

# Installation and setup manual

## Electro-hydraulic control for PV series

Design series  $\geq 40$ , *PVplus*

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### Variable displacement axial piston pump



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# Setup manual for electro hydraulic proportional controls for axial piston pumps, PV series

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**Note:** the compensator / control ordering codes shown represent the last three digits in the pump ordering code (digits 13 to 15).

## Note

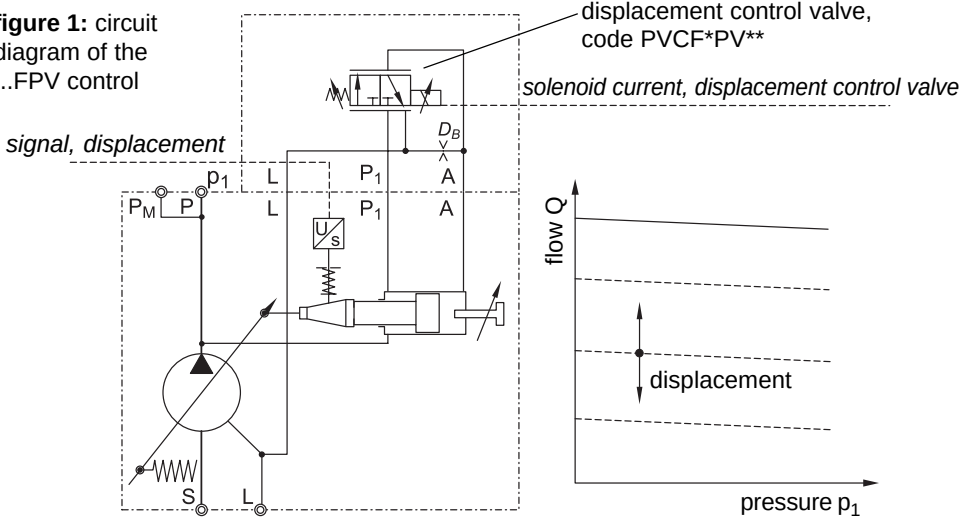
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### 1. Proportional displacement control, code ...FPV

The proportional displacement control allows a continuous variation of the pump displacement according to an electrical input command. Figure 1 shows the circuit diagram of a pump with this control.

**figure 1:** circuit diagram of the ...FPV control



An inductive position transducer (LVDT) measures the position of the servo piston and provides an information on the actual displacement (*signal, displacement*) to a control electronic. The servo piston is kept by the servo spring and the pump outlet pressure on its annulus area at maximum displacement. The larger piston area is pressurized by the control valve.

The control valve contains a control spool, which is moved by a spring and a proportional solenoid into its control position. The control spool makes a pressure divider circuit in combination with the control orifice  $D_B$  between control port A and return port L. This pressure divider circuit controls the pressure  $p_A$ . According to the area ratio of the servo piston, the control pressure  $p_A$  is approximately 25 % of the pump outlet pressure  $p_1$ .

The ordering code for a single control valve is: PVCF\*PV\*\*.

the first \* indicates the pump size:

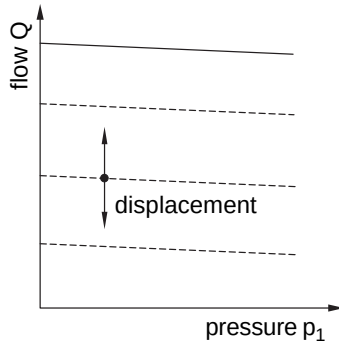
A stands for PV016 - PV092

E stands for PV140 - PV270

the two \* at the end indicate seal option and screws option (details see spare parts list PVI013).

displacement control valve, code PVCF\*PV\*\*

solenoid current, displacement control valve



At nominal current to the solenoid (1,3 A) the control spool is moved against the spring and connects control port A with the pump case (port L). The pump is working with full displacement, set by the displacement adjustment screw.

At no current to the solenoid the control spool is moved by the spring against the solenoid and connects control port A with the pump outlet. The pump outlet pressure  $p_1$  on the large servo piston area downstrokes the pump to minimum displacement. That requires a pump outlet pressure  $p_1$  of at least 15 bar.

If this pressure can not be maintained, special measures for a proper displacement control are required (see chapter 4 and 5). Without an appropriate load pressure the pump will stay at full displacement.

To control the proportional solenoid an electronic module is offered. The ordering code for a module to control the ...FPV control is: PQ0\*-F00. The \* stands for a number indicating one of the five frame sizes of PV series axial piston pumps.

Figure 2 shows this module from the outside, figure 3 the electronic control circuit.

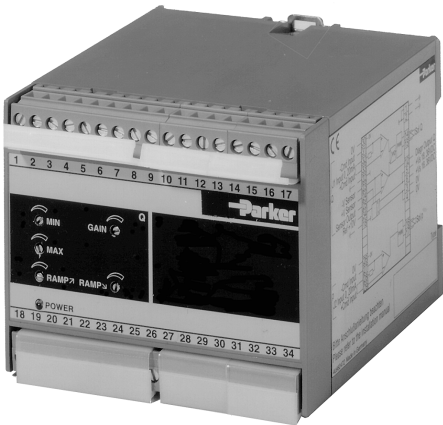


Figure 2: electronic module PQ0\*-F00

The modules are designed for snap track mounting according to EN 50022.

They require a power supply of 22 - 36 VDC. The module is connected to the LVDT (displacement feedback) and to the proportional solenoid of the displacement control valve according to the diagrams in chapter 9. The current requirement is approx. 1.4 A.

The input command for the displacement can either be given by a 0 - 10 V voltage input or by a 0 - 20 mA current input. The module provides a stabilized and filtered reference voltage of 0 V, which can be used with a potentiometer (min. 10 kΩ) to generate a voltage input command.

Internally the command is compared to the actual displacement given by the LVDT. Is the displacement too small, the solenoid current is raised. That leads to a reduction of the control pressure and to an increase of the pump displacement until the commanded value is reached.

At the diagnosis output of the module the actual displacement can be monitored. A voltage signal between 0 and approx. 10 V indicates a pump displacement between 0 and 100 % (for the largest displacement of a frame size, details see table on page 26).

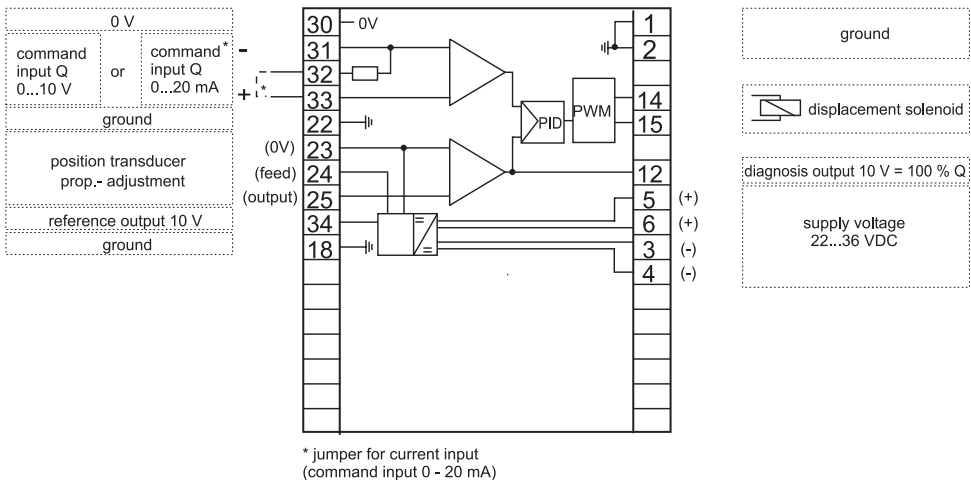


Figure 3: circuit diagram for electronic module PQ0\*-F00

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The module offers a gain adjustment to match the setting of the control circuit with the dynamic response of the hydraulic system.

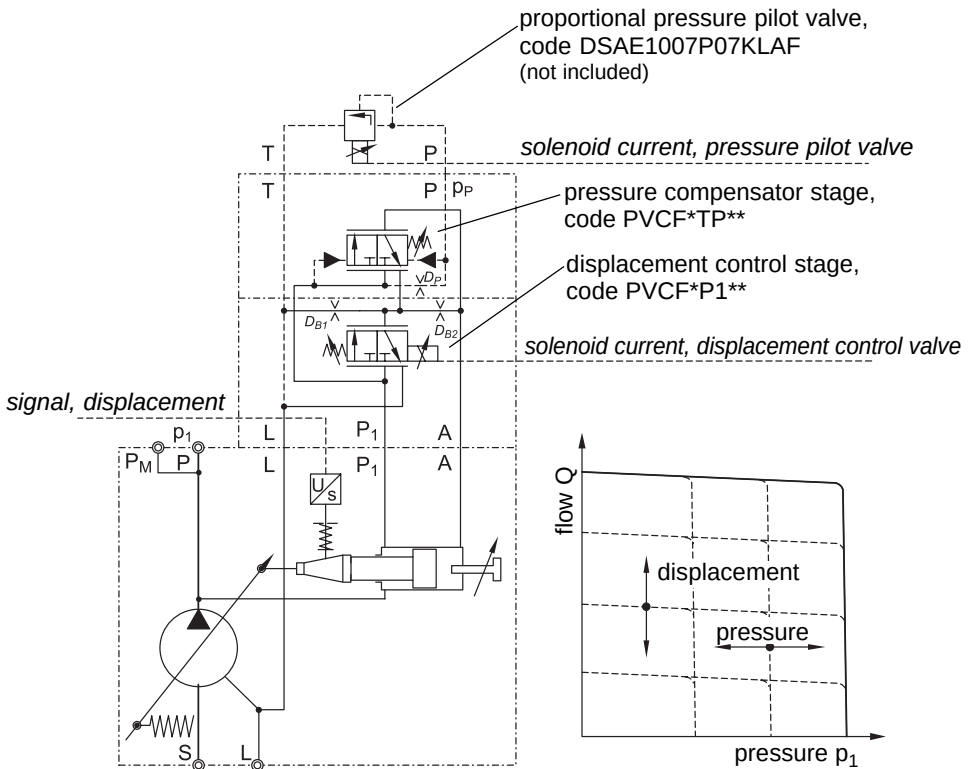
The module offers also a ramp function with individual adjustment for the up and the down ramp. Using the MAX adjustment the input signal resolution can be optimized to the desired displacement range. A MIN potentiometer allows the adjustment of a minimum displacement, which is adjusted, when the input signal exceeds 100 mV.

The proportional displacement control code ...FPV does not include pressure compensation. The hydraulic circuit has to be protected by a full flow pressure relief valve to avoid too high pressures in the hydraulic system.

## 2. Proportional displacement control with pressure compensation, codes ...FPR, ...FPZ

The compensator codes ...FPR resp. ...FPZ include a pressure compensation, which can override the proportional displacement control. This is achieved by adding a second control valve (remote pressure compensator) to the displacement control valve.

Figure 4 shows the hydraulic circuit of this compensator variation. In this example a proportional pressure control valve is used to pilot the remote pressure stage (not included in shipment). That allows a continuous adjustment of the pressure compensator setting by an electrical input command.



**Figure 4:** hydraulic circuit of the ...FPR / ...FPZ control

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The position of the control spool of the pressure compensator is controlled by the pressure drop across the pilot orifice  $D_P$  and by the compensator spring. The nominal control pressure difference is factory-set to a value of  $12 \pm 1$  bar.

As long as the pressure setting of the pilot valve (in figure 4: proportional pressure valve DSAE...) is not yet reached, the control valve spring keeps the control spool in the position shown. The control port of the displacement control valve is connected to the large servo piston area and controls the position of the servo piston.

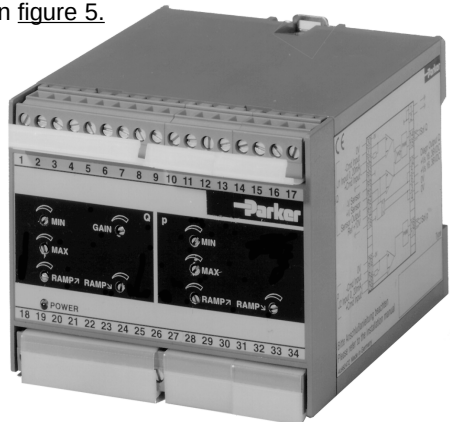
The displacement control operates as described in chapter 1. The adjustment of the control pressure is done between the control spool and control orifice  $D_{B1}$ .

When the set pressure of the pilot valve is reached, this valve opens and control flow from the pump outlet is passing the pilot orifice  $D_P$  and the pressure pilot valve before returning to the pump drain line. That creates a pressure drop across pilot orifice  $D_P$ . If this pressure drop reaches the 12 bar setting of the compensator, the control spool of the pressure stage is in its control position.

That leads to a reduction of the pump displacement in order to keep the pump outlet pressure constant. As the displacement control wants to keep the pump at the set displacement the proportional solenoid is powered with nominal current. That connects the control port of the displacement control valve with the pump case (port L).

The control spool of the pressure stage now controls the servo piston position by using the control orifice  $D_{B2}$  for pressure dividing. Pressure control is achieved as with a standard remote compensator. It is mandatory, that the displacement setting of the displacement control stage is high enough, to cover the flow requirements of the system, the pump and the control valves to maintain the desired pressure.

The electronic control module for this compensator option, code PQ0\*-P00 is shown in figure 5.



**Figure 5:** electronic module PQ0\*-P00

Beside the functions of version PQ0\*-F00 for the proportional displacement control described in chapter 1 it also offers the control of a proportional pressure pilot valve type DSAE1007P07KLAF.

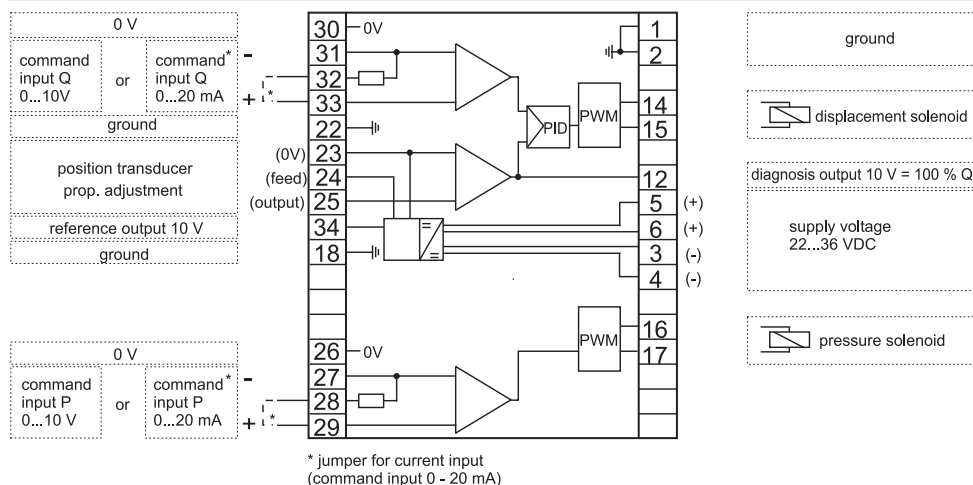
Figure 6 shows the electronic circuit of this control electronic. The upper part is exactly what has been described in chapter 1 for module PQ0\*-F00.

The maximum current requirement for version PQ0\*-P00 reaches up to 2.8 A, because now two proportional solenoids need to be supplied.

The lower part in figure 6 shows the control of the proportional pressure pilot valve. Also for pressure setting either a voltage command (0 - 10 V) or a current command (0 - 20 mA) can be used. Also this command signal can be controlled by a potentiometer connected to the reference voltage pin 34.

The pressure control circuit is equipped with an electronic network that linearizes the characteristic of the proportional pressure pilot valve (pressure over input signal). This network is dimensioned for Parker pressure valves.

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**Figure 6:** electronic circuit of module PQ0\*-P00

Therefore only the following valve versions are to be used with this module:

DSAE1007P07KLAF

Other valve models can lead to instability problems or malfunction of the control.

Both valves are dimensioned for a nominal pressure of 350 bar. By using the MAX adjustment of the pressure section at the control module, the input command range easily can be adjusted to any smaller nominal system pressure. In this way also for these lower pressures full resolution of the input command can be achieved.

For basic adjustment of the control valves as well as the LVDT see chapter 8. For electrical connections and cable requirements see chapter 9.

**Note:** Parker has decided for this design with a separate hydraulic-mechanically operated remote pressure compensator, which overrides the proportional displacement control for three reasons:

1. Piston pumps of the PV series have a large servo piston. That offers several advantages. On the other hand the servo piston has a high flow demand for compensation. A hydraulic-mechanical pressure compensator - as used here - can provide much higher control flows, than a proportional directional control valve used by other pump models, where this valve also provides pressure control basing of the signal of a pressure transducer.
2. The hydraulic-mechanical control valve „senses“ a pressure peak in the system, as the pressure acts direct on the control spool. Depending on the actual system pressure very high forces are available to operate the spool. Therefore this control rarely will tend to stick or malfunction, as proportional directional control valves may do under contaminated fluid conditions.
3. The pressure control using a proportional pressure control valve to pilot it, does not require a pressure sensor at the pump outlet. That saves this sensitive and expensive component. Nevertheless a closed loop pressure control can be offered if required (see next chapter).

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### 3. Proportional displacement control with closed loop pressure control, code ...FPG

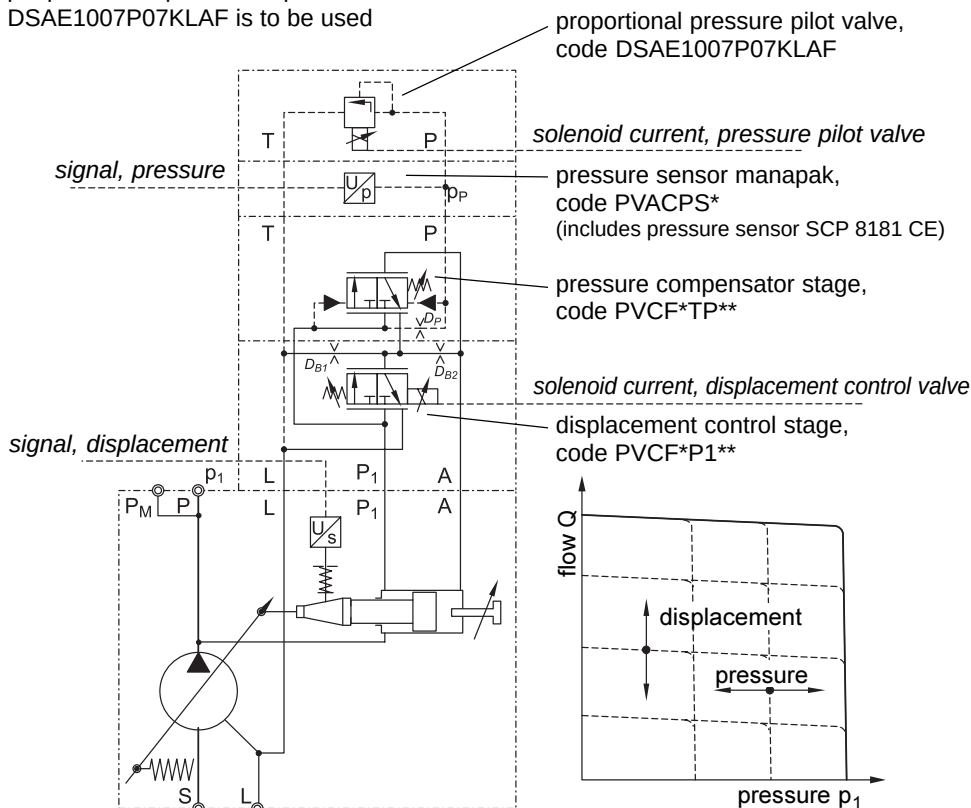
With compensator ordering code ...FPG (in addition to the content of code ...FPR) a pressure sensor and a proportional pressure valve mounted on the remote pressure control stage is included. That realizes a closed loop pressure control by using the electronic control module PQ0\*-Q00. It also offers the option of an electronic horse power compensation by using the electronic control module PQ0\*-L00. Figure 7 displays the hydraulic circuit of this control option.

For closed loop pressure control only the proportional pressure pilot valve code DSAE1007P07KLAF is to be used

The pressure sensor included in the shipment is of the model SCP 8181 CE supplied by the Parker Connectors Group and is mounted in a manapak. The complete unit can be ordered separately under code PVACPS\* (\* for seal material option).

Also included in the shipment is a proportional pressure pilot valve of the ordering code DSAE1007P07KLAF.

The hydraulic function is described in the last chapter. There are no differences. The difference is in the electronic control module PQ0\*-Q00, shown in figure 8.



**Figure 7:** hydraulic circuit of the ...FPG control



Figure 8: electronic module PQ0\*-Q00

The electronic circuit of this module is shown in figure 9. The difference to the circuit shown in figure 6 is the additional interface for a pressure sensor and the PID controller for a closed loop pressure control.

As shown in figure 7, the pressure sensor is positioned in the pilot circuit. According to the differential pressure adjusted at the compensator valve, the system pressure is higher than the controlled pressure.

This concept avoids stability problems with the control loop and the necessity of an external adjustment of the control loop. On the other hand there are additional measures necessary (e. g.: command signal correction), if linearity between input (command signal) and output (system pressure) is required.

Figure 10 shows the typical behaviour of pilot pressure  $p_R$  and system pressure  $p_1$  as function of the input signal.

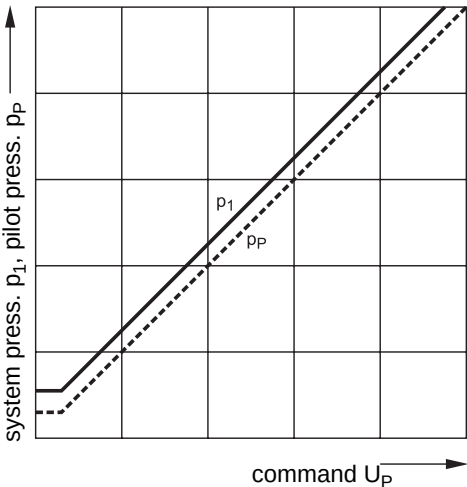


Figure 10: pressures over input signal

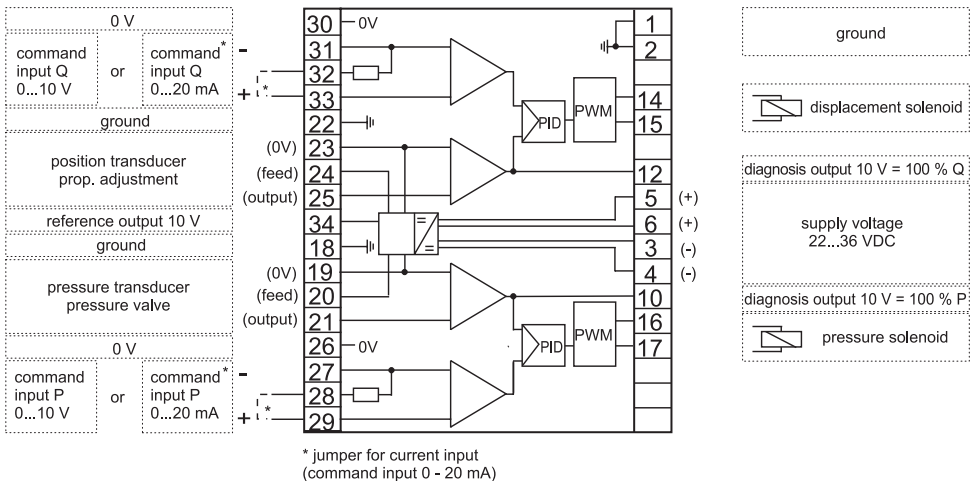


Figure 9: electronic circuit of module PQ0\*-Q00

The information on the actual system pressure together with the knowledge of the actual displacement opens another opportunity: as pressure multiplied with the output flow represents the hydraulic horse power, an electronic horse power control can be built.

The electronic module with ordering code PQ0\*-L00 offers this option. Figure 11 shows this module, figure 12 the electronic circuit of this module for an electronic p-Q-control with horse power limitation.

The module calculates the actual horse power from actual pressure and actual displacement.

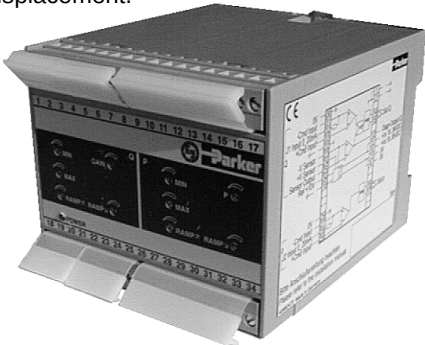


Figure 11: electronic module PQ0\*-L00

A control loop compares actual horse power with a commanded horse power provided either as a voltage signal (0 - 10 V) or as a current signal (0 - 20 mA). The 10 V (20 mA) signal represents the corner power of the largest pump displacement of a frame size. See page 26 for details.

If the effective horse power exceeds the commanded horse power, the displacement command is reduced accordingly.

Two ways to provide a horse power command can be used:

1. The 10 V reference signal (pin 34) can be connected to pin 9 and the max. horse power can be adjusted with the P potentiometer on the frontside of the module.
2. An external (voltage or current) command can be connected to pins 7 and 9.

The external command offers the possibility of a horse power summation for multiple pumps on one drive motor. The machine control, providing the horse power commands, has to make sure, that the sum of all commands never exceeds the capability of the motor.

At the diagnosis output pin 11 the actual horse power can be measured.

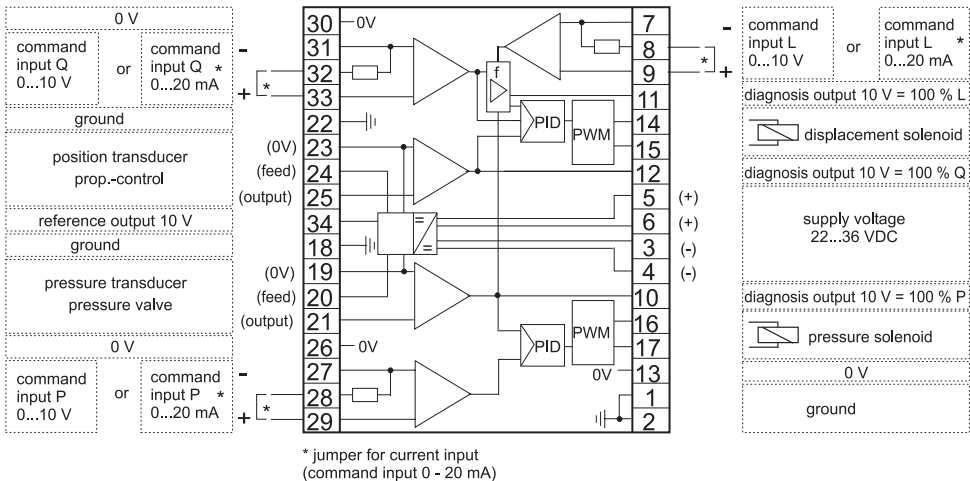


Figure 12: electronic circuit of the module PQ0\*-L00

#### 4. Preload valve for proportional controlled pumps, code PVAPVV...

As already mentioned in chapter 1, a proportional controlled variable displacement pump needs always a minimum outlet pressure of approx. 15 bar, to downstroke the pump against the servo spring force.

In some applications and especially at small displacement settings that is not always given.

Two possibilities to solve this issue are described in the following chapters:

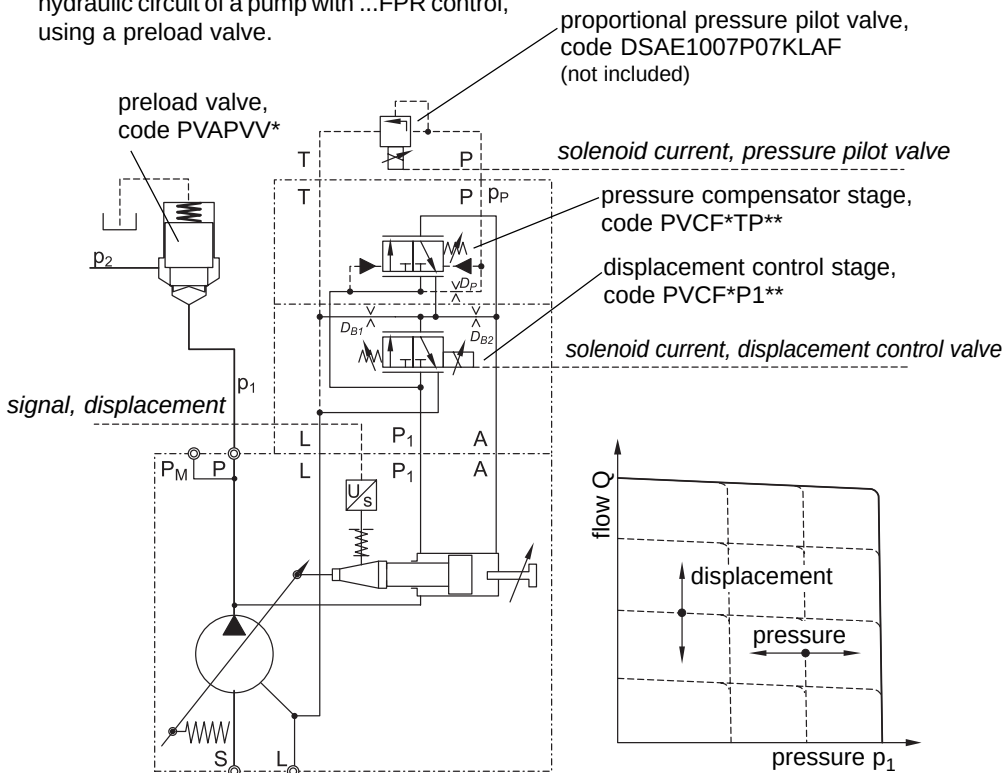
If an internal and external auxiliary pressure is available, this can be used to control the pump at low outlet pressure. This method, using a shuttle valve, is explained in chapter 5.

The other option is the use of a preload valve (sequence valve). Figure 13 shows the hydraulic circuit of a pump with ...FPR control, using a preload valve.

The preload valve is offered as a manifold, that can directly be flanged to the pressure port of the pump. The ordering code is PVAPVV\*. The \* stands for the frame size of the pump, the screw option and the seal material.

The preload valve is also available as slip in cartridge valve according to DIN 24 342.

Because of the spring preload the opening pressure  $p_1$  is approx. 30 bar. Because of the poppet design and due to the return line connection of the spring chamber, the opening pressure decreases at increasing system pressure to approx. 20 bar. At approx. 30 bar system pressure the valve is fully open (pressure drop < 1bar).



**Figure 13:** hydraulic circuit of a pump with ...FPR control and preload valve

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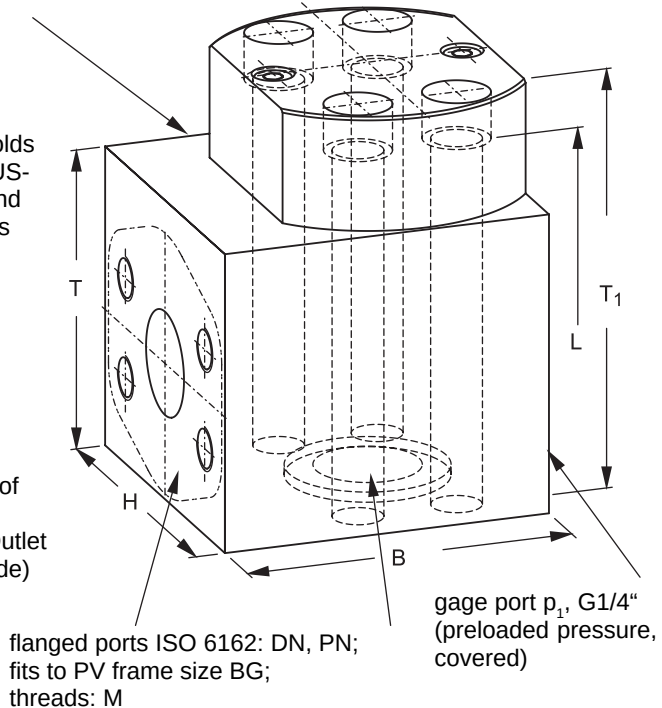
Figure 14 shows the preload manifold for direct mounting to the pressure port of the pump. It takes screws with the length L to mount it to the pump. L includes the length screwed into the pump end cover.

Input and output are designed as flange ports according to ISO 6162 and fit direct to the according PV frame size. Table 1 shows the main dimensions.

drain port L, G1/4"  
(covered)

**Note:** All auxiliary manifolds can also be supplied in US-version ( UNC threads and UNF ports) and with ports according to ISO 6149.

**Figure 14:** outside view of the preload manifold for direct pump mounting. Outlet optional to front (shaft side) or to the rear



**Table 1:** main dimensions of preload manifold

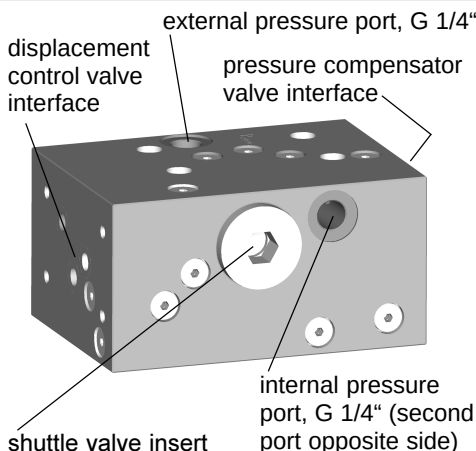
| dimension                    | BG1         | BG2         | BG3         | BG4         | BG5         |
|------------------------------|-------------|-------------|-------------|-------------|-------------|
| H[mm]                        | 100         | 100         | 110         | 110         | 120         |
| B[mm]                        | 90          | 90          | 100         | 100         | 125         |
| T[mm]                        | 80          | 80          | 92          | 92          | 105         |
| L[mm]                        | 102         | 102         | 122 (119*)  | 122 (119*)  | 136         |
| T <sub>1</sub> [mm]          | 116         | 116         | 137         | 137         | 155         |
| for size                     | PV016 - 023 | PV032 - 046 | PV063 - 092 | PV140 - 180 | PV270       |
| DN[mm]                       | 19 (3/4")   | 25 (1")     | 32 (1 1/4") | 32 (1 1/4") | 38 (1 1/2") |
| PN[bar]                      | 400         | 400         | 400         | 400         | 400         |
| M                            | M10         | M12         | M12 (M14*)  | M12 (M14*)  | M16         |
| valve insert                 | DIN E16     | DIN E16     | DIN E25     | DIN E25     | DIN E32     |
| Q <sub>nominal</sub> [l/min] | 160         | 160         | 300         | 300         | 550         |

\*: optional for PV063 - PV180, thread option 4

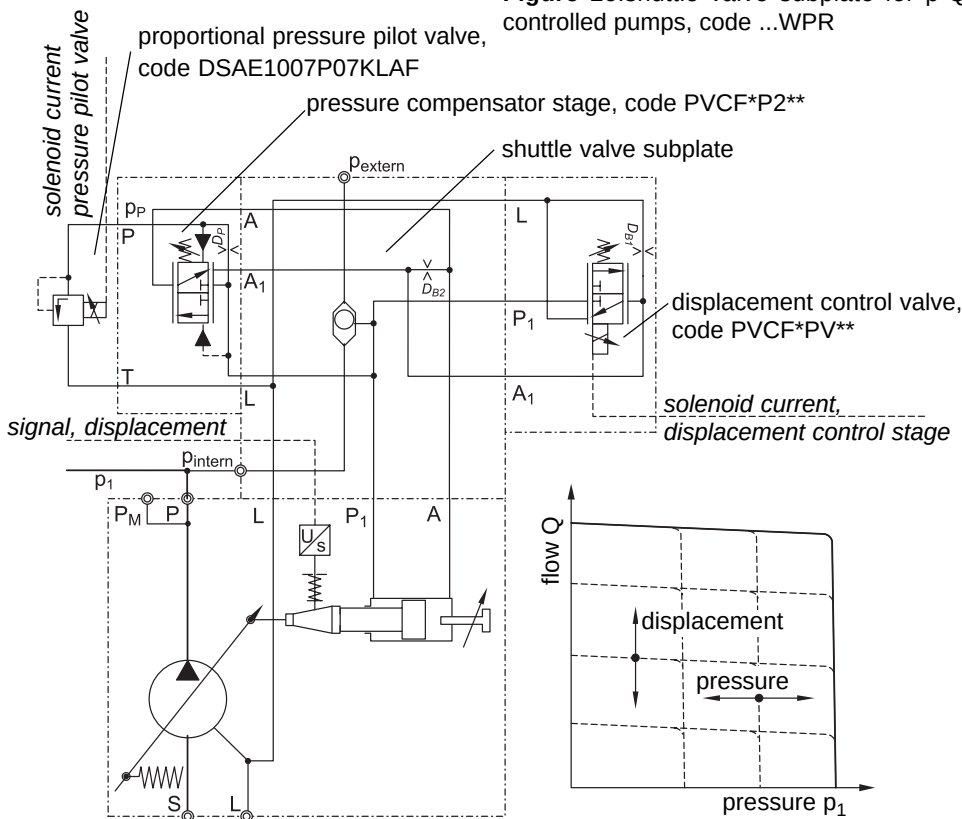
The alternative solution is, to disconnect the servo system from the pump outlet. A shuttle valve is mounted to supply the servo control either from the pump outlet (e. g. from the gage port) or from an external auxiliary pressure supply.

This external source for auxiliary power should be capable of a flow of 20 - 40 l/min (depending on pump size) at a pressure of 20 - 30 bar.

Figure 15 shows the hydraulic circuit of the ...WPR control, figure 16 the design of the shuttle valve block mounted to the pump.



**Figure 16:**shuttle valve subplate for p-Q-controlled pumps, code ...WPR



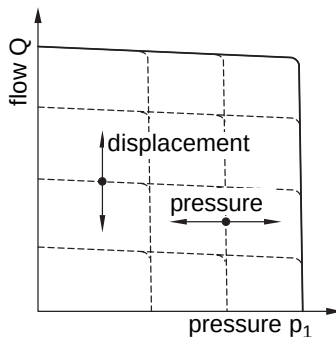
**Figure 15:** hydraulic circuit of a pump with ...WPR control (with shuttle valve subplate)

A quick unload valve valve, code PVAPSE\*, flanged direct to the pump outlet solves this problem. The \* in the ordering code stands for pump frame size, seal material and screw option.

Figure 17 shows the hydraulic circuit of a pump with p-Q-control equipped with this quick unload valve.

A slip-in cartridge valve is inserted into the pilot connection to the pressure compensator stage. The pilot flow to the proportional pressure pilot valve has to pass the orifice in the poppet of this valve. A second orifice is mounted in the valve cover. The poppet is kept closed with a 4-bar-spring.

The pressure compensator stage has in this case not the control spool with the internal pilot orifice, because pilot flow is now supplied externally through the quick unload poppet.



**Figure 17:** hydraulic circuit of an ...FPS control with quick unload valve manifold

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The ordering code for this pressure compensator stage is PVCF\*PS\*\*. The first \* stand for the pump frame size, A for BG 1 - 3, E for BG 4 and 5), the two \* at the end of the code stand for seal material and screw option. See spare parts list PVI013 for details.

In the pump ordering code this option is coded with ...FPS, code ...FPT indicates the equivalent version for closed loop pressure control / electronic horse power control.

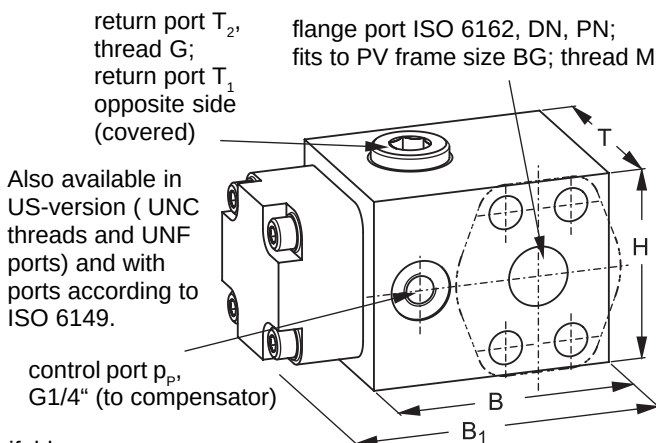
Under normal working conditions the control differential pressure of - in this case - 12 bar is created across the two orifices in quick unload valve poppet and cover. According to the orifice dimensions the differential pressure is split in a 1 : 3 ratio. That means: at the valve poppet there is a 3 bar pressure drop, at the orifice in the cover a 9 bar pressure drop.

In case of a pressure overshoot or when switching to a low command pressure the total differential pressure is significantly increased.

That results in a pressure drop across the poppet of more than 4 bar (spring preload) and the poppet opens to the return line. That leads to an immediate reduction of system pressure.

When the control differential pressure gets down to 16 bar the poppet closes again. Using this pump accessory the system pressure follows the command signal in both directions without delay.

Figure 18 shows the quick unload valve in a manifold fitting direct to the pump outlet, [table 2](#) lists its main dimensions.



**Figure 18:** quick unload manifold

**Table 2:** main dimensions of the quick unload manifold

| dimension                                 | BG1         | BG2         | BG3         | BG4         | BG5         |
|-------------------------------------------|-------------|-------------|-------------|-------------|-------------|
| B[mm]                                     | 100         | 100         | 110         | 110         | 130         |
| H[mm]                                     | 80          | 80          | 100         | 100         | 120         |
| T[mm]                                     | 80          | 80          | 80          | 80          | 100         |
| B <sub>1</sub> [mm]                       | 136         | 136         | 146         | 146         | 175         |
| for size                                  | PV016 - 023 | PV032 - 046 | PV063 - 092 | PV140 - 180 | PV270       |
| DN[mm]                                    | 19 (3/4")   | 25 (1")     | 32 (1 1/4") | 32 (1 1/4") | 38 (1 1/2") |
| PN[bar]                                   | 400         | 400         | 400         | 400         | 400         |
| M                                         | M10         | M12         | M12 (M14*)  | M12 (M14*)  | M16         |
| valve insert                              | DIN E16     | DIN E16     | DIN E16     | DIN E16     | DIN E25     |
| Q <sub>nominal</sub> [l/min]              | 160         | 160         | 160         | 160         | 300         |
| G (port T <sub>1</sub> , T <sub>2</sub> ) | 1/2"        | 1/2"        | 1/2"        | 1/2"        | 3/4"        |

\*: optional for PV063 - PV180, thread option 4

## 6. preload and quick unload manifold PVAPVE\* in combination with compensator code ...FPP resp. ...FPE

The pump accessory manifold code PVAPVS\* combines preload and quick unload function. Also here the \* stands for pump frame size, seal material and screw option.

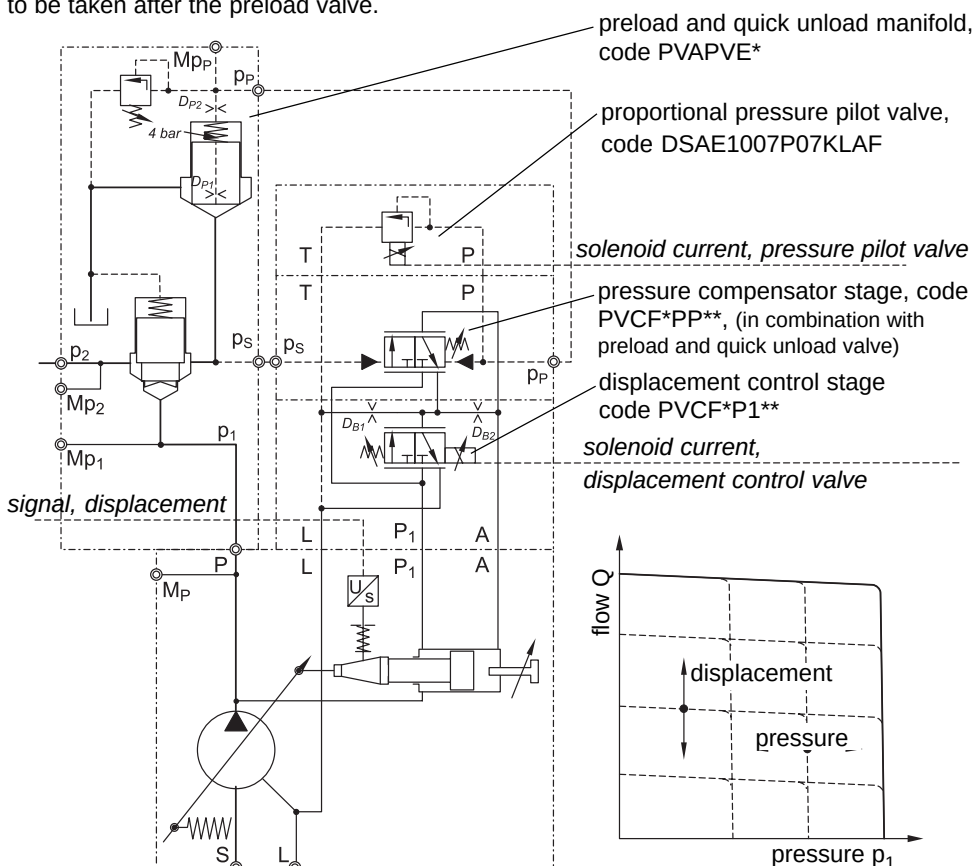
This manifold is also flanged direct to the pressure port of a PV pump. For functional description see the last chapters.

To ensure a correct function under all working conditions and to control immediately the load pressure, the control pressure has to be taken after the preload valve.

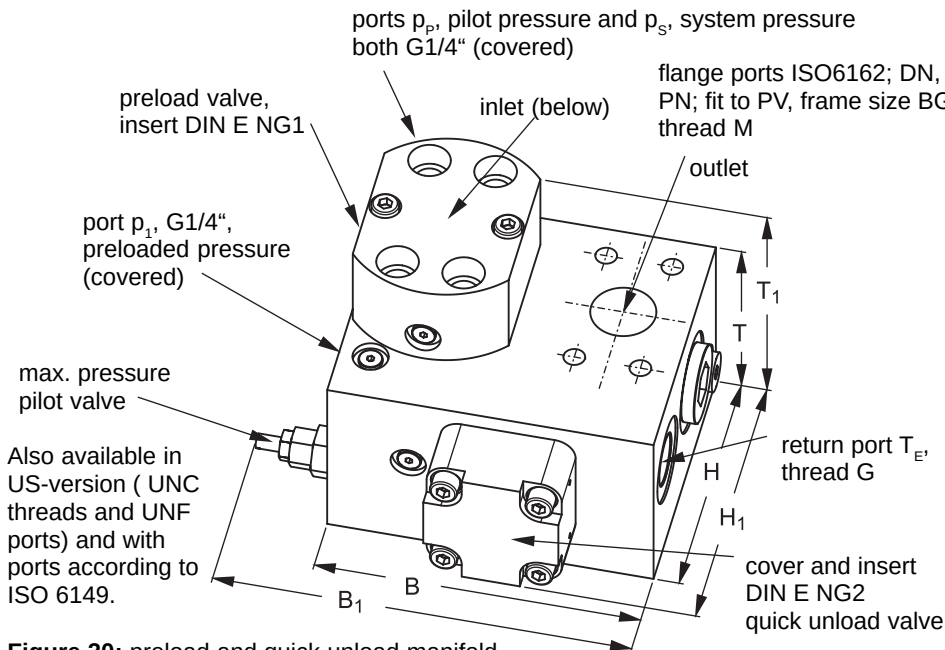
Sensing area of the control spool and spring chamber are both to be connected by pipe or hose to the control ports of this manifold. The hydraulic circuit diagram [figure 19](#) displays this.

Both functions are built into one manifold. [Figure 20](#) shows this manifold and [table 3](#) lists the main dimensions.

The dimension L indicates the total length of the mounting bolts and includes the length screwed into the pump end cover.



**Figure 19:** hydraulic circuit of the ...FPS control with preload and quick unload manifold



**Figure 20:** preload and quick unload manifold

**Table 3:** main dimensions of the preload and quick unload manifold

| dimension             | BG1         | BG2         | BG3         | BG4          | BG5         |
|-----------------------|-------------|-------------|-------------|--------------|-------------|
| B[mm]                 | 125         | 150         | 157         | 157          | 190         |
| H[mm]                 | 105         | 130         | 130         | 130          | 154         |
| T[mm]                 | 80          | 80          | 92          | 92           | 105         |
| L[mm]                 | 105         | 103         | 121         | 121          | 137,5       |
| $B_1$ [mm]            | 189         | 189         | 196         | 196          | 239         |
| $H_1$ [mm]            | 166         | 166         | 166         | 166          | 199         |
| $T_1$ [mm]            | 116         | 116         | 137         | 137          | 155         |
| for size              | PV016 - 023 | PV032 - 046 | PV063 - 092 | PV1240 - 180 | PV270       |
| DN[mm]                | 19 (3/4")   | 25 (1")     | 32 (1 1/4") | 32 (1 1/4")  | 38 (1 1/2") |
| PN[bar]               | 400         | 400         | 400         | 400          | 400         |
| M                     | M10         | M12         | M12 (M14*)  | M12 (M14*)   | M16         |
| valve insert NG1      | DIN E16     | DIN E16     | DIN E25     | DIN E25      | DIN E32     |
| $Q_{nominal}$ [l/min] | 160         | 160         | 300         | 300          | 550         |
| valve insert NG2      | DIN E16     | DIN E16     | DIN E16     | DIN E16      | DIN E25     |
| $Q_{nominal}$ [l/min] | 160         | 160         | 160         | 160          | 300         |
| G (port $T_E$ )       | 1/2"        | 1/2"        | 3/4"        | 3/4"         | 3/4"        |

\*: optional for PV063 - PV180, thread option 4

## Installation and setup manual

### 8. Basic adjustment of displacement feedback and compensator valves

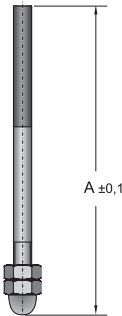
The inductive position transducer for displacement feedback (LVDT) and the compensator valves are factory preset and the settings are secured. New or re-adjustment is only necessary after repair.

#### LVDT for displacement feedback:

Prior to a basic setting the adjustment of the armature length is to be checked / re-adjusted (see [figure 21](#)). The exact dimension for this setting is given in [table 4](#):

**Table 4:** LVDT armature setting dimension frame size displacement dimension A [mm]

|     |                         |      |
|-----|-------------------------|------|
| BG1 | 16 - 23 cm <sup>3</sup> | 64,0 |
| BG2 | 32 - 46 cm <sup>3</sup> | 64,0 |
| BG3 | 63 - 92 cm <sup>3</sup> | 65,5 |
| BG4 | 140-180 cm <sup>3</sup> | 65,5 |
| BG5 | 270 cm <sup>3</sup>     | 65,5 |



**Figure 21:** setting dimension for LVDT armature

The adjustment is secured by a removable glue. A new setting again has to be secured to avoid uncontrolled re-setting.

At full upstroked pump the mechanical adjustment can be verified: The voltage at the LVDT output (pin 25 at the control module) should have a value as given in the table below ( $\pm 0,2$  V).

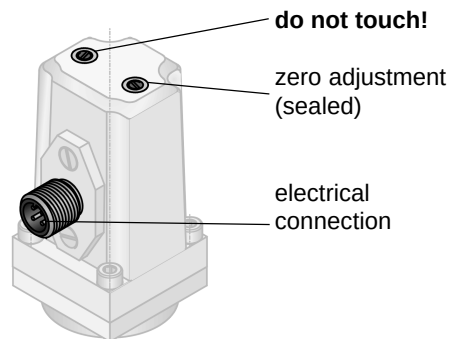
| size  | voltage | size  | voltage |
|-------|---------|-------|---------|
| PV016 | 6,34 V  | PV063 | 6,98 V  |
| PV020 | 6,03 V  | PV080 | 6,38 V  |
| PV023 | 5,80 V  | PV092 | 5,95 V  |
| PV032 | 6,01 V  | PV140 | 5,07 V  |
| PV040 | 5,63 V  | PV180 | 3,95 V  |
| PV046 | 5,45 V  | PV270 | 3,95 V  |

#### Zero adjustment:

Next the zero adjustment of the LVDT is to be checked. The LVDT and the solenoid of the displacement control valve are to be connected according to chapter 9 to the electronic control module.

At running pump the command for the displacement is to be set to 0 and the pressure relief valve of the circuit / test rig has to be set to a pressure  $> 25$  bar. All other connections / valves in the hydraulic circuit are to be closed.

The pump then will downstroke to deadhead at the minimum pump compensating pressure ( $10 \pm 2$  bar). By setting the zero adjustment potentiometer (see [figure 22](#)) at the LVDT the diagnosis output of the control module is to be set to 0 V, as the actual displacement is the minimum displacement that can be controlled. After adjustment the potentiometer **must** be sealed again, to protect the LVDT electronics against moisture.



**Figure 21:** inductive position transducer (LVDT), outside view

#### MAX-adjustment:

Next the command for the displacement is to be increased, until the maximum displacement of the pump is reached. That can either be monitored by using the diagnosis output or a flow meter at the pump outlet.

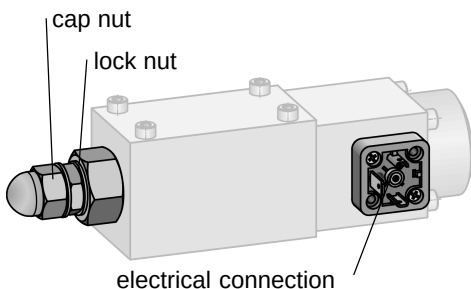
The maximum displacement is reached, if the displacement / flow does not further increase, even when the input command is still raised.

If the command reaches 10 V (max. input command) prior to that point (resp. at current input 20 mA), the displacement (the flow) can still be increased by using the MAX potentiometer on the module.

Is the maximum displacement is reached long before the command reaches 10 V, this can also be corrected by reducing the setting of the MAX potentiometer.

## Basic adjustment control valve:

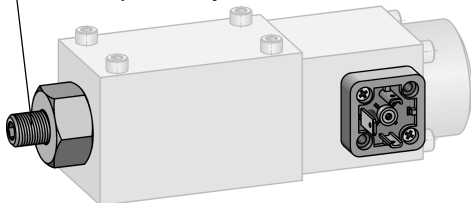
To adjust the displacement control valve, the cap nut, the lock nut, the washers and the o-rings are to be removed (figure 23). Then a 50 % command should be adjusted.



**Figure 23:** displacement control valve

In a control situation the solenoid should draw approx. 60 % of its nominal current (nominal current 1,3 A; current in control situation 750 mA). Under these conditions the solenoid provides approx. 50 % of its nominal force. That leads to a similar response for on- and offstroking. By turning the adjustment screw, this can be achieved. Clockwise turning increases the solenoid current (force).

## set screw (basic adjustment of control valve)



**Figure 24:** proportional displacement control valve with open set screw

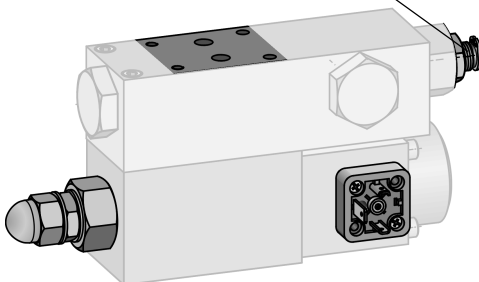
After the adjustment the lock nut secures this setting and the cap nut covers the set screw.

See also: installation manual for module PQ0\*-F00, publication 3240-M1/GB

**Caution: the proportional displacement control, code ...FPV does not include a pressure compensation. Therefore the hydraulic circuit needs to be protected with a pressure relief valve (safety valve). This valve has to be layed out for full pump flow.**

The remote pressure compensation stage of the p-Q-controls codes ...FPR, ...FPZ, ...FPG, ...FPS, ...FPT, ...FPP and ...FPE (see chapters 2 to 7) is adjusted as follows:

## differential pressure adjustment



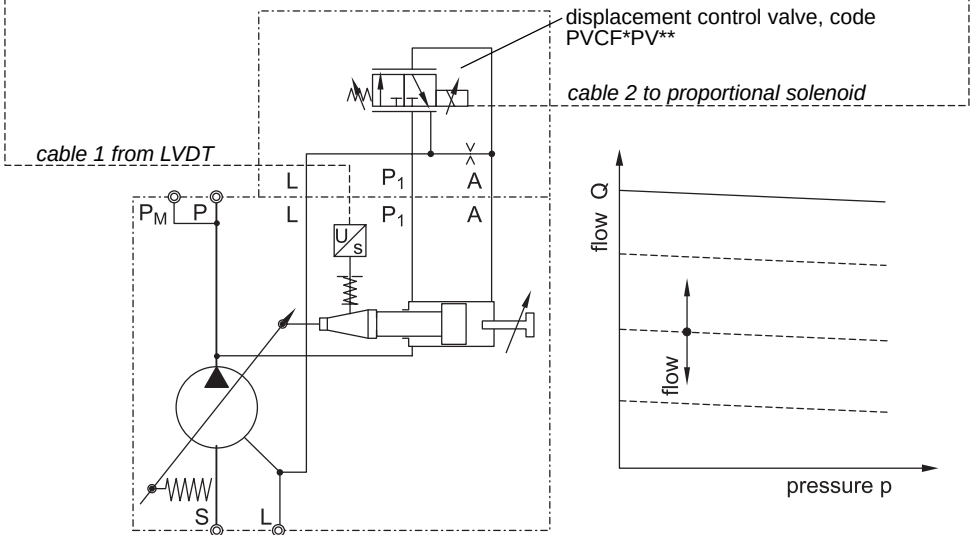
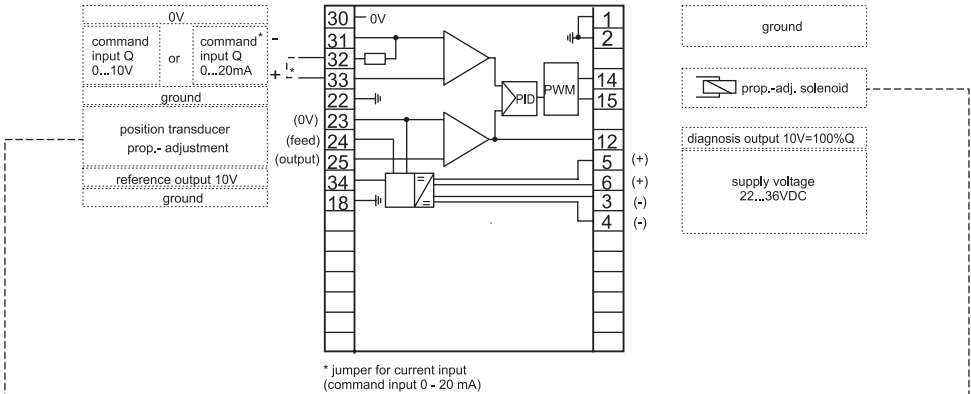
**Figure 25:** proportional p-Q-control

The factory setting for the differential pressure is  $12 \pm 1$  bar. For re-adjustment two pressure gages / transducers are required. The differential pressure to be adjusted is the difference between the two pressures on both sides of the control spool of the pressure compensator stage in a control situation. For compensator codes ...FPP and ...FPE this is the difference between the pressure  $p_F$  on the sensing side and the pilot pressure  $p_R$  (see figure 19).

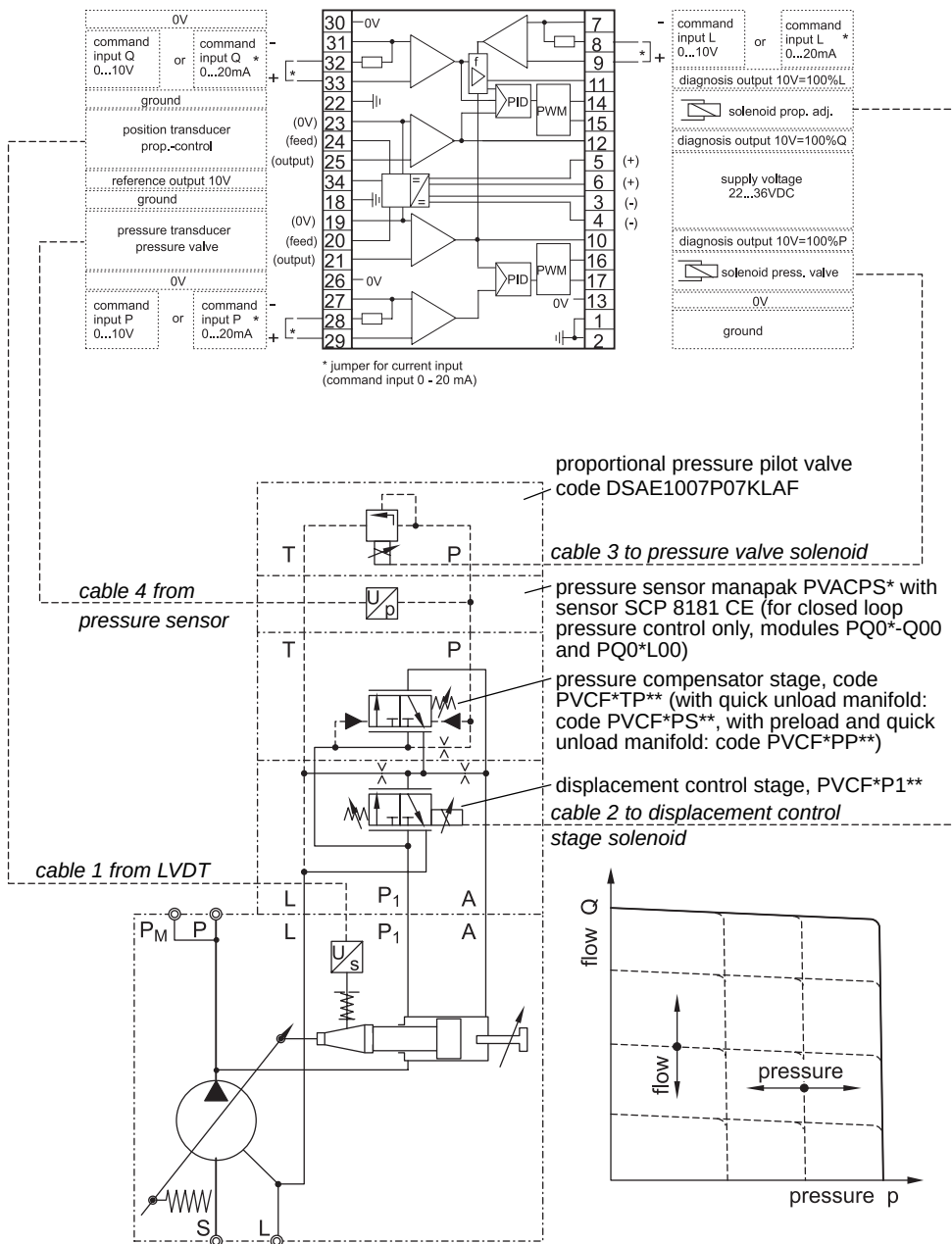
For all other codes it is the difference between pump outlet pressure  $p_1$  and pilot pressure  $p_R$ .

The leads to a minimum compensation pressure of 12 bar at completely unloaded spring chamber.

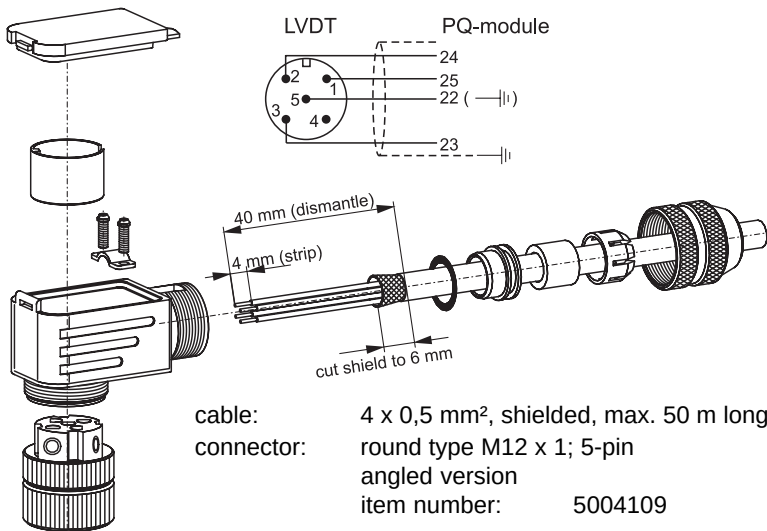
Connecting diagram for proportional displacement control; code ..FPV  
(cable description see page 22)



## Connecting diagram for p-Q-control; codes ..FPR, ...FPZ, ...FPG, ...FPS, ...FPT, ...FPP and ...FPE (cable descriptions see pages 22 and 23)



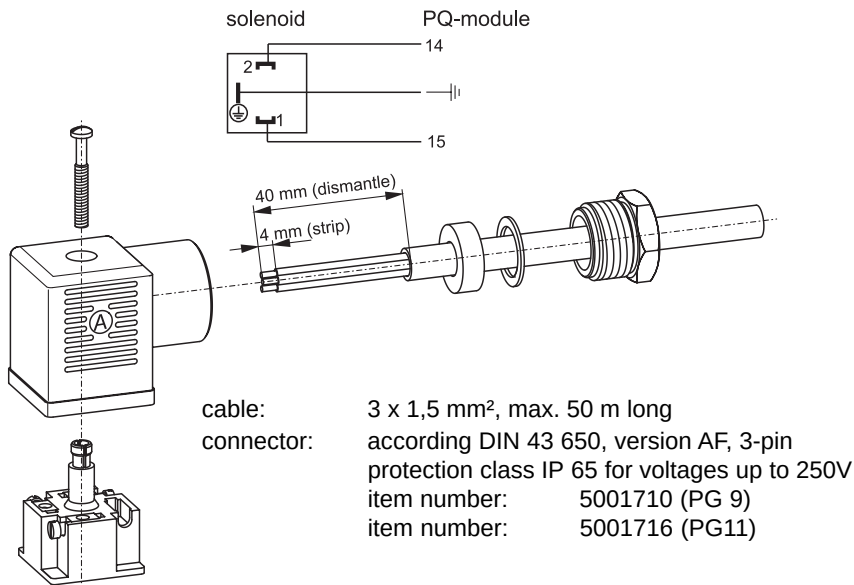
## **Table 1 from LVDT (displacement transducer)**



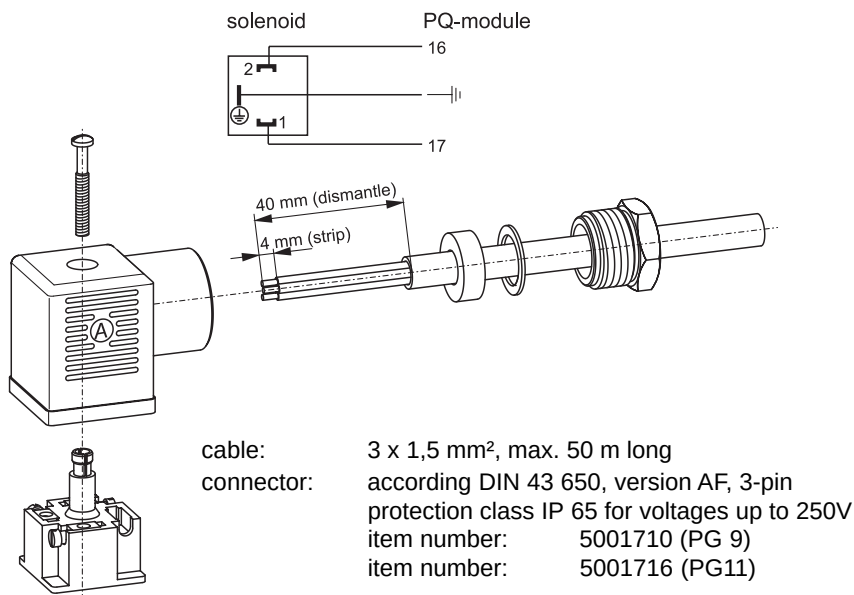
Alternative: shielded cable with molded connector; in different length and variations available e. g. through companies Amphenol, Heilbronn and Vogel, Renchingen.

This solution is recommended for dynamic stressed systems (vibrations) due to the lower connector weight.

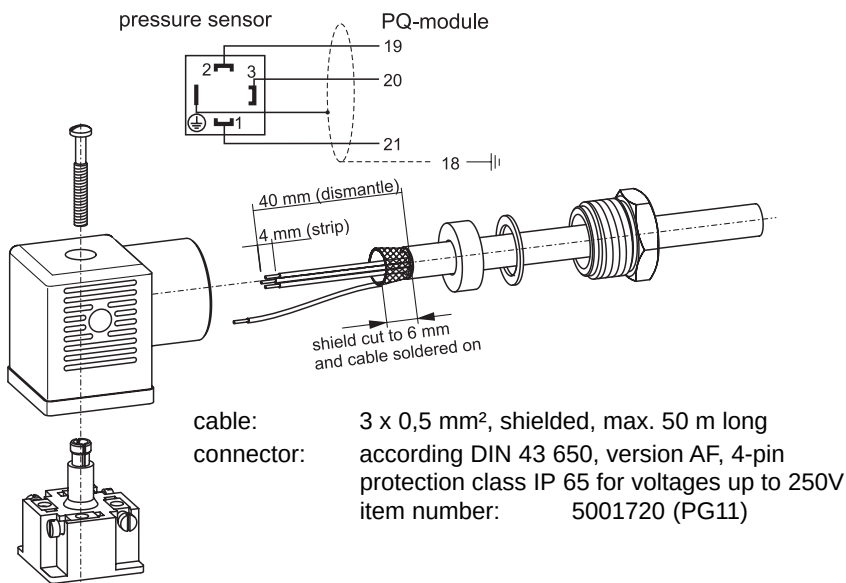
## **Table 2 to displacement control valve (displacement control)**



**Cable 3** to proportional pressure pilot valve solenoid (not for module PQ0\*-F00 resp. compensator code ...FPV)



**Cable 4** from pressure sensor(only for modules PQ0\*-Q00 and PQ0\*-L00 resp. compensator codes ...FPG, ...FPT and ...FPE)



## Installation and setup manual

### Trouble shooting guide

#### Pump delivers no output flow

##### Drive motor does not turn

reason Motor is not connected correctly or one of the three phases has failed. Motor does not turn smoothly when pump is disconnected from pump.

solution *Check motor connections, check electrical power supply*

reason Pump is mechanically blocked. Motor turns smoothly when disconnected from pump

solution *Send pump for service to factory.*

##### Drive motor only turns at slow speed

reason Motor is not selected properly. In star circuit not enough torque.

solution *Start pump at unloaded system. Use motor with more horse power.*

reason Pump is hydraulically blocked. No function of compensator, no pressure relief valve; Pump stops after a few turns.

solution *Check function of pump compensator (see below). Start pump at unloaded system.*

##### Drive motor turns, pump does not turn

reason Coupling is not or not correctly mounted.

solution *Check coupling assembly and correct it.*

##### Drive motor turns and pump turns

reason Wrong direction of rotation

solution *Change direction of motor rotation*

reason Fluid reservoir empty or not filled to level, suction line ends above fluid level.

solution *Fill reservoir to required level, if necessary increase suction pipe length.*

reason Suction line is blocked. E. g. by plugs, cleaning tissues, plastic-plugs. Ball valve in the suction line closed. Suction filter blocked.

solution *Check suction line for free flow. Open valves in suction line. Valves should be equipped with electrical indicator. Check suction filter.*

reason Suction line not gas tight, pump gets air into suction port .

solution *Seal suction line against air ingress.*

reason Pressure line / system is not able to bleed air out.

solution *Unload pressure port, unload system before start, bleed air from pressure line.*

##### Pump does not build up pressure, but delivers full flow at low pressure

reason Standard pressure compensator is set to minimum pressure.

solution *Adjust compensator setting to desired pressure.*

reason Orifice in remote pressure compensator blocked.

solution *Make sure orifice Ø 0,8 mm in control spool is free and open.*

reason No pressure pilot valve connected to port P<sub>R</sub>.

solution *Install suitable pressure pilot valve and adjust it to the desired setting.*

reason Multiple pressure pilot selector valve is not energized; Pump works in stand-by.

solution *Energize selector valve solenoid.*

reason No load sensing line connected.

solution *Connect system load sensing port to compensator.*

reason Load sensing valve is closed or too small.

solution *Open load sensing valve, use larger valve size.*

reason Too much pressure drop between pump and load sensing valve.

solution *Make sure connection is wide enough and has not too much pressure drop.*

reason Differential pressure at compensator is adjusted properly (too low).

solution *Check differential pressure adjustment and correct it as described above.*

## Installation and setup manual

|                                                                                |                                                                                                                                                                                             |
|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Pump does not build up pressure, but delivers full flow at low pressure</b> |                                                                                                                                                                                             |
| reason                                                                         | Horse power compensator setting changed.                                                                                                                                                    |
| solution                                                                       | <i>Check setting of horse power compensator and correct it, if required.</i>                                                                                                                |
| reason                                                                         | Proportional displacement control is not connected as required.                                                                                                                             |
| solution                                                                       | <i>Check wiring; connect according to installation manual for electronic module.</i>                                                                                                        |
| reason                                                                         | Displacement transducer (LVDT) adjustment changed.                                                                                                                                          |
| solution                                                                       | <i>Correct zero setting at displacement transducer.</i>                                                                                                                                     |
| reason                                                                         | Electronic module has no supply power.                                                                                                                                                      |
| solution                                                                       | <i>Make sure module is powered with 22 - 36 V DC.</i>                                                                                                                                       |
| reason                                                                         | Plug instead of orifice Ø 0,8 mm in the load sensing line to pump.                                                                                                                          |
| solution                                                                       | <i>Install orifice as required.</i>                                                                                                                                                         |
| reason                                                                         | Cylinder block lifts from valve plate due to excessive wear.                                                                                                                                |
| solution                                                                       | <i>Send pump to factory for service.</i>                                                                                                                                                    |
| <b>Pump does not compensate</b>                                                |                                                                                                                                                                                             |
| reason                                                                         | No orifice is in load sensing line to compensator code FFC.                                                                                                                                 |
| solution                                                                       | <i>Install orifice Ø 0,8 mm as shown in circuit diagram (page 9).</i>                                                                                                                       |
| reason                                                                         | No pressure pilot valve connected to compensator or valve is blocked.                                                                                                                       |
| solution                                                                       | <i>Connect pressure pilot valve to compensator, make sure valve opens as required.</i>                                                                                                      |
| reason                                                                         | Load sensing line connected incorrect (e. g. upstream of load sensing valve)                                                                                                                |
| solution                                                                       | <i>Connect load sensing line downstream (actuator side) of load sensing valve.</i>                                                                                                          |
| reason                                                                         | No or too low pressure at pump outlet port.                                                                                                                                                 |
| solution                                                                       | <i>Pump outlet pressure must be at least 15 bar, because otherwise the bias spring in the pump cannot be compressed.</i>                                                                    |
| <b>Pump does not upstroke, sticks at zero displacement.</b>                    |                                                                                                                                                                                             |
| reason                                                                         | Compensator is blocked due to contamination.                                                                                                                                                |
| solution                                                                       | <i>Clean hydraulic fluid, clean compensator valve.</i>                                                                                                                                      |
| reason                                                                         | Cable to LVDT or proportional solenoid is interrupted                                                                                                                                       |
| solution                                                                       | <i>Check wiring and make sure cable is ok. Replace if necessary.</i>                                                                                                                        |
| <b>Compensator is unstable</b>                                                 |                                                                                                                                                                                             |
| reason                                                                         | Compensator spool is sticking due to contamination of hydraulic fluid.                                                                                                                      |
| solution                                                                       | <i>Clean hydraulic system, clean compensator valve.</i>                                                                                                                                     |
| reason                                                                         | Compensator differential pressure changed (too low or too high)                                                                                                                             |
| solution                                                                       | <i>Adjust compensator differential pressure to required setting.</i>                                                                                                                        |
| reason                                                                         | Wrong pilot orifice or pressure pilot valve improperly selected.                                                                                                                            |
| solution                                                                       | <i>Select pilot orifice and pressure pilot valve as recommended.</i>                                                                                                                        |
| reason                                                                         | Dynamic critical system, e. g.: pressure compensator combined with pressure reducing valve, load sensing (flow) compensator combined with flow control valve.                               |
| solution                                                                       | <i>use remote pressure compensator instead of standard pressure compensator, install orifice in load sensing line remote from compensator (as close as possible to load sensing valve).</i> |

**For additional information, spare parts or service requirements please contact:**

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## Installation and setup manual

### Important settings and diagnosis values

#### Settings / diagnosis values

| size/<br>code | max.<br>displacement<br>[cm <sup>3</sup> /rev] | diagnosis signal<br>at V <sub>G</sub> max<br>[Volt <sub>-0,5</sub> ] | LVDT signal<br>at V <sub>G</sub> max<br>[Volt ±0,05] | LVDT signal<br>at V <sub>G</sub> min<br>[Volt] | diagnosis signal<br>at V <sub>G</sub> min<br>[Volt] |
|---------------|------------------------------------------------|----------------------------------------------------------------------|------------------------------------------------------|------------------------------------------------|-----------------------------------------------------|
| PV016         | 16                                             | 7,1                                                                  | 6,34                                                 | 7,5                                            | 0,0                                                 |
| PV020         | 20                                             | 8,8                                                                  | 6,03                                                 | 7,5                                            | 0,0                                                 |
| PV023         | 23                                             | 10,0                                                                 | 5,80                                                 | 7,5                                            | 0,0                                                 |
| PV032         | 32                                             | 7,1                                                                  | 6,01                                                 | 7,5                                            | 0,0                                                 |
| PV040         | 40                                             | 8,8                                                                  | 5,63                                                 | 7,5                                            | 0,0                                                 |
| PV046         | 46                                             | 10,0                                                                 | 5,45                                                 | 9,0                                            | 0,0                                                 |
| PV063         | 63                                             | 7,0                                                                  | 6,98                                                 | 9,0                                            | 0,0                                                 |
| PV080         | 80                                             | 8,8                                                                  | 6,38                                                 | 9,0                                            | 0,0                                                 |
| PV092         | 92                                             | 10,0                                                                 | 5,95                                                 | 9,0                                            | 0,0                                                 |
| PV140         | 140                                            | 7,9                                                                  | 5,07                                                 | 9,0                                            | 0,0                                                 |
| PV180         | 180                                            | 10,0                                                                 | 3,95                                                 | 9,0                                            | 0,0                                                 |
| PV270         | 270                                            | 10,0                                                                 | 3,95                                                 | 9,0                                            | 0,0                                                 |

#### Max. horse power and according horse power command

| size/<br>code | max. horse<br>power approx.<br>[kW] | command for<br>max. power<br>[V] |
|---------------|-------------------------------------|----------------------------------|
| PV016         | 15,5                                | 7,0                              |
| PV020         | 19,5                                | 8,7                              |
| PV023         | 22,5                                | 10,0                             |
| PV032         | 31,0                                | 7,0                              |
| PV040         | 39,0                                | 8,7                              |
| PV046         | 45,0                                | 10,0                             |
| PV063         | 61,5                                | 6,8                              |
| PV080         | 78,0                                | 8,7                              |
| PV092         | 89,5                                | 10,0                             |
| PV140         | 136,0                               | 7,8                              |
| PV180         | 175,0                               | 10,0                             |
| PV270         | 263,0                               | 10,0                             |

#### Calculation example:

A PV080 is to be driven with an input horse power of 37,5 kW. Max. horse power for a PV080 is 78 kW. The voltage (command) input according to this horse power is 8.7 V as shown in the table left side.

To adjust a horse power limit of 37,5 kW a command voltage of

$$37,5 \text{ kW} / 78,0 \text{ kW} \times 8,7 \text{ V} = 4,2 \text{ V}$$

must be supplied to the horse power command input. A current command (for module with current input 0 - 20 mA) must be set to **8,2 mA** accordingly.



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