Bulletin Hy11 PVI017/GB

Installation and setup manual Electro-hydraulic control for PV series

Design series ≥ 40, PV*plus*

Variable displacement axial piston pump

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

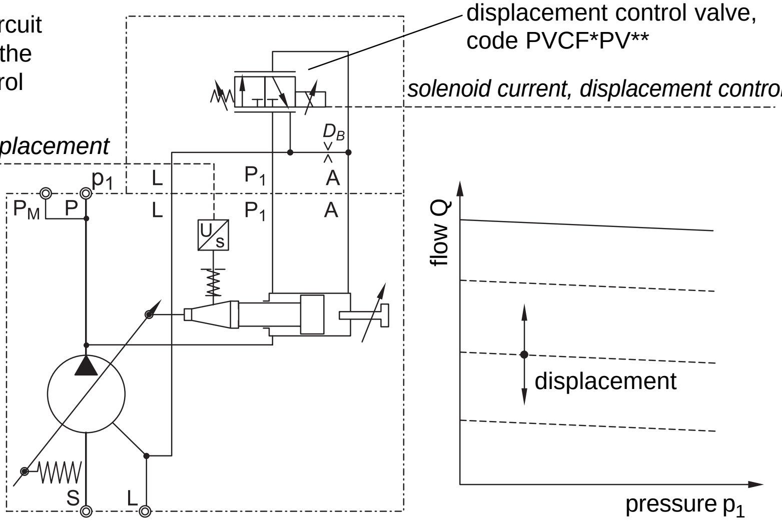
contents **page**

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

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



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).

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.

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.

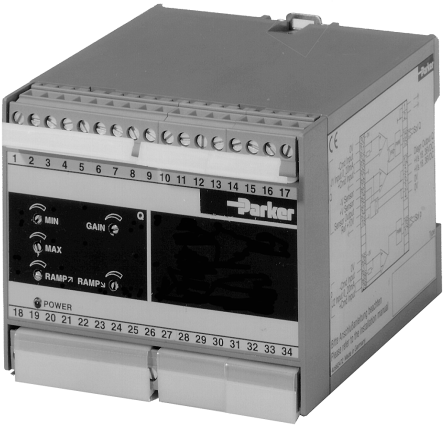


Figure 2: electronic module PQ0*-F00

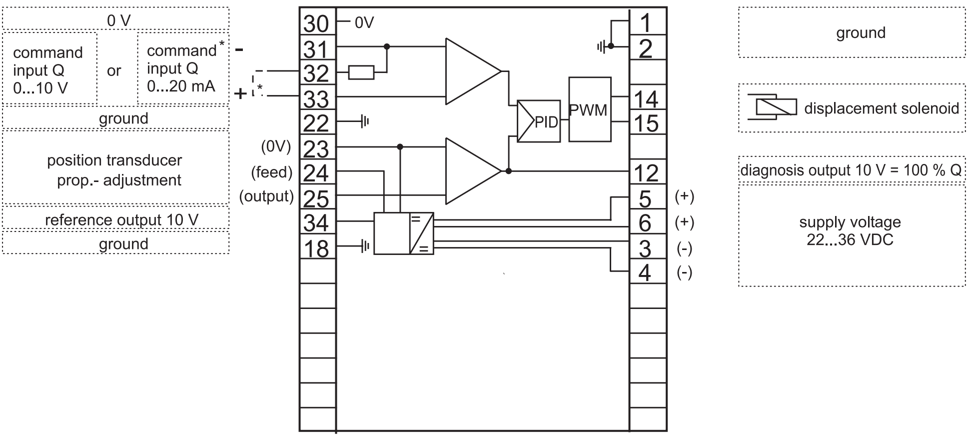
The modules are designed for snap track mounting according to EN 50022.

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).



* jumper for current input
(command input 0 - 20 mA)

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

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 by optimized to the desired displacement range. A MIN potentiometer allows the adjustment of a minimum displacement, which ist 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.

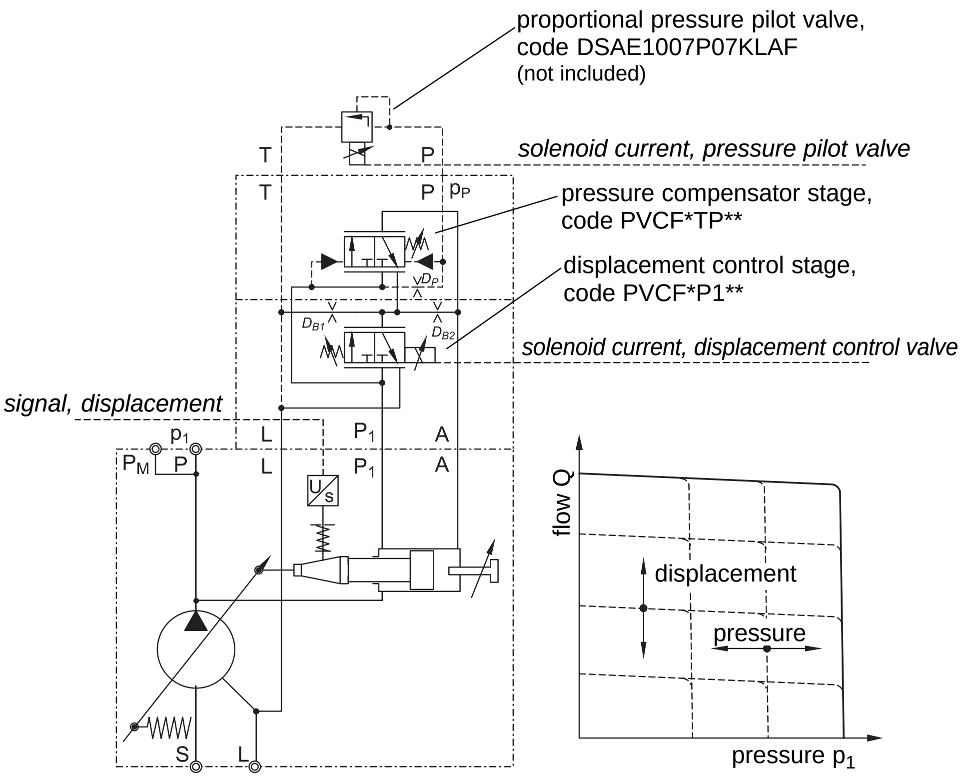


Figure 4: hydraulic circuit of the ...FPR / ...FPZ control

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 ± 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.

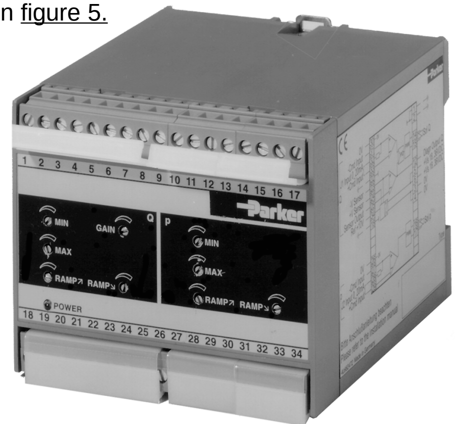


Figure 5: electronic module PQ0*-P00

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.

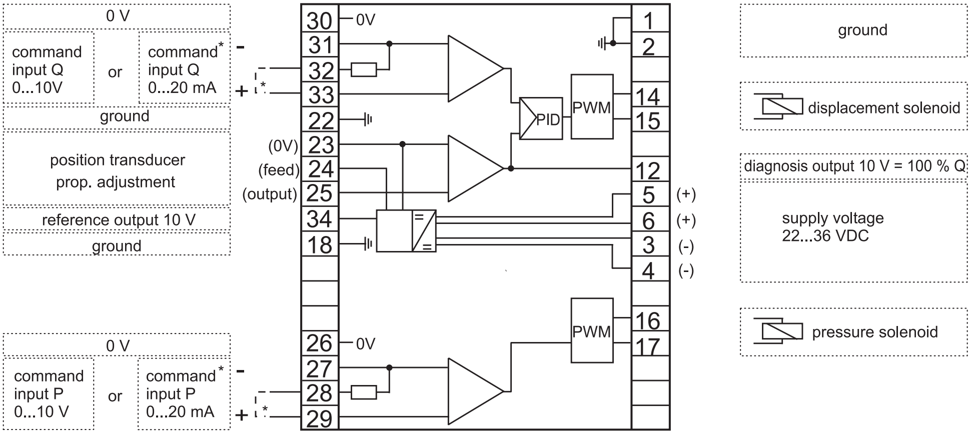


Figure 6: electronic circuit of module PQ0*-P00

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 commend range easily can be adjusted to any smaller nominal system pressure. In this way also for these lower pressures full resolution of the input commend 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).

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.

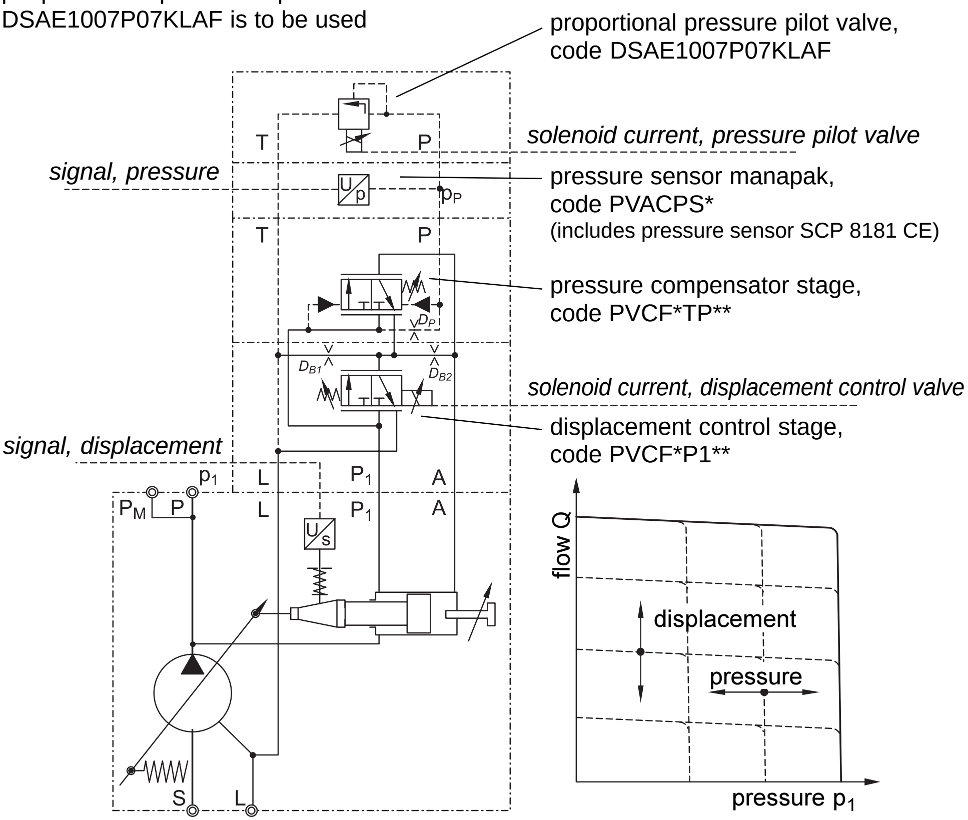


Figure 7: hydraulic circuit of the ...FPG control

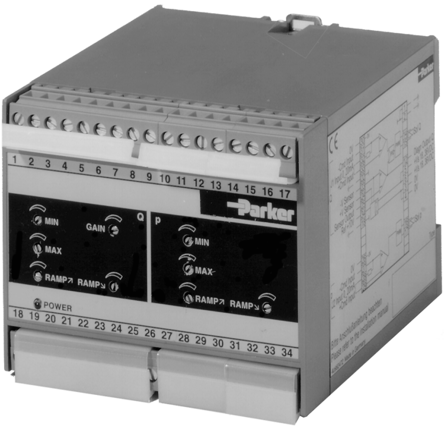


Figure 8: electronic module PQ0*-Q00

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.

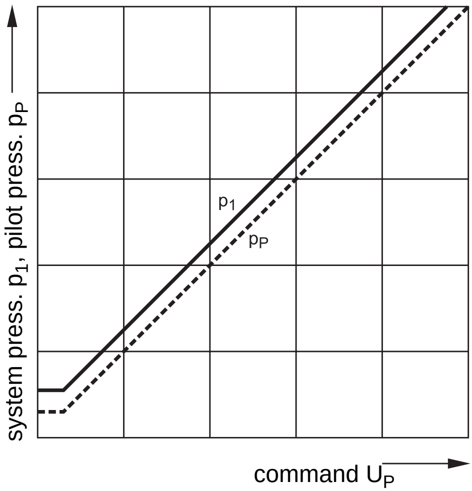
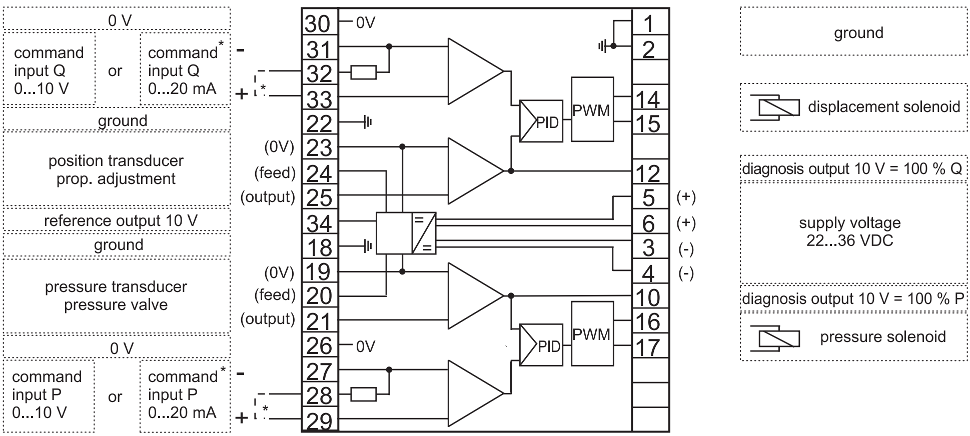


Figure 10: pressures over input signal



* jumper for current input
(command input 0 - 20 mA)

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.

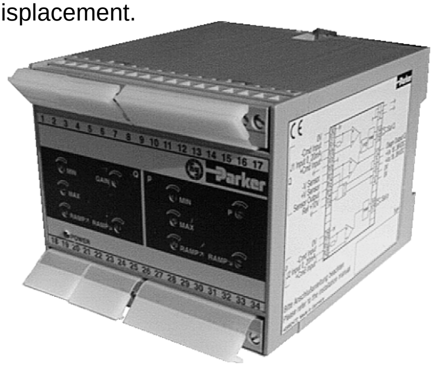


Figure 11: electronic module PQ0*-L00

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.

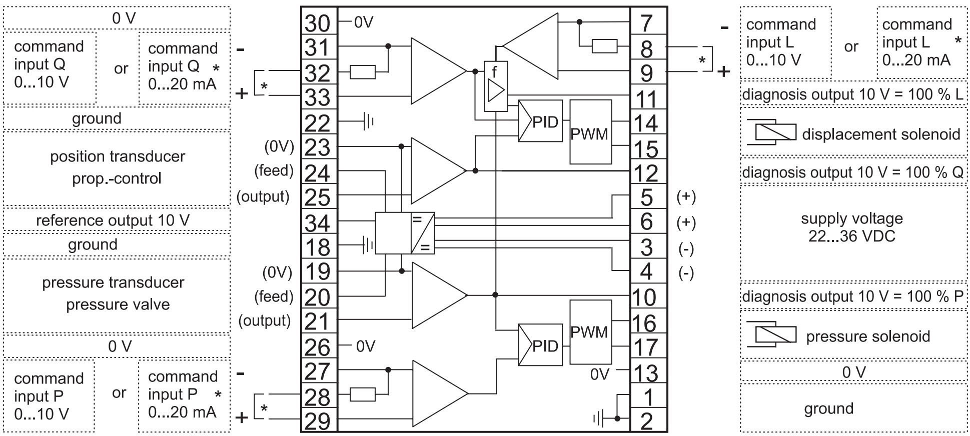
If the effective horse power exceeds the commanded horse power, the displacement command is reduced accordingly.

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.



* jumper for current input
(command input 0 - 20 mA)

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 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).

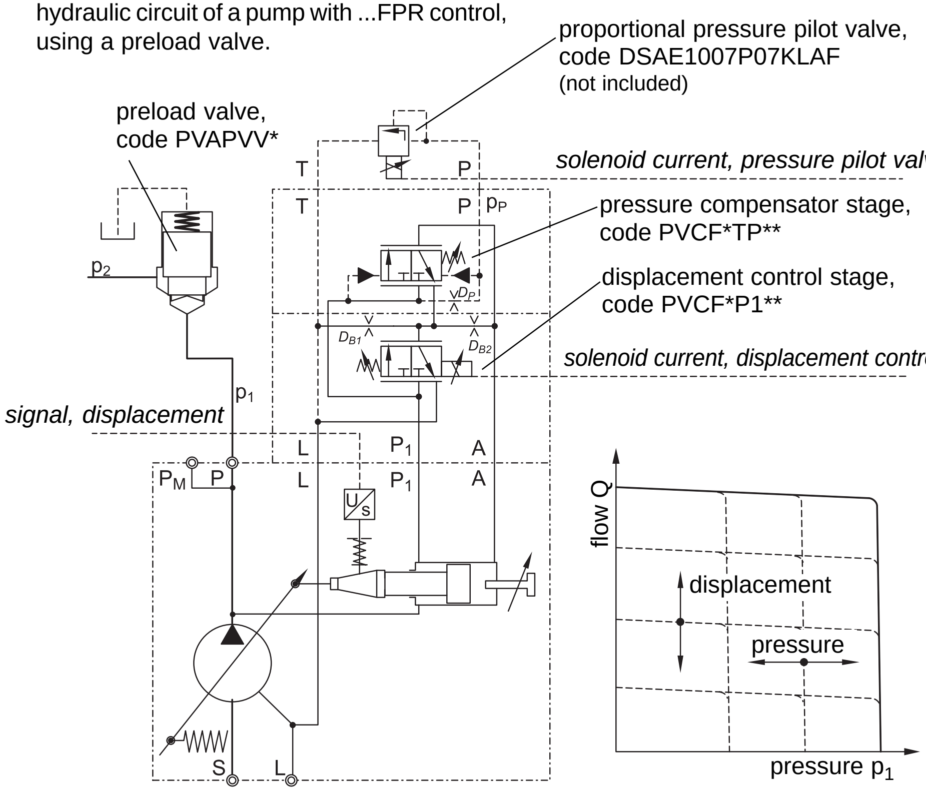
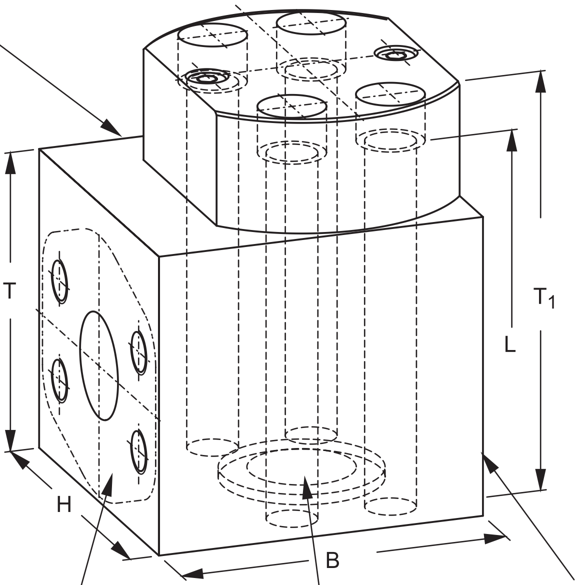


Figure 13: hydraulic circuit of a pump with ...FPR control and preload valve

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.



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_1[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
$Q_{nominal}$[l/min]	160	160	300	300	550

*: optional for PV063 - PV180, thread option 4

5. Shuttle valve subplate for proportional controlled pumps, code ...WPV, ...WPR, ...WPZ, ...WPG

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.

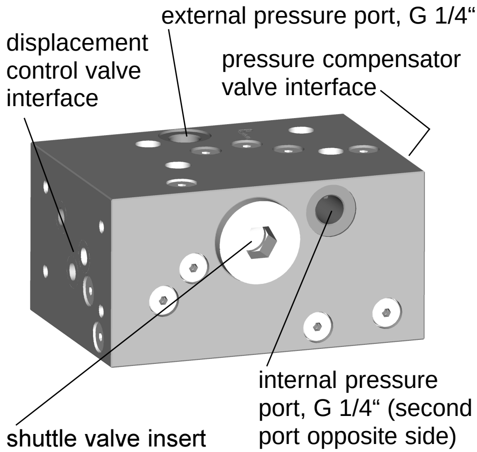


Figure 16:shuttle valve subplate for p-Q-controlled pumps, code ...WPR

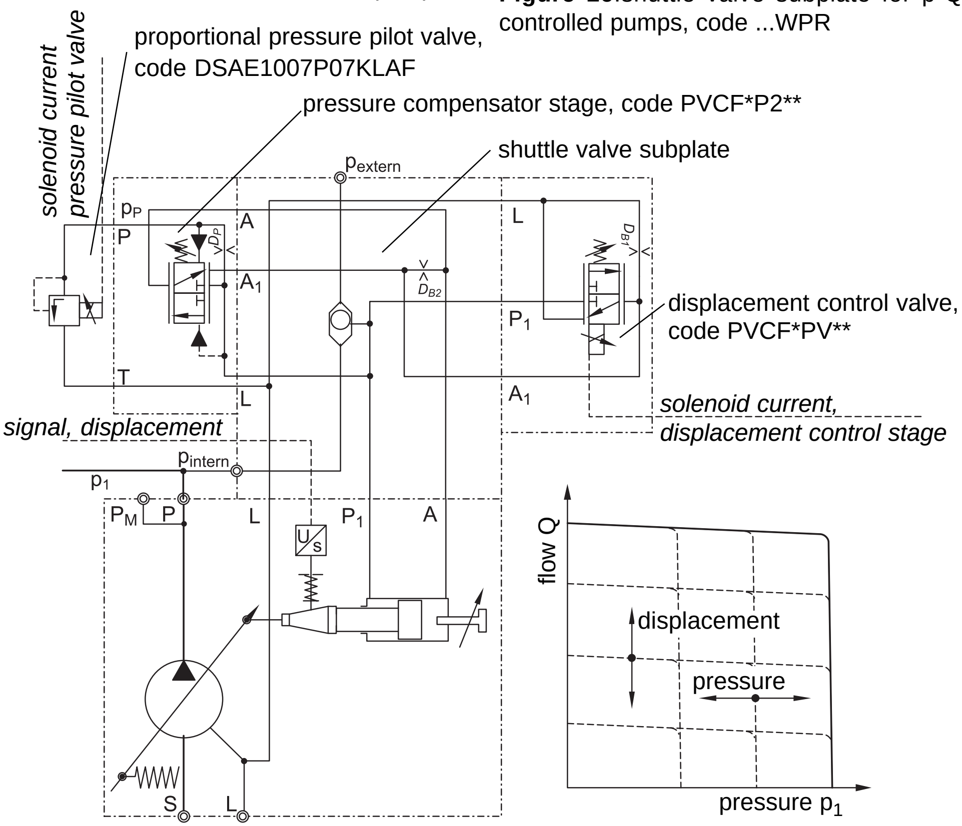


Figure 15: hydraulic circuit of a pump with ...WPR control (with shuttle valve subplate)

5. Quick pressure relief with quick unload valve, code PVAPSE* in combination with controls code ...FPS resp. ...FPT

When working with proportional pressure controlled pumps there is a handicap compared to valve controlled systems: when switching to a lower pressure setting the system pressure does not follow immediately the input signal.

Reason for this is the fact, that a pump can supply flow but cannot take flow to relief a system. To decrease the pressure in a system, compression volume has to be taken away in order to reduce the pressure. A pump only can be downstroked to deadhead and pressure can only decrease due to leakage and pilot power requirements. That can take up to several seconds.

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.

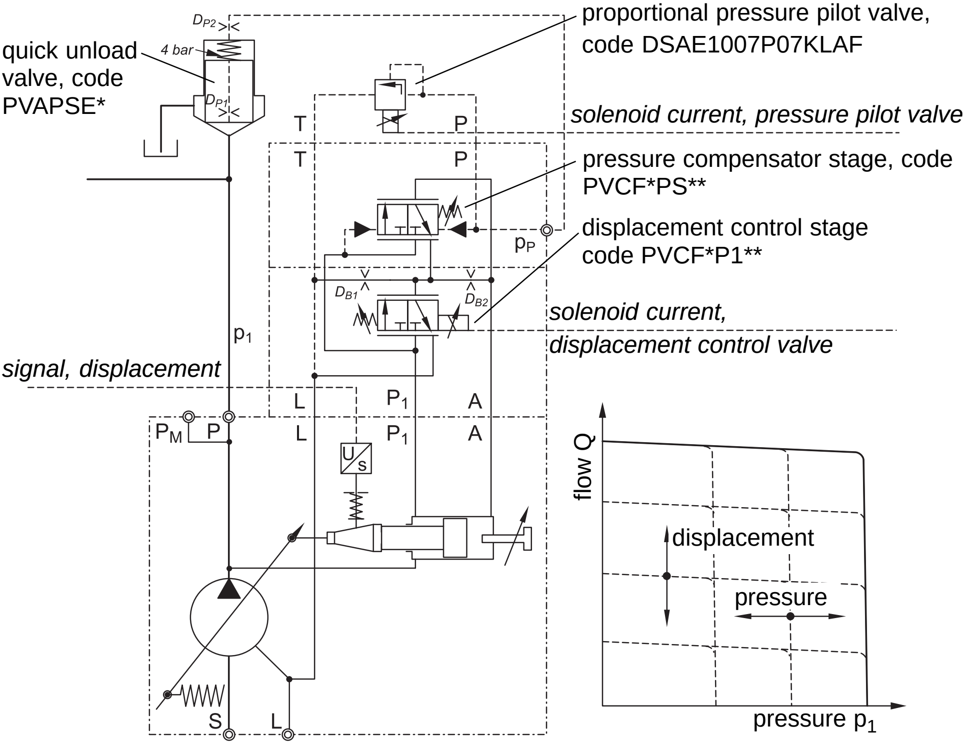


Figure 17: hydraulic circuit of an ...FPS control with quick unload valve manifold

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.

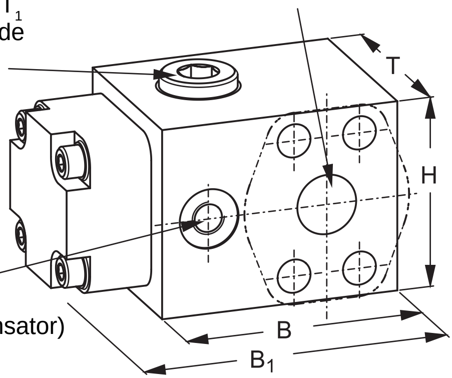


Figure 18: quick unload manifold

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_1[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
$Q_{nominal}$[l/min]	160	160	160	160	300
G (port T_1, T_2)	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 mainfold code PVAPVS* combines preload and quick unload function. Also here the * stands for pump frame size, seal material and screw option.

This manifols 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.

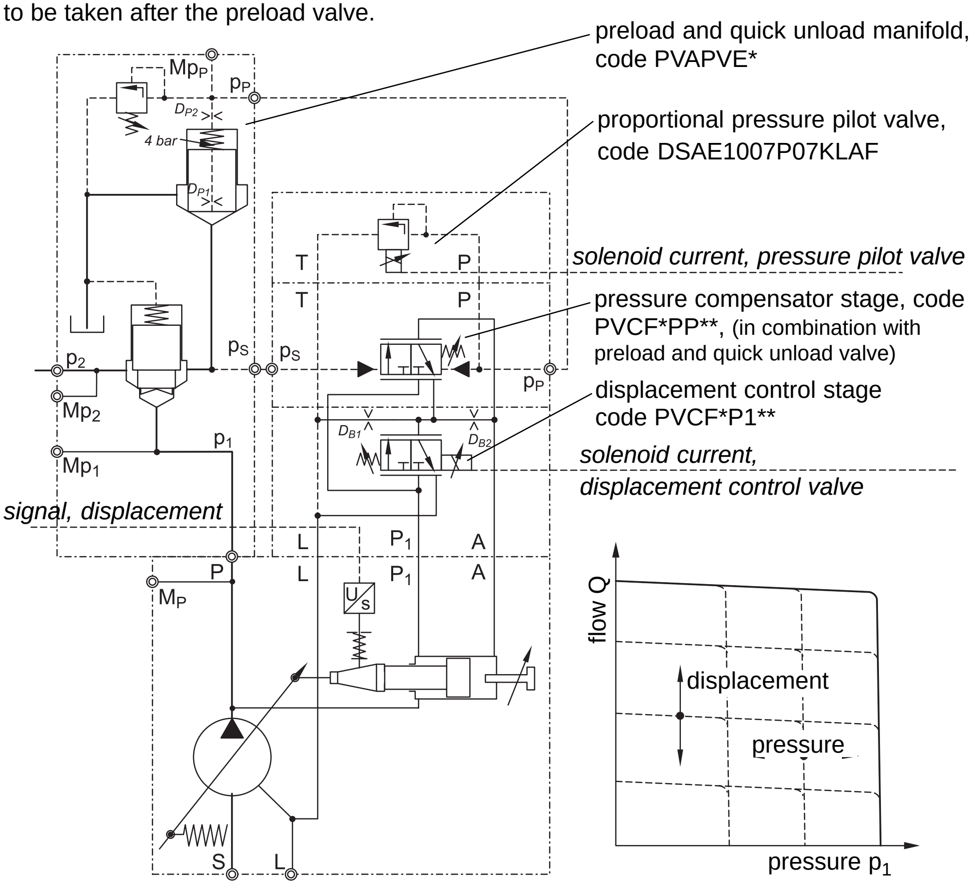


Figure 19: hydraulic circuit of the ...FPS control with preload and quick unload manifold

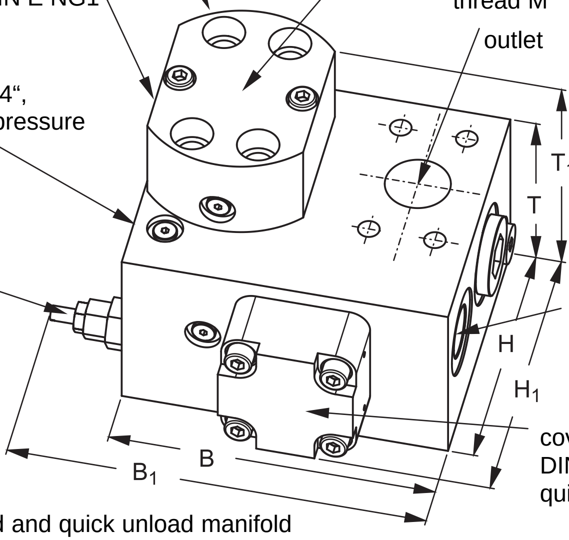


Figure 20: preload and quick unload manifold

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

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-adjustemnt is only necessary after repair.

LVDT for displacement feedback:

Prior to a basic setting the adjustment of the armature lentgh 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^3	64,0
BG2	32 - 46 cm^3	64,0
BG3	63 - 92 cm^3	65,5
BG4	140-180 cm^3	65,5
BG5	270 cm^3	65,5

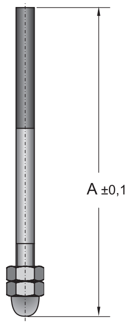


Figure 21: setting dimension for LVDT armature

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 (± 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 ± 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.

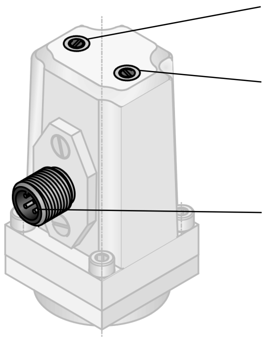


Figure 21: inductive positon transducer (LVDT), outside view

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.

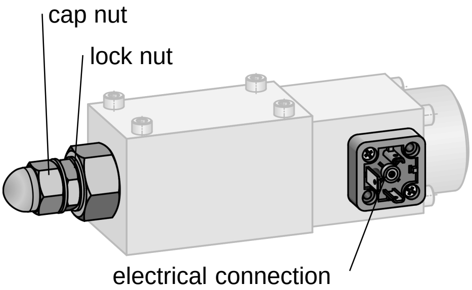


Figure 23: displacement control valve

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).

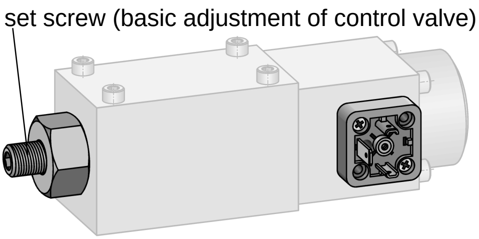


Figure 24: proportional displacement control valve with open set screw

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:

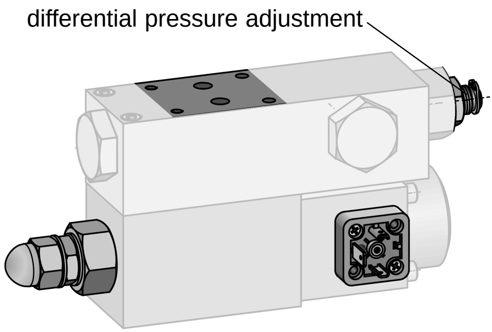


Figure 25: proportional p-Q-control

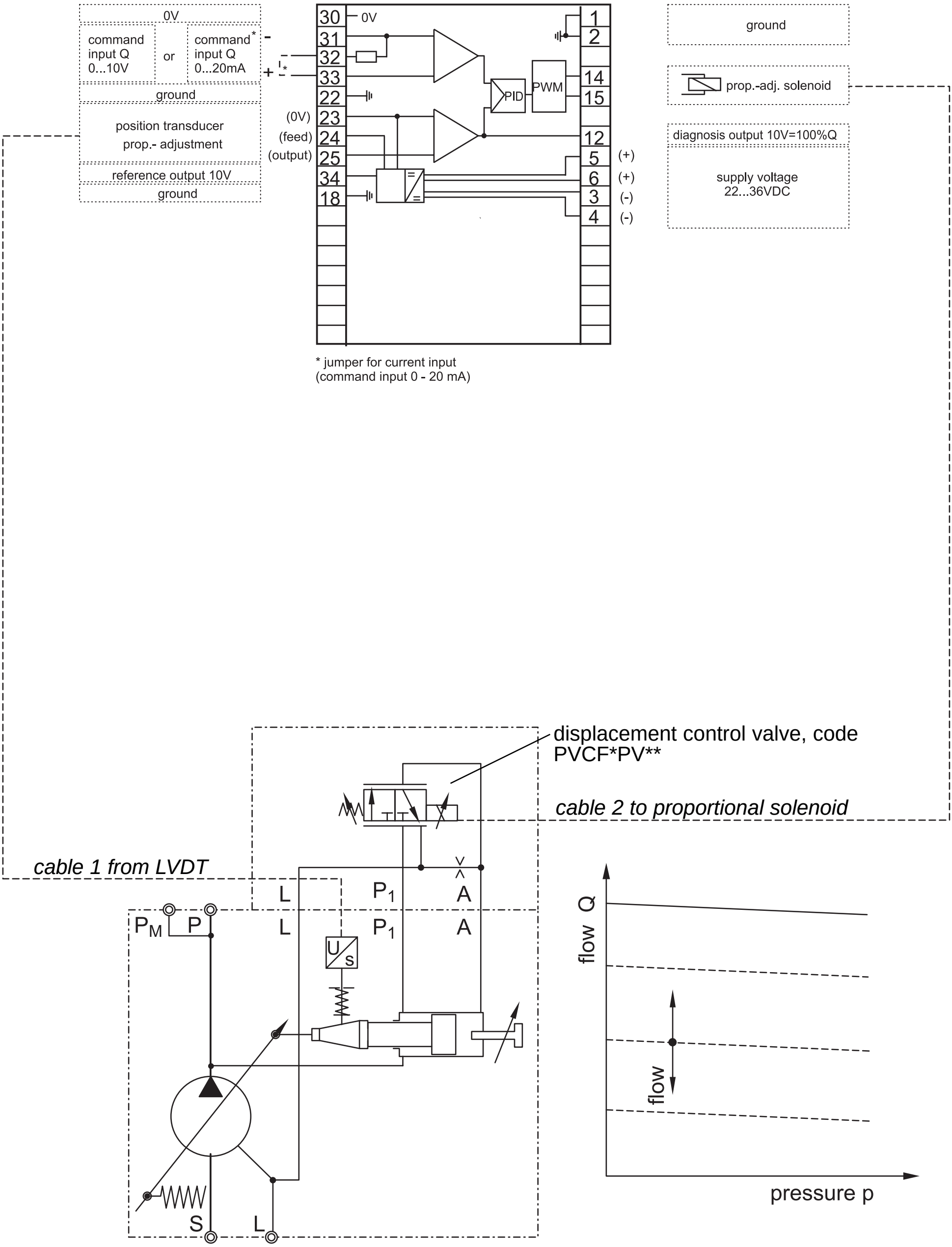
The factory setting for the differential pressure is 12 ± 1 bar. For re-adjustment two preeure gages / transducers are required. The differential pressure to be adjusted is the difference between the two pressures on both sides of the control spool of the pressure compensator stage in a control situation. 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.

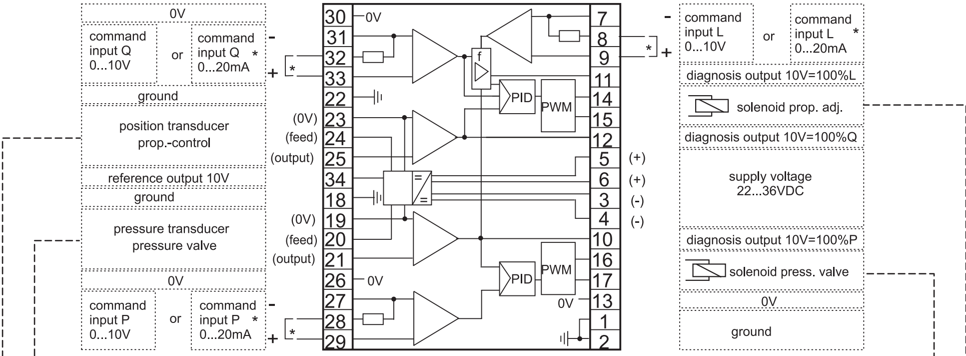
The leads to a minimum compensation pressure of 12 bar at completely unloaded spring chamber.

Connecting diagram for proportional displacement control; code ..FPV

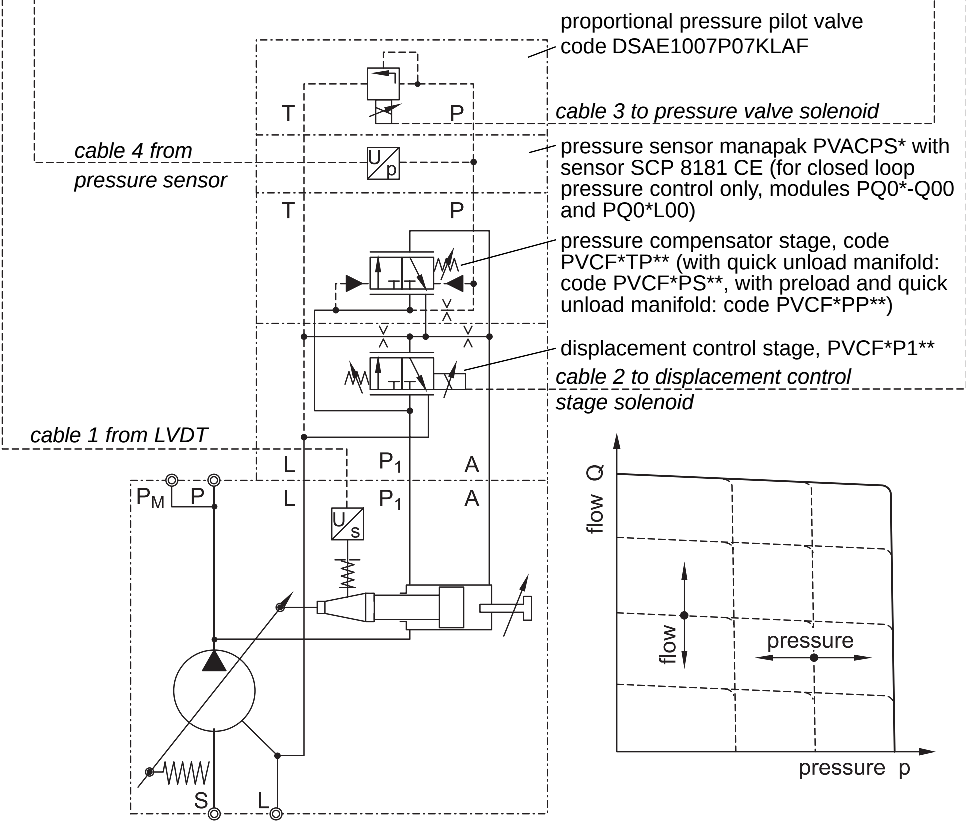
(cable description see page 22)



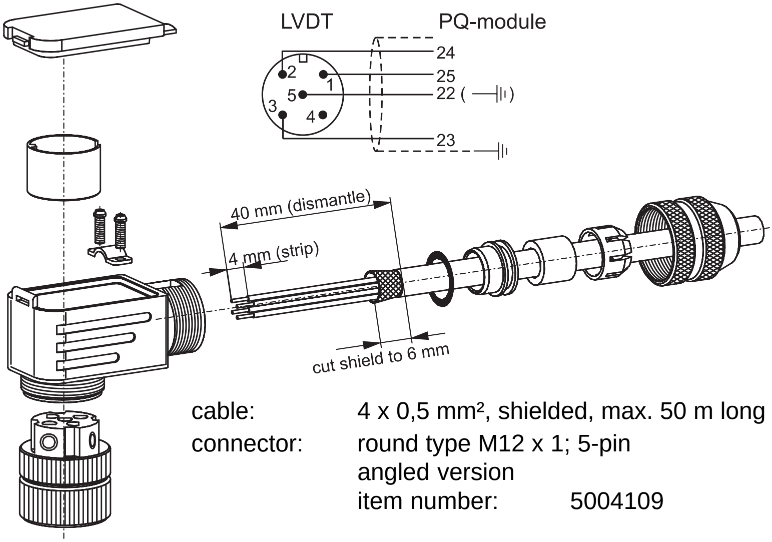
Connecting diagram for p-Q-control; codes ..FPR, ...FPZ, ...FPG, ...FPS, ...FPT, ...FPP and ...FPE (cable descriptions see pages 22 and 23)



* jumper for current input
(command input 0 - 20 mA)



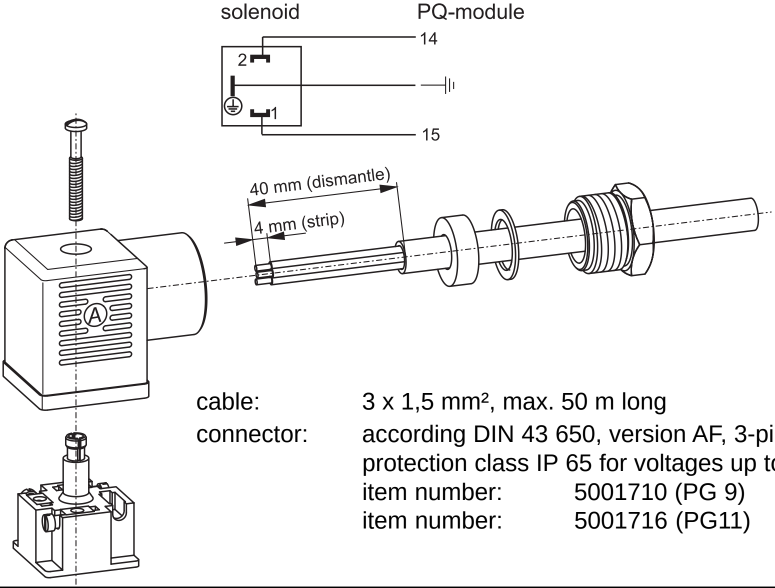
Cable 1 from LVDT (displacement transducer)



cable:	4 x 0,5 mm², shielded, max. 50 m long
connector:	round type M12 x 1; 5-pin
	angled version
	item number: 5004109

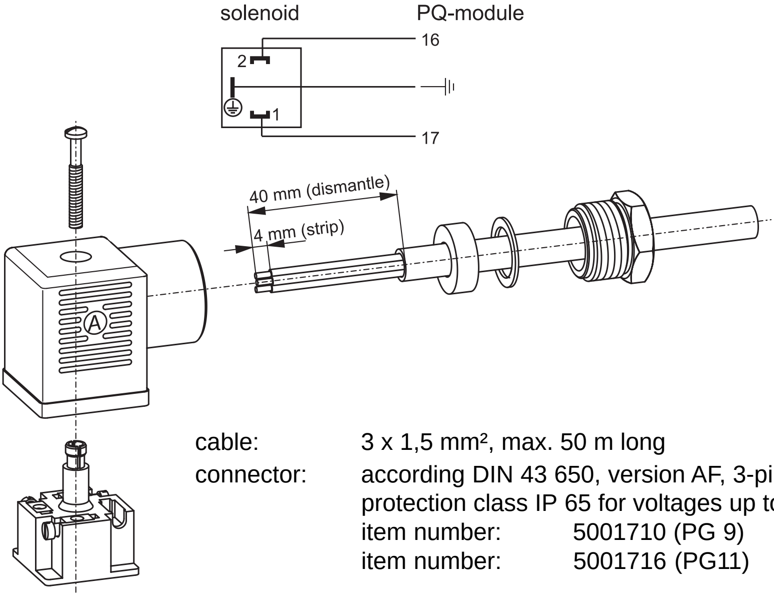
Alternative: shielded cable with molded connector; in different length and variations available e. g. through companies Amphenol, Heilbronn and Vogel, Renchingen.
This solution is recommended for dynamic stressed systems (vibrations) due to the lower connector weigth.

Cable 2 to displacement control valve (displacement control)



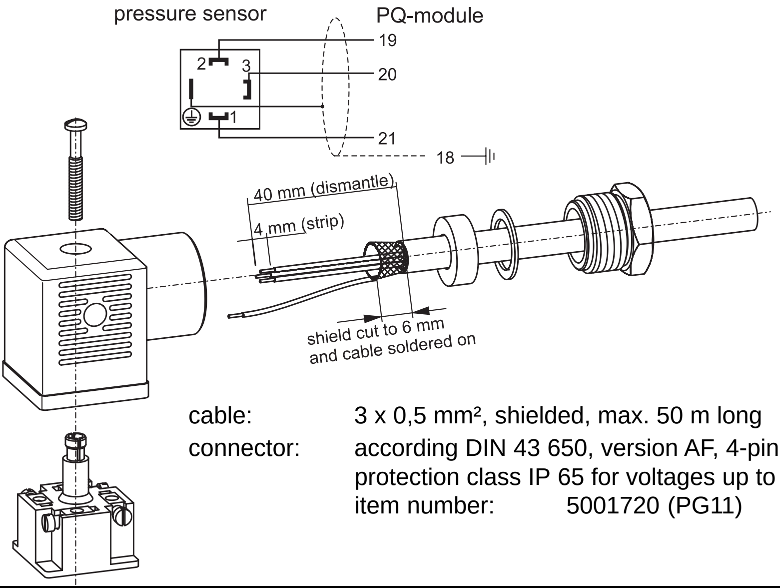
cable:	3 x 1,5 mm², max. 50 m long
connector:	according DIN 43 650, version AF, 3-pin
	protection class IP 65 for voltages up to 250V
	item number: 5001710 (PG 9)
	item number: 5001716 (PG11)

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



cable: 3 x 1,5 mm², max. 50 m long
connector: according DIN 43 650, version AF, 3-pin
protection class IP 65 for voltages up to 250V
item number: 5001710 (PG 9)
item number: 5001716 (PG11)

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



cable: 3 x 0,5 mm², shielded, max. 50 m long
connector: according DIN 43 650, version AF, 4-pin
protection class IP 65 for voltages up to 250V
item number: 5001720 (PG11)

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 e 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	*Fille 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 ingression.*
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_R.
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.*

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

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

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Important settings and diagnosis values

Settings / diagnosis values

size/ code	max. displacement [cm³/rev]	diagnosis signal at $V_G$max [Volt $_{-0,5}$]	LVDT signal at $V_G$max [Volt $\pm 0{,}05$]	LVDT signal at $V_G$min [Volt]	diagnosis signal at $V_G$min [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 comand

size/ code	max. horse power approx. [kW]	command for max. power [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 kW / 78,0 kW x 8,7 V = 4,2 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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