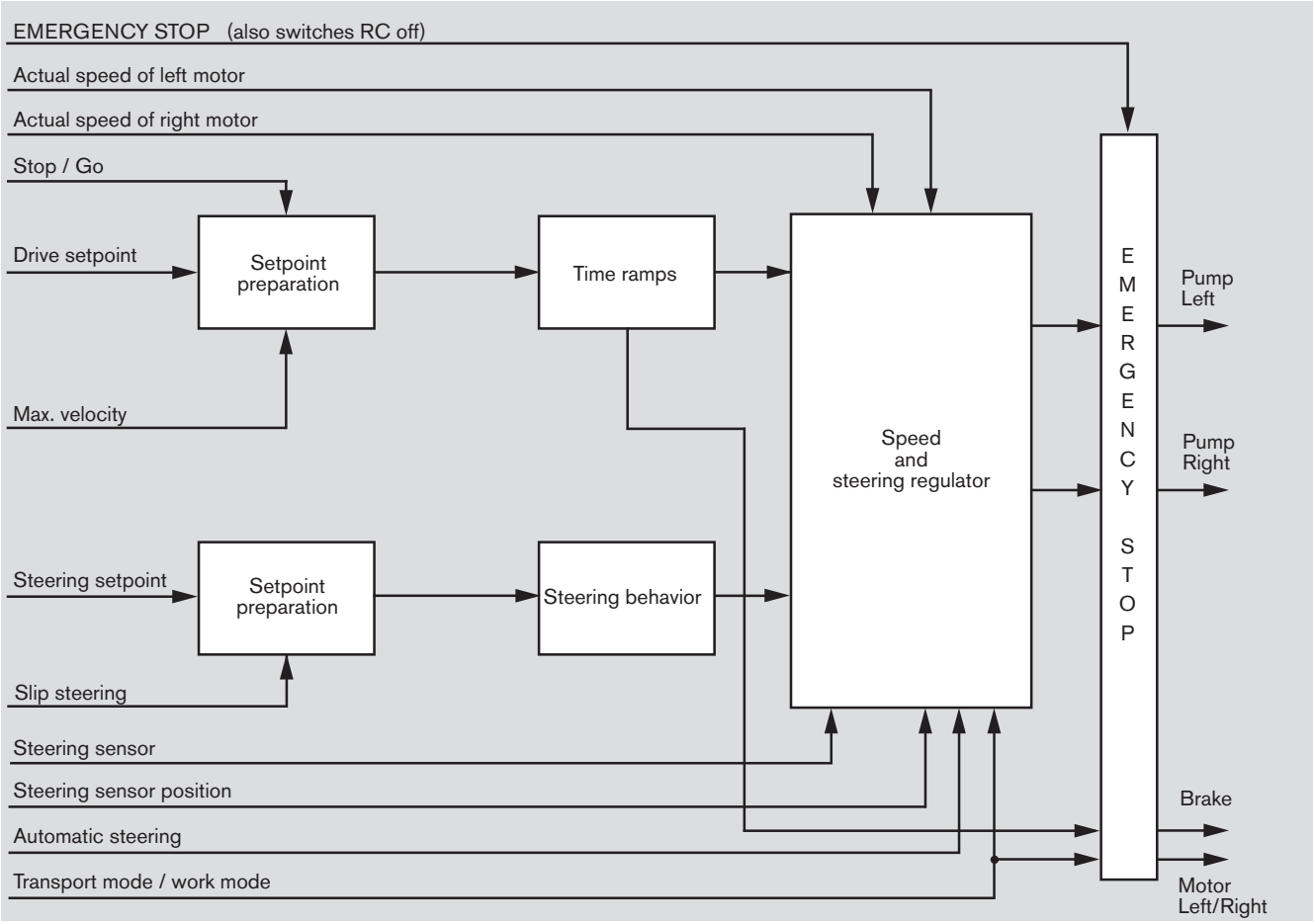


Figure 5: Dual path control DPCB: How it works

Steering Behavior

Steering behavior is controlled by two variables:

- The steering direction and the setpoint are defined by the steering potentiometer.
- The control of the PWM outputs for the specified setpoint is defined on the basis of a variable steering behavior curve. Four curves are available (linear, hard, medium, soft).

The steering potentiometer is in the neutral position if it is positioned within a user-definable range around the zero position (dead band).

The steering angle is set when the steering potentiometer is moved to a position outside the dead band. The actual current at the PWM outputs changes depending on the deflection of the lever and the selected curve. The corresponding proportional solenoids of the left and right pumps are actuated.

Setting the drives to slip steering, so as to achieve the smallest possible turning radius, can only be done with the vehicle at a standstill. Slip steering is turned on and off by a switch on the vehicle.

Steering Regulation

During the commissioning of the vehicle, steering regulation can be activated to make it easier to control the steering behavior.

The setpoint defined with the steering potentiometer determines the steering angle. The steering function is realized by having the hydraulic motors run at different speeds. The steering regulation governs the speed ratio of the left and right hydraulic motors, in such a way that the defined steering angle is set. To achieve this, the actual speeds of the left and right hydraulic motors are detected separately by sensors.

Automatic Steering

For **variant B**, automatic steering can be activated by operating a switch on the vehicle.

Automatic steering can only be activated in work mode.

When automatic steering is switched on, the vehicle is steered automatically via a steering sensor.

Another switch on the vehicle indicates whether the sensor is mounted on the left or right side of the vehicle.

Tamper/Vibration

For **variant C**, two additional functions are available, namely tamper and vibration. These can be used, for example, when compacting construction material with a paver. Two additional drives are actuated for this purpose.

The two additional functions are activated together by means of a switch on the vehicle. They can be operated separately from one another, by activating them individually when putting the vehicle into operation.

In each case the setpoint is defined with a potentiometer. The acceleration times can be set for each of the two additional functions separately.

The current speed of the additional drives can be detected via speed sensors and shown on the connected display.

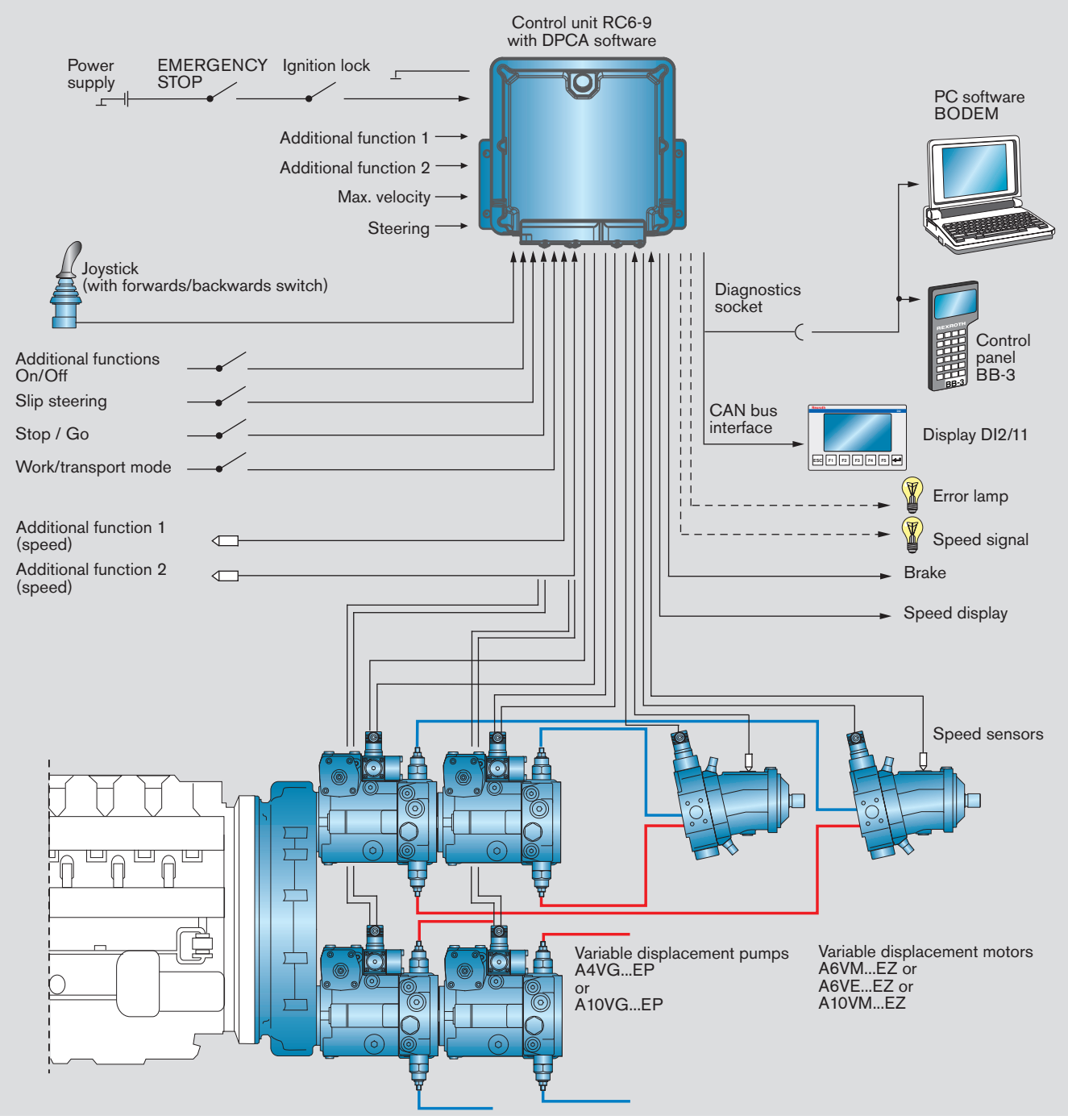


Figure 6: Typical configuration for DPCC

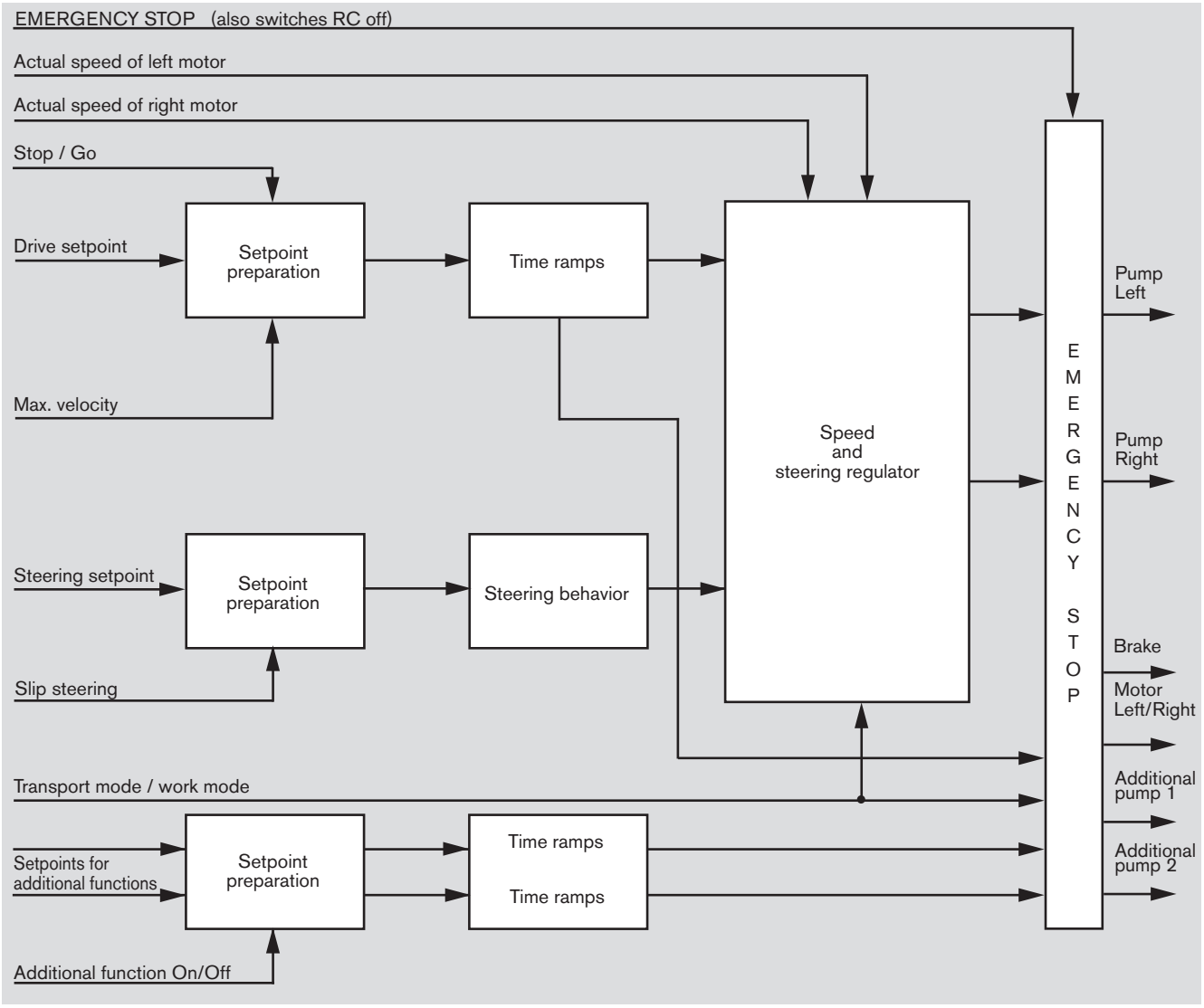


Figure 7: Dual path control DPCC: How it works

Display

For **variant C**, a display can be connected for calibration of the dual path control system and for diagnostics. The process variables and error messages are sent to the display via the CAN bus.

Either DI2/11 or OPUS+ can be used for the display. The used display must be selected in the parameters. Rexroth recommends use of the DI2/11 display, since it is more user-friendly and has more functions.

Safety functions

Various options are available for monitoring travel behavior:

- Start condition

  The start condition is used to prevent the drive from starting unintentionally.

  After the control unit is switched on (ignition switch turned on), the lever (the direction switches) must be in the neutral position and slip steering must be switched off in order for the drive to be started.

  To acknowledge faults, the lever must be placed in the neutral position.

- Monitoring of inputs and outputs

  The wires of the proportional solenoid outputs and of the steering and speed potentiometers are monitored for cable breaks and short circuit.

  In the event of a fault, only the safety critical parts are switched off.

Important Features

- The travel speed setpoint is defined via a lever.
- The steering setpoint is defined separately via a steering potentiometer.
- By deflecting the steering potentiometer with the lever in the neutral position, it is possible to steer on the spot.
- To define the travel behavior, either transport mode or work mode can be selected.
- Speed regulation for controlled straight line driving is built in.
- **Variant B** only: The vehicle can be steered automatically via a steering sensor.
- A brake control is integrated.
- For the travel speed, an analog actual value (0-5 V) can be detected.
- Automatic calibration of both drives allows compensation of hydraulic differences.
- **Variant C** only: Additional tamper and vibration functions can be actuated via proportional outputs
- Travel behavior is monitored by different safety functions.
- The steering and speed potentiometers are monitored for cable breaks and short circuit.
- The inputs and outputs of the control unit are monitored (cable breaks, short circuit). In the event of a fault or if the emergency stop switch is operated, the drive is stopped immediately.
- Faults can very easily be indicated by the connected error lamp.
- **Variant C** only: All errors can be output via the CAN bus interface to the DI2/11 display.
- Any faults that occur are logged in the control unit and can be read later on with BODEM or BB-3 in plain text.

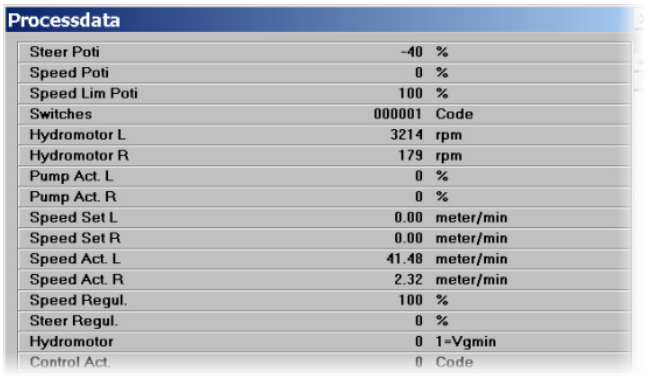
Main Parameters

- Potentiometer for steering (dead band, steering behavior)
- Lever for travel direction (dead band, acceleration behavior, braking parameters)
- Configuration (speed regulation, speed display, speed pulses in hydraulic motor, automatic calibration of minimum currents for controlling the pumps)
- Minimum and maximum magnet current for pumps forwards and backwards
- **Variant B** only: Configuration of automatic steering
- **Variant C** only: Potentiometer for additional functions (time ramps)
- **Variant C** only: Minimum and maximum magnet current for the additional functions

Parameter Setting and Diagnostics

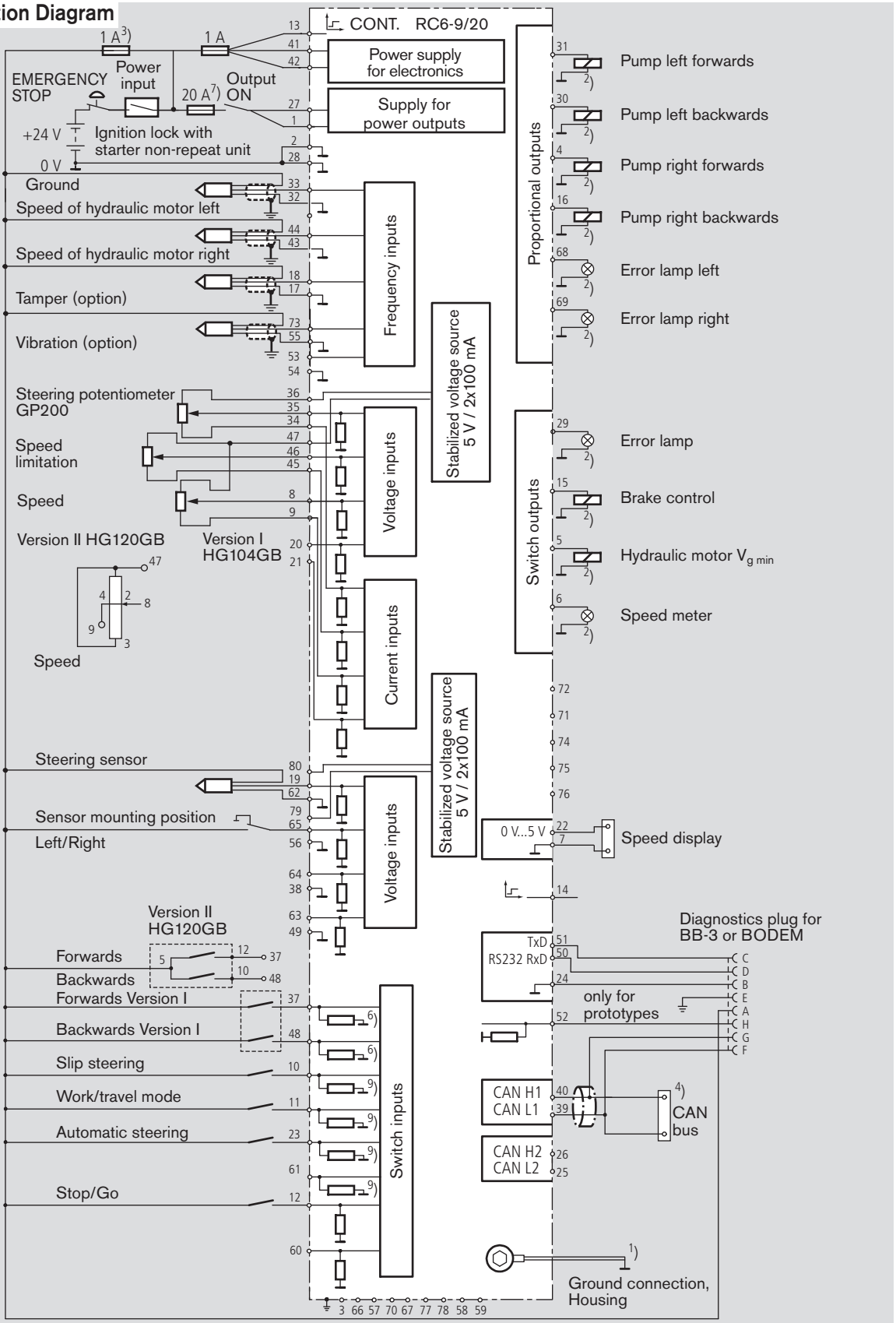
The parameters which have to be set for commissioning the DPCB/C dual path control system can easily be adjusted with the BODEM PC software

For diagnosis and troubleshooting, you can display the main process variables and error messages with BODEM.



Instead of BODEM, you can also use the BB-3 control panel for defining parameters and diagnostics.

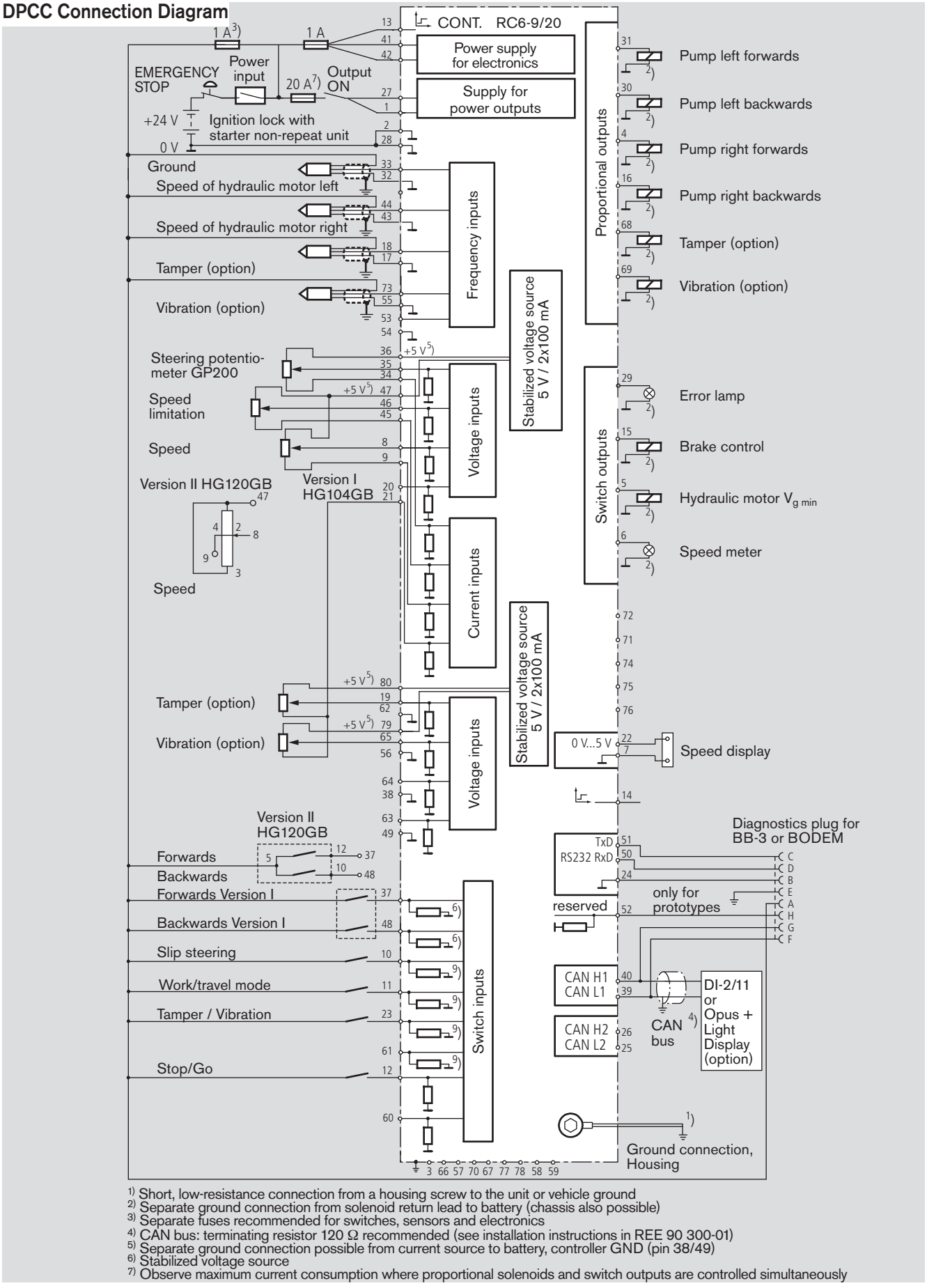
DPCB Connection Diagram



1) Short, low-resistance connection from a housing screw to the unit or vehicle ground
2) Separate ground connection from solenoid return lead to battery (chassis also possible)
3) Separate fuses recommended for switches, sensors and electronics
4) CAN bus: terminating resistor 120 Ω recommended (see installation instructions in REE 90 300-01)
5) Separate ground connection possible from current source to battery, controller GND (pin 38/49)
6) Stabilized voltage source
7) Observe maximum current consumption where proportional solenoids and switch outputs are controlled simultaneously

Figure 8: Inputs and outputs on the DPCB control unit

DPCC Connection Diagram



1) Short, low-resistance connection from a housing screw to the unit or vehicle ground
2) Separate ground connection from solenoid return lead to battery (chassis also possible)
3) Separate fuses recommended for switches, sensors and electronics
4) CAN bus: terminating resistor 120 Ω recommended (see installation instructions in REE 90 300-01)
5) Separate ground connection possible from current source to battery, controller GND (pin 38/49)
6) Stabilized voltage source
7) Observe maximum current consumption where proportional solenoids and switch outputs are controlled simultaneously

Figure 9: Inputs and outputs on the DPCC control unit

Components Required

The following electronic components are required:

- RC6-9/20 control unit with mating connector (RE 95200)
- AS/DPCB software, Version 10 or
  AS/DPCC software, Version 10
- HG104 joystick (RE 95041) with direction switches
- GP200 steering potentiometer
- HDD speed sensors (RE 95135) with mating connectors
- WS1 angle sensor (RE 95140) with mating connector
- Switch for slip steering
- Switch for selecting travel behavior modes
- Emergency stop switch

The following electronic components can be used:

- Potentiometer (1-5 kOhm) for limiting the maximum travel speed
- Speed sensor IDR (RE 95130) with mating connector for displaying two external speeds (**variant B**) or speeds of the additional functions (**variant C**)
- Stop/Go switch
- **Variant B** only: Angle sensor WS1 (RE 95140) with mating connector as steering sensor
- **Variant B** only: Switch for automatic steering
- **Variant B** only: Switch for mounting position of steering sensor
- **Variant C** only: Potentiometer (1-5 kOhm) for assignment setpoint for additional functions
- **Variant C** only: Switch for additional functions
- **Variant C** only**:** Display DI2/11 (RE 95089) for defining parameters and diagnosis

The following hydraulic components are required:

- Variable displacement pump with suitable control device
  A4VG…EP (RE 92003) or
  A10VG…EP (RE 92750)
- Variable displacement motor with suitable control device
  A6VM…EZ (RE 91604) or
  A6VE…EZ (RE 91606) or
  A10VM…EZ (RE 91703)
- **Variant C** only (additional functions):
  Variable displacement pump with suitable control device
  A4VG…EP (RE 92003) or
  A10VG…EP (RE 92750)

The following items are required for commissioning and service:

- Diagnostics socket (RE 95085)
- BODEM PC software with BODEM connecting cable (RE 95085)
- BB-3 control panel with BB-3 connecting cable (RE 29798 and RE 95080)

Safety Instructions

- The suggested circuits do not imply any technical liability of Rexroth for the system.
- The safety instructions in RE 90301-01-B must be observed.
- Leads for speed sensors must be shielded. The shield must be connected to the electronics on one side or to the machine or vehicle ground via a low-resistance connection.
- Cables to the electronics must not be routed close to other power-conducting cables in the machine or vehicle.
- Sufficient distance from radio systems must be maintained.
- All connectors must be unplugged from the electronics during electrical welding operations.
- The electronics may only be tested with the proportional solenoids connected.
- The proportional solenoids must not be connected to spark suppression diodes.
  Switching solenoids at the outputs of the RC control unit need not be connected to spark suppression diodes.
  Other inductive loads that are in the system but not connected to the RC must be connected to spark suppression diodes.
- In order to preserve the warranty, any installation or replacement of the RC software (flash EPROM) must be performed by Rexroth personnel.
- Follow the user manuals RE 95325-B (**DPCA**) and RE 95326-B (**DPCB/C**).

Bosch Rexroth AG
Mobile Hydraulics
Product Unit Mobile Electronics
Elchingen Plant
Glockeraustrasse 2
89275 Elchingen, Germany
Phone +49 (0) 73 08 82-0
Facsimile +49 (0) 73 08 72 74
info.brm-me@boschrexroth.de
www.boschrexroth.com/brm