

Technical Information

PVE Series 4 and PVHC Electrohydraulic Actuators



Revision history*Table of revisions*

Date	Changed	Rev
April 2020	Added note to PVE Control section, updated version number to match online catalogue	0910
	Changed document number from 'BC00000050' to 'BC152886484010'	XX
December 2018	PVEA tech data update.	0808
June 2018	edits to PVE Hysteresis and Ripple topic	0807
April 2018	Safety - minor edits	0806
March 2018	add to Code numbers - PVE accessories	0805
February 2018	Removal of line of text from page 23	0804
2006 - 2017	Various changes.	0102-0803
May 2005	First edition.	0101

Contents

General Information

List of abbreviations for PVG/PVE.....	5
Literature reference for PVG products.....	6
Standards for PVE.....	7
PVE with connector variants.....	7
Warnings.....	8
PVE series 4 introduction.....	8
PVE stands for PVE actuator	8
PVG with PVE structural layout.....	9

Functionality

PVG functionality.....	11
PVE functionality.....	11
PVE hydraulic subsystems.....	11
Variant of hydraulic subsystem: PVEA.....	12
Variant of hydraulic subsystem: PVE with ramp.....	13
Variant of hydraulic subsystem: PVHC.....	13
Mechanical subsystem.....	14
Electronic subsystem.....	14

Safety

Safety and monitoring.....	16
PVG fault monitoring and reaction.....	16
Active fault reaction is activated after 500 ms of error (PVEA: 750 ms).....	16
Passive fault reaction is activated after 250 ms of error (PVEA: 750 ms).....	16
The solenoid valves are disabled when:.....	17
Spool position feedback (-SP).....	17
Direction indication feedback (-DI).....	18
Solenoid disabling function (-NP).....	18
Safety in Application.....	19
Example of a control system for manlift.....	20
Examples of wiring block diagram.....	21

PVE Control

PVE control by voltage.....	23
PLUS+1® Compliant.....	24
ATEX PVE.....	24
PVEU–PVE with fixed control signal range.....	24
PVE controlled with PWM signal.....	24
PVEP control.....	25
PVEO.....	26
PVE ON/OFF activation.....	26
PVE for float spool.....	26
There are two variants of float spool PVBS.....	27
PVHC control.....	28
PVE Hysteresis and Ripple.....	29
Example of PVE use.....	29

Technical Data

PVE operating parameters	32
PVHC control specification.....	33
PVEO and PVEM control specification.....	33
PVEA, PVEH, PVES and PVEU control specification	34
PVEP Technical Data.....	35
PVE dimensions for PVG 32 and PVG 100.....	35
PVE dimensions for PVG 120.....	37
PVEO pinout.....	39
PVEO connection.....	40
PVE standard connection data / pinout	40
PVE standard connections.....	41
Standard PVE with DI.....	42

Contents

Standard PVE with SP.....	42
Standard PVE with NP.....	43
PVHC connection.....	43
PVE with separate float pin.....	44
PVEP with controlled PWM.....	44

Warnings

PVE warnings.....	46
-------------------	----

Code Numbers

PVE code numbers for PVG 32 and PVG 100 use.....	47
PVE code numbers for use on PVG 120.....	48
PVE accessories.....	49
Connector code numbers at other suppliers	50
PVED-CC code numbers for use on PVG 32 and PVG 100.....	50

General Information

List of abbreviations for PVG/PVE

Abbreviation	Description
ASIC	Application Specific Integrated Circuit - the part of the PVE where spool position is controled to follow setpoint
ATEX	Certificated for use in explosive environment
AVC	Auxillery Valve Comand - ISOBUS/J1939 standard signal for valve control
AVCTO	Auxillery Valve Comand Time Out - Fault monitoring setting
AVEF	Auxillery Valve Estimated Flow - ISOBUS/J1939 standard signal for valve feedback
CAN	Controller Area Network - Communication method used by PVED
CLC	Closed Loop Circuit
CRC	Cyclic Redundancy Check - Method for ensuring validity of data.
-DI	PVE with Direction Indication
DM1	Diagnostic Message 1 - J1939 message informing about present fault
DM2	Diagnostic Message 2 - J1939 message informing about fault history
DM3	Diagnostic Message 3 - J1939 message clearing fault history
DSM	Device State Machine. Deterministic description of system process
ECU	Electronic Control Unit
EH	Electrohydraulic
-F	PVE for Float spool. Two variants: 4 pin with float at 75%. 6 pin with separate float.
FMEA	Failure Mode Effect Analysis
ISOBUS	Communication standard for CAN
J1939	Communication standard for CAN
LED	Light Emitting Diode
LS	Load Sensing
LVDT	Linear Variable Differential Transducer - Position sensor
NC	Normally Closed solenoid valve in PVE
NC-H	Normally Closed standard solenoid valve in PVEH
NC-S	Normally Closed solenoid valve Super in PVES
NO	Normally Open solenoid valve in PVE
PLC	Programmable Logical Circuit
PLUS+1®	Trademark for Danfoss controllers and programming tool
POST	Power On Self Test. Boot up evaluation for PVED
Pp	Pilot Pressure. The oil gallery for PVE actuation
PVB	Proportional Valve Basic module - valve slice
PVBS	Proportional Valve Basic module Spool
PVBZ	Proportional Valve Basic module Zero leakage
PVE	Proportional Valve Electric actuator
PVEA	PVE variant with 2-6 % hysteresis
PVED	PVE variant Digital controlled via CAN communication
PVEH	PVE variant with 4-9% Hysteresis
PVEM	PVE variant with 25-35% hysteresis
PVEO	PVE variant with ON/OFF actuation
PVEP	PVE variant PWM controled
PVES	PVE variant with 0-2% hysteresis
PVEU	PVE variant with US 0-10V
PVG	Proportional multi-section Valve Group
PVHC	PV variant with High Current controlled valve actuator

General Information

Abbreviation	Description
PVM	Proportional Valve Manual control with handle
PVP	Proportional Valve Pump side module.Inlet
PVS	Proportional Valve end plate
PVSK	Proportional Valve end plate crane. Inlet module with Spool Control
PWM	Pulse Width Modulation
S4 DJ	Series 4 Digital J1939 service tool software for PVED-CC
SAE	Society Automotive Engineering
-R	PVE with Ramp function
-NP	PVE with solenoid disable in Neutral Position
-SP	PVE with Spool Position feedback
uC	Microcontroller
uCSM	Microcontroller State Machine
U_{DC}	Power supply Direct Current; also called V_{bat} for battery voltage
U_S	Steering voltage for the PVE control; also called V_S

Literature reference for PVG products

Literature reference

Literature title	Type	Order number
PVG 32 Proportional Valve Group	Technical Information	BC152886483664
PVG 100 Proportional Valve Group	Technical Information	BC152886483475
PVG 120 Proportional Valve Group	Technical Information	BC152886483344
PVG 32 Metric ports	Technical Information	BC152886484163
PVE Series 7	Technical Information	BC173386484192
PVE Series 4	Technical Information	BC152886484010
PVED-CC Electro-hydraulic actuator	Technical Information	520L0665
PVED-CX Electro-hydraulic actuator	Technical Information	BC152886483682
PVE-CI	Technical Information	BC163786485206
Basic module for PVBZ	Technical Information	BC152886484167
PVSK module with integrated diverter valve and P-disconnect function	Technical Information	BC152886484133
PVPV / PVPM pump side module	Technical Information	BC152886484316
Combination module PVGI	Technical Information	BC152886483392
PVSP/M Priority module	Technical Information	BC152886484066
Hitch Control	System Description	AB152886482484
	User Manual	11033753

General Information

Literature reference (continued)

Literature title	Type	Order number
PVBZ	Data Sheet	AI152886482357
PVBZ-HS	Data Sheet	AI152886482219
PVBZ-HD	Data Sheet	AI152886482140
MC024-010 and MC024-012 Controllers	Data Sheet	AI152886480785

Standards for PVE

- International Organization for Standardization ISO 13766 Earth moving machinery - *Electromagnetic compatibility*.
- EN 50014:1997 +A1, A2: 1999
- EN 50028: 1987. For ATEX approved PVE
 - IEC EN 61508
 - ISO 12100-1 / 14121
 - EN 13849 (Safety related requirements for control systems)
 - Machinery Directive 2006/42/EC" (1st Edition December 2009)

PVE with connector variants

Hirschmann/DIN variant



DEUTSCH variant



AMP variant



General Information

Warnings

Before implementing actuators in any application, read all warnings. Warnings are listed next to the most relevant section and repeated in the chapter [PVE-EX warnings](#).

Do not regard the warnings as a full list of potential risks. Depending on the application and use, other potential risks can occur.

Warning

All brands and all types of directional control or proportional valves, which are used in many different operation conditions and applications, can fail and cause serious damage.

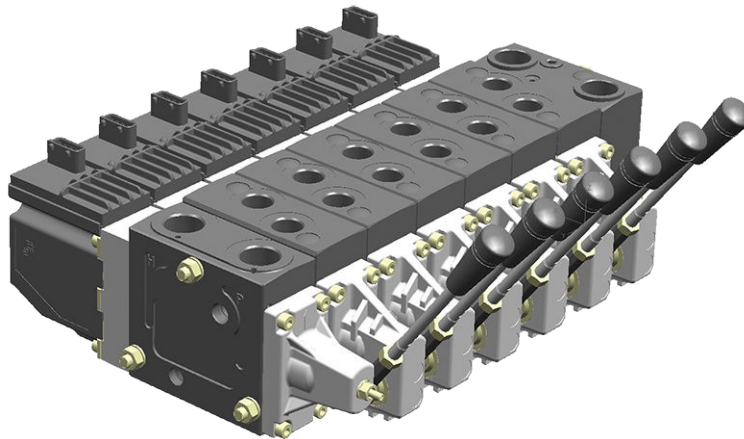
You must perform a risk assessment. The machine builder/system integrator alone is responsible for making the final selection of the products and assuring that all performance, safety and warning requirements of the application are met.

The process for choosing the control system and safety levels is governed by the Machinery Directive 2006/42/EC and EU harmonized standard EN 13849 (Safety related requirements for control systems).

PVE series 4 introduction

PVE Series 4 is the common name for the Danfoss PVG electrical actuator. This technical information covers our voltage controlled PVE and our current controlled PVHC actuator. For the PVHC please see in the PVHC section. The digital actuators PVED-CC and PVED-CX are covered in their special technical information.

PVE controlled PVG with PVSK



PVE stands for PVE actuator

The Danfoss PVE is built on more than thirty years experience of electrical valve control and is the perfect fit for our high performance proportional valves PVG 32, PVG 100 and PVG 120, as it is for our EH steering.

All our products are developed in close cooperation with system manufacturers from the mobile hydraulic market. That is the reason for our high performance in all market segments

The PVE can be controlled from a switch, a joystick, a PLC, a computer or a Danfoss PLUS+1[®] microcontroller. The PVE is available in multiple variants. A short list here just gives the main variations.

Available PVE variants

Actuation	On/Off
	Proportional - Closed loop controlled
	Proportional - Direct control

General Information

Available PVE variants (continued)

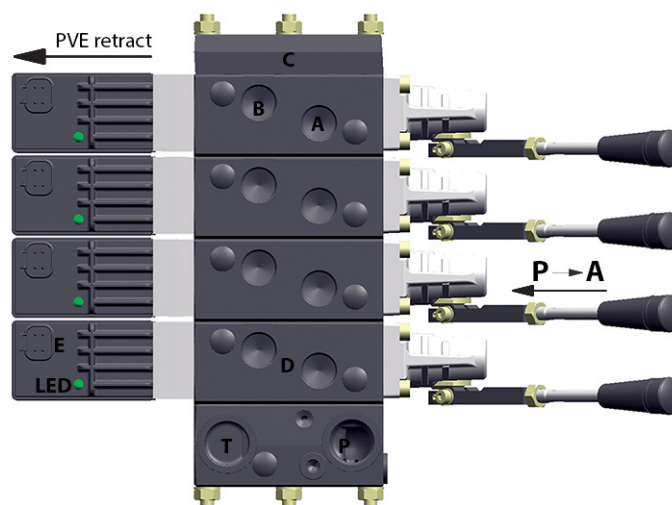
Control signal	Voltage
	PWM
	Current (PVHC)
Precision	Standard precision
	High precision
	Super high precision
Feedback	Spool position
	Direction indicator
	Error
	None
Connectors	DEUTSCH
	AMP
	DIN/Hirschmann
Fault detection and reaction	Active
	Passive
	None
Power supply	11 V – 32 V multi-voltage
	12 V
	24 V

PVG with PVE structural layout

The PVG is a sectional spool valve stack with up to 12 individually controlled proportional valves. The PVG with the PVE can be operated as single valves or several valves in cooperation. The oil flow out of the work section (A- or B-port) can be controlled by a combination of the following:

- PVE controlling the spool position using pilot oil pressure.
- A handle (PVM) in mechanical interface with the spool.

PVG 32 structural lay-out with naming

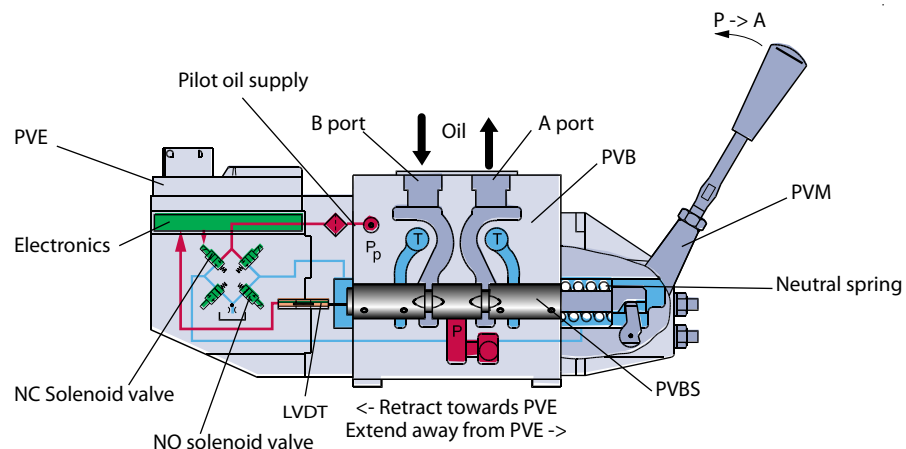


Legend:

- A – A-port
- B – B-port
- C – PVS end plate
- D – PVB basic module
- E – Connector Pin
- T – Tank port
- P – Work flow

General Information

Valve section - standard mounted - seen from PVP with naming



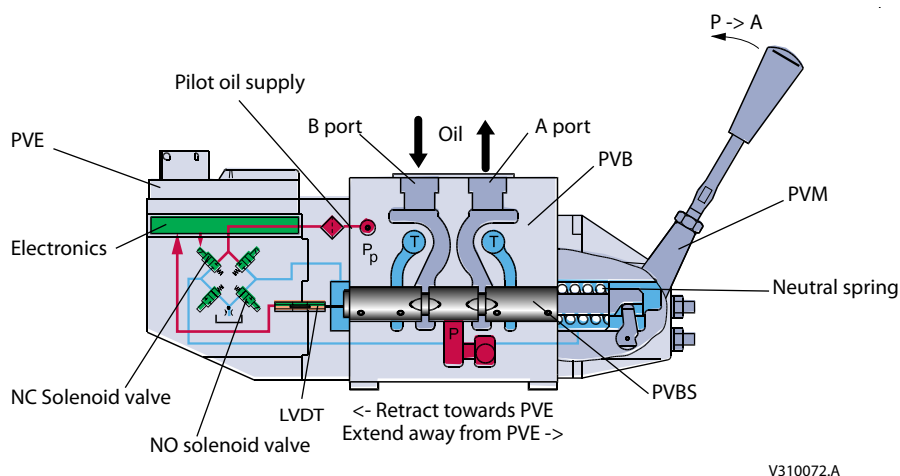
V310072.A

Functionality

PVG functionality

This chapter will give an overview of the PVG and its functionality.

Valve section with naming - standard mounted - seen from PVP



The PVG valve distributes oil from pump flow to a particular work function in the application via a specific valve section. This is done by moving the spool (PVBS).

Depending on the choice of components the oil work flow enters the PVG through the PVP (proportional valve pump side module) or the PVSK (proportional valve end plate for crane) and enters the PVB (proportional valve basic module) via the P gallery and leaves through the T gallery.

In the figure above you see a valve section seen from PVP towards PVSK with the PVM and PVE standard mounted. PVM and PVE can in general be interchanged, that is called option mounted.

With the spool in neutral, where it is kept by the neutral spring, the connection to the application via ports is blocked.

Moving the spool towards the PVE, as in figure 4, opens a connection between P and A and also between B and T. This is done by either pushing the PVM or sending a retract command to PVED. The PVED move the spool by letting Pilot Oil Pressure (P_p) push on the right end of the PVBS and releasing pressure from the left end. For details on PVG please see relevant technical information.

Any PVG with PVM can be operated by PVM alone, independent of a power supply. Any PVG with can monitor PVBS if power and communication conditions are present.

PVE functionality

This section has focus on how the PVE works and interacts. The description here is general and variant specific descriptions will all refer to this.

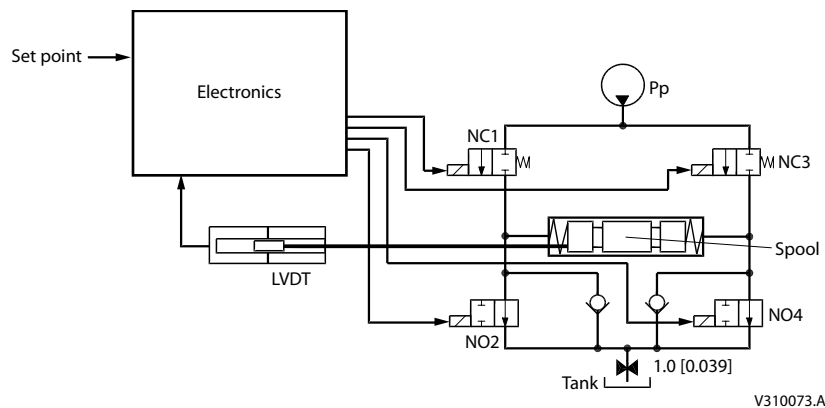
The PVE is an electro mechanical device, meaning that functionality is depending on mechanical, hydraulic, electrical and control conditions given by PVE, PVG, application and vehicle. The result of this is that implementing operation and safety conditions also must include vehicle specific considerations.

PVE hydraulic subsystems

The hydraulic subsystem is used for moving the spool and thereby open the valve for work flow.

Functionality

Pilot oil diagram



The hydraulic subsystem moves the spool and thereby opens the valve for work flow. The heart in the hydraulic subsystem is the solenoid valve bridge which controls the Pilot Pressure (P_p) on spool ends. It consist of four poppet valves, the two upper are normally closed (NC) and the two lower are normally open (NO).

The P_p will work against the PVBS neutral spring when the spool is moved out of blocked (neutral) and together with the spring when going in blocked. This combined with a larger opening in the NO than in the NC will give a faster movement towards blocked than out of blocked.

When the PVE is powered the solenoids are all put in closed state. To move the PVBS to the right NC1 and NO4 are opened and NC3 and NO4 are kept closed.

The activation of the solenoid valves represents oil consumption and thereby also a pressure drop in the pilot oil gallery. By simultaneous use of multiple PVE the P_p can fall and result in performance problems.

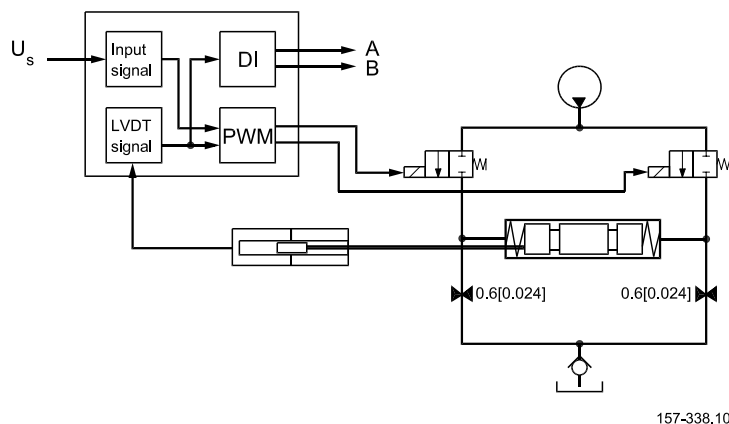
The two check valves next to the NO are anti-cavitation valves. The orifice to tank reduces tank pressure spikes and can also be used for ramp function.

Warning

Obstacles for the Pilot oil pressure (P_p) can have direct influence on spool control. Reduced P_p will limit spool control. Too high P_p can harm the PVE.

Variant of hydraulic subsystem: PVEA

Hydraulic variant: PVEA



Functionality

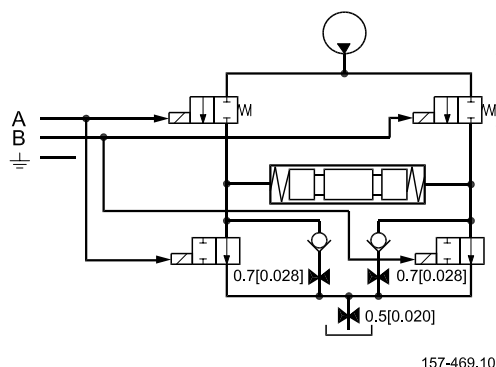
NO2 and NO4 are replaced with orifices.



PVEA is not for use on PVG 100.

Variant of hydraulic subsystem: PVE with ramp

Hydraulic subsystem variant: PVE with ramp



Tank orifice has smaller diameter. With electrical proportional actuation, the main spool position is adjusted so that its position corresponds to an electrical control signal. The control signal is converted into a hydraulic pressure signal that moves the main spool in the PVG. This is done by means of two proportional pressure-reducing valves. The electrical actuator can be controlled either by a current amplifier card, or directly from a programmable microcontroller.

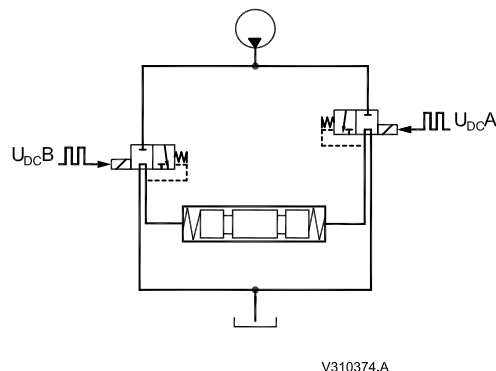
For more information see these technical informations:

- PVG 32 Proportional Valve Groups **BC152886483664**,
- PVG 100 Proportional Valve Groups **BC152886483475** and
- PVG 120 Proportional Valve Groups **BC152886483344**.

Variant of hydraulic subsystem: PVHC

The PVHC does not work as a PVE and does not have transducer, anti cavitation nor protection against tank pressure spikes. It is necessary to use the PVHC in combination with 25 bar [362.6 psi] pilot pressure, and standard FC spools fitted for hydraulic actuation. Because of the 25 bar pilot pressure, it is not possible to combine PVHC with PVE on a PVG.

Hydraulic subsystem variant: PVHC



With electrical proportional actuation, the main spool position is adjusted so that its position corresponds to an electrical control signal. The control signal is converted into a hydraulic pressure signal that moves the main spool in the PVG. This is done by means of two proportional pressure-reducing valves. The

Functionality

electrical actuator can be controlled either by a current amplifier card, or directly from a programmable microcontroller.

For more information see these technical informations:

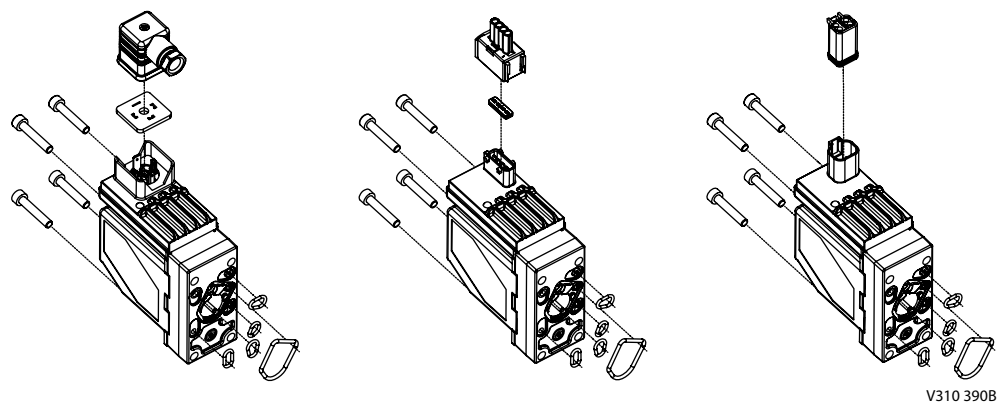
- PVG 32 Proportional Valve Groups **BC152886483664**,
- PVG 100 Proportional Valve Groups **BC152886483475** and
- PVG 120 Proportional Valve Groups **BC152886483344**.

Mechanical subsystem

The mechanical subsystem gives interface to valve and control system and provides protection to hydraulic and electrical/electronic subsystem. The LVDT, not used on all variants, gives feed back to electronics on spool position. The LVDT is calibrated in production and recalibration should only be done in special cases. The standard PVE has an aluminum block for distributing pilot oil. PVE with anodized block are available.

The connector gives the electrical interface to power and control system. Danfoss have a variety of connectors. We know that tradition and the aspects of serviceability are important when our customers choose. We have chosen the Deutsch connector as our main solution. The quality of wiring has direct influence on water integrity and signal quality therefore disturbance or changes in cabling can influence safety and performance.

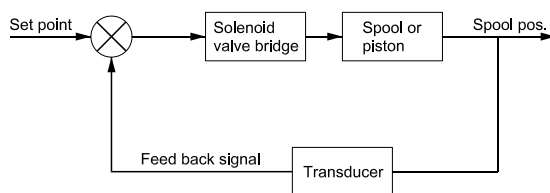
PVE connectors: Hirschmann/DIN, AMP and Deutsch



Electronic subsystem

The PVE (A/H/M/S/U) control signal is a low current voltage, a PWM can also be used. The PVEP has build-in a PWM evaluation and cannot be controlled by proportional voltage. The control signal is referred to as U_s .

Function blocks for electronics



157-503.10

The PVE features Closed Loop Control (CLC). This is made possible by on board electronics and an integrated feedback transducer that measures spool movement. The integrated electronics compensate for flow forces on the spool, internal leakage, changes in oil viscosity, pilot pressure, etc. This results in lower hysteresis and better resolution.

Functionality

In principle the set-point determines the level of pilot pressure which moves the main spool. The position of the main spool is sensed in the LVDT which generates an electric feed-back signal registered by the electronics. The variation between the set-point signal and feed-back signal actuates the solenoid valves. The solenoid valves are actuated so that hydraulic pilot pressure drives the main spool into the correct position.

The **LVDT (Linear Variable Differential Transducer)** is an inductive transducer with very high resolution. When the LVDT is moved by the main spool a voltage is induced proportional to the spool position. The use of LVDT gives contact-free connection between mechanics and electronics. This means an extra long lifetime and no limitation as regards the type of hydraulic fluid used.

The PVEO and PVHC do not have embedded control electronics and do not support closed loop control.

Safety

Safety and monitoring

The choice of PVE also decides the level of feedback and safety. PVE are available with fault monitoring, spool direction indication, spool position feedback and separate float control.

The fault monitoring is available in PVEA/H/S/P/U and is a utilization of the ASIC.

Direction Indication is available in PVEO/A/H and they are dual powered PVE where separate pins give an active feedback for spool movement.

Spool position is available in PVES and is a precise feedback on a separate pin for actual spool position.

The separate float control is a protection against unintended float activation.

The PVEM, PVEO and PVHC do not have fault monitoring.

PVG fault monitoring and reaction

The fault monitoring system is available in two versions:

- Active fault monitoring provides a warning signal and deactivates the solenoid valves. A reboot of the PVE is required to reactivate.
- Passive fault monitoring provides a warning signal only. A reboot is not required.

Both active and passive fault monitoring systems are triggered by the same four main events:

1. Control signal monitoring

The Control signal voltage (US) is continuously monitored. The permissible range is between 15% and 85% of the supply voltage. Outside this range the section will switch into an error state. A disconnected US pin (floating) is recognized as neutral set point.

2. Transducer supervision

The internal LVDT wires are monitored. If the signals are interrupted or short-circuited, the PVE will switch into an error state.

3. Supervision of spool position

The actual position must always correspond to the demanded position (U_S). If the actual spool position is further out from neutral than the demanded spool position or in opposite direction, the PVE will switch into an error state. Spool position closer to neutral and in same direction will not cause an error state. The situation is considered "in control".

4. Float monitoring

Float must be entered or left within a time limit. On the six pin float PVE too high delay will cause an error state. The float Time Outs has own thresholds. Only relevant for the six pin PVEH-F.

Active fault reaction is activated after 500 ms of error (PVEA: 750 ms).

- The solenoid valve bridge is disabled and the PVBS is released to spring control
- The error pin is powered*
- The LED change color
- The state is memorized and continues until PVE reboot

Passive fault reaction is activated after 250 ms of error (PVEA: 750 ms)

- The solenoid valve bridge is NOT disabled and the PVBS is NOT released
- The error pin is powered (for PVE with direction indication both DI pins goes low by fault.)
- The LED change color
- The state is active for minimum 100 ms and is reset when error disappears

Safety

Warning

Error pins from more PVEs may not be interconnected. Not activated error pins are connected to ground and will disable any active signal. Error pins are signal pins and can only supply very limited power consumption.

To avoid the electronics in undefined state a general supervision of power supply (U_{DC}) and internal clock frequency is implemented. This function applies to PVEA, PVEH, PVEP, PVES and PVEU independently of fault monitoring version and PVEM - and will not activate fault monitoring.

The solenoid valves are disabled when:

- the supply voltage exceeds 36 V
- the supply voltage falls below 8.5 V
- the internal clock frequency fails

PVE fault monitoring overview

PVE type	Fault monitoring	Delay before error out	Error mode	Error output status	Fault output on PVE ¹⁾	LED light	Memory (reset needed)
PVEO PVEM PVHC	No fault monitoring	-	-	-	-	-	-
PVEA PVEH PVEP PVES PVEU	Active	500 ms (PVEA: 750 ms)	No fault	Low	< 2 V	Green	-
			Input signal faults	High	$\sim U_{DC}$	Flashing red	Yes
			Transducer (LVDT)			Constant red	
			Close loop fault				
	Passive	250 ms (PVEA: 750 ms)	No fault	Low	< 2 V	Green	-
			Input signal faults	High	$\sim U_{DC}$	Flashing red	No
			Transducer (LVDT)			Constant red	
			Close loop fault				
PVE Float six pin	Active	500 ms	Float not active	High	$\sim U_{DC}$	Constant red	Yes
		750 ms	Float still active				

¹⁾ Measured between fault output pin and ground.

Warning

It's up to the customer to decide on the required degree of safety for the system.

For PVE with direction indication:

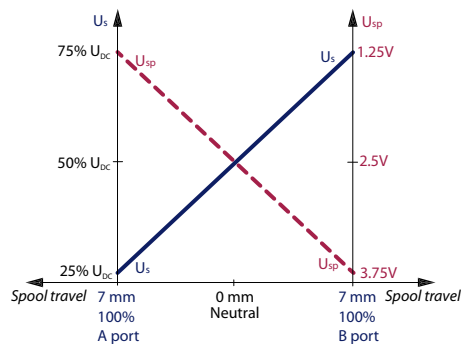
- both DI pins go low when error is active.
- when U_{DC1} is disabled, U_S is not monitored and defined as 50%.

Spool position feedback (-SP)

The -SP functionality is a 1.25 V to 3.75 V feedback, with 2.5 V as neutral value.

Safety

Spool position feedback (-SP)



Direction indication feedback (-DI)

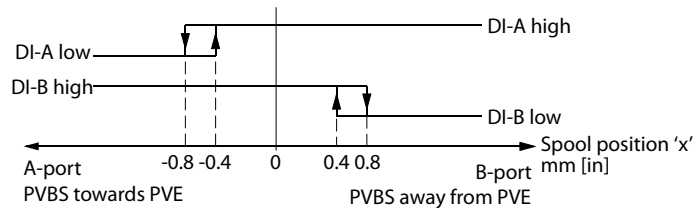
PVE with build in indication for spool movement direction are available.

The PVE-DI has dual power supply. U_{DC1} only supplies solenoid valves. U_{DC2} supplies electronics and feed back. The PVE does not work without U_{DC2} . DI-A and DI-B are relative standard mounting. The input signal fault monitoring is disabled if U_{DC1} is disabled. DI-A and DI-B are relative standard mounting.

The DI has two direction feedback signals with output high (close to U_{DC}) when the spool is in neutral position. If the spool moves out of neutral position, the direction signal switches to low (< 0.2 V). One of the signals goes low by spool ~ 0.8 mm out of neutral and high by spool within 0,4 mm out of neutral.

Both direction indication signals go low when the error indicator goes high.

Direction indication feedback



157-435.10

As shown in the figure, both "DI-A" and "DI-B" signals are "High" when the spool is in neutral position. When the spool is moving in the A direction, the "DI-A" signal goes "Low" and the "DI-B" signal stays "High". The reverse is true when the spool is moved in the B direction.

Values for Direction Indicators (-DI)

Transition from high to low	0.8 ± 1 mm [0.031 in]
Transition from low to high	0.4 ± 1 mm [0.015 in]
Transition to low both pins	error pin goes high
Maximum load of DI-A, DI-B	50 mA
Voltage DI high by load 20 mA	$> U_{DC} - 1.5$ V
Voltage DI high by load 50 mA	$> U_{DC} - 2.0$ V
Voltage DI low	< 0.2 V

Solenoid disabling function (-NP)

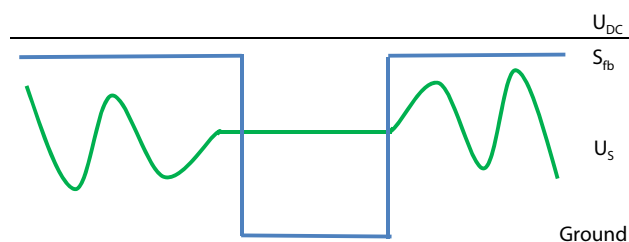
PVEH-NP and PVEA-NP have a build in feature that disables the solenoids by US at 50% and gives a feedback on the solenoid status. This is done to facilitate application monitoring. The fault monitoring is still activated but the closed loop will remain passive until the control signal shifts.

Safety

US disable range		48 % U_{DC} to 52 % U_{DC}
Solenoid disable reaction time	From active to passive	750 ms \leftrightarrow 1000 ms
	From passive to active	0 ms \leftrightarrow 50 ms
Solenoid feedback signal	Maximum load	50 mA
	Voltage if solenoid active by load 20 mA	$> U_{DC} - 1.5 \text{ V}$
	Voltage if solenoid active by load 50 mA	$> U_{DC} - 2.0 \text{ V}$
	Voltage if solenoid passive	$< 1 \text{ V}$

PVEH-F (six pin) has also the disable function but not the feedback. Our general recommendation is disabling of PVE that are not in active use.

Solenoid disabling function (-NP) curves



Safety in Application

All types of control valves (incl. proportional valves) can fail, thus the necessary protection against the serious consequences of function failure should always be built into the system. For each application an assessment should be made for the consequences of pressure failure and uncontrolled or blocked movements.

To determine the degree of protection that is required to be built into the application, system tools such as FMEA (Failure Mode and Effect Analysis) and Hazard and Risk Analysis can be used.

FMEA – IEC EN 61508

FMEA (Failure Mode and Effect Analysis) is a tool used for analyzing potential risks. This analytical technique is utilized to define, identify, and prioritize the elimination or reduction of known and/or potential failures from a given system before it is released for production. Please refer to the standard IEC FMEA 61508.

Hazard and risk analysis ISO 12100-1/14121

This analysis is a tool used in new applications as it will indicate whether there are special safety considerations to be met according to the machine directives EN 13849. Dependent on the determined levels conformity this analysis will determine if any extra requirements for the product design, development process, production process or maintenance, example the complete product life cycle.

Warning

All brands and all types of directional control or proportional valves, which are used in many different operation conditions and applications, can fail and cause serious damage.

Analyze all aspects of the application. The machine builder/system integrator alone is responsible for making the final selection of the products and assuring that all performance, safety and warning requirements of the application are met. The process of choosing the control system and safety levels is governed by the machine directives EN 13849 (Safety related requirements for control systems).

Safety

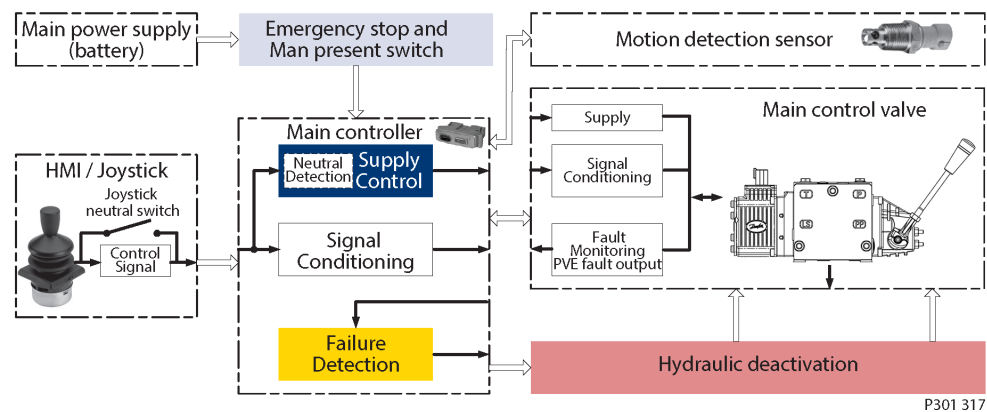
Example of a control system for manlift

Example of a control system for man-lift



Example of a control system for man-lift using PVE Fault monitoring input signals and signals from external sensors to ensure the PLUS+1® main controllers correct function of the man-lift.

Typical PVE wiring block diagram



Warning

It is the responsibility of the equipment manufacturer that the control system incorporated in the machine is declared as being in conformity with the relevant machine directives.

Safety

PVG 32 – used in system with fixed displacement pumps:

- PVSK, commonly used in crane application - full flow dump
- PVPX, LS dump to tank

PVG 100 – alternative LS dump/pilot supply disconnect:

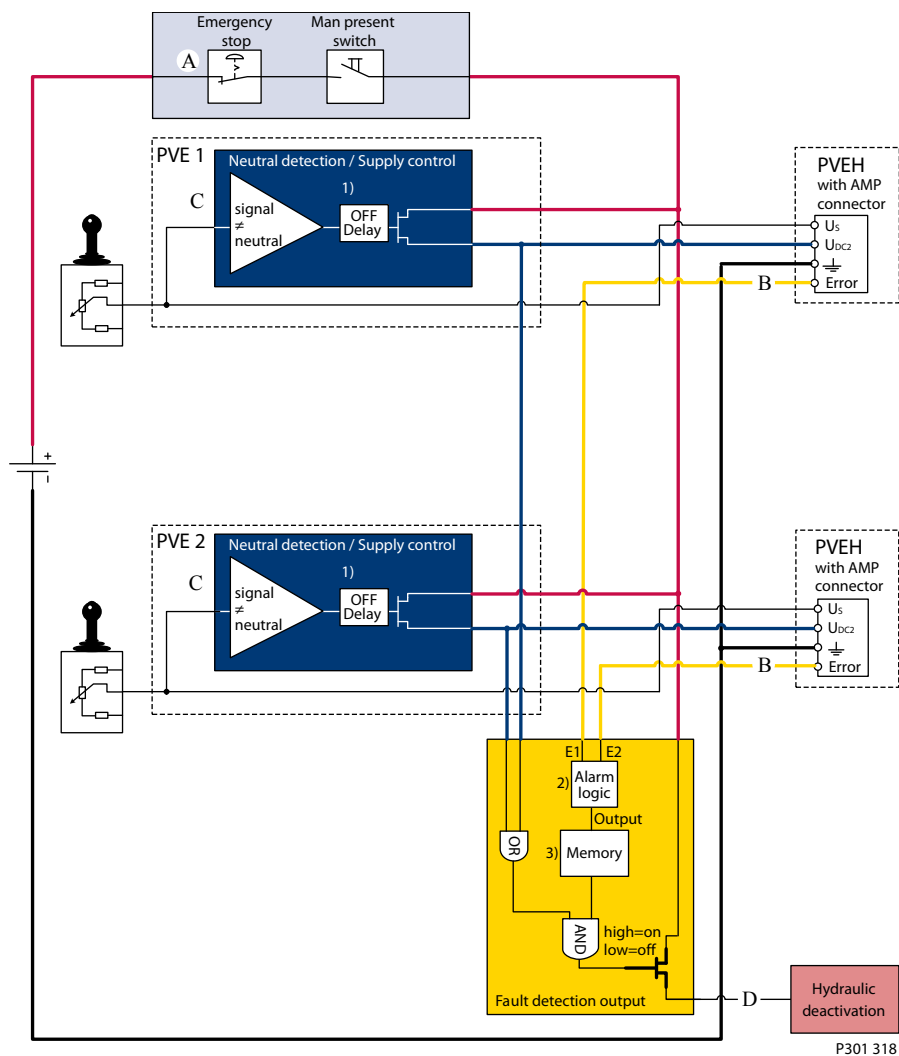
- PVPP, pilot oil supply shut off
- External cartridge valve connecting LS pressure or main pressure to tank

PVG 120 – pump disconnect/block for variable pumps:

- PVPE, full flow dump for the PVG 120
- External cartridge valve connecting LS pressure to tank

Examples of wiring block diagram

Example 1



Typical wiring block diagram using PVEH with neutral power off switch and fault monitoring output for hydraulic deactivation.

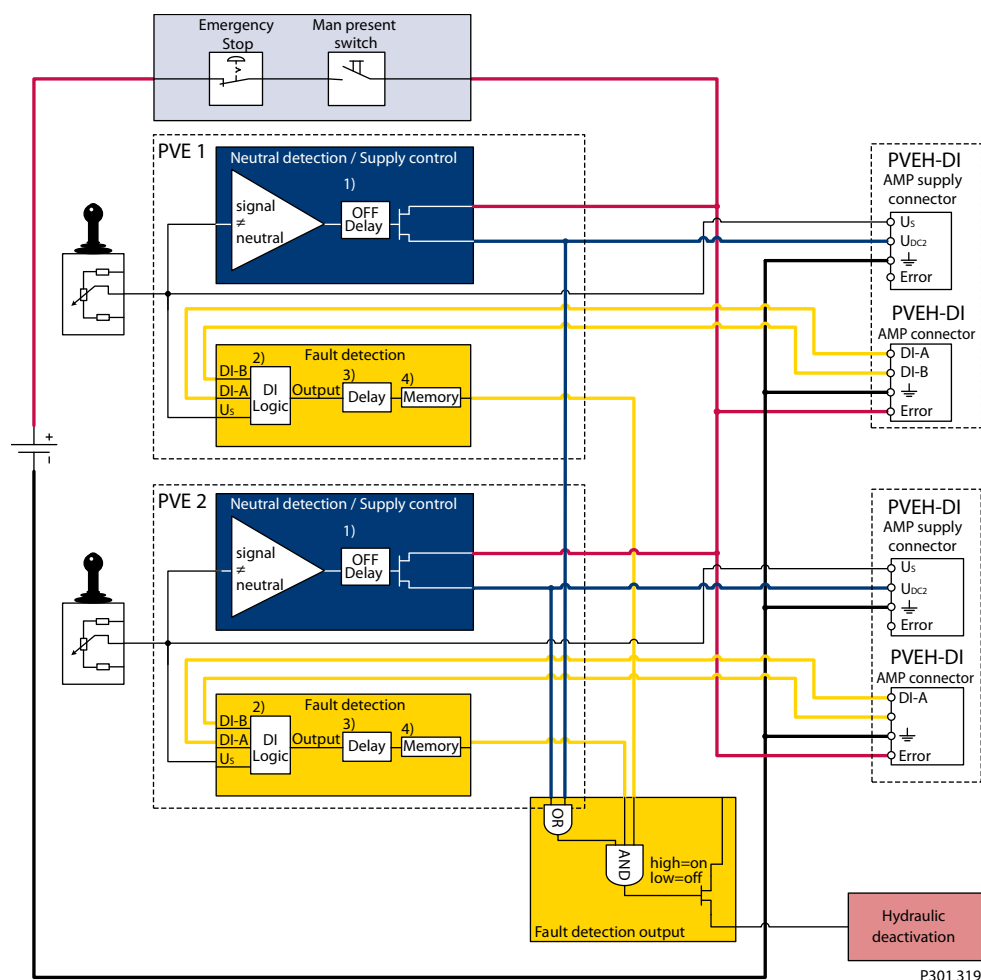
Safety

- A** Emergency stop / man present switch
- B** PVE Fault monitoring signals
- C** Neutral signal detection
- D** Deactivation of the hydraulic system (System Control Logic, example: PLUS+1® for signal monitoring and triggering signal)

Warning

It is the responsibility of the equipment manufacturer that the control system incorporated in the machine is declared as being in conformity with the relevant machine directives.

Example 2



Fault monitoring for deactivation of the hydraulic system with extra fault inputs using the PVE's with DI (Direction Indication) function. System Control Logic, example PLUS+1® for signal monitoring and triggering signal for deactivation of the hydraulic system.

Warning

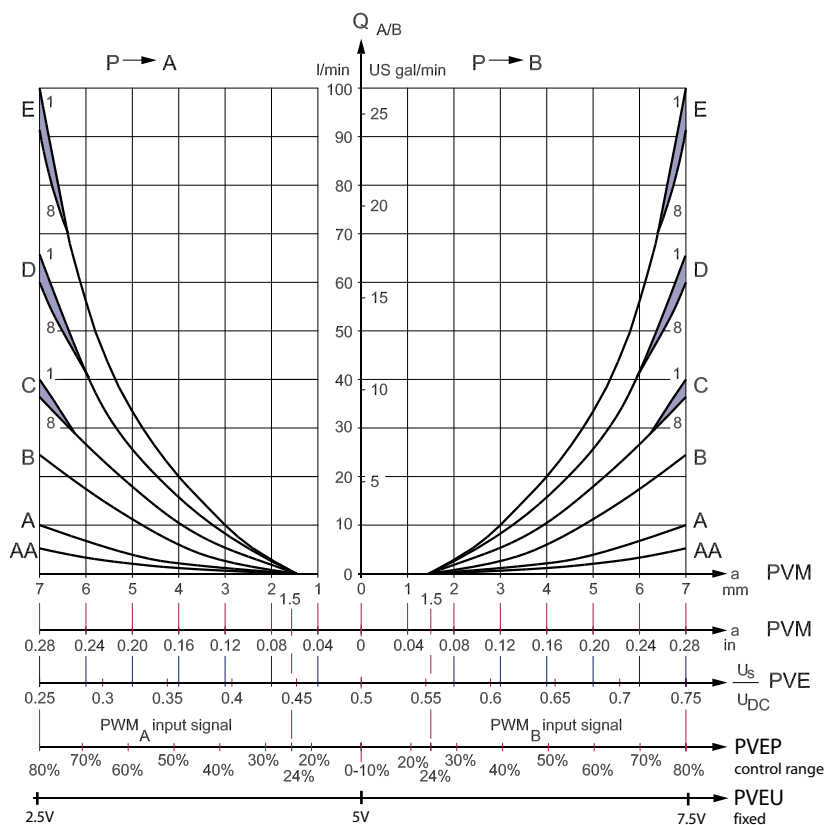
It is the responsibility of the equipment manufacturer that the control system incorporated in the machine is declared as being in conformity with the relevant machine directives.

PVE Control

PVE control by voltage

- The PVE is controlled with a low current voltage signal.
- The spool stroke is proportional to the control voltage (U_S).
- The power is supplied via the supply wire (U_{BAT} or U_{DC}).
- The ratio U_S/U_{DC} defines the actuation. For PVEU a defined voltage.
- A not connected U_S pin (floating) is recognized as U_S = ½ U_{DC}.

PVE characteristic – control by voltage



Values for standard mounted PVE (PVEA/M/H/S)

Function	Signal voltage (U _S)
Neutral	U _S = 0.5 • U _{DC}
Q: P → A	U _S = (0.5 → 0.25) • U _{DC}
Q: P → B	U _S = (0.5 → 0.75) • U _{DC}

PVE Control

PLUS+1® Compliant

PVEA, PVEH, PVES, PVEO, PVEP and PVED can be controlled by PLUS+1®

The U_{DC} has a capacitance of 2.2 μF which can give problems with some micro-controller power supply.

Warning

PVEM is not PLUS+1® Compliant.

When using a Multifunction output on the PLUS+1 controllers it is not possible to power more than two PVEs above 24 Vdc. If you need to power three or more PVEs above 24 Vdc, you will need to use the DigOut option.

ATEX PVE

The Danfoss PVE ATEX portfolio has the same monitoring and control characteristics as the equivalent standard PVE.

PVEU-PVE with fixed control signal range

The PVEU (PVE 0-10V) is designed for PLC/ microcontroller(uC) control hence the U. The control signal U_S is fixed 0 V to 10 V independent of supply voltage U_{DC} .

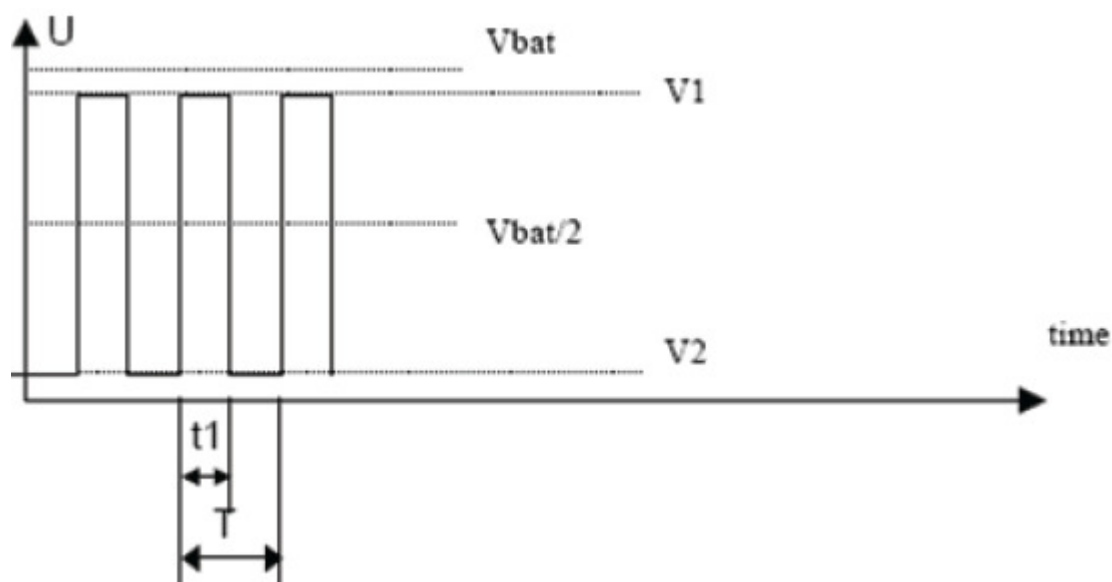
Signal voltage - PVEU

Function	Signal voltage PVEU
Neutral	5 V
Q: P → A	5 V → 2,5 V
Q: P → B	5 V → 7,5 V

PVE controlled with PWM signal

The standard PVE, PVEA/M/H/S, can also be controlled by a pulse with modulated PWM signal.

The V1 and V2 for PWM must be symmetrically located around U_{DC2} and $V1 \leq U_{DC}$.



PVE Control

Duty cycles for PVEA/PVEM/PVEH/PVES/PVEU

Function	Duty cycle (dc) for PVEA/PVEM/PVEH/PVES/PVEU
Neutral	50% dc
Q: P → A	50% dc → 25% dc
Q: P → B	50% dc → 75% dc

Recommended PWM frequency for PVE

PVE type	PWM frequency
PVEM	> 200 Hz
PVEA/H/S/U	> 1 kHz

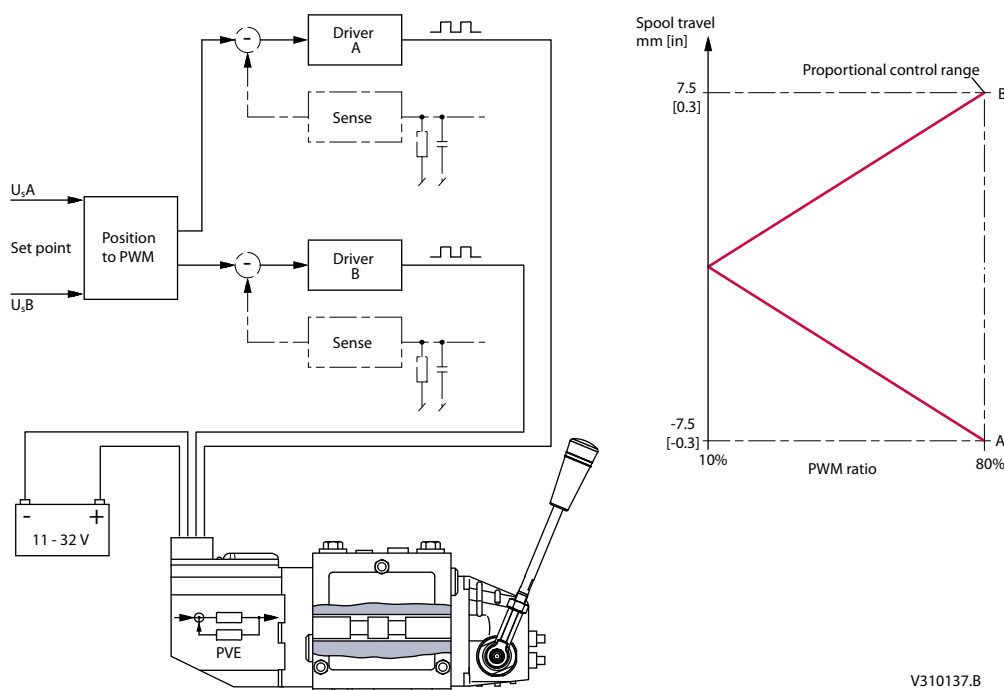
Warning

The PWM is not evaluated by the PVE so variance/failure in period (T) will not be detected.

PVEP control

The PVEP is designed for PWM control signals only.

PVEP schematic and characteristic



Warning

It is important that the power supply (U_{DC}) is connected before the PWM signal.

PWM signals are low power voltage signals; hence no current drivers are needed.

PWM frequency can be chosen between 100 to 1000 Hz.

Current control is not possible with PVEP.

The PVEP performs a true time difference measurement on the PWM input, thus there is no filtering or conversion involved.

PVE Control

PVEP signals

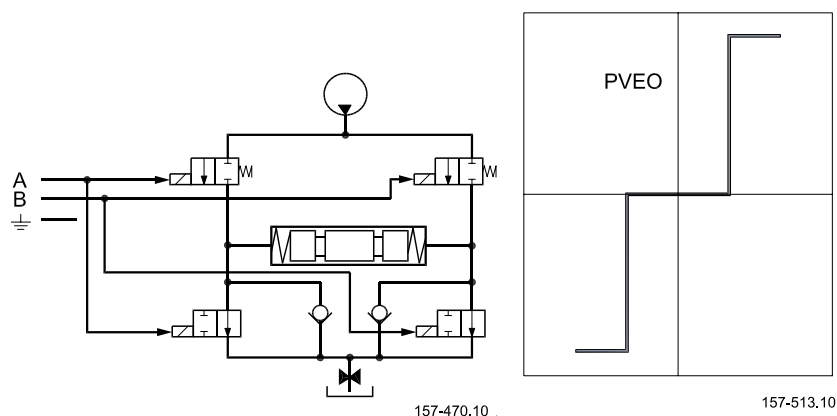
Duty cycle A-signal (pin 1)	Duty cycle B-signal (pin 2)	Function	Error Pin output (pin 3)
0%	0%	Neutral	Low
10%	0%		
0%	10%		
$\geq 10\%$	$\geq 10\%$	Fault (Error)	High
$< 10\%$	$10 \rightarrow 80\%$	B-port flow	Low
$10 \rightarrow 80\%$	$< 10\%$	A-port flow	Low
$A > 86\%$	$B > 86\%$	Fault (Error)	High

PVEO

PVE ON/OFF activation

The PVEO has two independent powered sets of solenoids. By powering a set of pins the actuator is activated. By standard mounted PVE the A set gives full flow on A port and B gives on B port. Both directions activated at same time will keep the spool in neutral.

PVEO schematic and characteristic



Warning

The PVEO is designed to have $U_{DC}=12\text{ V}$ or $U_{DC}=24\text{ V}$.

The solenoids might be activated by voltage down to 6 V.

PVE for float spool

Danfoss has developed two PVE variants to support the float spool. The float spool is a 4/4 spool, where as the standard is a 4/3 spool giving another characteristic and maximum stroke. These variations are covered by the built-in electronics. PVE for float spools are not designed for standard 4/3 spools.

PVE Control

There are two variants of float spool PVBS

- Float A – 0.8 mm dead band, max flow at 5.5 mm. Float at A = 8 mm, from 6.2 mm partial float.

(PVEH-F with six pin connector gives protection against entering float by using low U_S . The float signal has priority to the U_S in the PVEH-F six pin.)

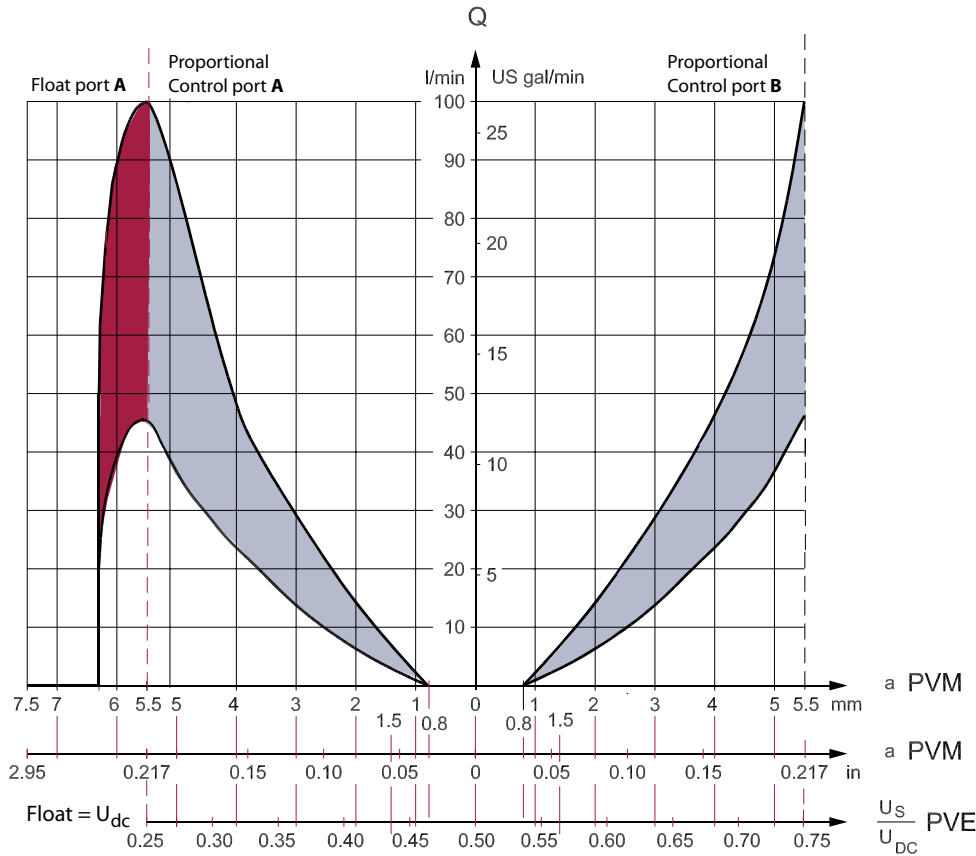
- Float B – 1.5 mm dead band, max flow at 4.8 mm. Float at B = 8 mm, from 6 mm partial float.

(PVEM-F and PVEH-F with four pin connectors give no built-in protection against entering float.)

Variants of the float spool PVBS

Float	PVE	PVBS	Progressive control	Float control
A	PVEH-F (6 pin)	Dead band 0.8 mm Max float at 5.5 mm	U_S : 25% -> 75% U_{DC}	U_{DC} to float pin Has priority
B	PVEH-F (4 pin)	Dead band 1.5 mm Max float at 4.8 mm	U_S : 35% -> 65% U_{DC}	U_S = 75% U_{DC}

PVE characteristic – Float A



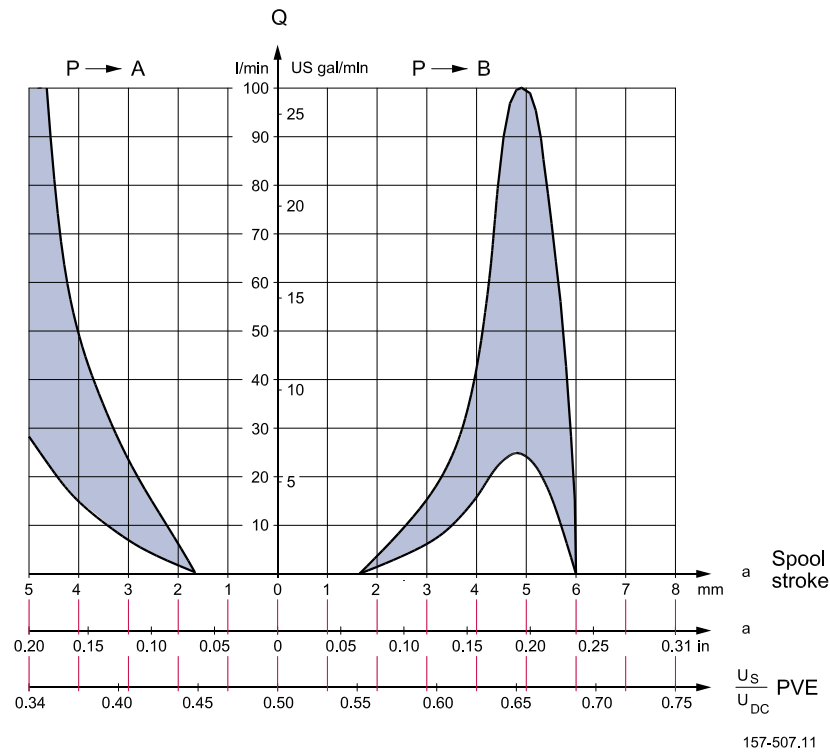
PVBS maximum float is 5.5 mm [0.22 in].

PVE has six pins.

Float when special pin powered at U_{DC} .

PVE Control

PVE characteristic – Float B



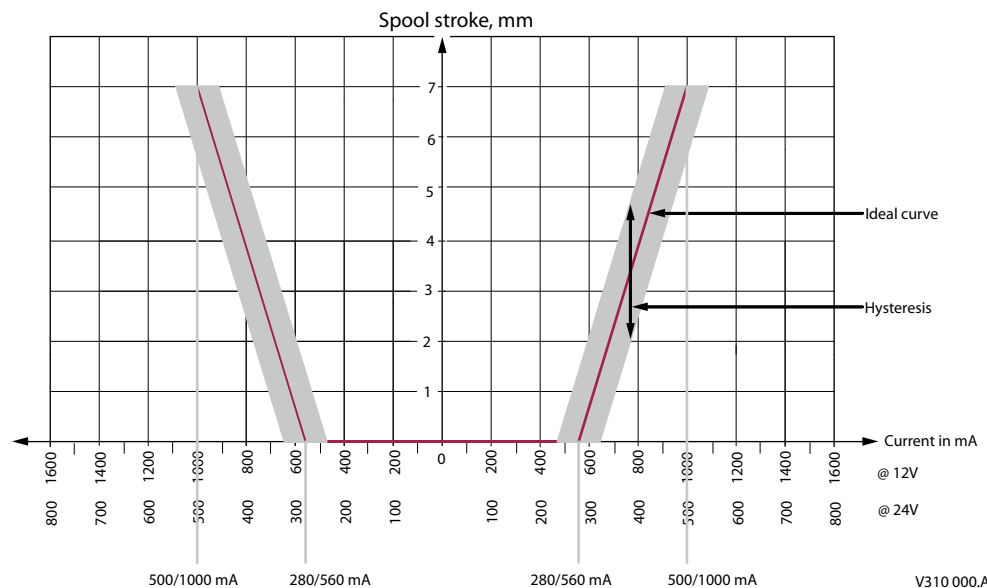
PVBS maximum float is 4.8 mm [0.19 in].

PVE has four pins.

Float at $U_S/U_{DC} = 0.75$

PVHC control

PVHC characteristic



PVE Control

PVHC current response and hysteresis @ 25 bar Pp, 21 ctS, 25 °C. The PVHC control is done by dual Pulse Width Modulated (PVM) high current supply 100-400 Hz PWM control signals.

The PVHC does not have fault monitoring and internal closed loop control of the spool.

The PVHC has high hysteresis. The hysteresis is affected by viscosity, friction, flow forces, dither frequency and modulation frequency.

The spool position will shift when conditions are changed e.g. temperature change.

For PVG controlled by PVHC hysteresis is influenced by lever (PVM).

PVE Hysteresis and Ripple

PVE hysteresis overview

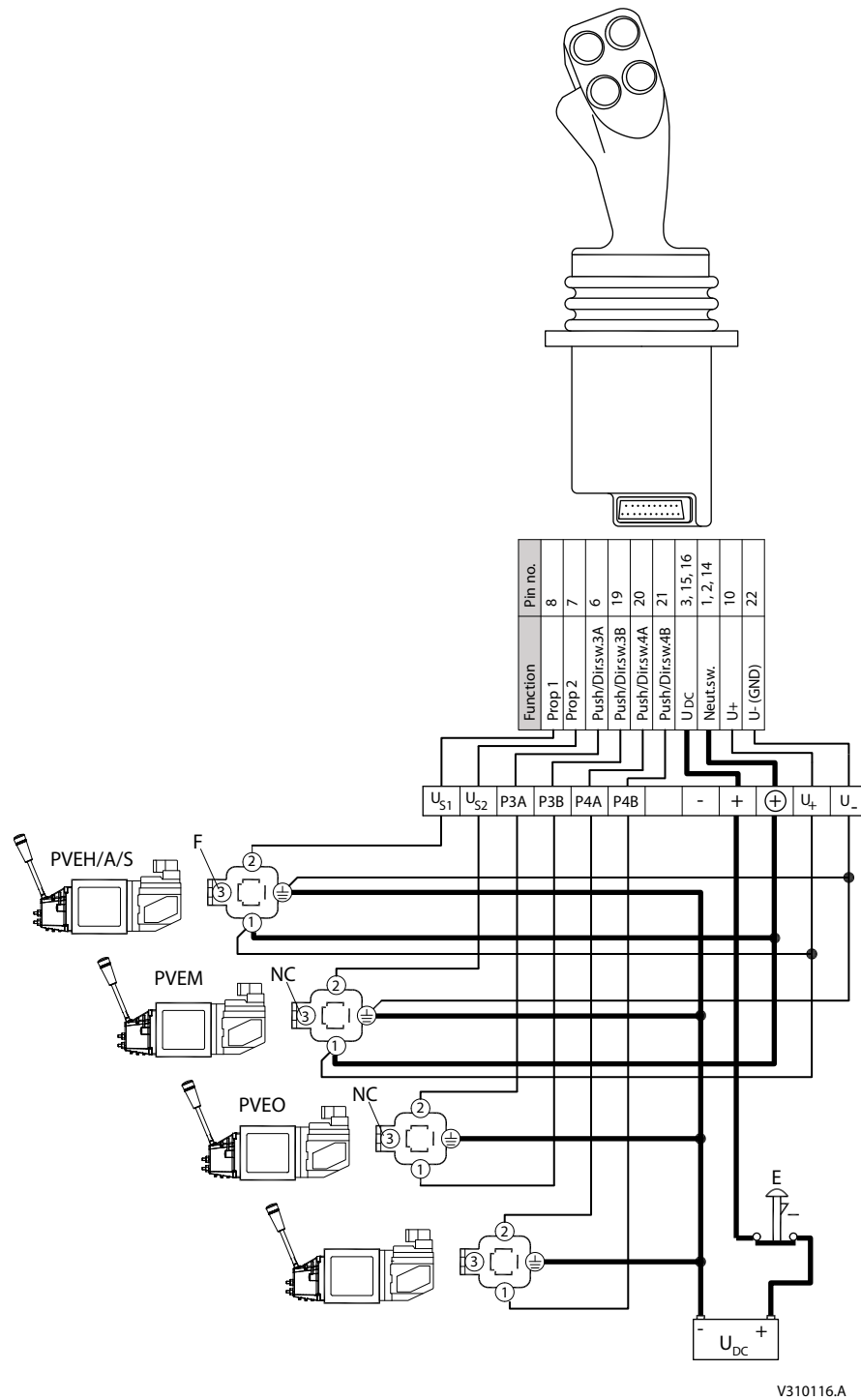
PVE type	PVEP, PVES	PVEA	PVEH	PVEM
Hysteresis (h)	<0.5 %	2 %	4 %	15 %
Steady state ripple @constant Us	0.2 mm	0.3 mm	0.2 mm	0.0 mm

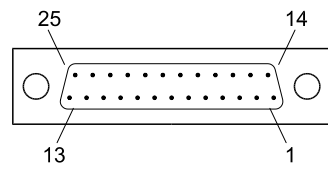
Example of PVE use

Signal leads must not act as supply leads at the same time unless the distance between the actuator module PVE and terminal board is less than 3 m [3.3 yards] and the lead cross-section is min. 0.75 mm² [AWG 18].

PVE Control

25 pin SUB-D connector with M3 screws (MIL-DTL-24308)



PVE Control

162B78.11

- E** – Emergency stop
- F** – Signal output, fault monitoring
- NC** – Not connected

Technical Data

PVE operating parameters

Declaration of conformity

The PVEA/H/P/S/U have CE marking according to the EU directive EMC Directive 2004/108/EC. The declarations are available at Danfoss. The PVEO/M and PVHC are not subject to this directive.

The PVE use without oil supply can harm the system.

The PVE is designed for use with pilot pressure range 10 to 15 bar [145 to 220 psi]. Intermittent pressure peaks up to 50 bar [725 psi] can be accepted. Intermittent is no longer than 5 seconds and not more than once per minute.

The technical data below are from typical test results. For the hydraulic system mineral based hydraulic fluid with a viscosity of 21 mm²/s [102 SUS], 12 bar [174 psi] and a temperature of 50 °C [122 °F] was used:

Fluid consumption

Function		Supply voltage	PVEA	PVEH/ M/ O/ U-PVHC prop. high	PVEP/ S/ U prop. super
Pilot oil flow for PVE l/min [US gal/min]	neutral	OFF	0	0	0.3 [0.106]
	locked	ON	0.4 [0.106]	0.1 [0.026]	0.1 [0.026]
	continuous		1.0 [0.264]	0.7 [0.185]	0.8 [0.21]

Fluid specification

	Minimum	Range	Maximum
Fluid viscosity mm ² /s [SUS]	4 [39]	12 → 75 [65 ÷ 347]	460 [2128]
Fluid temperature	-30°C [-22°F]	30 → 60°C [86 ÷ 140°F]	90°C [194 °F]

Pilot pressure

	Minimum	Nominal	Maximum
PVE ¹⁾	10.0 bar [145 psi]	13.5 bar [196 psi]	15.0 bar [220 psi]
PVHC ²⁾	21 bar [305 psi]	25 bar [363 psi]	25 bar [363 psi]

¹⁾ Relative to T pressure.

²⁾ Designed to be used with hydraulic activated spools, (over tank).

Operating temperature

	Minimum	Maximum
Ambient	-30°C [-22°F]	60°C [140°F]
Stock	-40°C [-40°F]	90°C [194°F]
Recommended long time storage in packaging	10°C [50°F]	30°C [86°F]

Filtering in the hydraulic system

Required operating cleanliness level		Standard
Filtering in the hydraulic system	18/16/13	ISO 4406, 1999 version

For further information see Danfoss documentation *Hydraulic Fluids and Lubricants, Technical Information, BC152886484524*.

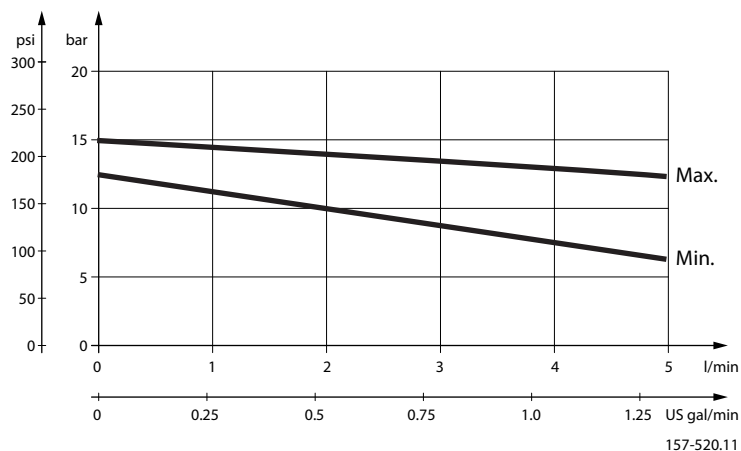
Technical Data

Enclosure and connector versions

Version of connector	Hirschmann connector	AMP JPT connector	Deutsch® connector
Grade of enclosure	IP 65	IP 66	IP 67

According to the international standard IEC 529 NB: In particularly exposed applications, protection in the form of screening is recommended.

PVP modules, Pilot pressure curves



PVHC control specification

Supply voltage U_{DC}	12 V _{DC}	24 V _{DC}
Controller output current	0 – 1500 mA	0 – 750 mA
Pilot pressure	20 – 25 bar [290-363 psi]	
Resistance	4.75 $\Omega \pm 5\%$	20.8 $\Omega \pm 5\%$
Response time	150 – 200 ms	
PWM frequency	100 → 400 Hz	

PVHC reaction time

From neutral position to max. spool travel at power on	max.	0.235s
	rated	0.180s
	min.	0.120s
From max. spool travel to neutral position at power off	max.	0.175s
	rated	0.090s
	min.	0.065s

PVEO and PVEM control specification

PVEO and PVEM control specification

Supply voltage U_{DC}	rated	12 V _{DC}	24 V _{DC}
	range	11 → 15 V	22 → 32 V
	max. ripple	5%	

Technical Data

PVEO and PVEM control specification (continued)

Current consumption	typical	740 mA	365 mA
	minimum	550 mA	290 mA
	maximum	820 mA	420 mA
Current via DI	maximum	100 mA	

PVEO and PVEM reaction time

Reaction time in seconds		PVEO	PVEO-R	PVEM
From neutral position to max. spool travel at power on	max.	0.235s	0.410s	0.700s
	rated	0.180s	0.350s	0.450s
	min.	0.120s	0.250s	0.230s
From max. spool travel to neutral position at power off	max.	0.175s	0.330s	0.175s
	rated	0.090s	0.270s	0.090s
	min.	0.065s	0.250s	0.065s
From neutral position to max. spool travel by constant power	max.	–		0.550s
	min.			0.210s
From max. spool travel to neutral position by constant power	max.			0.150s
	min.			0.040s

PVEA, PVEH, PVES and PVEU control specification

PVEA, PVEH, PVES and PVEU control specification

Parameter	PVE-H, -S, -U	PVEA
Supply rated voltage U_{DC} V (max. ripple 5%)	11 → 32 V	11 → 32 V
Current consumption at rated voltage	0.57 A @ 12 V / 0.3 A @ 24 V	0.33 A @ 12 V / 0.17 A @ 24 V
Signal voltage neutral	$0.5 \times U_{DC}^*$	$0.5 \times U_{DC}$
Signal voltage A-port ↔ B-port	$0.25 \rightarrow 0.75 \times U_{DC}$	$0.25 \rightarrow 0.75 \times U_{DC}$
Signal current at rated voltage	0.25 → 0.70 mA	0.25 → 0.70 mA
Input impedance in relation to $0.5 \times U_{DC}$	12 kΩ	12 kΩ
Power consumption	7 W	3.5 W
Error pin max current	100 mA	100 mA

* PVEU 5 V

PVEA, PVEH, PVES and PVEU reaction time in sec. (minus PVG 120)

Supply voltage	Function		PVEA Prop. fine	PVEH, PVEP, PVES, PVEU
Disconnected by means of neutral switch	Reaction time from neutral position to max. spool travel	max.	0.50	0.23
		rated	0.32	0.15
		min.	0.25	0.120
	Reaction time from max. spool travel to neutral position	max.	0.55	0.175
		rated	0.40	0.09
		min.	0.30	0.065

Technical Data

PVEA, PVEH, PVES and PVEU reaction time in sec. (minus PVG 120) (continued)

Supply voltage	Function		PVEA Prop. fine	PVEH, PVEP, PVES, PVEU
Constant voltage	Reaction time from neutral position to max. spool travel	max.	0.50	0.20
		rated	0.32	0.12
		min.	0.25	0.05
	Reaction time from max. spool travel to neutral position	max.	0.25	0.10
		rated	0.20	0.09
		min.	0.15	0.065

PVEP Technical Data

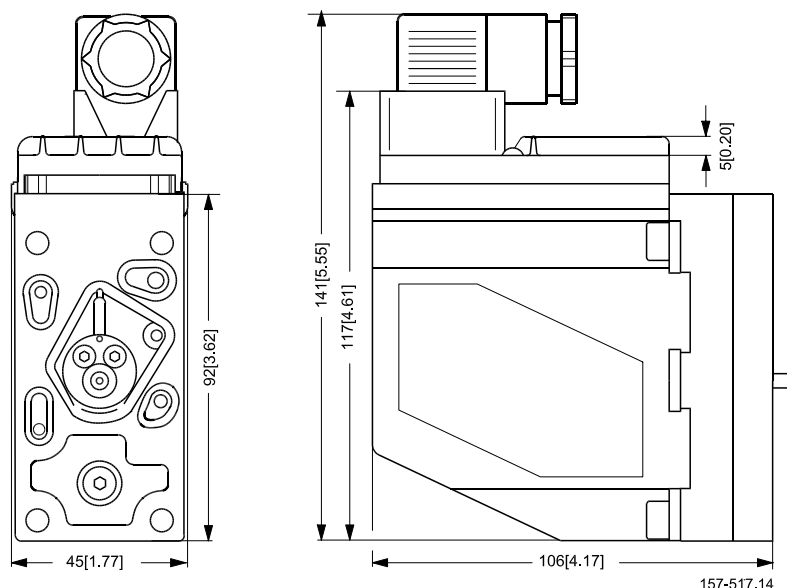
PVEP control specification

Supply voltage U_{DC}	range	11 → 32 V
	max. ripple	5%
	over voltage (max. 5 min)	36 V
PWM control range (duty cycle)		10 → 80%
PWM frequency		100 → 1000 Hz
PWM input voltage swing		0 → U_{DC}
PWM Trigger point		70% of U_{DC}
Input impedance (standard pull down)		5 k Ω
Input capacitor		---
Power consumption		7 W
Error voltage	Fault	U_{DC}
	No Fault	< 2 V

All connector terminals are short-circuit protected, protected against reverse connection and their combinations. Connecting error pins from two or more PVE's will cause the surveillance system to malfunction.

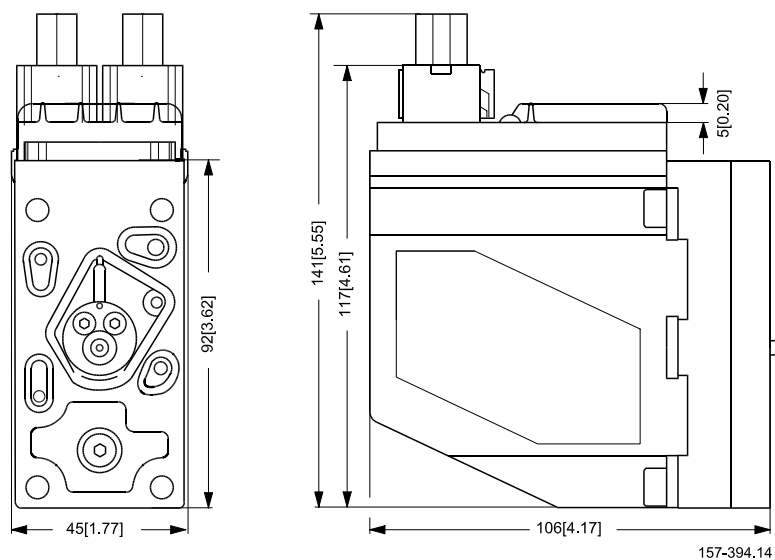
PVE dimensions for PVG 32 and PVG 100

PVE with Hirschmann connector

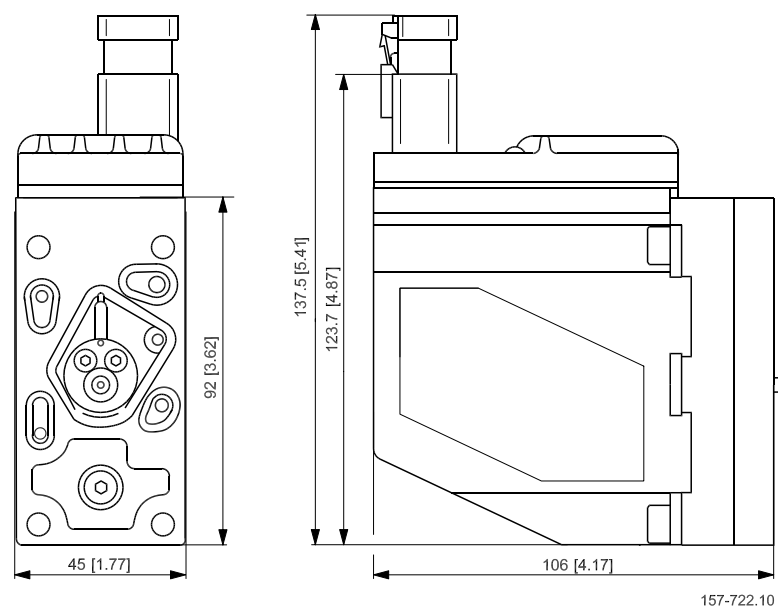


Technical Data

PVE with AMP connector

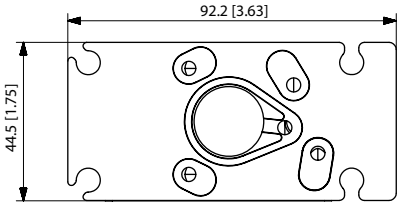


PVE with Deutsch® connector

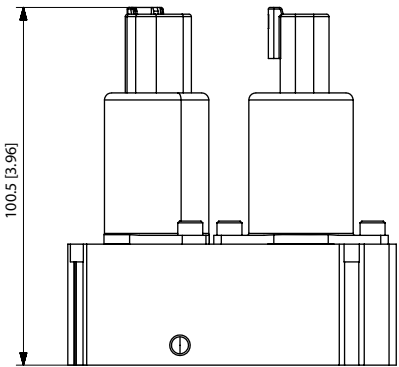
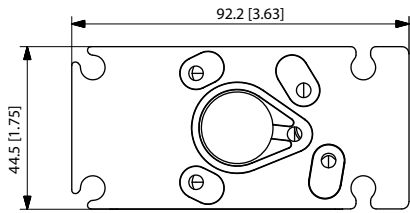


Technical Data

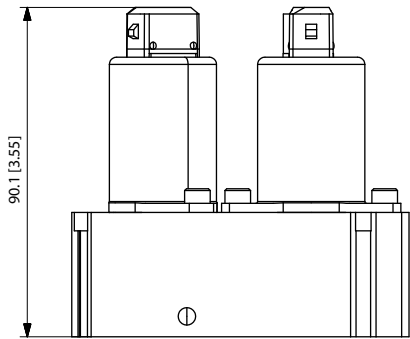
PVHC with Deutsch® connector



PVHC with AMP connector



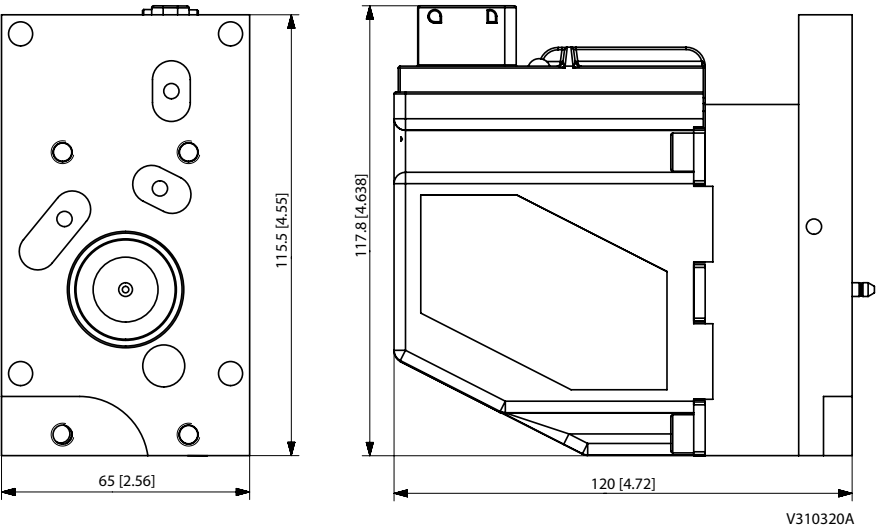
V310 388



V310 387

PVE dimensions for PVG 120

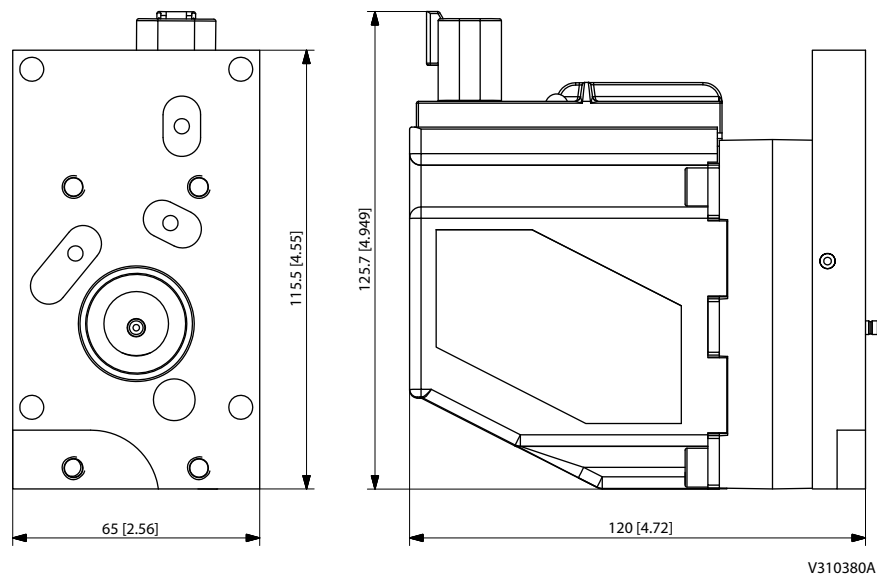
PVE with AMP connector for PVG 120



V310320A

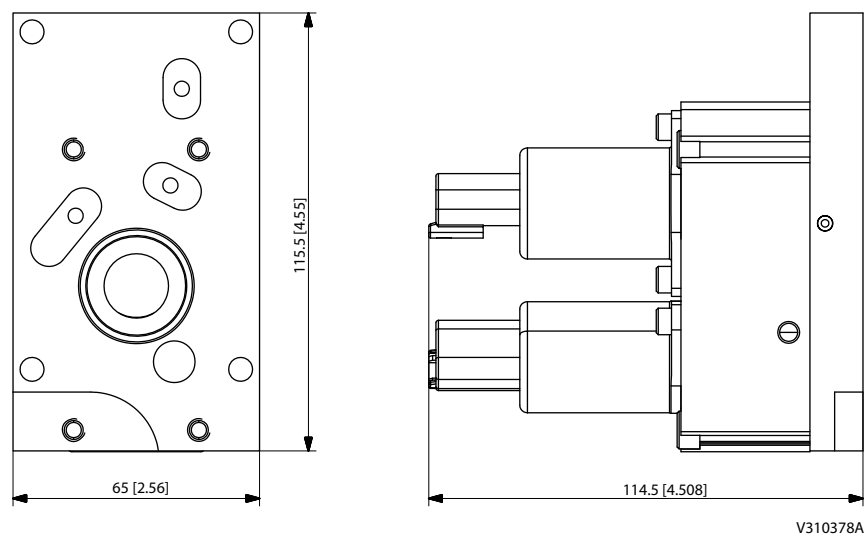
Technical Data

PVE with Deutsch® connector for PVG 120



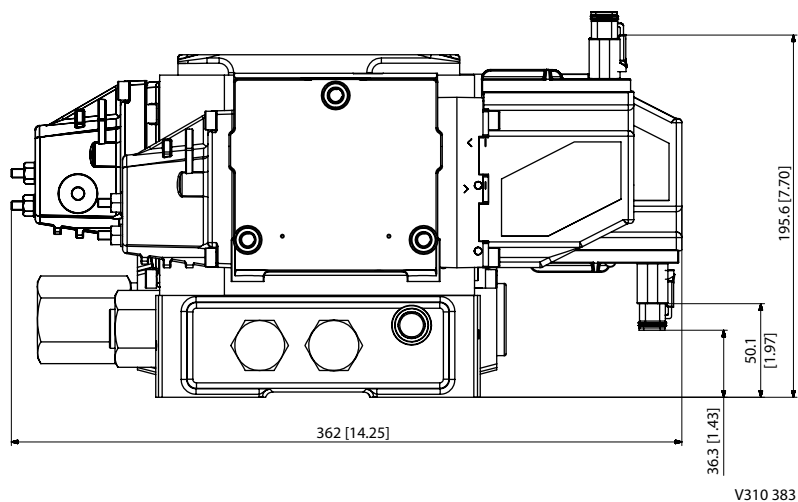
Please notice that connector needs extra space for mounting.

PVHC with Deutsch® connector for PVG 120



Technical Data

PVG 120 and PVG 32 combo with Deutsch® connector



PVEO pinout

PVEO with direction indication (DI) connection

Connector 1	A U_{DC}	B U_{DC}	Gnd	Gnd
AMP (gray)	p 1	p 2	p 3	p 4

Connector 2	DI-B	DI-A	Gnd	U_{DC2}
AMP (black)	p 1	p 2	p 3	p 4

PVEO standard connection

Connector	A	B
AMP/Hirschmann/DIN	pin 1	pin 2
Deutsch®	pin 1	pin 4

Function	A (pin 1)	B (pin 2)
Neutral	0	0
Q: P → A	U_{DC}	0
Q: P → B	0	U_{DC}

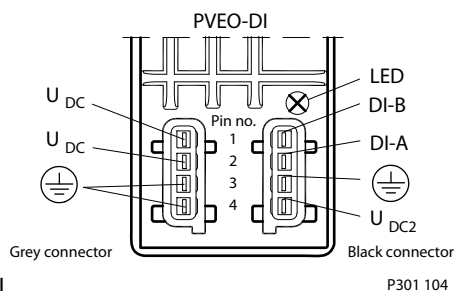
All PVEO Connections

Connector	A	B
AMP/Hirschmann/DIN	pin 1	pin 2
Deutsch®	pin 1	pin 4

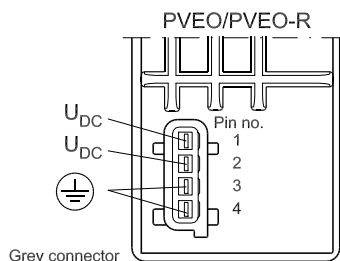
- Ground pins are internally connected.
- Pin 3 is not connected on Hirschmann/DIN version of PVEO.
- U_{DC2} supplies electronics for feedback signal on PVEO-DI.

Technical Data

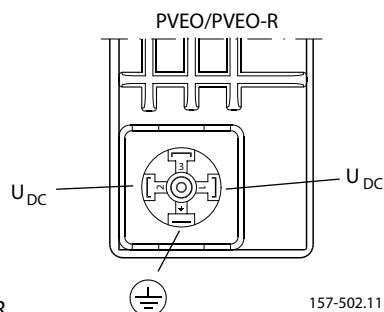
PVEO connection



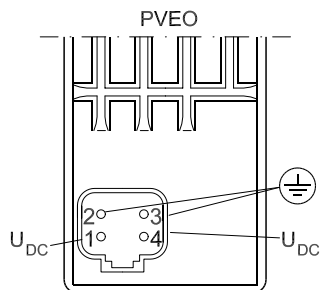
AMP version of PVEO-DI



AMP version of PVEO/PVEO-R



Hirschmann/DIN version of PVEO / PVEO-R



DEUTSCH version of PVEO

PVE standard connection data / pinout

PVEA / PVEH / PVEM / PVES / PVEU connection (also with float B, 4-pin)

Connector	U_S	U_{DC}	Gnd	Error
AMP	pin 1	pin 2	pin 3	pin 4
Hirschmann/DIN	pin 2	pin 1	gnd	pin 3
Deutsch*	pin 1	pin 4	pin 3	pin 2

On PVEM the error pin is not used and not connected (pin 3 Hirschmann/DIN). Ground pins are internally connected.

Technical Data

Control (U_s) for standard mounted PVEA / PVEH / PVEM / PVES

Function	Voltage relative	PWM
Neutral	$0.5 \cdot U_{DC}$	50%
Q: P → A	$0.5 \rightarrow 0.25 \cdot U_{DC}$	50% → 25%
Q: P → B	$0.5 \rightarrow 0.75 \cdot U_{DC}$	50% → 75%

Control (U_s) for standard mounted PVEU

Function	PVEU
Neutral	5 V
Q: P → A	5 V → 2.5 V
Q: P → B	5 V → 7.5 V

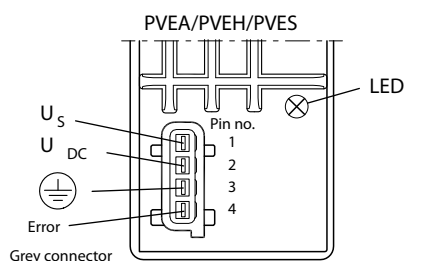
Control (U_s) for standard mounted PVEH / PVEM float B, 4-pin version

Function	Voltage relative	PWM
Neutral	$0.5 \cdot U_{DC}$	50%
Q: P → A	$0.5 \rightarrow 0.34 \cdot U_{DC}$	50% → 34%
Q: P → B	$0.5 \rightarrow 0.65 \cdot U_{DC}$	50% → 65%
Float	$0.75 \cdot U_{DC}$	75%

PVEM is not PLUS+1® Compliant.

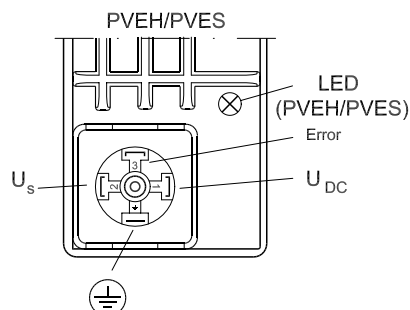
PVE standard connections

AMP version



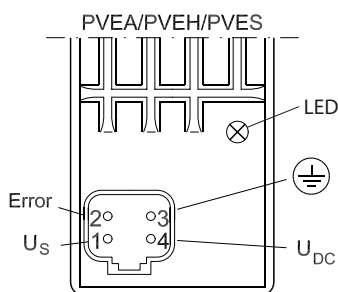
Used for PVEA/PVEH/PVES/PVEU.

Hirschmann/DIN



Used for PVEH/PVEM/PVES/PVEH float B/PVEM float B.

Deutsch® version



Used for PVEA/PVEH/PVES/PVEU/PVEH float B.

Technical Data

Standard PVE with DI

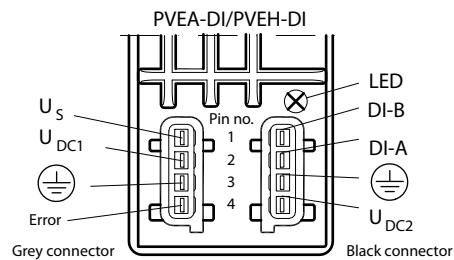
Connection PVE with direction indication (DI)

Connector 1	U_S	U_{DC1}	Gnd	Error
AMP (gray)	p 1	p 2	p 3	p 4
Deutsch®	p 1	p 4	p 3	p 2

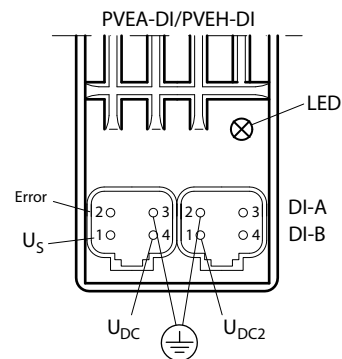
Connector 2	DI-B	DI-A	Gnd	U_{DC2}
AMP (black)	p 1	p 2	p 3	p 4
Deutsch®	p 4	p 3	p 2	p 1 Ground pins are internally connected.

- U_{DC2} only supplies electronics for feedback signal and error pin on PVEA-DI / PVEH-DI. Two separate power sources can be used.

AMP version: PVEA-DI/PVEH-DI



Deutsch® version: PVEA-DI/PVEH-DI



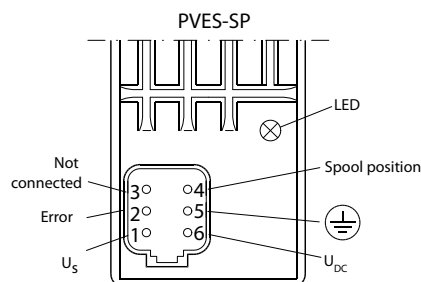
P301 105

Standard PVE with SP

Connection PVE with Spool Position (SP)

Connector	U_S	Error	SP	Gnd	U_{DC}
Deutsch	p 1	p 2	p 4	p 5	p 6

Deutsch version: PVES-SP



Technical Data

Standard PVE with NP

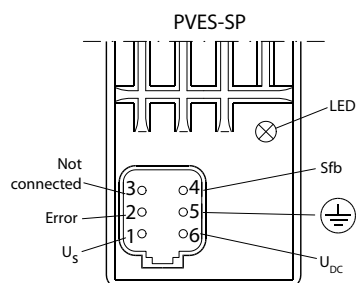
Connection PVE with Neutral Power off (NP)

Connector	U _S	Error	Sfb	Gnd	UDC
Deutsch*	p 1	p 2	p 4	p 5	p 6

Control (US) for standard mounted PVEA-DI/ PVEH-DI, PVES-SP, PVEA-NP, PVEH-NP

Function	U _S	PWM
Neutral	$0.5 \cdot U_{DC}$	50%
Q: P → A	$0.5 \rightarrow 0.25 \cdot U_{DC}$	50% → 25%
Q: P → B	$0.5 \rightarrow 0.75 \cdot U_{DC}$	50% → 75%

Deutsch* version: PVES-NP



PVHC connection

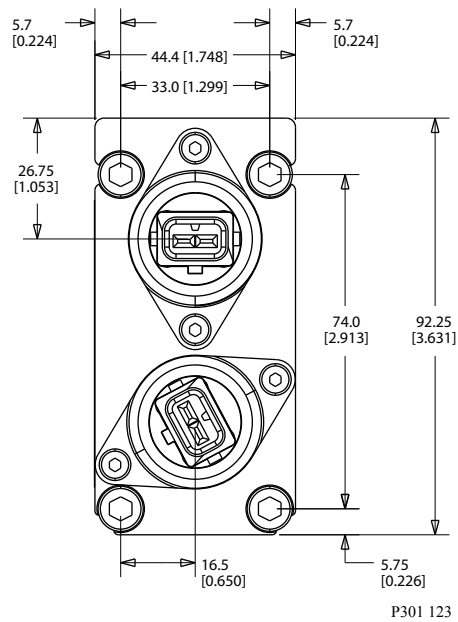
- 100-400 Hz PWM control signals.
- Each connector controls one direction and must have U_{DC} and ground
- No constraints on pin for U_{DC} and ground.

Input control

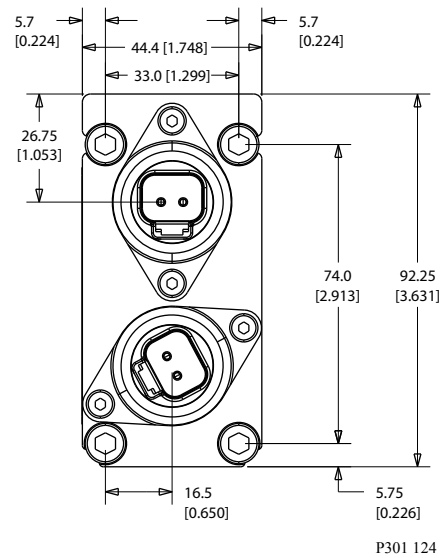
Parameter	Control range	
	12 V	24 V
Controller output current range	0 - 1500 mA	0 - 750 mA

Technical Data

PVHC with AMP version



PVHC with Deutsch® version

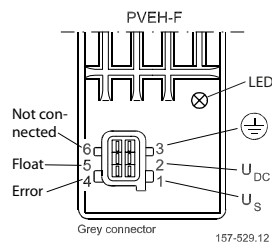


PVE with separate float pin

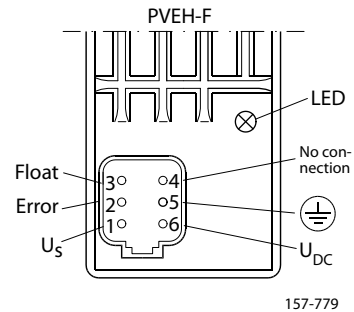
PVEH with float A, 6-pin connection

Connector	U_S	U_{DC}	Float	Ground	Error
AMP	pin 1	pin 2	pin 5	pin 3	pin 4
Deutsch®	pin 1	pin 6	pin 3	pin 5	pin 2

AMP with separate float pin



Deutsch® version with separate float pin



PVEP with controlled PWM

PVEP connection

Connector	PWM A	Error	PWM B	Gnd	U_{DC}
Deutsch®	p 1	p 2	p 3	p 5	p 6

Technical Data*Control (U_c) for standard mounted PVEP*

Function	Voltage relative	PWM
Neutral	< 10%	< 10%
Q: P → A	10% → 80%	< 10%
Q: P → B	< 10%	10% → 80%

Warnings

PVE warnings

Warning

Not applying to the Operational Conditions can compromise safety.

All brands and all types of directional control valves – including proportional valves – can fail and cause serious damage. It is therefore important to analyze all aspects of the application. Because the proportional valves are used in many different operation conditions and applications, the machine builder/ system integrator alone is responsible for making the final selection of the products – and assuring that all performance, safety and Warning requirements of the application are met.

A PVG with PVE can only perform according to description if conditions in this Technical Information are met.

In particularly exposed applications, protection in the form of a shield is recommended.

When the PVE is in fault mode the quality of performance and validity of feedback is limited depending on the fault type.

Error pins from more PVEs may not be connected. Inactive error pins are connected to ground and will disable any active signal. Error pins are signal pins and can only supply very limited power consumption.

Deviation from recommended torque when mounting parts can harm performance and module.

Adjustment of the position transducer (LVDT) will influence calibration, and thereby also safety and performance.

When replacing the PVE, the electrical and the hydraulic systems must be turned off and the oil pressure released.

PVEA is not for use on PVG 100.

Hydraulic oil can cause both environmental damage and personal injury.

Module replacement can introduce contamination and errors to the system. It is important to keep the work area clean and components should be handled with care.

After replacement of modules or cables wiring quality must be verified by a performance test.

By actuation at voltage below nominal PVG will have reduced performance.

The PVE is not designed for use with voltage outside nominal.

Obstacles for the Pilot oil can have direct influence on spool control.

Reduced pilot oil pressure will limit spool control.

Too high pilot oil pressure can harm the PVE.

Code Numbers

PVE code numbers for PVG 32 and PVG 100 use

Deutsch® connector code numbers

Feature		S	std.	float A	float B	DI	NP	SP	Fast-no memory	ramp
Connector			1x4	1x6	1x4	2x4	1x6	1x6	1x4	
PVEA*	active	–	157B4792			157B4796	11105542			
	passive		11107365							
PVEH	active		157B4092	157B4398		157B4096	11105543			
	passive		157B4093		157B4392					
PVES	active	S	157B4892						157B4894	
	passive	S	11089276					11108994		
PVEP	active	S	11034832*							
PVEU	passive	S	11089090							
PVEO	12V	–	157B4291							11109080
	24V		157B4292							11109092

* 1x6 = one plug six pins

S = super fine hysteresis, 1x4 = one plug four pins

AMP connector code numbers

Feature		S	std.	float A	DI	anodized	ramp-ano	ramp
Connector			1x4	1x6	2x4	1x4	1x4	1x4
PVEA*	active	–	157B4734		157B4736			
	passive		157B4735		157B4737	157B4775		
PVEH	active		157B4034	157B4338	157B4036	157B4074		
	passive		157B4035		157B4037	157B4075		
PVES	active	S	157B4834					
	passive	S	157B4835			157B4865		
PVEU	active	S	11089091					
	active	–	157B4044					
	passive		157B4045					
PVEO	12V		157B4901		11157283			157B4903
	24V		157B4902		11157282	157B4272	157B4274	157B4904

* 1x6 = one plug six pins

S = super fine hysteresis, 1x4 = one plug four pins

Warning

PVEA is not for use on PVG 100.

Hirschmann/DIN connector code numbers

Feature		S	std.	float B	anodized	ramp
Connector			1x4	1x4	1x4	1x4
PVEH	active		157B4032	157B4332		
	passive		157B4033		157B4073	
PVES	active	S	157B4832			
	passive	S	157B4833			

Code Numbers

Hirschmann/DIN connector code numbers (continued)

Feature		S	std.	float B	anodized	ramp
Connector			1x4	1x4	1x4	1x4
PVEM	12 V		157B4116	157B4416		157B4516
	24 V		157B4128	157B4428		157B4528
PVEO	12 V		157B4216		157B4266	157B4217
	24 V		157B4228		157B4268	157B4229

S = super fine hysteresis, 1x4 = one plug four pins

ATEX (24 V) connector code numbers

Cable type		S	PFOP	PFOP	PFOP, cable dir PVB	BFOU
Flying wire			5 m	10 m	5 m	5 m
PVEH	passive		11084101	11084109	11084092	11084098
PVES		S	11084102	11084110	11084093	11084099
PVEO			11084100	11084108	11084051	11084097

S = super fine hysteresis

AMP/Deutsch® code numbers for PVHC

Connector		Code Number
PVHC AMP	12 V	11112037
	24 V	11112036
PVHC Deutsch®	12 V	11112038
	24 V	11112039

PVE code numbers for use on PVG 120

AMP code numbers

Feature		anodized
Connector		1x4 = one plug x four pins
PVEH	active	155G4094
	passive	155G4095
PVEO	12 V	155G4282
	24 V	155G4284

Hirschmann/DIN code numbers

Feature		anodized
Connector		1x4 = one plug x four pins
PVEH	active	155G4092
	passive	155G4093
PVES	passive	11111210
PVEO	12 V	155G4272
	24 V	155G4274

Code Numbers

Deutsch code numbers

Feature		anodized
Connector		1x4 = one plug x four pins
PVEH	passive	11111206
PVES	passive	11111207
PVEO	12 V	11110601
	24 V	11110652
PVHC	12 V	11110597
	24 V	11110598

ATEX (24 V) connector code numbers

Cable type		PFOP	PFOP	PFOP, cable dir PVB	BFOU
Flying wire		5 m	10 m	5 m	5 m
PVEH	passive	11084104	11084112	11084096	11084107
PVEO		11084103	11084111	11084095	11084106

PVE accessories

Connector code numbers

Code number	Description	
157B4992	AMP CONNECTING KIT (GREY)	4 pin with housing, contact and wire sealing
157B4993	AMP CONNECTING KIT (BLACK)	4 pin with housing, contact and wire sealing
984L3156	EL-PLUG, ON-OFF black	Hirschmann DIN connector set*
K29657	Deutsch female DT-2	2 pin with housing, contact wire sealing

Set of seals code numbers

Code number	Description	Actuator
157B4997	Set of seals	PVE for PVG 32/ PVG 100
155G8519		PVE for PVG 120 (also interface plate/PVB for PVHC)
11061235		PVHC for PVG 32/ PVG 100

Cables code numbers

Feature		Wire colors						Length	Code number
Connector		pin 1	pin 2	pin 3	pin 4	pin 5	pin 6		
Deutsch	4 pin	white	blue	yellow	red	—	—	4 m	11007498
	6 pin	white	blue	yellow	red	black	green	4 m	11007513
AMP	4 pin	white	blue	yellow	red	—	—	4 m	157B4994
	6 pin	white	red	black	yellow	green	blue	5 m	157B4974
AMP/black coding	4 pin	white	blue	yellow	red	—	—	4 m	157B4995 **-DI

Cables are with oil resistant coating.

Code Numbers

** -DI additional cable for PVE with direction indication.

Connector code numbers at other suppliers

Connector part numbers for purchase at other suppliers

Connector		House	wire sealing (blue)	JPT contact (loose piece)	sealing mat between male-female part
Deutsch® female	4 pin	DT06-4S	—	—	—
	6 pin	DT06-6S			
AMP female/gray	4 pin	2-967059-1	828904-1	929930-1	963208-1
	6 pin	2-963212-1	—		963205-1
AMP female/black	4 pin	1-967059-1			—
AMP crim tool		169400-1			
AMP die set for crimp tool		734253-0			

These connector code numbers are not Danfoss numbers.

PVED-CC code numbers for use on PVG 32 and PVG 100

Cables code numbers for PVED-CC

Feature		Wire colors				Description	Code number
Connector		pin 1	pin 2	pin 3	pin 4		
Deutsch®	4 pin	white	blue	yellow	red	4 m cable	11007498
AMP	4 pin	white	blue	yellow	red	4 m cable	157B4994
AMP/black	4 pin	white	blue	yellow	red	4 m cable	157B4995

Cables code numbers for PVED-CC (continued)

Feature		Description	Code number
Connector			
Service tool interface cable/ AMP		4 m cable	157B4977
AMP		0.1m loop cable	157B4987
AMP/black		Terminator	157B4988
Deutsch®		0.1m loop cable	11007531
Deutsch®		Terminator	11007561
Deutsch®		Terminator dummy	11007563

CAN Interface

10104136	CG 150 CAN USB interface
----------	--------------------------

Connector		2x4 = two plugs x four pins
Deutsch®	SW 2.68	11079033
AMP	SW 2.68	11079034

Products we offer:

- DCV directional control valves
- Electric converters
- Electric machines
- Electric motors
- Gear motors
- Gear pumps
- Hydrostatic motors
- Hydrostatic pumps
- Orbital motors
- PLUS+1® controllers
- PLUS+1® displays
- PLUS+1® joysticks and pedals
- PLUS+1® operator interfaces
- PLUS+1® sensors
- PLUS+1® software
- PLUS+1® software services, support and training
- Position controls and sensors
- PVG proportional valves
- Steering components and systems
- Telematics

Danfoss Power Solutions is a global manufacturer and supplier of high-quality hydraulic and electric components. We specialize in providing state-of-the-art technology and solutions that excel in the harsh operating conditions of the mobile off-highway market as well as the marine sector. Building on our extensive applications expertise, we work closely with you to ensure exceptional performance for a broad range of applications. We help you and other customers around the world speed up system development, reduce costs and bring vehicles and vessels to market faster.

Danfoss Power Solutions – your strongest partner in mobile hydraulics and mobile electrification.

Go to www.danfoss.com for further product information.

We offer you expert worldwide support for ensuring the best possible solutions for outstanding performance. And with an extensive network of Global Service Partners, we also provide you with comprehensive global service for all of our components.

Hydro-Gear

www.hydro-gear.com

Daikin-Sauer-Danfoss

www.daikin-sauer-danfoss.com

Local address:

**Danfoss
Power Solutions (US) Company**
2800 East 13th Street
Ames, IA 50010, USA
Phone: +1 515 239 6000

**Danfoss
Power Solutions GmbH & Co. OHG**
Krokamp 35
D-24539 Neumünster, Germany
Phone: +49 4321 871 0

**Danfoss
Power Solutions ApS**
Nordborgvej 81
DK-6430 Nordborg, Denmark
Phone: +45 7488 2222

**Danfoss
Power Solutions Trading
(Shanghai) Co., Ltd.**
Building #22, No. 1000 Jin Hai Rd
Jin Qiao, Pudong New District
Shanghai, China 201206
Phone: +86 21 2080 6201

Danfoss can accept no responsibility for possible errors in catalogues, brochures and other printed material. Danfoss reserves the right to alter its products without notice. This also applies to products already on order provided that such alterations can be made without subsequent changes being necessary in specifications already agreed. All trademarks in this material are property of the respective companies. Danfoss and the Danfoss logotype are trademarks of Danfoss A/S. All rights reserved.