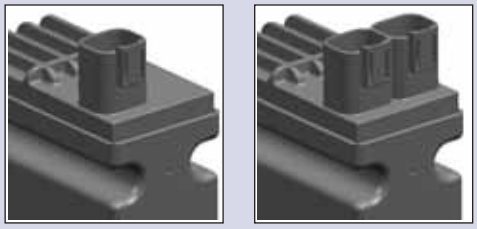
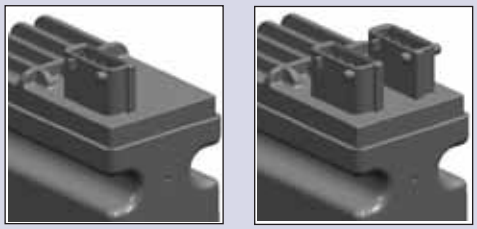
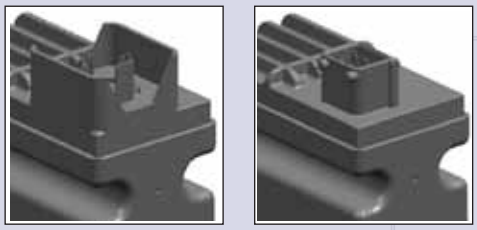
SAUER DANFOSS

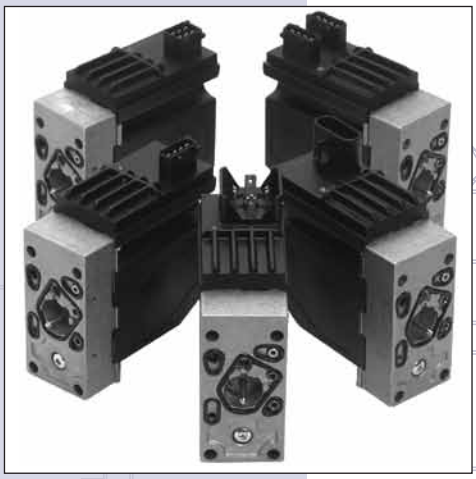
# PVE – Series 4 for PVG 32, PVG 100 and PVG 120

## Technical Information











COMPLIANT

# PVE Series 4 for PVG 32, PVG 100 and PVG 120
# Technical Information
## Revisions

### Revision History

*Table of Revisions*

| Date | Page | Changed | Rev |
|---|---|---|---|
| Jun 2011 | All | Major update | FA |
| Jan 2012 | 44-45 | Change to 44 pages | FB |

### List of Abbreviations

| | |
|---|---|
| ATEX | Certificated for use in flammable environment |
| CLC | **C**losed **L**oop **C**ircuit |
| -DI | PVE with **D**irection **I**ndication. |
| EH | Electro Hydraulic |
| -F | PVE for **F**loat spool. Two variants: 4 pin with float at 75%. 6 pin with separate float |
| FMEA | **F**ailure **M**ode **E**ffect **A**nalysis |
| LED | **L**ight **E**mitting **D**iode |
| LS | **L**oad **S**ensing |
| LVDT | **L**inear **V**ariable Differential **T**ransducer |
| NC | Solenoid valve in PVE **N**ormally **C**losed.<br>NC-H Standard NC like in PVEH, NC-S Super like in PVES |
| NO | Solenoid valve in PVE **N**ormally **O**pen |
| PLC | **P**rogrammable **L**ogical **C**ircuit |
| PLUS+1 | Trade mark for Sauer-Danfoss controllers and programming tool |
| Pp | **P**ilot **P**ressure. The oil gallery for PVE actuation |
| PVB | **P**roportional **V**alve **B**asic module. Valve slice |
| PVBS | **P**roportional **V**alve **B**asic module **S**pool |
| PVBZ | **P**roportional **V**alve **B**asic module **Z**ero leakage |
| PVE | **P**roportional **V**alve **E**lectric actuator |
| PVEA | PVE variant with 2-6% hysteresis |
| PVED | PVE variant **D**igital controlled via CAN communication |
| PVEH | PVE variant with 4-9% hysteresis |
| PVEM | PVE variant with 25-35% hysteresis |
| PVEO | PVE variant with **O**N/OFF actuation |
| PVEP | PVE variant PWM controled |
| PVES | PVE variant with 0-2% hysteresis |
| PVEU | PVE variant with $U_S$ = 0-10 V |
| PVG | **P**roportional **V**alve Group. Multi section valve |
| PVHC | Current controlled valve actuator |
| PVM | **P**roportional **V**alve Manual control. Handle |
| PVP | **P**roportional **V**alve Pump side module. Inlet |
| PVS | **P**roportional **V**alve end plate |
| PVSK | **P**roportional **V**alve end plate Crane. Inlet module with **S**pool Control |
| PWM | Pulse Width Modulation |
| -R | PVE with **R**amp function |
| -SP | PVE with **S**pool **P**osition feedback |
| uC | micro **C**ontroler |
| $U_{DC}$ | Power supply **D**irect **C**urrent. Also called $V_{bat}$ for battery voltage |
| $U_S$ | **S**teering voltage for the PVE control. Also called $V_S$ |



Front cover illustrations:V310299, V310300, V310294, V310292 ,V310295, V310291, F300704, drawing 157-506.

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# PVE Series 4 for PVG 32, PVG 100 and PVG 120
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## Connection and Activation



## Code Numbers

## Reference

Sauer-Danfoss Doc **520L0344**, *PVG 32 Proportional Valve Groups, Technical Information*.
Sauer-Danfoss Doc **520L0720**, *PVG 100 Proportional Valve Groups, Technical Information*.
Sauer-Danfoss Doc **520L0356**, *PVG 120 Proportional Valve Groups, Technical Information*.
Sauer-Danfoss Doc **520L0665**, *PVED-CC Electro Hydraulic actuator, Technical Information*
Sauer-Danfoss Doc **11070179**, *PVED-CX Electro Hydraulic actuator, Technical Information.*

## Standards

- 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 or DIN*

*Deutsch*

*AMP*

## Product Warnings

⚠ Warning

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.

⚠ Warning

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

⚠ Warning

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

⚠ Warning

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

⚠ Warning

Error pins from more PVEs may not be connected. Inactive error pins are connected to ground and will disable any active signal.

⚠ Warning

Error pins are signal pins and can only supply very limited power consumption.

⚠ Warning

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

⚠ Warning

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

⚠ Warning

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

**Product Warnings (continued)**

⚠ Warning
Hydraulic oil can cause both environmental damage and personal injury.

⚠ Warning
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.

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

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

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

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

⚠ Warning
Reduced pilot oil pressure will limit spool control.

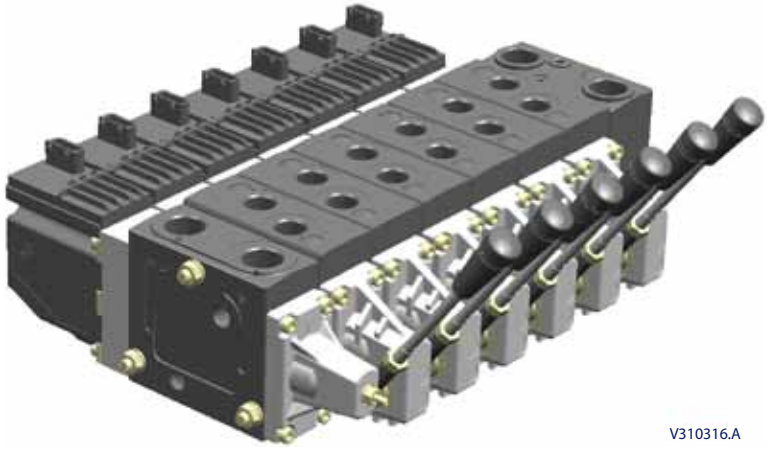
⚠ Warning
Too high pilot oil pressure can harm the PVE.

## Introduction

PVE Series 4 is the common name for the Sauer-Danfoss PVG electrical actuator.

This technical information has focus on the analog actuators. The digital actuators PVED-CC and PVED-CX are covered in their special technical information.

*PVE controlled PVG with PVSK*




**PVE stands for Proportional Valve Electrical actuator.**
The Sauer-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 PVG32, PVG100 and PVG120.

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 Sauer-Danfoss PLUS+1™ micro-controller.

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

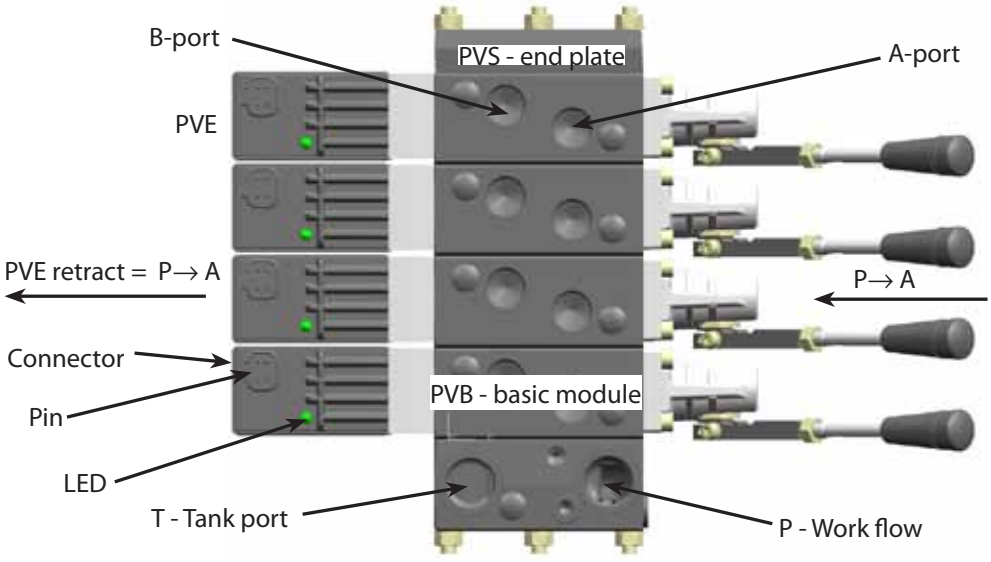
## Overview

The PVG is a sectional spool valve stack with up to 12 individually controlled proportional valves. With the PVE the PVG 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*



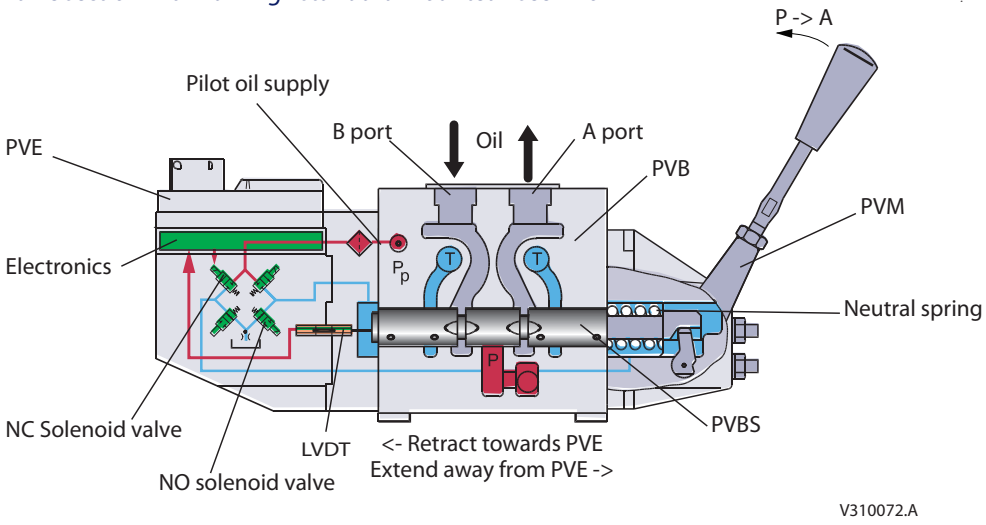
## PVG Functionality

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), a PVSK, a mid inlet or other system interface and enters the PVB (proportional valve basic module) via the P gallery and leaves through the T gallery. The PVP/PVSK also supplies the Pilot oil pressure (Pp) for the PVE to activate the spool (PVBS).

When looking at the figure you see the valve section from PVP towards PVS with the PVM and PVE standard mounted. When PVM and PVE are interchanged it's called option mounted.

*Valve section with naming - standard mounted - seen from PVP*




Oil out of A-port = PVM pushed towards PVB = retract = LVDT moves into PVE.

With the spool in neutral, default position when held by the neutral spring, the connection to the application via ports is blocked.

Moving the PVBS towards the PVE, as in the figure, opens a connection between P and A and also between B and T. This is done by either pushing the PVM or activating the PVE. The PVE moves the PVBS by letting Pilot Oil Pressure (Pp) push on the right end of the PVBS and releasing pressure from the left end. For details on PVG 32 please see *PVG 32 Proportional Valve Groups, Technical Information,* **520L0334**.

## 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.

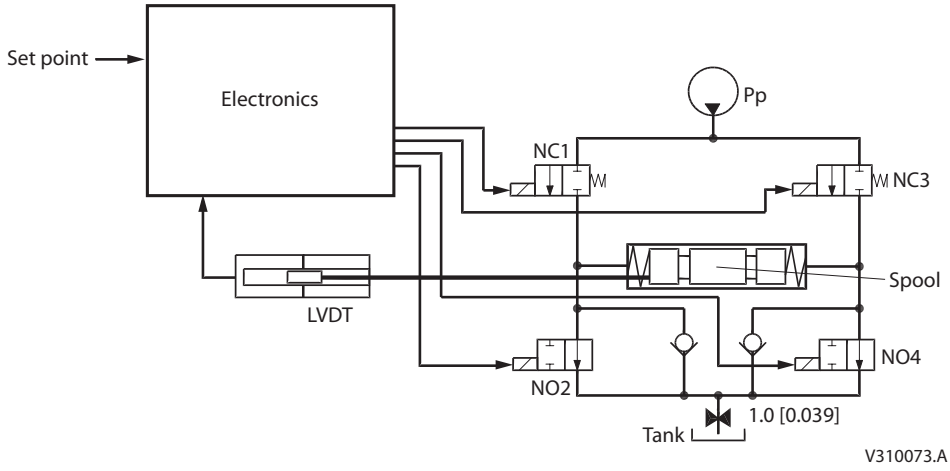
The PVE is an electro mechanical device, meaning that functionality is depending on mechanical, hydraulic, electrical and control conditions given by PVE, PVG, application and vehicle. The result of this is that implementing operation and safety conditions also must include vehicle specific considerations.

**PVE Functionality (continued)**

## Hydraulic subsystem

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

*Pilot oil diagram*




The hydraulic sub system 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 (Pp) 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 Pp 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 Pp 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.

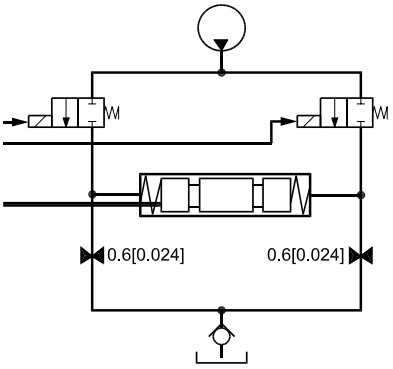
**⚠ Warning**

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

## PVE Functionality (continued)

### Hydraulic variants: PVEA

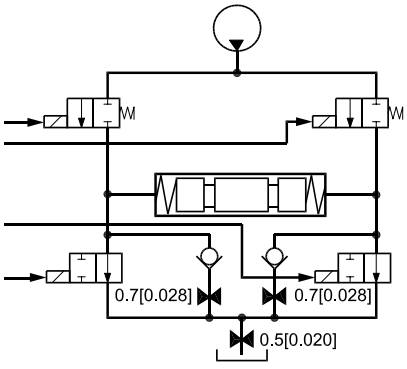
*NO2 and NO4 are replaced with orifices.*




157-338.10

### PVE with ramp

*Tank orifice has smaller diameter.*

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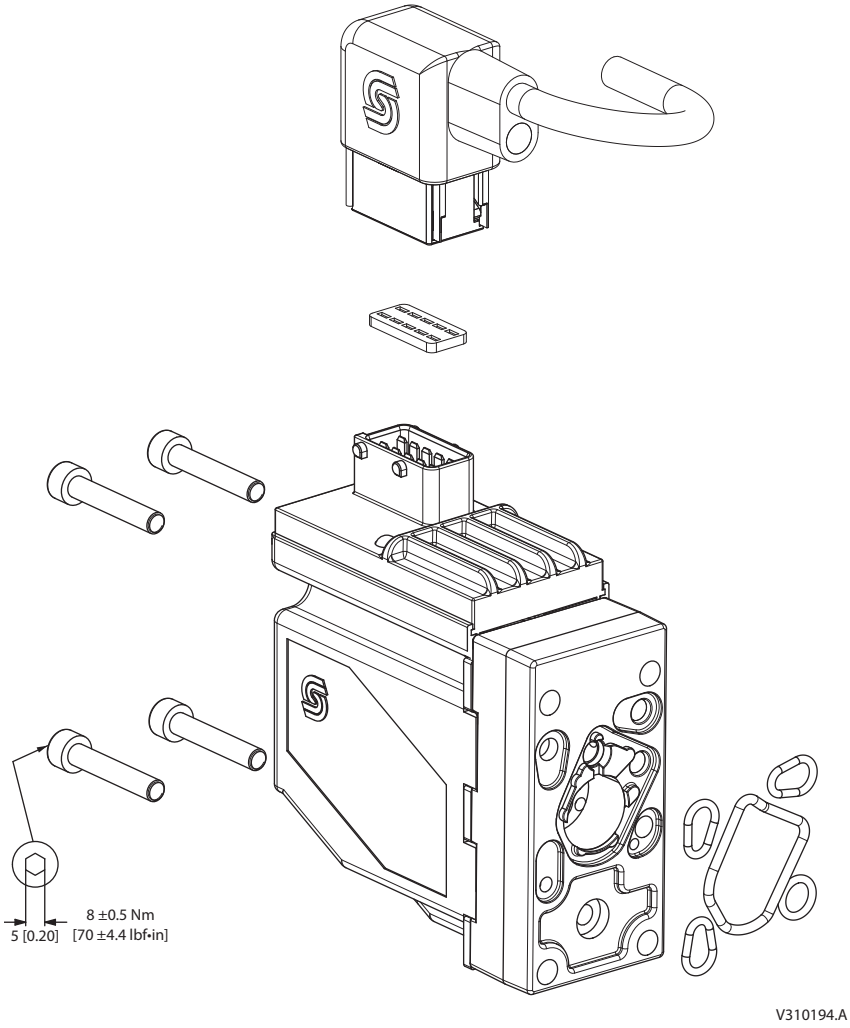
**PVE Functionality (continued)**

## 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. Sauer-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 with bolts and connectors*

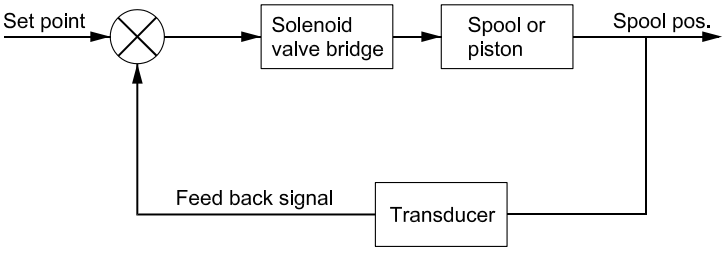


## PVE Functionality (continued)

### 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.

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 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 and is a utilization of the ASIC.

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

Spool position is a precise feedback on a separate pin giving actual position, but not with a redundant power supply.

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

The PVEM and PVEO do not have fault monitoring.

### 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 three main events:

1. *Control signal monitoring*
   The Control signal voltage ($U_S$) 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 $U_S$ 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 (>12%, PVEA: >25%) 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.

The neutral position has a tolerance of 0,5 mm relative the calibrated neutral position.

## Safety and Monitoring (continued)

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*
- The LED change color
- The state is active for minimum 100 ms and is reset when error disappears

* for PVE with direction indication both DI pins goes low by fault.

**⚠ Warning**

Error pins from more PVEs may not be connected. 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 and PVES 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

## Safety and Monitoring (continued)

*Fault monitoring overview*

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

1) Measured between fault output pin and ground.

**⚠ Warning**

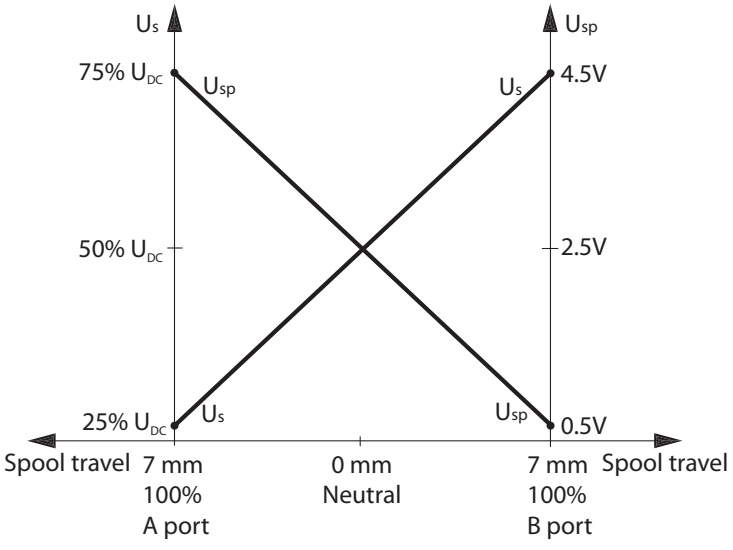
It's up to the customer to decide on the required degree of safety for the system.

ON DI the DI pins go low when error out goes high.

## Spool Position Feedback (-SP)

The –SP functionality is a 0,5V to 4,5V inverted feedback with 2,5V as neutral value.

*Spool Position Feedback*



## Direction Indication Feedback (-DI)

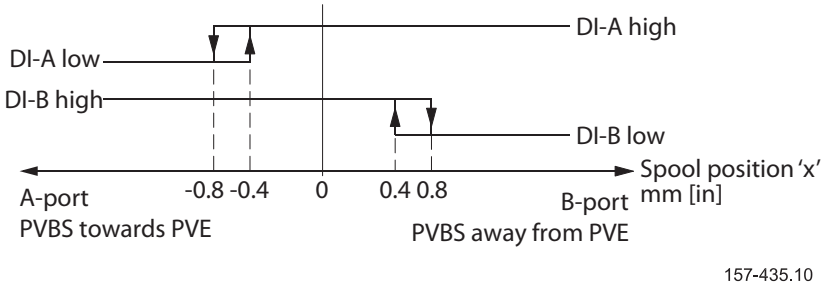
PVE with build in indication for spool movement direction are available.

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 DI has two direction feeedback 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*




*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 both Direction Indicators, pin A and pin B*

| | |
|---|---|
| **Transition to low from high** | 0.8 ± 0.1 mm [0.031 in] |
| **Transition to high from low** | 0.4 ± 0.1 mm [0.015 in] |
| **Transition to low both pins** | error pin goes high |
| **Maximum load of "DI-A" , "DI-B"** | 50 mA |
| **Voltage $U_{DC}$ high by load 20 mA** | > $U_{DC}$ –1.5 V |
| **Voltage $U_{DC}$ high by load 50 mA** | > $U_{DC}$ –2.0 V |
| **Voltage low** | < 0.2 V |

## Building in Safety

All makes and 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 an FMEA (Failure Mode and Effect Analysis) and Hazard and Risk Analysis can be used.

### FMEA (Failure Mode and Effect Analysis) IEC EN 61508

FMEA 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 IEC FMEA Standard 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 meet according to the machine directives EN 13849. Dependent on the determined levels conformety this analysis will detirmine if any extra requirements for the product design, development process, production process or maintenance, i.e. the complete product life cycle.

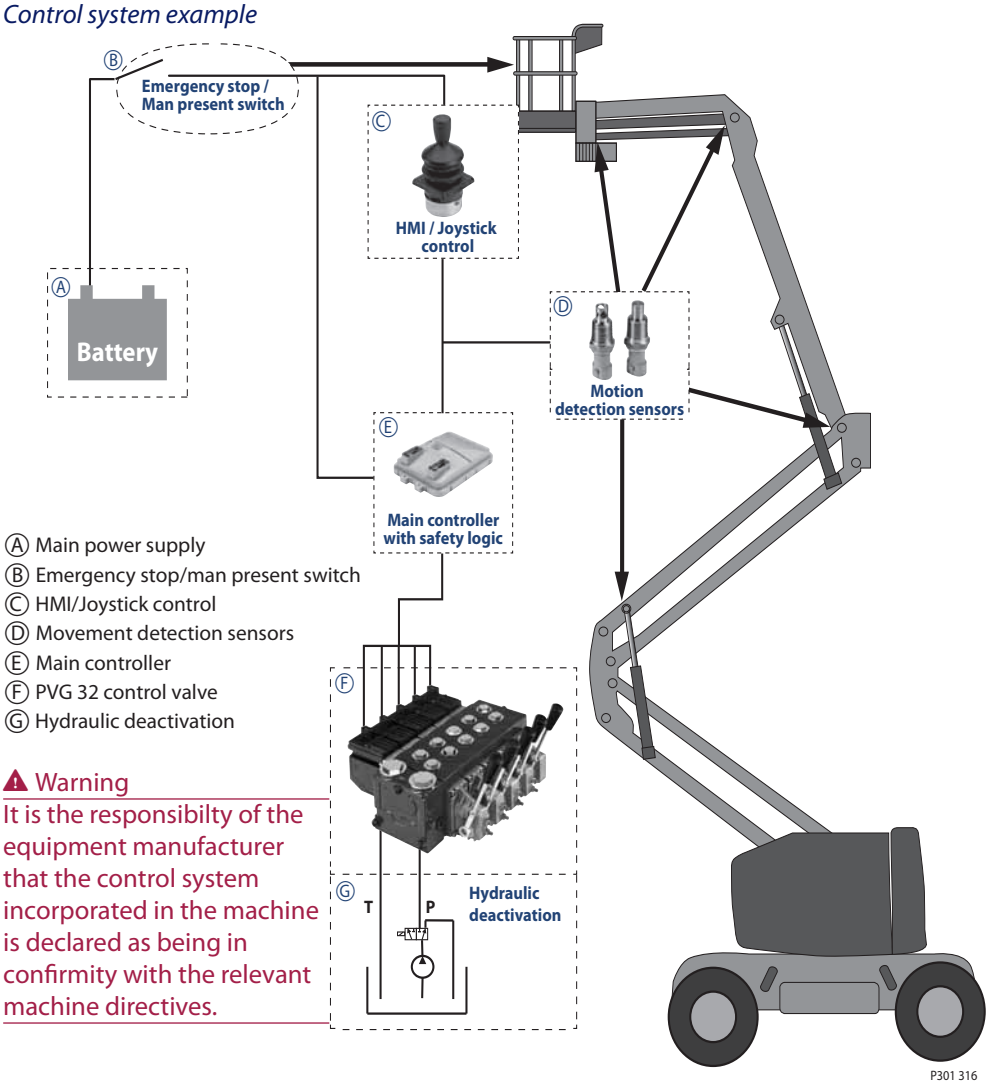
⚠ Warning

All makes/brands and types of directional control valves – inclusive 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 manufacturer of the application is alone 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).

## Control System Example

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

*Control system example*

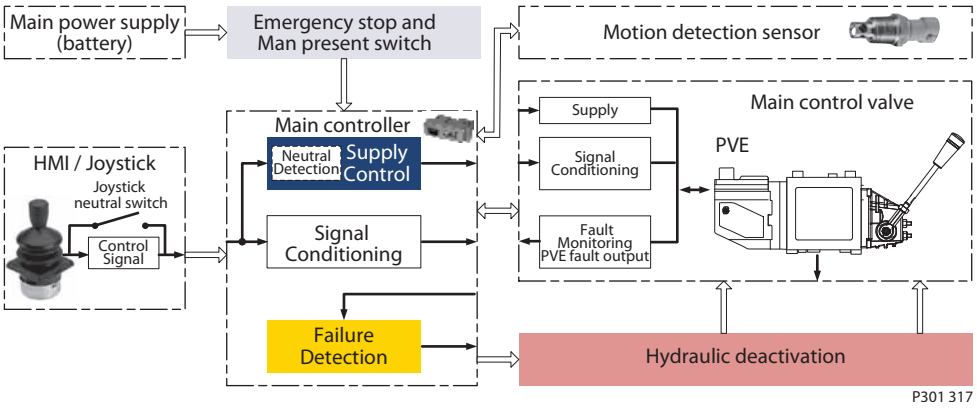



Ⓐ Main power supply
Ⓑ Emergency stop/man present switch
Ⓒ HMI/Joystick control
Ⓓ Movement detection sensors
Ⓔ Main controller
Ⓕ PVG 32 control valve
Ⓖ Hydraulic deactivation

**⚠ Warning**

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

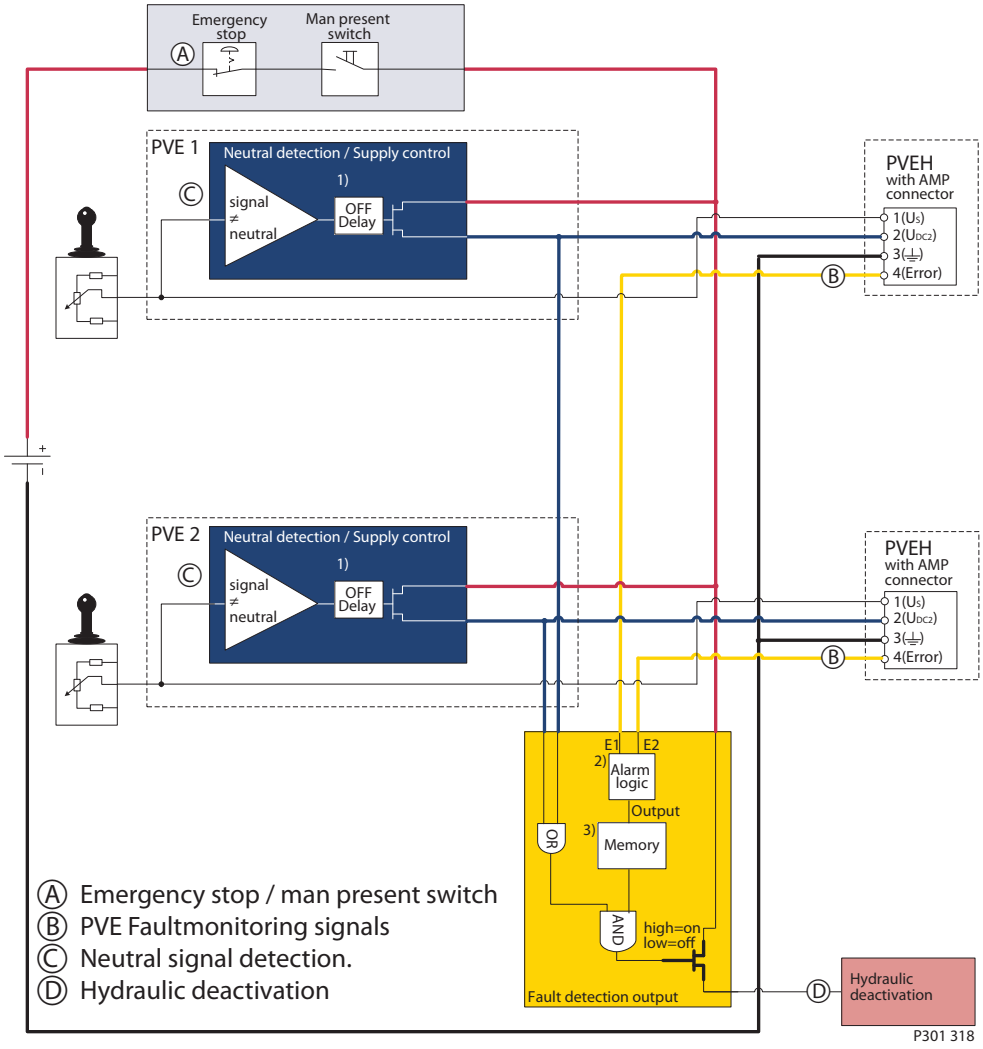
*Electrical block diagram for above illustration*



## Control System Example (continued)

Example of a typical wiring block diagram using PVEH with neutral power off switch and fault monitoring output for hydraulic deactivation.

*Typical wiring block diagram example*




System Control Logic e.g. PLUS+1™ for signal monitoring and triggering signal for deactivation of the hydraulic system.

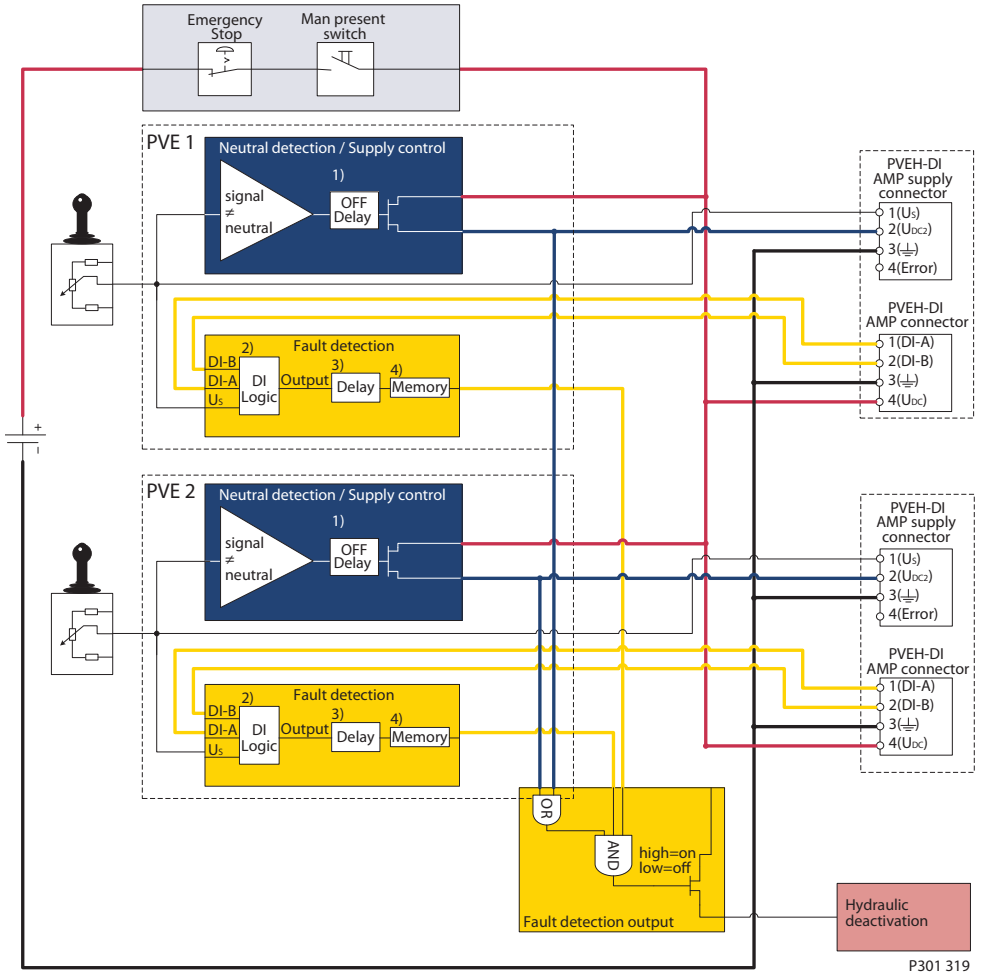
**⚠ Warning**

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

## Control System Example (continued)

Similar to previous example using fault monitoring for deactivation of the hydraulic system with extra fault inputs using the PVE's with DI (Direction Indication) function.

*Example of fault monitoring for deactivation of the hydraulic system*




System Control Logic e.g. PLUS+1™ for signal monitoring and triggering signal for deactivation of the hydraulic system.

**⚠ Warning**

It is the equipment manufacturers responsibility to ensure that the control system incorporated in the machine is declared as being in conformity with the relevant machine directives.

**Control System Example (continued)**

Other non-electrical modules which can be used in connection with hydraulic deactivation at different levels.

**PVG32– Mainly used in system with fixed displacement pumps**

- PVSK, commonly used in crane application - full flow dump
- PVPE, full flow dump for the PVG 120

**PVG100 – Alternative LS dump or pilot supply disconnect**

- PVPP, pilot oil supply shut off
- External cartridge valve connecting LS Pressure to Tank
- External cartridge valve connecting main Pressure to Tank

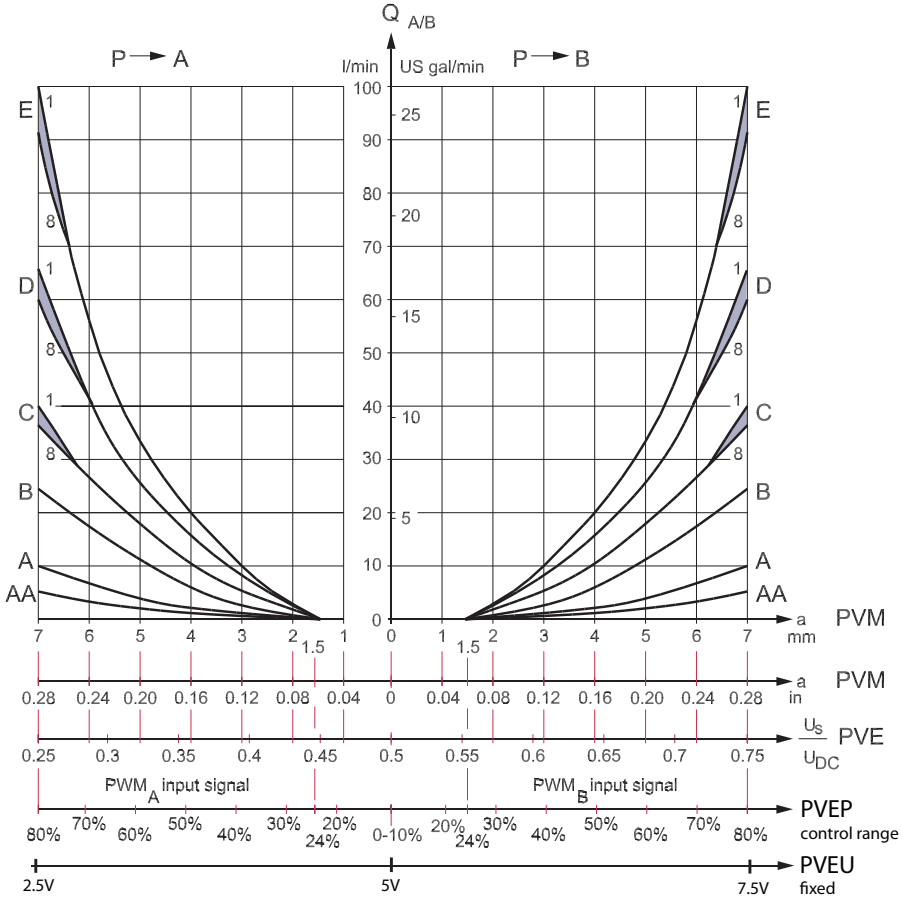
**PVG120 – Pump disconnect/block for variable pumps**

- PVPX, LS dump to tank

## PVE Control by Voltage

- The standard 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 $U_S$ / $U_{DC}$ define the actuation.
- A not connected $U_S$ pin (floating) is recognized as $U_S = ½U_{DC}$

*PVE characteristic – control by voltage*




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

| Function | Signal voltage ($U_S$) |
|---|---|
| Neutral | $U_S = 0.5 \cdot U_{DC}$ |
| Q: P → A | $U_S = (0.5 \rightarrow 0.25) \cdot U_{DC}$ |
| Q: P → B | $U_S = (0.5 \rightarrow 0.75) \cdot U_{DC}$ |

## PLUS+1™ compliance

PVEA, PVEH, PVES, PVEO, PVEP and PVED can be controlled by PLUS+1.
The $U_{DC}$ has a capacitance of 2,2uF which can give problems with some micro-controller power supply. To eliminate this problem Sauer-Danfoss has designed a special resistance supply and control cable.

## ATEX PVE

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

## PVE Control by Voltage (continued)

### PVEU – PVE with fixed control signal range

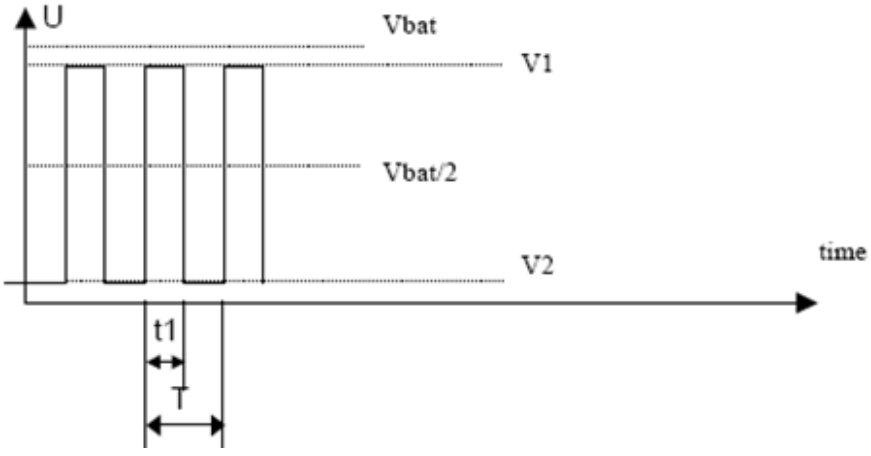
TThe PVEU (PVE 0-10V) is designed for PLC / microcontroller(uC) control hence the U.
The control signal $U_S$ is fixed 0 V to 10 V independent of supply voltage $U_{DC}$.

*Signal voltage - PVEU*

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

### 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≤ $U_{DC}$.




*Duty cycles - PVE (PVEA/M/H/S)*

| Function | Duty cycle (dc) PVEA/M/H/S |
|---|---|
| Neutral | 50% dc |
| Q: P → A | 50% dc → 25% dc |
| Q: P → B | 50% dc → 75% dc |

Sauer-Danfoss recommends PWM frequency:

- PVEM > 200 Hz
- PVEA/H/S > 1 kHz

**⚠ Warning**

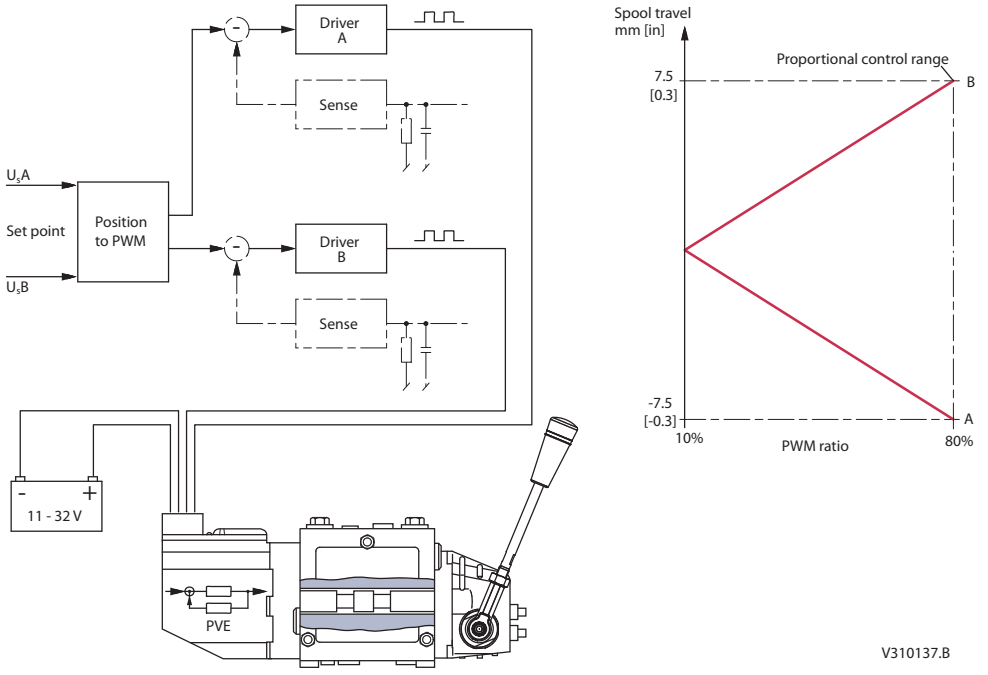
The PWM is not evaluated by the PVE so variance/failure in period (T) will not be detected.

## PVE Control by Voltage (continued)

### PVEP

The PVEP is designed for PWM control signals only.

*PVEP schematic and characteristic*




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. 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.

PWM frequency can be chosen between 100 to 1000 Hz.

*PVEP signals*

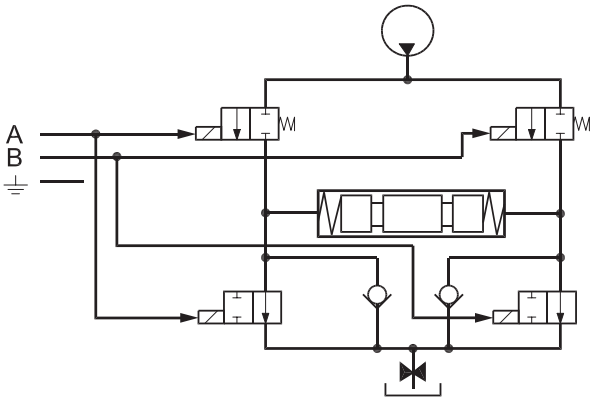
| Duty cycle A-signal (pin 1) | Duty cycle B-signal (pin 1) | Function | Error Pin output (pin 3) |
|---|---|---|---|
| 0% | 0% | Neutral | Low |
| 10% | 0% | | |
| 0% | 10% | | |
| ≥ 10% | ≥ 10% | Fault (Error) | High |
| < 10% | 10 → 80% | B-port flow | Low |
| 10 → 80% | < 10% | A-port flow | Low |
| A > 86% | B > 86% | Fault (Error) | High |

## PVEO

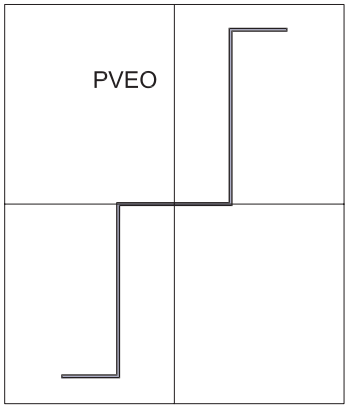
### PVE ON/OFF activation

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*




157-470.10




157-513.10

**⚠ Warning**

The PVEO is designed to have $U_{DC}$=12 V or $U_{DC}$=24 V. The solenoids might be activated by voltage down to 6 V.

## PVE to the Float Spool

Sauer-Danfoss has developed two PVE variants to support the float spool.

The float PVBS is a four position PVBS, where as the standard is a three position giving another characteristic for positioning and flow. This variation is covered by the built-in electronics.

*There are two variants of float PVBS.*

- Float B – 1,5 mm dead band, max flow at 4,8 mm. Float at B = 8 mm, from 6 mm partial float.
- Float A – 0,8 mm dead band, max flow at 5,5 mm. Float at A = 8 mm, from 6,2 mm partial float ( PVBZ).

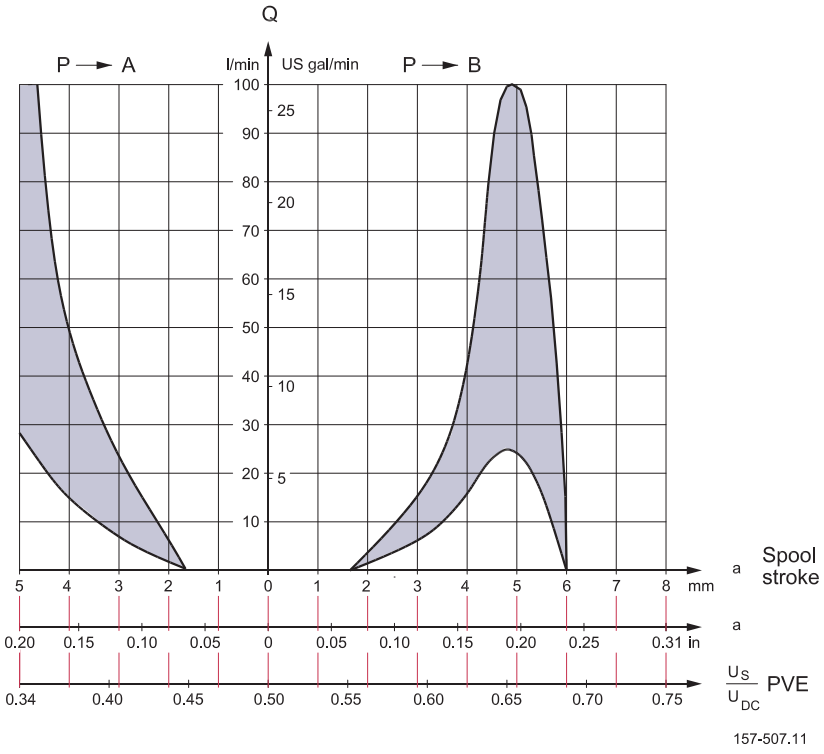
PVEM-F and PVEH-F with four pin connector are for float B and gives no built-in protection against entering float.

PVEH-F with six pin connector is for float A and gives protection against entering float.

## PVE to the Float Spool (continued)

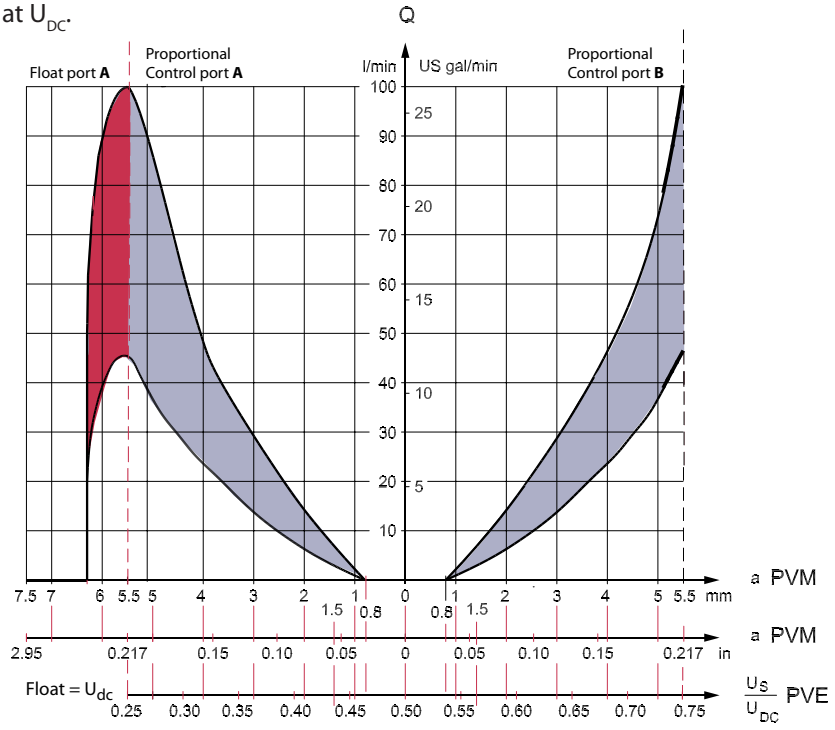
*PVE characteristic – Float B*

PVBS maximum float is 4.8 mm [0.19 in]. PVE has four pins. Float at $U_S / U_{DC} = 0.75$




*PVE characteristic – Float A*

PVBS maximum float is 5.5 mm [0.22 in]. PVE has six pins. Float when special pin powered at $U_{DC}$.



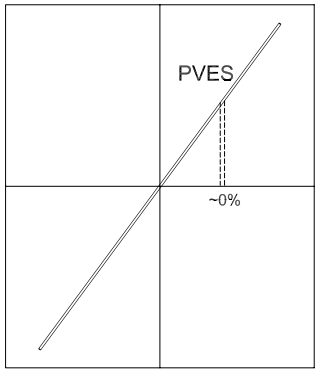
## Hysteresis

The controllability of the PVE depends on the solenoid valve bridge and the electronic capacity of the module. Hysteresis is a measurement on spool position precision and repeatability. Hysteresis is not a description of position maintenance.

### PVES Series 4

The PVES has an ASIC closed loop circuit and the NC-S solenoids.

*PVES voltage, position diagram*

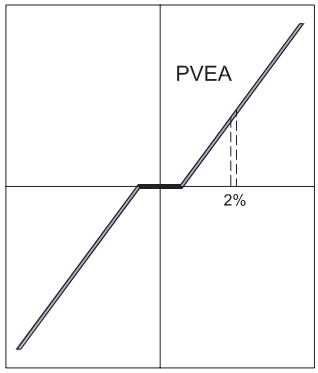



157-775.10

### PVEA Series 4

The PVEA has an ASIC closed loop circuit, standard NC solenoids and orifice instead of NO solenoids.

*PVEA voltage, position diagram*

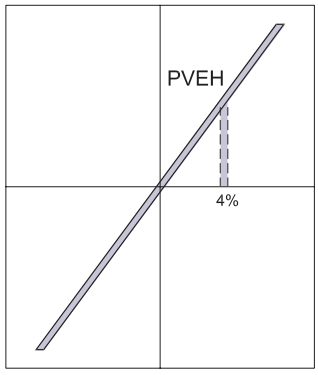



157-510.10

### PVEH Series 4

The PVEH has an ASIC closed loop circuit and the standard NC solenoids.

*PVEH voltage, position diagram*




157-511.10

*PVE hysteresis overview*

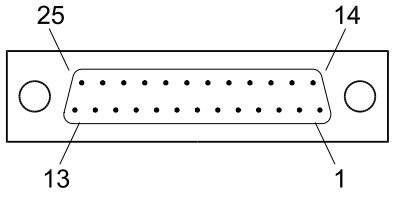
| PVE | S | A | H | M |
|---|---|---|---|---|
| **Maximum** | 2 % | 6 % | 8.6 % | 35 % |
| **Typical** | <½ % | 2 % | 4 % | 25 % |

PVEP has the PVES characteristic.
PVEU is available with both standard PVEH and super fine PVES characteristic.

## Example of 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].

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



## 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 Sauer-Danfoss.
The PVEO/M are not subject to this directive.

### Operating conditions

The PVE is designed for use with pilot oil supply. 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 following technical data are from typical test results. For the hydraulic system mineral based hydraulic oil with a viscosity of 21 $mm^2/s$ [102 SUS] and a temperature of 50 °C [122 °F] was used.

### PVEO

*PVEO Supply voltage*

| | | | |
|---|---|---|---|
| **Supply voltage $U_{DC}$** | rated | 12 $V_{DC}$ | 24 $V_{DC}$ |
| | range | 11 ÷ 15 V | 22 ÷ 30 V |
| | max. ripple | 5 % | 5 % |
| **Current consumption** | Typical | 365 mA | 740 mA |
| | minimum | 290 mA | 550 mA |
| | maximum | 420 mA | 820 mA |
| **Current via DI** | maximum | 100 mA | |

*Reaction time PVEO ON/OFF (minus PVG 120)*

| **Reaction time in seconds** | | **PVEO s** | **PVEO with ramp s** |
|---|---|---|---|
| **From off to max. spool travel (rated voltage)** | max. | 0.18 | 0.35 |
| | rated | 0.12 | 0.25 |
| | min. | 0.235 | 0.41 |
| **From maximum spool travel to blocked position (power disabled)** | max. | 0.175 | 0.33 |
| | rated | 0.09 | 0.27 |
| | min. | 0.065 | 0.25 |

*PVEA, PVEH and PVES*

| | | |
|---|---|---|
| **Supply voltage $U_{DC}$** | rated | 11 ÷ 32 V |
| | range | |
| | max. ripple | 5 % |
| **Current consumption at rated voltage** | PVEH/PVES (PVEA) | 0.57 (0.33) A @ 12 V<br>0.3 (0.17) A @ 24 V |
| **Signal voltage** | neutral | 0.5 x $U_{DC}$ |
| | A-port↔B-port | 0.25 ÷ 0.75 • $U_{DC}$ |
| **Signal current at rated voltage** | | 0.25 ÷ 0.70 mA |
| **Input impedance in relation to 0.5 • $U_{DC}$** | | 12 KΩ |
| **Power consumption** | PVEH/PVES (PVEA) | 7 (3.5) W |
| **Error pin** | max current | 100 mA |

## Operating Parameters (continued)

*PVEP*

| | |
|---|---|
| **Supply voltage $U_{DC}$ range** | 11 ÷ 32 V |
| **Supply voltage $U_{DC}$ max. ripple** | 5% |
| **Supply voltage $U_{DC}$ 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 kΩ |
| **Input capacitor** | --- |
| **Power consumption** | 7 W |
| **Error voltage: Fault** | $U_{DC}$ |
| **Error voltage: 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.

*Reaction time PVEA, PVEH and PVES (minus PVG 120)*

| Supply voltage | Function | | PVEA Prop. fine s | PVEH Prop. high s | PVES Prop. super s | PVEP PWM Ctrl s |
|---|---|---|---|---|---|---|
| Disconnected by means of neutral switch | Reaction time from neutral position to max. spool travel | max. | 0.500 | 0.230 | 0.230 | 0.230 |
| | | rated | 0.320 | 0.150 | 0.150 | 0.150 |
| | | min. | 0.250 | 0.120 | 0.120 | 0.120 |
| | Reaction time from max. spool travel to neutral position | max. | 0.550 | 0.175 | 0.175 | 0.175 |
| | | rated | 0.400 | 0.090 | 0.090 | 0.090 |
| | | min. | 0.300 | 0.065 | 0.065 | 0.065 |
| Constant voltage | Reaction time from neutral position to max. spool travel | max. | 0.500 | 0.200 | 0.200 | 0.200 |
| | | rated | 0.320 | 0.120 | 0.120 | 0.120 |
| | | min. | 0.250 | 0.050 | 0.050 | 0.050 |
| | Reaction time from max. spool travel to neutral position | max. | 0.250 | 0.100 | 0.100 | 0.100 |
| | | rated | 0.200 | 0.090 | 0.090 | 0.090 |
| | | min. | 0.150 | 0.065 | 0.065 | 0.065 |
| Hysteresis* | | rated | 2% | 4% | 0% | 5% |

* Hysteresis is indicated at rated voltage and f=0.02 Hz for one cycle (one cycle = neutral → full A → full B → neutral.

## Operating Parameters (continued)

### *Oil consumption PVEO*

| Function | | Supply Voltage | PVEO |
|---|---|---|---|
| Pilot oil flow for PVE | neutral* | OFF | 0 l/min [0 US gal/min] |
| | locked* | ON | 0.1 l/min [0.026 US gal/min] |
| | continuous actuations* | | 0.7 l/min [0.185 US gal/min] |

* 12 bar [174 psi] and 21 mm²/s [102 SUS]

### *Oil consumption PVEA, PVEH and PVES*

| Function | | Supply Voltage | PVEA prop. fine | PVEH prop. high | PVES prop. super |
|---|---|---|---|---|---|
| Pilot oil flow for PVE | neutral* | OFF | 0 l/min [0 US gal/min] | 0 l/min [0 US gal/min] | 0.3 l/min [0.106 US gal/min] |
| | locked* | ON | 0.4 l/min [0.106 US gal/min] | 0.1 l/min [0.026 US gal/min] | 0.1 l/min [0.026 US gal/min] |
| | continuous actuations* | | 1.0 l/min [0.264 US gal/min] | 0.7 l/min [0.185 US gal/min] | 0.8 l/min [0.211 US gal/min] |

* 12 bar [174 psi] and 21 mm²/s [102 SUS]

### *Oil viscosity*

| | | |
|---|---|---|
| **Oil viscosity** | range | 12 ÷ 75 mm²/s [65 ÷ 347 SUS] |
| | min. | 4 mm²/s [39 SUS] |
| | max. | 460 mm²/s [2128 SUS] |

### *Oil temperature*

| | | |
|---|---|---|
| **Oil temperature** | range | 30 ÷ 60°C [86 ÷ 140°F] |
| | min. | -30°C [-22°F] |
| | max. | 90°C [194 °F] |

### *Pilot pressure*

| | | |
|---|---|---|
| **Pilot pressure (relative to T pressure)** | nom. | 13.5 bar [196 psi] |
| | min. | 10.0 bar [145 psi] |
| | max. | 15.0 bar [217 psi] |

### *Operating temperature*

| | Min | Max |
|---|---|---|
| **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*

| | |
|---|---|
| **Max. allowed degree of contamination** | 18/16/13 (ISO 4406, 1999 version) |

For further information see Sauer-Danfoss documentation, **520L0464**.

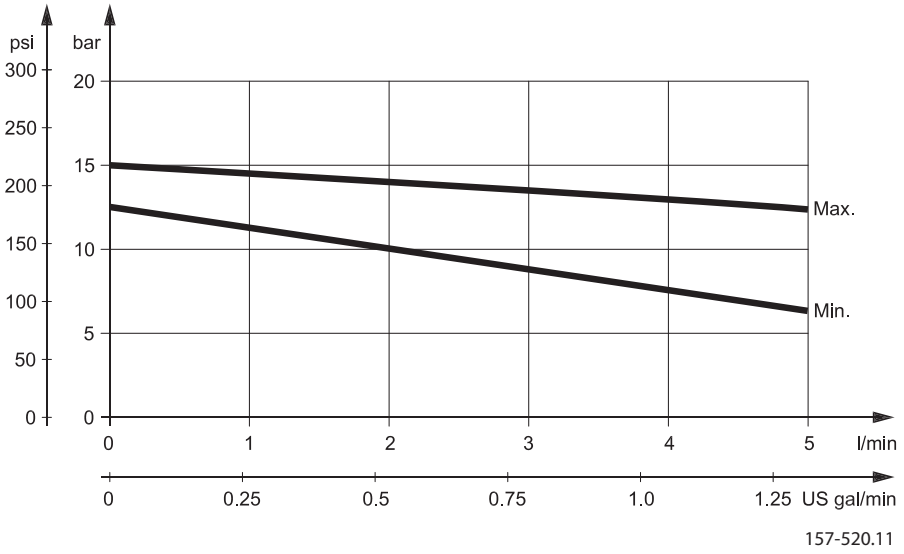
### *Enclosure and connector*

| Version of connector | Hirschmann connector | AMP JPT connector | Deutsch connector |
|---|---|---|---|
| **Grade of enclosure*** | IP 65 | IP 66 | IP 67 |

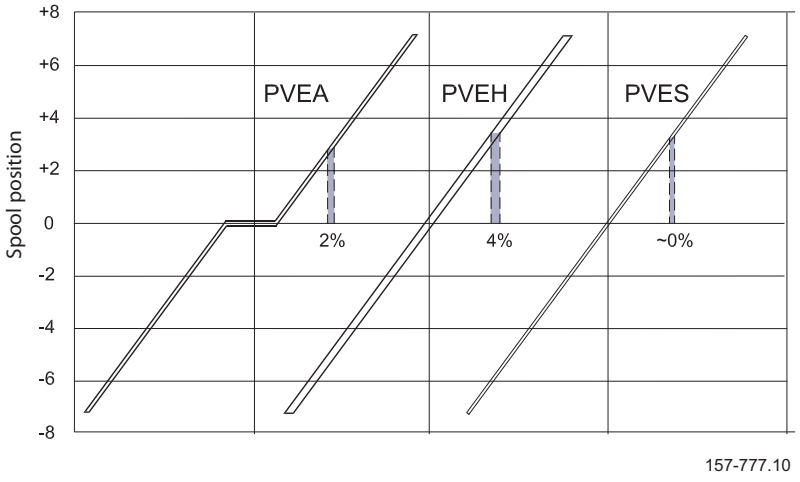
* According to the international standard IEC 529
NB: In particulary exposed applications, protection in the form of screening is recommended.

## Operating Parameters (continued)

*PVP modules, Pilot pressure curves*




*Spool position curves*



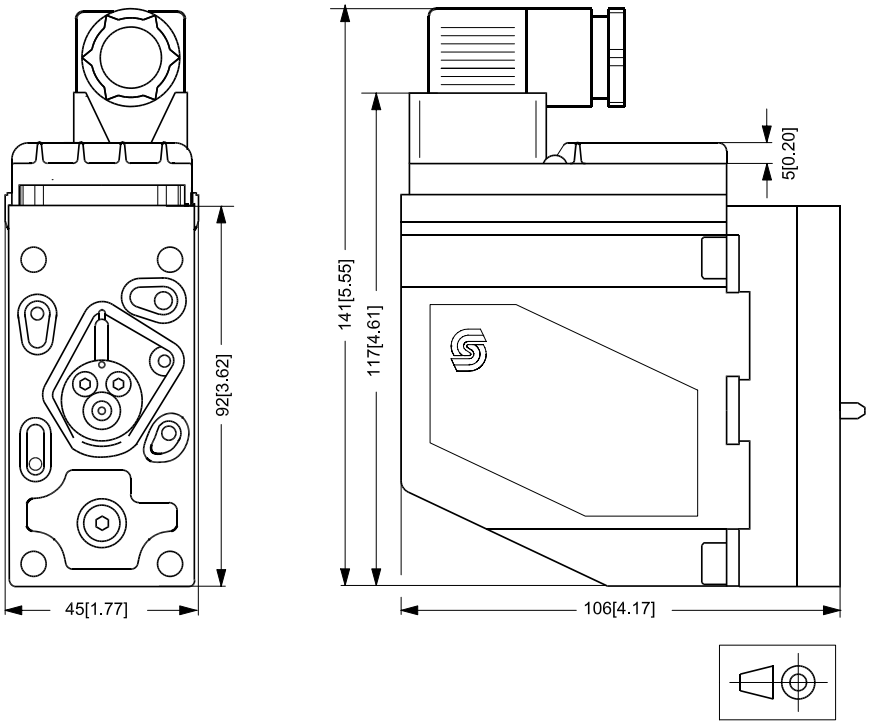

**⚠ Warning**

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

## General Dimensions

### PVE for PVG 32 and PVG 100

*PVE with Hirschmann connector*

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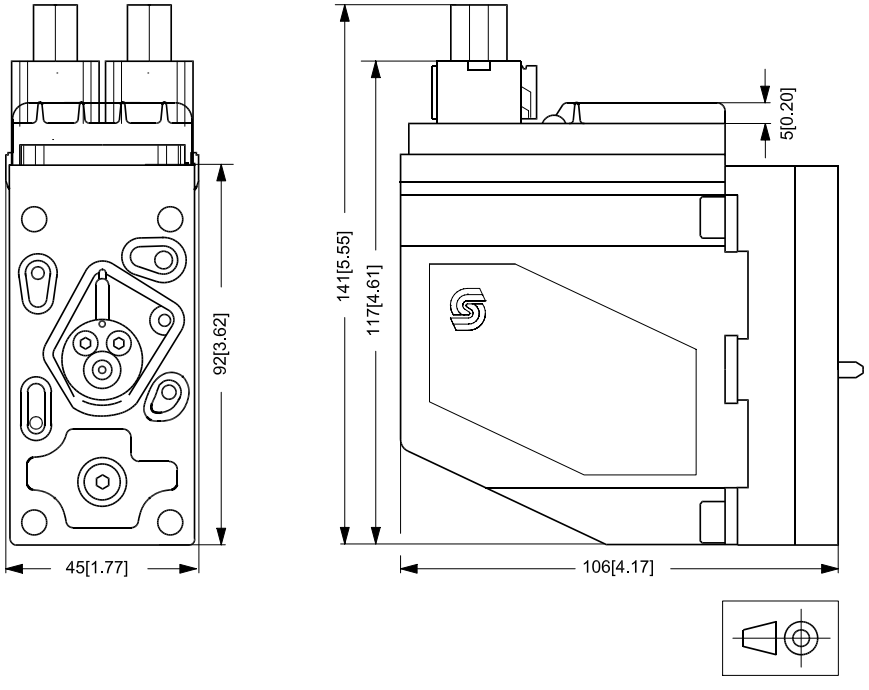
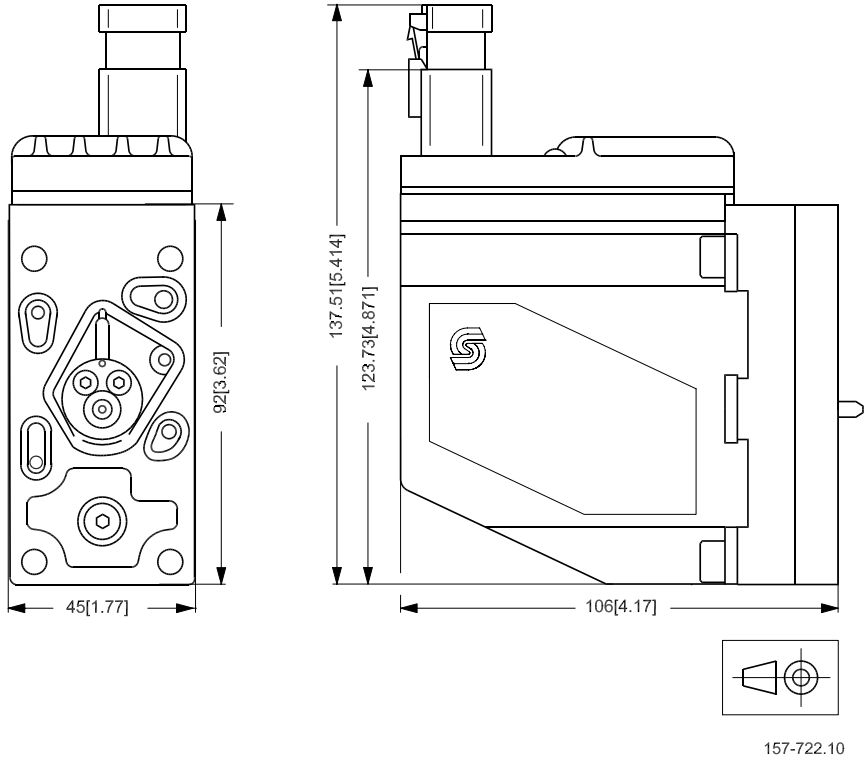
*PVE with AMP connector*



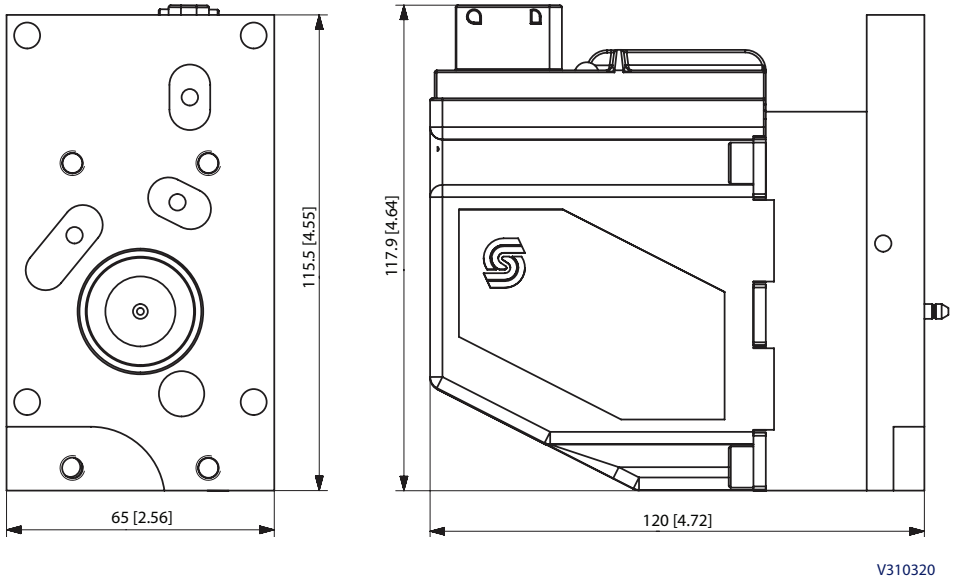

157-394.14

## General Dimensions (continued)

*PVE with Deutsch connector*




*PVE for PVG 120*




Height for PVE 120 is the same as for PVE 32 with same connector type.

## Version ON/OFF

*Connection PVEO with direction indication (DI)*

| Connector 1 | A $U_{DC}$ | B $U_{DC}$ | Gnd | Gnd |
|---|---|---|---|---|
| AMP (grey) | 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 |

*Connection PVEO standard*

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

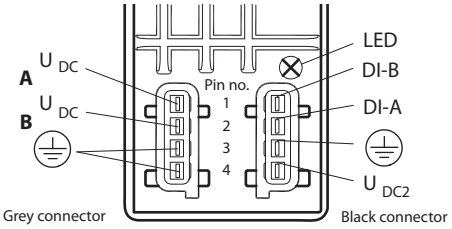
| Function | A (pin 1) | B (pin 2) |
|---|---|---|
| Neutral | 0 | 0 |
| Q: P → A | $U_{DC}$ | 0 |
| Q: P → B | 0 | $U_{DC}$ |

*Control all PVEO*

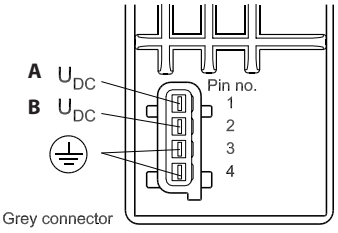
| Connector | A | B |
|---|---|---|
| AMP Hirschmann/DIN | pin 1 | pin 2 |
| Deutsch | pin 1 | pin 4 |

- 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.

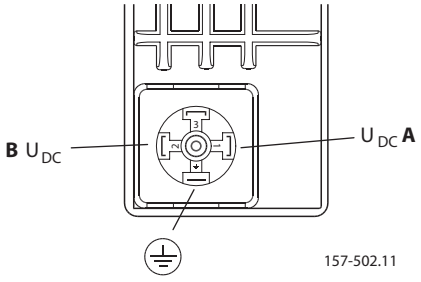
*AMP version of PVEO–DI*



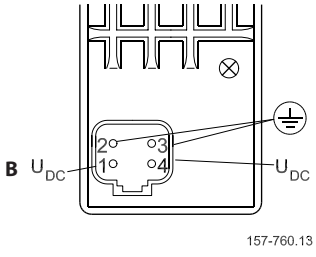

*AMP version of PVEO/PVEO–R*




*Hirschmann/DIN version of PVEO / PVEO–R*




*Deutsch version of PVEO*



## Proportional Version

### Standard PVE

*Connection PVEA/PVEH/PVEM/PVES/PVEU - also with float B four 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 3 |

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

*Control ($U_S$) for standard mounted PVEA/ PVEH/ PVEM/ PVESn*

| Function | Voltage relative | PWM |
|---|---|---|
| Neutral | 0,5 • $U_{DC}$ | 50% |
| Q: P → A | 0,5 → 0,25 • $U_{DC}$ | 50% → 25% |
| Q: P → B | 0,5 → 0,75 • $U_{DC}$ | 50% → 75% |

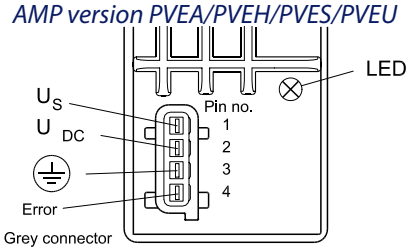
*Control ($U_S$) for standard mounted PVEU*

| Function | PVEU |
|---|---|
| Neutral | 5 V |
| Q: P → A | 5 V → 2,5 V |
| Q: P → B | 5 V → 7,5 V |

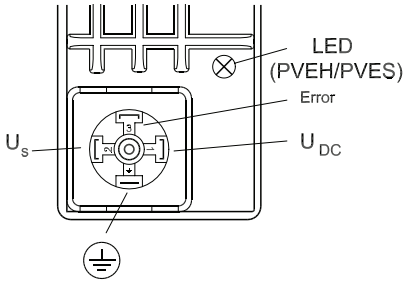
*Control ($U_S$) for standard mounted PVEH/ PVEM float B four pin version*

| Function | Voltage relative | PWM |
|---|---|---|
| Neutral | 0,5 • $U_{DC}$ | 50% |
| Q: P → A | 0,5 → 0,34 • $U_{DC}$ | 50% → 34% |
| Q: P → B | 0,5 → 0,65 • $U_{DC}$ | 50% → 65% |
| Float | 0,75 • $U_{DC}$ | 75% |

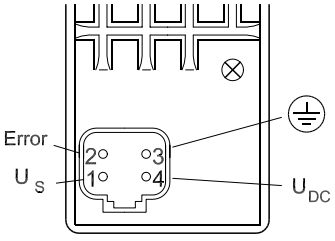
*AMP version PVEA/PVEH/PVES/PVEU*




*Hirschmann/DIN version PVEH/PVEM/ PVES/PVEH float B/PVEM float B*




*Deutsch version PVEA/PVEH/PVES/PVEU/ PVEH float B*



## Proportional Version (continued)

### Standard PVE with DI

*Connection PVE with direction indication (DI)*

| Connector 1 | $U_S$ | $U_{DC1}$ | Gnd | Error |
|---|---|---|---|---|
| AMP (grey) | p 1 | p 2 | p 3 | p 4 |
| Deutsch | p 1 | p 4 | p 3 | p 2 |

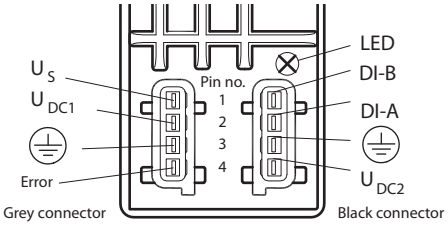
| Connector 2 | DI-B | DI-A | Gnd | $U_{DC2}$ |
|---|---|---|---|---|
| AMP (black) | p 1 | p 2 | p 3 | p 4 |
| Deutsch | p 4 | p 3 | p 2 | p 1 |

*Control ($U_S$) for standard mounted PVEA–DI/ PVEH–DI*

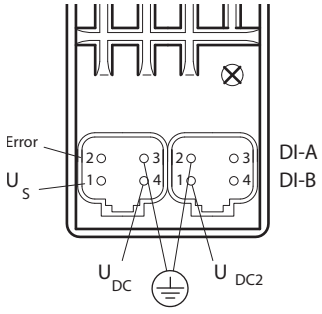
| Function | $U_S$ | PWM |
|---|---|---|
| Neutral | $0,5 \cdot U_{DC}$ | 50% |
| Q: P → A | $0,5 \rightarrow 0,25 \cdot U_{DC}$ | 50% → 25% |
| Q: P → B | $0,5 \rightarrow 0,75 \cdot U_{DC}$ | 50% → 75% |

- 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*




### Standard PVE with SP

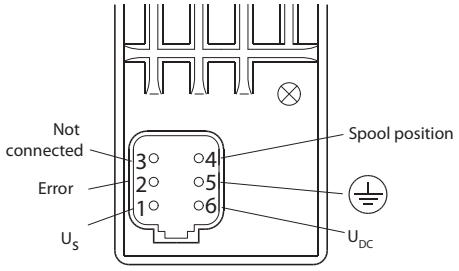
*Connection PVE with Spool Position (SP)*

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

*Control ($U_S$) for standard mounted PVEA–DI/ PVEH–DI*

| 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–SP*



## Proportional Version (continued)

### PVE with separate Float pin

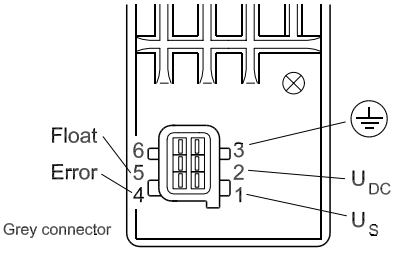
*Connection PVEH with float A six pin*

| Connector | $U_S$ (control) | $U_{DC}$ (power) | 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 |

*Control ($U_S$) for standard mounted PVEH/ PVEM float A six pin version*

| Function | Voltage relative | PWM |
|---|---|---|
| Neutral | 0,5 • $U_{DC}$ | 50% |
| Q: P → A | 0,5 → 0,25 • $U_{DC}$ | 50% → 25% |
| Q: P → B | 0,5 → 0,75 • $U_{DC}$ | 50% → 75% |
| Float | $U_{DC}$ on Float pin | |

*AMP with separate float pin*

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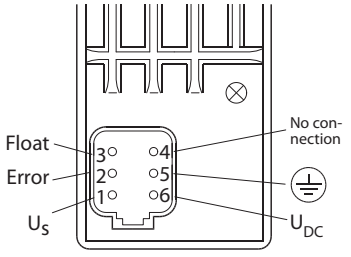
*Deutsch version with separate float pin*




P301 029

### PVE with PWM controled – PVEP

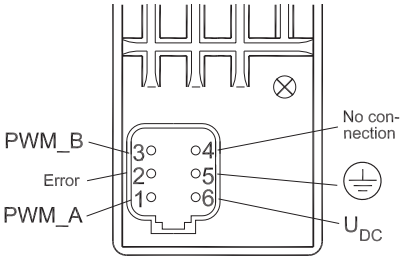
*Connection PVEP*

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

*Control ($U_S$) for standard mounted PVEP*

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

*Deutsch version with PVEP*




157-728.13

## PVE Code Numbers for use on PVG 32 and PVG 100

### *AMP connector code numbers*

| Feature | | S super fine hysteresis | 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 | | 157B4906 | | | 157B4903 |
| | 24V | | 157B4902 | | 157B4905 | 157B4272 | 157B4274 | 157B4904 |

*1x4 = one plug four pins* *1x6 = one plug six pins* *S = super fine hysteresis*

### *Deutsch connector code numbers*

| Feature | | S super fine hysteresis | std. | float A | float B | DI | SP | Fast-no memory |
|---|---|---|---|---|---|---|---|---|
| **Connector** | | | **1x4** | **1x6** | **1x4** | **2x4** | **1x6** | **1x4** |
| **PVEA** | active | | 157B4792 | | | 157B4796 | | |
| **PVEH** | active | | 157B4092 | 157B4398 | | 157B4096 | | |
| | passive | | 157B4093 | | 157B4392 | | | |
| **PVES** | active | S | 157B4892 | | | | | 157B4894 |
| | passive | S | 11089276 | | | | 11020776 | |
| **PVEP** | active | S | 11034832 * | | | | | |
| **PVEU** | passive | S | 11089090 | | | | | |
| **PVEO** | 12V | | 157B4291 | | | | | |
| | 24V | | 157B4292 | | | | | |

*1x4 = one plug four pins;* *S = super fine hysteresis;*
**1x6 = one plug six pins;*

### *Hirschmann/DIN connector code numbers*

| Feature | | S super fine hysteresis | std. | float B | anodized | ramp |
|---|---|---|---|---|---|---|
| **Connector** | | | **1x4** | **1x4** | **1x4** | **1x4** |
| **PVEH** | active | | 157B4032 | 157B4332 | 157B4073 | |
| | passive | | 157B4033 | | | |
| **PVES** | active | S | 157B4832 | | | |
| | passive | S | 157B4833 | | | |
| **PVEM** | 12V | | 157B4116 | 157B4416 | | 157B4516 |
| | 24V | | 157B4128 | 157B4428 | | 157B4528 |
| **PVEO** | 12V | | 157B4216 | | 157B4266 | 157B4217 |
| | 24V | | 157B4228 | | 157B4268 | 157B4229 |

*1x4 = one plug four pins;* *S = super fine hysteresis*

### *ATEX (24 V) connector code numbers*

| Feature | | S super fine hysteresis | std. | std. | opt. | 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 |

## PVE Code Numbers for use on PVG 120

### *AMP code numbers*

| Feature | | anodized |
|---|---|---|
| **Connector** | | **1x4** |
| **PVEH** | active | 155G4094 |
| | passive | 155G40945 |
| **PVEO** | 12V | 155G4282 |
| | 24V | 155G4283 |

*1x4 = one plug four pins*

### *Hirschmann/DIN code numbers*

| Feature | | anodized |
|---|---|---|
| **Connector** | | **1x4** |
| **PVEH** | active | 155G4092 |
| | passive | 155G4093 |
| **PVEO** | 12V | 155G4272 |
| | 24V | 155G4274 |

### *ATEX (24 V) connector code numbers*

| Feature | | std. | std. | opt. | BFOU |
|---|---|---|---|---|---|
| **Flying wire** | | **5 m** | **10 m** | **5 m** | **5 m** |
| **PVEH** | passive | 11084104 | 11084112 | 11084096 | 11084107 |
| **PVEO** | | 11084103 | 11084111 | 11084095 | 11084106 |

### *Connector code numbers*

| Part number | Name | |
|---|---|---|
| **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 |
| **984L3165** | EL-PLUG, ON-OFF black | Hirschmann DIN connector set* |

### *Set of seals code numbers*

| Part number | Name | Actuator |
|---|---|---|
| **157B4997** | Set of seals | PVE for PVG 32/ PVG 100 |
| **155G8519** | Set of seals | PVE for PVG 120 |
| **11061235** | Set of seals | 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 |

## 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/grey** | 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 | | | |

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