ENGINEERING
TOMORROW

Technical Information

# Electrohydraulic Actuator
## PVE Series 7

powersolutions.danfoss.com

## Revision history

*Table of revisions*

| Date | Changed | Rev |
|---|---|---|
| February 2016 | Added detailed Fault Monitoring description | 0103 |
| January 2016 | Minor updates | 0102 |
| November 2016 | First edition | 0101 |

## Contents

## Contents

## PVE Electrical Actuator

### PVE Electrical Actuator

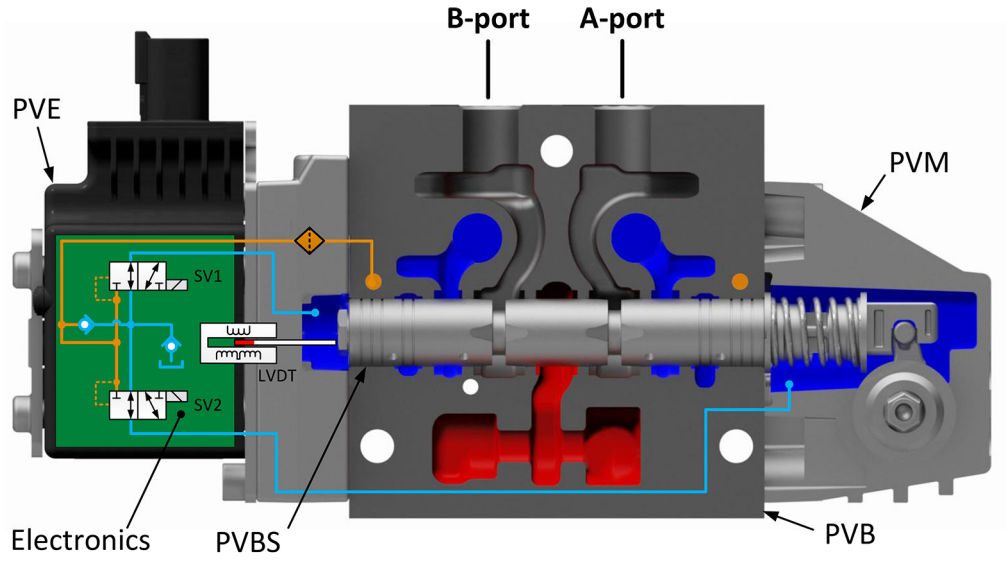
The analog PVE Series 7 is an electro-hydraulic actuator used to control a single work section of a PVG proportional valve group. The PVE Series 7 actuator program includes variants with different performance levels and features for PVG 32/100/120/128/256.

The actuator positions the main spool in a PVG work section in order to control either the flow or the pressure of the oil distributed to/from the work function. The control signal to the actuator is an analog voltage signal, enabling the user to operate the work function remotely by means of a joystick, a controller or the similar.

The analog PVE Series 7 actuator program features five different main hydraulic principle variants (PVEO/PVEM/PVEA/PVEH/PVES). The different hydraulic principles combined with the different solenoid valve regulation principles determine whether the actuator controls the spool proportionally according to a demand signal or ON/OFF according to a voltage signal.

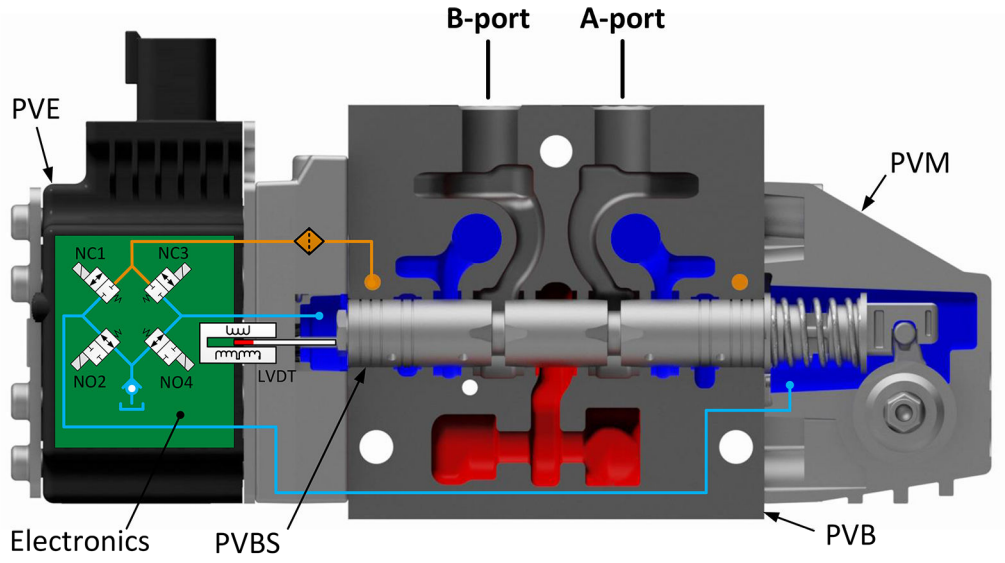
The electro-hydraulic solenoid valve bridge of the actuator is available in different designs utilizing different regulation principles, depending on performance variant. The actuator positions the main spool by distributing pilot oil pressure to either side of it, pressurizing one side by pilot pressure while relieving the opposite side to tank and vice versa, as illustrated below. All proportional actuators feature a closed-loop spool control and continuous fault monitoring.

*PVG 32 with PVEO/PVEM (PVEO without LVDT)*



## PVE Electrical Actuator

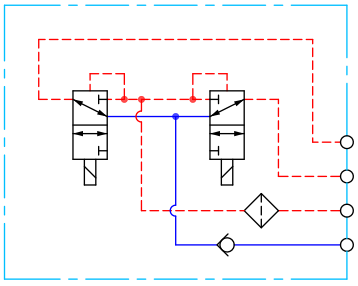
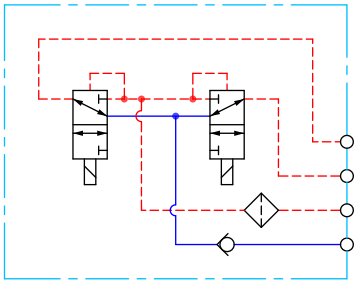
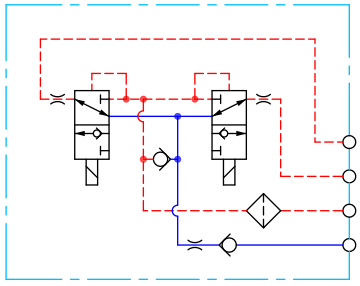
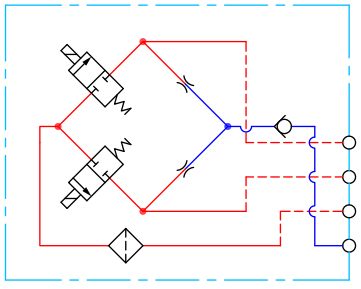
*PVG 32 with PVEH/PVES*



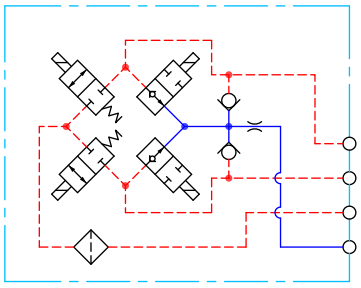
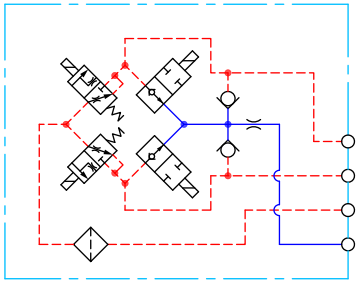

PVEA has the same housing as PVEO/PVEM and similar hydraulic principle as PVEH/PVES, but with fixed orifices instead of NO2 and NO4.

## PVE Variant Overview

### PVE Variant Overview

| Symbol | Description |
|---|---|
|  P109195 | *PVEO*<br>ON/OFF voltage control for non-proportional functions.<br>• Neutral position or maximum spool stroke according to control signal<br>• Variants available with 12 Vdc or 24 Vdc supply voltage<br>• Variants available with DEUTSCH, AMP or DIN/Hirschmann connectors<br>• To be used with standard PVE pilot oil pressure of 13.5 bar<br>• LED only indicating Power ON or Power OFF<br>• Variants available with Ramp (-R) or Direction Indication output (-DI) functionality |
|  P109195 | *PVEO-HP*<br>ON/OFF voltage control for non-proportional functions.<br>• Neutral position or max. spool stroke acc. to control signal<br>• Variants available for 12 Vdc or 24 Vdc power supply<br>• Variants available with DEUTSCH, AMP or DIN/Hirschmann connectors<br>• To be used with PVH/PVHC pilot oil pressure of 25 bar<br>• LED only indicating Power ON or Power OFF |
|  P109196 | *PVEM*<br>Proportional spool control for functions with medium performance demands.<br>• All variants with 9-32 Vdc multi-voltage power supply<br>• Variants only available with DIN/Hirschmann connectors<br>• To be used with standard PVE pilot oil pressure of 13.5 bar<br>• All variants with LED indicating error state and passive fault monitoring<br>• Variants available with Float (-F), Quick Ramp (-R) or Quick Reaction functionality |
|  P109197 | *PVEA*<br>Proportional spool control for functions with high performance demands.<br>• All variants with 9-32 Vdc multi-voltage power supply<br>• Variants available with DEUTSCH, AMP or DIN/Hirschmann connectors<br>• To be used with standard PVE pilot oil pressure of 13.5 bar<br>• All variants with LED indicating error state and active or passive fault monitoring<br>• Variants available with Direction Indication output (-DI) or Neutral Power-Off (-NP) functionality |

## PVE Variant Overview

| Symbol | Description |
|---|---|
|  P109198 | *PVEH*<br>Proportional spool control for functions with high performance demands.<br>• All variants with 9-32 Vdc multi-voltage power supply<br>• Variants available with DEUTSCH, AMP or DIN/Hirschmann connectors<br>• To be used with standard PVE pilot oil pressure of 13.5 bar<br>• All variants with LED indicating error state and active or passive fault monitoring<br>• Variants available with Float (-F), Direction Indication (-DI), Neutral Power-Off (-NP), Spool Position output (-SP) or 0-10 Vdc control signal (-U) functionality |
|  P109199 | *PVES*<br>Proportional spool control for functions with very high performance and reaction demands.<br>• All variants with 9-32 Vdc multi-voltage power supply<br>• Analog voltage control signal 25-75% of supply voltage<br>• Variants available with DEUTSCH, AMP or DIN/Hirschmann connectors<br>• To be used with standard PVE pilot oil pressure of 13.5 bar<br>• All variants with LED indicating error state and active or passive fault monitoring<br>• Variants available with Spool Position output (-SP) or 0-10 Vdc control signal (-U) functionality |

## PVEO

The PVEO actuator is a non-proportional ON/OFF control actuator with open-loop spool control primarily used to control simple ON/OFF work functions where a proportional control of speed or oil flow is not a requirement. The PVEO is available in two different performance variants, the standard PVEO and the PVEO-R with ramp.

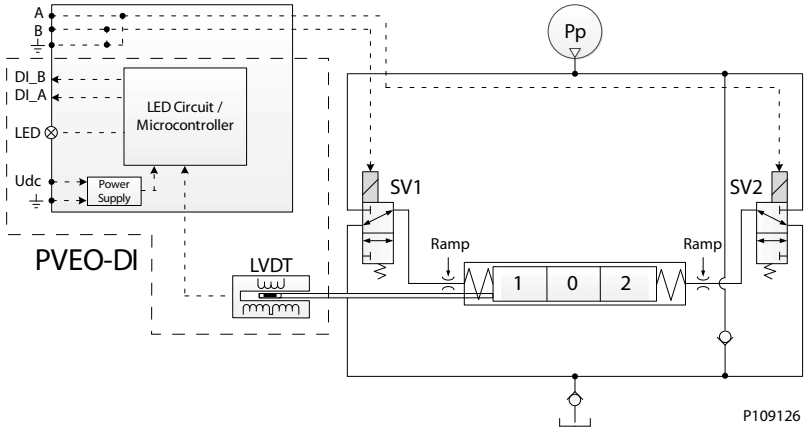
The standard PVEO functionality includes the simplest electric circuit of the PVE Series 7 actuator program, using a fixed 12 Vdc or 24 Vdc supply voltage or signal voltage and a simple LED circuit to control the LED light indicating Power ON/OFF.

The PVEO-DI variant includes an LVDT spool position monitor and a more advanced electric circuit with an embedded micro-controller and separate power supply to handle the Direction Indication functionality.

An energization of solenoid valve SV1 and a simultaneous de-energization of SV2 will cause the main spool to move to the right direction and vice versa. If both SV1 and SV2 are energized or de-energized simultaneously, the main spool stays locked in its neutral position.

*Functionality*

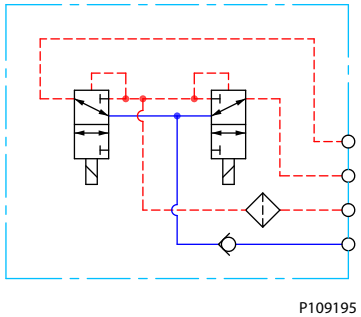
**PVEO**



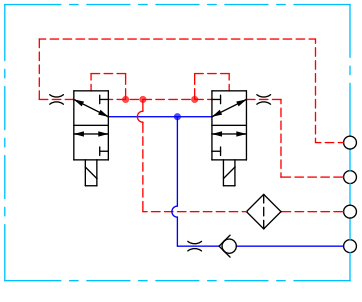

## PVEO Schematics and Dimensions

*Schematics*

**PVEO**

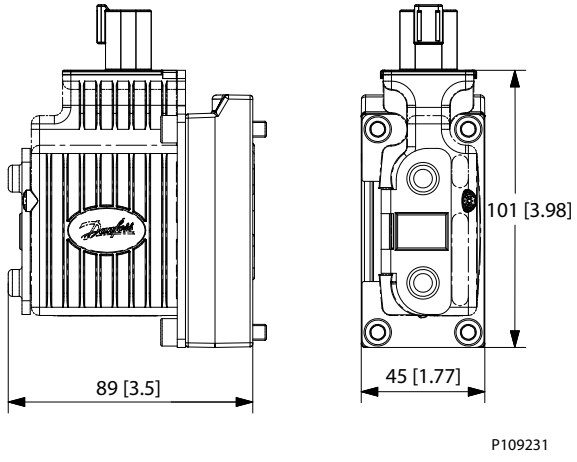



**PVEO-R**



## PVEO

*Dimensions*

| PVEO | Connector height |
|---|---|
|  | DEU = 30 mm [1.2 in]<br>AMP = 38 mm [1.5 in]<br>DIN = 40 mm [1.6] |

## PVEO Technical Data

*Control Specification*

| Description | Type | Value | |
|---|---|---|---|
| Supply Voltage (Udc) | Rated | 12 Vdc | 24 Vdc |
| | Range | 11 to 15 Vdc | 22 to 30 Vdc |
| | Max. ripple | 5% | |
| *Current Consumption* | Typical | 480 mA | 250 mA |
| | Minimum | 430 mA | 220 mA |
| | Maximum | 950 mA | 480 mA |

*Operating Conditions*

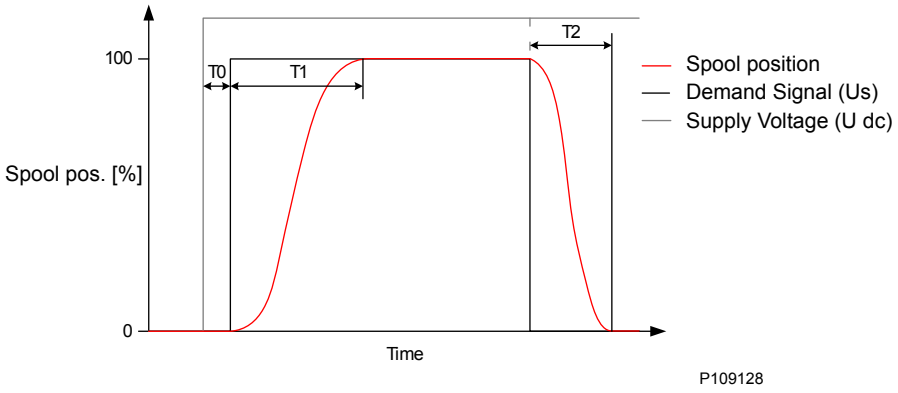
| Description | Type | Value | |
|---|---|---|---|
| Pilot Pressure | Nominal | 13.5 bar | [196 psi] |
| | Minimum | 10.0 bar | [145 psi] |
| | Maximum | 15.0 bar | [218 psi] |
| *Oil Consumption* | Neutral | 0.0 l/min | [0.0 gal/min] |
| | Locked position | 0.0 l/min | [0.0 gal/min] |
| | Actuating | 0.9 l/min | [0.24 gal/min] |
| | Actuating (PVEO-R) | 0.3 l/min | [0.08 gal/min] |
| Storage Temperature | Ambient | -50 to +90°C | [-58 to +194°F] |
| Operating Temperature | Ambient | -40 to +90°C | [-40 to +194°F] |
| Oil Viscosity | Operating range | 12 to 75 cSt | [65 to 347 SUS] |
| | Minimum | 4 cSt | [39 SUS] |
| | Maximum | 460 cSt | [2128 SUS] |
| Oil Cleanliness | Maximum | 18/16/13 (according to ISO 4406) | |

## PVEO

*LED Characteristic*

| Color | LED Characteristic | Description |
|---|---|---|
| Green | | Power ON |

## PVEO Reaction Times




| Reaction | PVEO/PVEO-DI | PVEO-R |
|---|---|---|
| T0 – Boot-up [ms] | 0 | 0 |
| T1 – Neutral to max. spool stroke @ Power ON [ms] | 110 | 300 |
| T2 – Max. spool stroke to neutral @ Power OFF [ms] | 110 | 110 |
| T1 – Neutral to max. spool stroke @ Constant Udc [ms] | 110 | 300 |
| T2 – Max. spool stroke to neutral @ Constant Udc [ms] | 110 | 110 |

For more information on reaction times, see *Reaction Times*.

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

## PVEO Variants for PVG

*PVG 32/100 Variants*

| Part number | Type | *Connector* | IP | Udc | *Functionality* |
|---|---|---|---|---|---|
| 11166843 | PVEO | 1x4 DEU | 67 | 12 Vdc | Standard |
| 11166838 | PVEO | 1x4 DEU | 67 | 24 Vdc | Standard |
| 11166866 | PVEO | 1x4 AMP | 66 | 12 Vdc | Standard |
| 11166837 | PVEO | 1x4 AMP | 66 | 24 Vdc | Standard |
| 11166836 | PVEO | 1x4 DIN | 65 | 12 Vdc | Standard |
| 11166743 | PVEO | 1x4 DIN | 65 | 24 Vdc | Standard |
| 11166753 | PVEO-R | 1x4 DEU | 67 | 12 Vdc | Ramp |
| 11166754 | PVEO-R | 1x4 DEU | 67 | 24 Vdc | Ramp |
| 11166867 | PVEO-R | 1x4 AMP | 66 | 12 Vdc | Ramp |
| 11166776 | PVEO-R | 1x4 AMP | 66 | 24 Vdc | Ramp |
| 11166831 | PVEO-R | 1x4 DIN | 65 | 12 Vdc | Ramp |
| 11166908 | PVEO-R | 1x4 DIN | 65 | 24 Vdc | Ramp |

## PVEO

*PVG 32/100 Variants (continued)*

| Part number | Type | *Connector* | IP | Udc | *Functionality* |
|---|---|---|---|---|---|
| 11168740[1] | PVEO-DI | 2x4 AMP | 66 | 12 Vdc | Standard |
| 11166869[1] | PVEO-DI | 2x4 AMP | 66 | 24 Vdc | Standard |

[1] Includes *Direction Indication* special feature

*PVG 120 Variants*

| Part number | Type | *Connector* | IP | Udc | *Functionality* |
|---|---|---|---|---|---|
| 11166755 | PVEO | 1x4 DEU | 67 | 12 Vdc | Standard |
| 11166757 | PVEO | 1x4 DEU | 67 | 24 Vdc | Standard |
| 11166815 | PVEO | 1x4 AMP | 66 | 12 Vdc | Standard |
| 11166816 | PVEO | 1x4 AMP | 66 | 24 Vdc | Standard |
| 11166822 | PVEO | 1x4 DIN | 65 | 12 Vdc | Standard |
| 11166744 | PVEO | 1x4 DIN | 65 | 24 Vdc | Standard |
| 11166882 | PVEO-R | 1x4 AMP | 66 | 24 Vdc | Ramp |
| 11166909 | PVEO-R | 1x4 DIN | 65 | 24 Vdc | Ramp |

*PVG 128/256 Variants*

| Part number | Type | *Connector* | IP | Udc | *Functionality* |
|---|---|---|---|---|---|
| 11186328 | PVEO | 1x4 DEU | 67 | 12 Vdc | Standard |
| 11186330 | PVEO | 1x4 DEU | 67 | 24 Vdc | Standard |
| 11186331 | PVEO | 1x4 DIN | 65 | 12 Vdc | Standard |
| 11186342 | PVEO | 1x4 DIN | 65 | 24 Vdc | Standard |

*PVG 60 Variants*

| Part number | Type | *Connector* | IP | Udc | *Functionality* |
|---|---|---|---|---|---|
| 11166939 | PVEO | 1x4 DIN | 65 | 12 Vdc | Standard |
| 11166940 | PVEO | 1x4 DIN | 65 | 24 Vdc | Standard |

## PVEO-HP

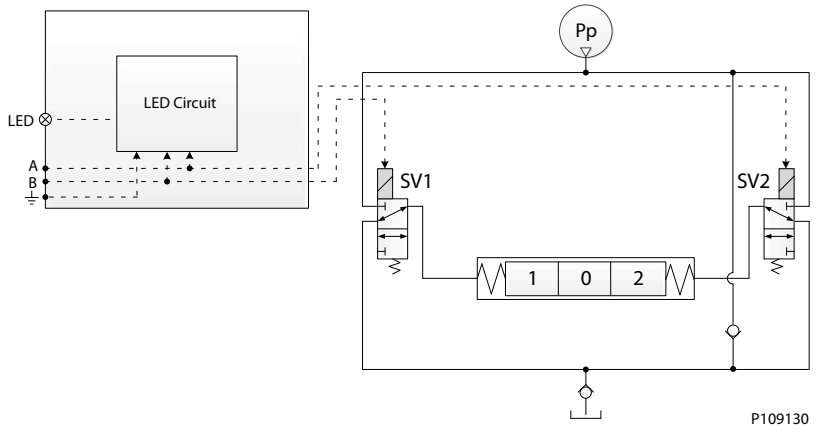
The PVEO-HP actuator is a high pressure non-proportional ON/OFF control actuator with open-loop spool control primarily used to control simple ON/OFF work functions where a proportional control of speed or oil flow is not a requirement.

The standard PVEO-HP functionality includes the simplest electric circuit of the PVE Series 7 actuator program, using a fixed 12 Vdc or 24V dc supply voltage or signal voltage and a simple LED circuit to control the LED light indicating Power ON/OFF.

An energization of solenoid valve SV1 and a simultaneous de-energization of SV2 will cause the main spool to move to the right direction and vice versa. If both SV1 and SV2 are energized or de-energized simultaneously, the main spool stays locked in its neutral position.

*Functionality*

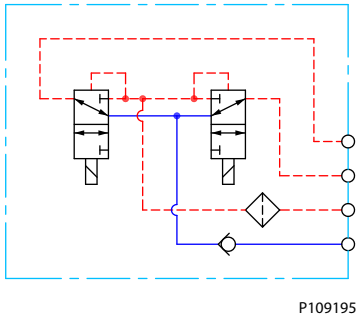
**PVEO-HP**




## PVEO-HP Schematics and Dimensions

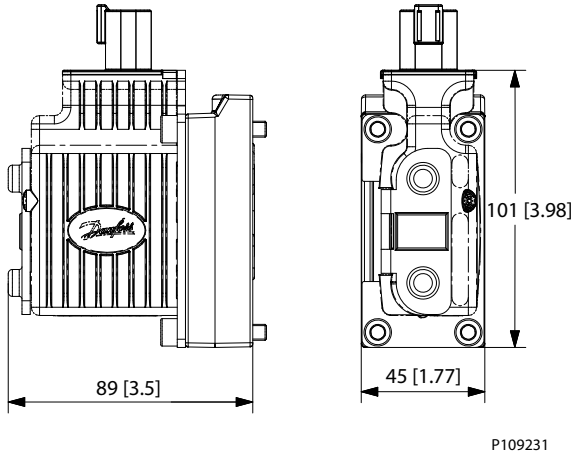
*Schematics*

**PVEO-HP**



## PVEO-HP

*Dimensions*

| PVEO-HP | Connector height |
|---|---|
|  | DEU = 30 mm [1.2 in]<br>AMP = 38 mm [1.5 in]<br>DIN = 40 mm [1.6 in] |

For more information on dimensions, please see *Dimension Overview*.

## PVEO-HP Technical Data

*Control Specification*

| Description | Type | Value | |
|---|---|---|---|
| Supply Voltage (Udc) | Rated | 12 Vdc | 24 Vdc |
| | Range | 11 to 15 Vdc | 22 to 30 Vdc |
| | Max. ripple | 5% | |
| *Current Consumption* | Typical | 750 mA | 380 mA |
| | Minimum | 660 mA | 340 mA |
| | Maximum | 1460 mA | 740 mA |

*Operating Conditions*

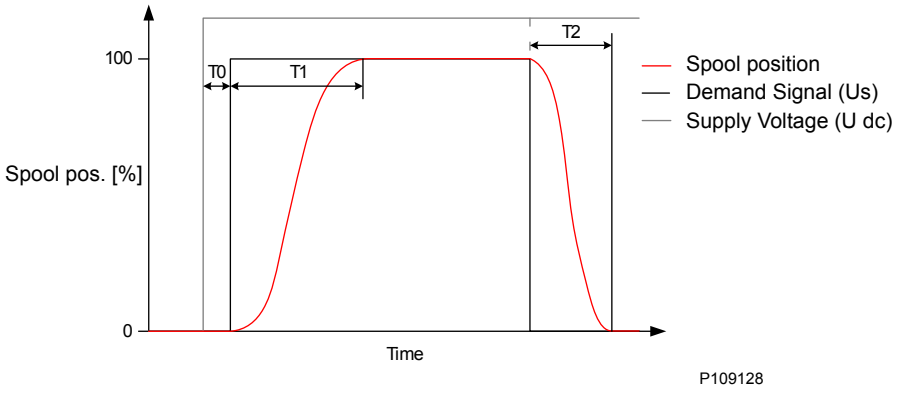
| Description | Type | Value | |
|---|---|---|---|
| Pilot Pressure | Nominal | 25.0 bar | [363 psi] |
| | Minimum | 21.0 bar | [305 psi] |
| | Maximum | 25.0 bar | [363 psi] |
| *Oil Consumption* | Neutral | 0.0 l/min | [0.0 gal/min] |
| | Locked position | 0.0 l/min | [0.0 gal/min] |
| | Actuating | 0.9 l/min | [0.24 gal/min] |
| Storage Temperature | Ambient | -50 to +90°C | [-58 to +194°F] |
| Operating Temperature | Ambient | -40 to +90°C | [-40 to +194°F] |
| Oil Viscosity | Operating range | 12 to 75 cSt | [65 to 347 SUS] |
| | Minimum | 4 cSt | [39 SUS] |
| | Maximum | 460 cSt | [2128 SUS] |
| Oil Cleanliness | Maximum | 18/16/13 (according to ISO 4406) | |

## PVEO-HP

*LED Characteristic*

| Color | LED Characteristic | Description |
|---|---|---|
| Green | | Power ON |

## PVEO-HP Reaction Times




| Reaction | PVEO-HP |
|---|---|
| T0 – Boot-up [ms] | 0 |
| T1 – Neutral to max. spool stroke @ Power ON [ms] | 90 |
| T2 – Max. spool stroke to neutral @ Power OFF [ms] | 70 |
| T1 – Neutral to max. spool stroke @ Constant Udc [ms] | 90 |
| T2 – Max. spool stroke to neutral @ Constant Udc [ms] | 70 |

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

For more information on reaction times, see *Reaction Times*.

## PVEO-HP Variants for PVG

*PVG 32/100 variants*

| Part number | Type | *Connector* | IP | Udc | *Functionality* |
|---|---|---|---|---|---|
| 11166765 | PVEO-HP | 1x4 DEU | 67 | 12 Vdc | Standard |
| 11166766 | PVEO-HP | 1x4 DEU | 67 | 24 Vdc | Standard |
| 11166763 | PVEO-HP | 1x4 AMP | 66 | 12 Vdc | Standard |
| 11187524 | PVEO-HP | 1x4 AMP | 66 | 24 Vdc | Standard |
| 11187551 | PVEO-HP | 1x4 DIN | 65 | 12 Vdc | Standard |
| 11187562 | PVEO-HP | 1x4 DIN | 65 | 24 Vdc | Standard |

## PVEM

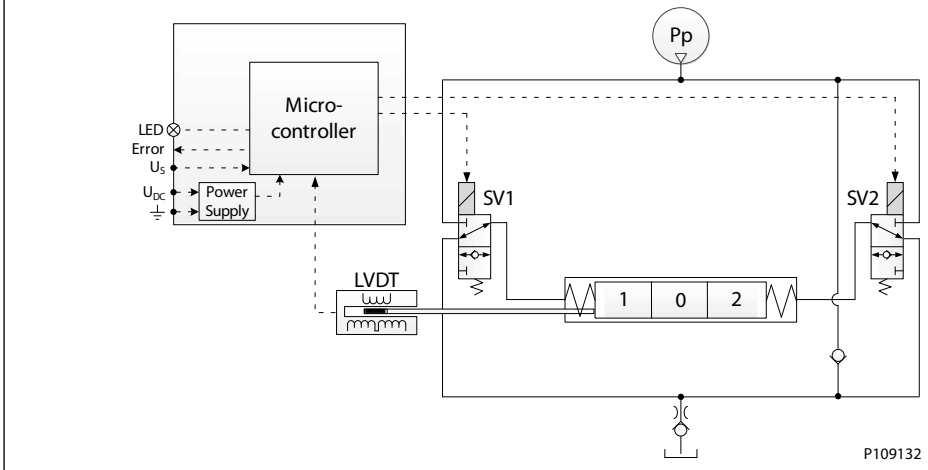
The PVEM actuator is a proportional control actuator with closed-loop spool control primarily used to control work functions with medium performance requirements. The PVEM is available in three different performance variants, the standard PVEM, the PVEM-R with ramp and the PVEM-Q with quick reaction.

The PVEM functionality includes an electric circuit with a closed-loop logic. An embedded micro-controller processes the signal voltage and the LVDT feedback signal and regulates the solenoid valves accordingly. Features such as passive fault monitoring, LED indicating fault state, error output pin and Power Save are all default PVEM features.

An energization of solenoid valve SV1 and a simultaneous stepwise modulation of SV2 causes the main spool to move to the right direction and vice versa. When the main spool is stroked to the far right, a simultaneous energization of both SV1 and SV2 locks the main spool in its stroked position. When both SV1 and SV2 are de-energized the main spool moves back to its neutral position by means of the main spool neutral spring and the hydraulic principle.

*Functionality*

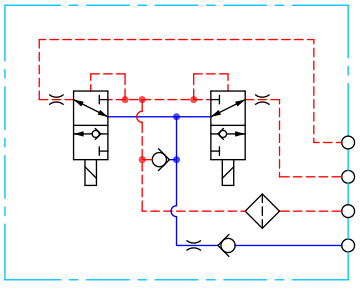
**PVEM**



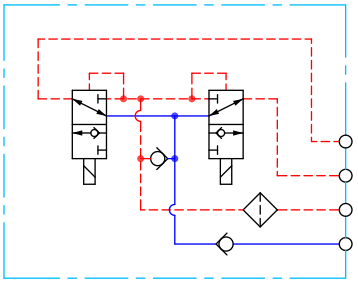

## PVEM Schematics and Dimensions

*Schematics*

**PVEM/PVEM-FLB/PVEM-R**

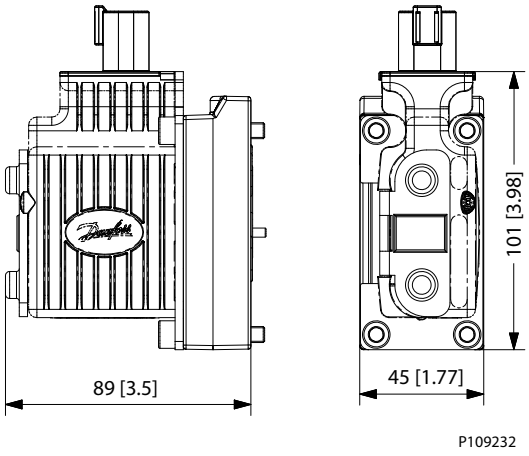



**PVEM-Q**



## PVEM

*Dimensions*

| PVEM | Connector height |
|---|---|
|  | DEU = 30 mm [1.2 in]<br>AMP = 38 mm [1.5 in]<br>DIN = 40 mm [1.6 in] |

For more information on dimensions, please see *Dimension Overview*.

## PVEM Technical Data

*Control Specification*

| Description | Type | Value |
|---|---|---|
| Supply Voltage (Udc) | Rated | 11 to 32 Vdc |
| | Range | 11 to 32 Vdc |
| | Max. ripple | 5% |
| *Signal Voltage (Us)* | Neutral | Us = 0.5 Udc |
| | Q: P to A | Us = (0.5 to 0.25) · Udc |
| | Q: P to B | Us = (0.5 to 0.75) · Udc |
| *Signal Voltage PWM (Us)* | Neutral | Us = 50% DUT |
| | Q: P to A | Us = 50% to 25% DUT |
| | Q: P to B | Us = 50% to 75% DUT |
| *PWM Frequency (Us)* | Recommended | > 200 Hz |
| *Current Consumption* | @ 12 Vdc | 690 mA |
| | @ 24 Vdc | 350 mA |
| Input Impedance | Rated | 12 kΩ |
| Input Capacitance | Rated | 100 nF |

*Operating Conditions*

| Description | Type | Value | |
|---|---|---|---|
| Pilot Pressure | Nominal | 13.5 bar | [196 psi] |
| | Minimum | 10.0 bar | [145 psi] |
| | Maximum | 15.0 bar | [220 psi] |

## PVEM

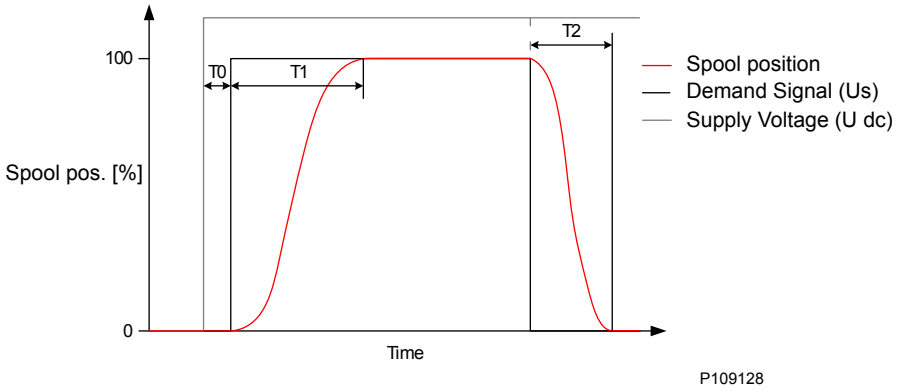
*Operating Conditions (continued)*

| Description | Type | Value | |
|---|---|---|---|
| *Oil Consumption* | Neutral | 0.0 l/min | [0.0 gal/min] |
| | Locked Position | 0.0 l/min | [0.0 gal/min] |
| | Actuating | 0.5 l/min | [0.13 gal/min] |
| | Actuating (PVEM-R) | 0.3 l/min | [0.07 gal/min] |
| | Actuating (PVEM-Q) | 1.0 l/min | [0.26 gal/min] |
| Storage Temperature | Ambient | -50 to +90°C | [-58 to +194°F] |
| Operating Temperature | Ambient | -40 to +90°C | [-40 to +194°F] |
| Oil Viscosity | Operating range | 12 to 75 cSt | [65 to 347 SUS] |
| | Minimum | 4 cSt | [39 SUS] |
| | Maximum | 460 cSt | [2128 SUS] |
| Oil Cleanliness | Maximum | 18/16/13 (according to ISO 4406) | |

*LED Characteristic*

| Color | LED Characteristics | Description |
|---|---|---|
| Green | | Operating |
| Green @ 1.5 Hz | | Neutral - *Power Save* |
| Red | | Internal fault |
| Red @ 1.5 Hz | | External or float fault |

## PVEM Reaction Times



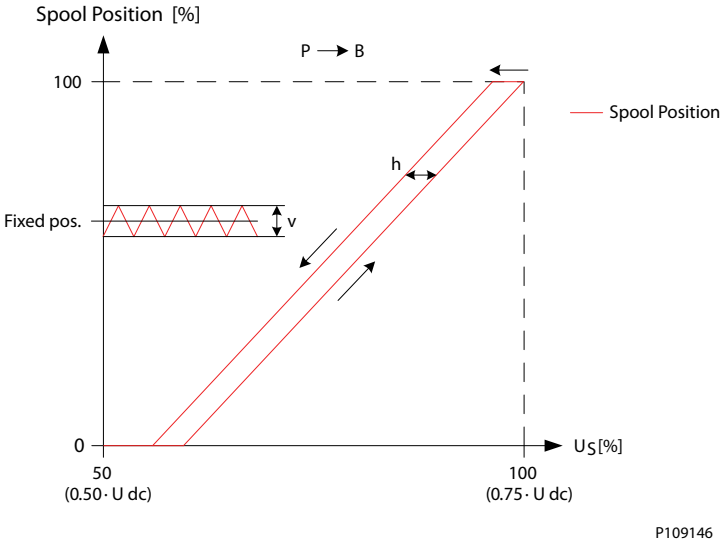

| Reaction | PVEM/-FLB | PVEM-R | PVEM-Q |
|---|---|---|---|
| T0 – Boot-up [ms] | 15 | 15 | 15 |
| T1 – Neutral to max. spool stroke @ Power ON [ms] | 225 | 325 | 125 |
| T2 – Max. spool stroke to neutral @ Power OFF [ms] | 110 | 110 | 110 |
| T1 – Neutral to max. spool stroke @ Constant Udc [ms] | 210 | 310 | 110 |
| T2 – Max. spool stroke to neutral @ Constant Udc [ms] | 90 | 90 | 90 |

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

For more information on reaction times, see *Reaction Times*.

## PVEM

### PVEM Hysteresis and Ripple




| Description | Type | PVEM |
|---|---|---|
| Hysteresis (h) | Rated [%] | 15 |
| Steady state ripple @ fixed US (v) | Rated [mm] | 0.0 |

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

For more information on hysteresis and ripple, see *Hysteresis and Ripple*.

### PVEM Variants for PVG

*PVG 32/100 Variants*

| Part number | Type | *Connector* | IP | *Fault Monitoring* | *Functionality* |
|---|---|---|---|---|---|
| 11166829 | PVEM | 1x4 DIN | 65 | Passive | Standard |
| 11166852 | PVEM-FLB | 1x4 DIN | 65 | Passive | Float B-port |
| 11166845 | PVEM-R | 1x4 DIN | 65 | Passive | Ramp |
| 11166853 | PVEM-Q | 1x4 DIN | 65 | Passive | Quick Reaction |

## PVEA

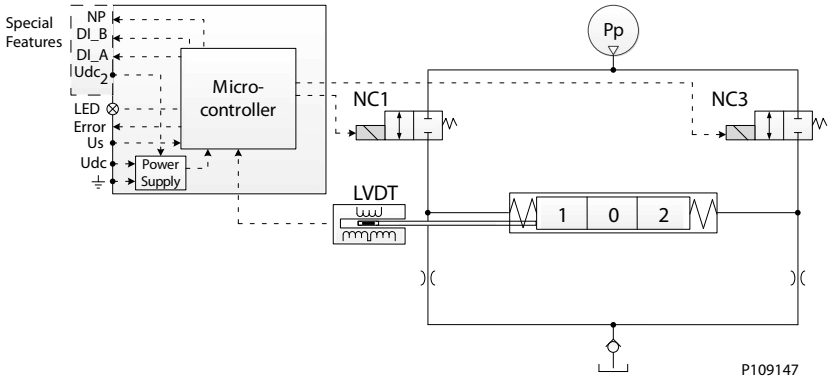
The PVEA actuator is a proportional control actuator with a closed-loop spool control primarily used to control work functions with above medium performance requirements.

The PVEA functionality includes an electric circuit with a closed-loop logic. An embedded micro-controller processes the signal voltage and the LVDT feedback signal and regulates the solenoid valves accordingly. Features such as active or passive fault monitoring, LED indicating fault state, error output pin and Power Save are all default PVEA features.

A continuous modulation of solenoid valve NC1 and a simultaneous de-energization of NC3 causes the main spool to move to the right direction and vice versa. When the main spool is stroked to the far right, a simultaneous modulation of both NC1 and NC3 balances the main spool in its stroked position. The main spool oscillates in its stroked position at a frequency corresponding to the modulation frequency. When both NC1 and NC3 are de-energized, the main spool moves back to its neutral position by means of the main spool neutral spring and the hydraulic principle.

*Functionality*

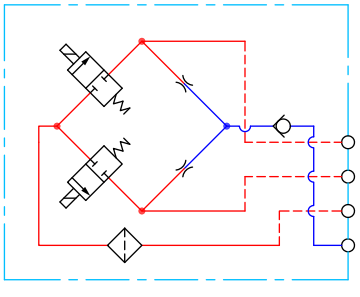
**PVEA**




## PVEA Schematics and Dimensions

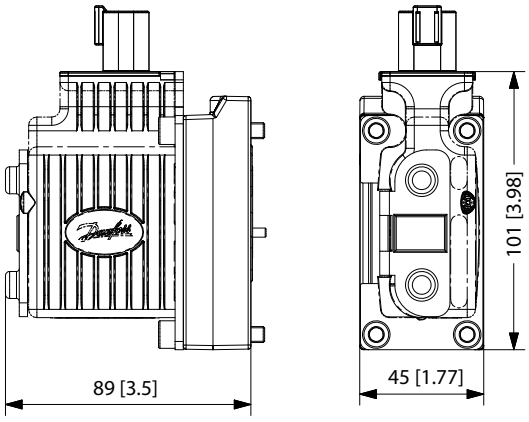
*Schematics*

**PVEA**



## PVEA

*Dimensions*

| PVEA | Connector height |
|---|---|
|  | DEU = 30 mm [1.2 in]<br>AMP = 38 mm [1.5 in]<br>DIN = 40 mm [1.6 in] |

For more information on dimensions, see *Dimension Overview*.

## PVEA Technical Data

*Control Specification*

| Description | Type | Value |
|---|---|---|
| Supply Voltage (Udc) | Rated | 11 to 32 Vdc |
| | Range | 11 to 32 Vdc |
| | Max. ripple | 5% |
| *Signal Voltage (Us)* | Neutral | Us = 0.5 Udc |
| | Q: P to A | Us = (0.5 to 0.25) · Udc |
| | Q: P to B | Us = (0.5 to 0.75) · Udc |
| *Signal Voltage PWM (Us)* | Neutral | Us = 50% DUT |
| | Q: P to A | Us = 50% to 25% DUT |
| | Q: P to B | Us = 50% to 75% DUT |
| *PWM Frequency (Us)* | Recommended | > 1000 Hz |
| *Current Consumption* | @ 12 Vdc | 290 mA |
| | @ 24 Vdc | 150 mA |
| *DI Current* | Maximum | 200 mA |
| Input Impedance | Rated | 12 kΩ |
| Input Capacitance | Rated | 100 nF |

*Operating Conditions*

| Description | Type | Value | |
|---|---|---|---|
| Pilot Pressure | Nominal | 13.5 bar | [196 psi] |
| | Minimum | 10.0 bar | [145 psi] |
| | Maximum | 15.0 bar | [220 psi] |
| *Oil Consumption* | Neutral | 0.0 l/min | [0.0 gal/min] |
| | Locked Position | 0.4 l/min | [0.0 gal/min] |
| | Actuating | 1.0 l/min | [0.24 gal/min] |

## PVEA

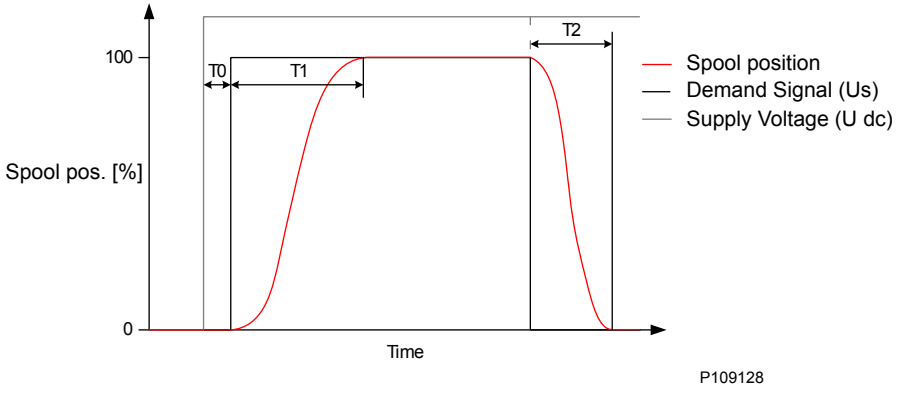
*Operating Conditions (continued)*

| Description | Type | Value | |
|---|---|---|---|
| Storage Temperature | Ambient | -50 to +90°C | [-58 to +194°F] |
| Operating Temperature | Ambient | -40 to +90°C | [-40 to +194°F] |
| Oil Viscosity | Operating range | 12 to 75 cSt | [65 to 347 SUS] |
| | Minimum | 4 cSt | [39 SUS] |
| | Maximum | 460 cSt | [2128 SUS] |
| Oil Cleanliness | Maximum | 18/16/13 (according to ISO 4406) | |

*LED Characteristic*

| Color | LED Characteristic | Description |
|---|---|---|
| Green | | Actuating |
| Green @ 1.5 Hz | | Neutral - *Power Save* |
| Red | | Internal fault |
| Red @ 1.5 Hz | | External or Float fault |

## PVEA Reaction Times



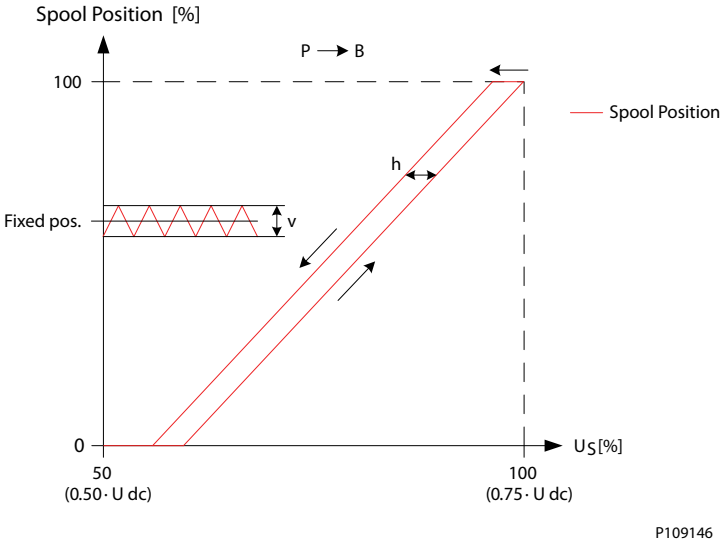

| Reaction | PVEA |
|---|---|
| T0 – Boot-up [ms] | 15 |
| T1 – Neutral to max. spool stroke @ Power ON [ms] | 280 |
| T2 – Max. spool stroke to neutral @ Power OFF [ms] | 200 |
| T1 – Neutral to max. spool stroke @ Constant Udc [ms] | 265 |
| T2 – Max. spool stroke to neutral @ Constant Udc [ms] | 200 |

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

For more information on reaction times, see *Reaction Times*.

## PVEA

### PVEA Hysteresis and Ripple




| Description | Type | PVEA |
|---|---|---|
| Hysteresis (h) | Rated [%] | 2 |
| Steady state ripple @ fixed Us (v) | Rated [mm] | 0.3 |

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

For more information on hysteresis and ripple, see *Hysteresis and Ripple*.

### PVEA Variants for PVG

*PVG 32/100 Variants*

| Part number | Type | *Connector* | IP | *Fault monitoring* | *Functionality* |
|---|---|---|---|---|---|
| 11177346 | PVEA | 1x4 DEU | 67 | Passive | Standard |
| 11177347 | PVEA | 1x4 DEU | 67 | Active | Standard |
| 11177353 | PVEA | 1x4 AMP | 66 | Passive | Standard |
| 11177348 | PVEA | 1x4 AMP | 66 | Active | Standard |
| 11177345[1] | PVEA-NP | 1x6 DEU | 67 | Active | Standard |
| 11177357[2] | PVEA-DI | 2x4 DEU | 67 | Active | Standard |
| 11177356[2] | PVEA-DI | 2x4 AMP | 66 | Passive | Standard |
| 11177355[2] | PVEA-DI | 2x4 AMP | 66 | Active | Standard |

[1] Includes *Neutral Power-OFF* special feature

[2] Includes *Direction Indication* special feature

## PVEH

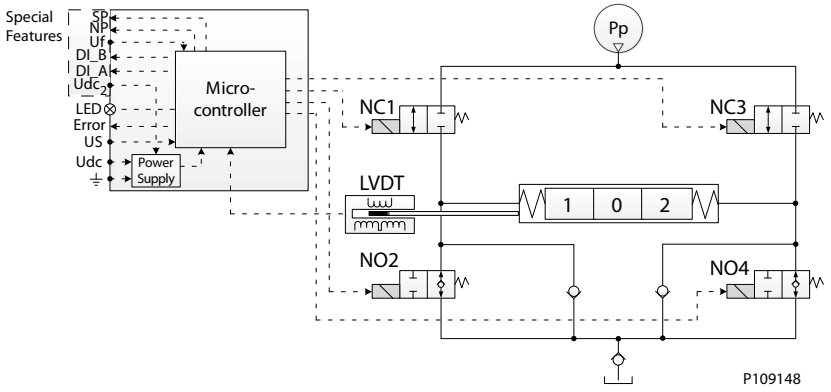
The PVEH actuator is a proportional control actuator with closed-loop spool control primarily used to control work functions with high performance requirements.

The PVEH functionality includes an electric circuit with a closed-loop logic. An embedded micro-controller processes the signal voltage and the LVDT feedback signal and regulates the solenoid valves accordingly. Features such as active or passive fault monitoring, LED indicating fault state, error output pin and Power Save are all default PVEH features.

A continuous modulation of solenoid valves NC1 and NO4 together, with a simultaneous energization of NO2 and de-energization of NC3, causes the main spool to move to the right direction and vice versa. When the main spool is stroked to the far right, a simultaneous energization of both NO2 and NO4 and de-energization of both NC1 and NC3 locks the main spool in its stroked position. An emergency stop activated when the spool is stroked will cause all solenoid valves to de-energize causing the main spool to move back to its neutral position by means of the main spool neutral spring and the hydraulic principle.

*Functionality*

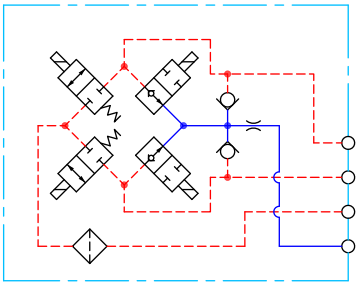
**PVEH**




## PVEH Schematics and Dimensions

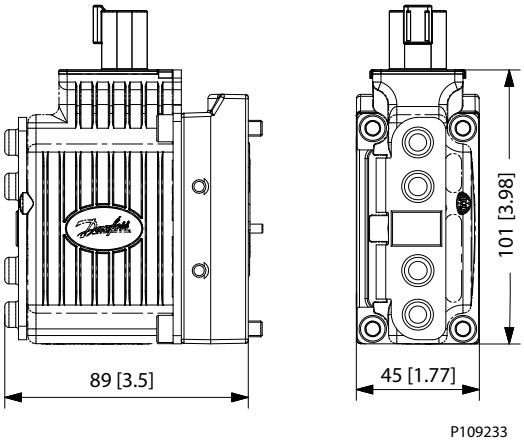
*Schematics*

**PVEH**



## PVEH

*Dimensions*

| PVEH | Connector height |
|---|---|
|  | DEU = 30 mm [1.2 in]<br>AMP = 38 mm [1.5 in]<br>DIN = 40 mm [1.6 in] |

## PVEH Technical Data

*Control Specification*

| Description | Type | Value |
|---|---|---|
| Supply Voltage (Udc) | Rated | 11 to 32 Vdc |
| | Range | 11 to 32 Vdc |
| | Max. ripple | 5% |
| *Signal Voltage (Us)* | Neutral | Us = 0.5 Udc |
| | Q: P to A | Us = (0.5 to 0.25) · Udc |
| | Q: P to B | Us = (0.5 to 0.75) · Udc |
| *Signal Voltage PWM (Us)* | Neutral | Us = 50% DUT |
| | Q: P to A | Us = 50% to 25% DUT |
| | Q: P to B | Us = 50% to 75% DUT |
| *PWM Frequency (Us)* | Recommended | > 1000 Hz |
| *Current Consumption* | @ 12 Vdc | 540 mA |
| | @ 24 Vdc | 270 mA |
| *DI Current* | Maximum | 200 mA |
| Input Impedance | Rated | 12 kΩ |
| Input Capacitance | Rated | 100 nF |

*Operating conditions*

| Description | Type | Value | |
|---|---|---|---|
| Pilot Pressure | Nominal | 13.5 bar | [196 psi] |
| | Minimum | 10.0 bar | [145 psi] |
| | Maximum | 15.0 bar | [218 psi] |
| *Oil Consumption* | Neutral | 0.0 l/min | [0.0 gal/min] |
| | Locked Position | 0.0 l/min | [0.0 gal/min] |
| | Actuating | 0.7 l/min | [0.18 gal/min] |
| Storage Temperature | Ambient | -50 to +90°C | [-58 to +194°F] |

## PVEH

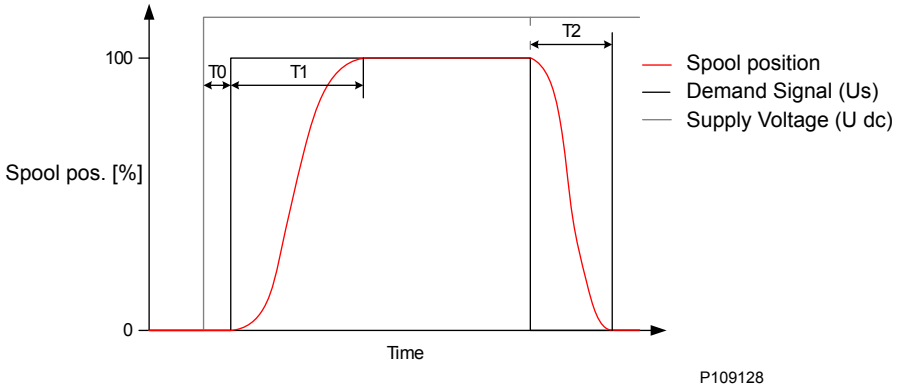
*Operating conditions (continued)*

| Description | Type | Value | |
|---|---|---|---|
| Operating Temperature | Ambient | -40 to +90°C | [-40 to +194°F] |
| Oil Viscosity | Operating range | 12 to 75 cSt | [65 to 347 SUS] |
| | Minimum | 4 cSt | [39 SUS] |
| | Maximum | 460 cSt | [2128 SUS] |
| Oil Cleanliness | Maximum | 18/16/13 (according to ISO 4406) | |

*LED characteristic*

| Color | LED Characteristic | Description |
|---|---|---|
| Green | | Actuating |
| Green @ 1.5 Hz | | Neutral - *Power Save* |
| Red | | Internal fault |
| Red @ 1.5 Hz | | External or float fault |
| Yellow | | *Disable Mode* |

## PVEH Reaction Times



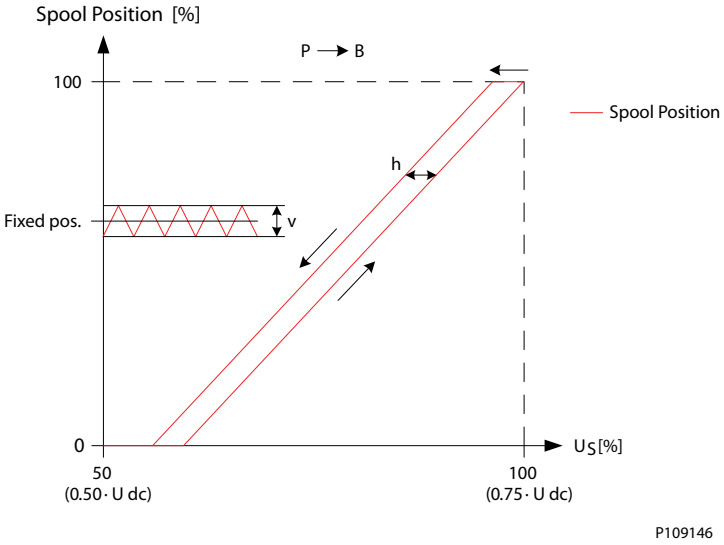

| Reaction | PVEH |
|---|---|
| T0 – Boot-up [ms] | 15 ms |
| T1 – Neutral to max. spool stroke @ Power ON [ms] | 125 ms |
| T2 – Max. spool stroke to neutral @ Power OFF [ms] | 110 ms |
| T1 – Neutral to max. spool stroke @ Constant Udc [ms] | 110 ms |
| T2 – Max. spool stroke to neutral @ Constant Udc [ms] | 90 ms |

For more information on reaction times, see *Reaction Times*.

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

## PVEH

### PVEH Hysteresis and Ripple




| Description | Type | PVEH |
|---|---|---|
| Hysteresis (h) | Rated [%] | 4 |
| Steady state ripple @ fixed Us (v) | Rated [mm] | 0.0 |

For more information on hysteresis and ripple, see *Hysteresis and Ripple*.

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

### PVEH Variants for PVG

*PVG 32/100 variants*

| Part number | Type | *Connector* | IP | *Fault monitoring* | *Functionality* |
|---|---|---|---|---|---|
| 11166732 | PVEH | 1x4 DEU | 67 | Passive | Standard |
| 11166775 | PVEH | 1x4 DEU | 67 | Active | Standard |
| 11166825 | PVEH | 1x4 AMP | 66 | Passive | Standard |
| 11166818 | PVEH | 1x4 AMP | 66 | Active | Standard |
| 11166824 | PVEH | 1x4 DIN | 65 | Passive | Standard |
| 11166817 | PVEH | 1x4 DIN | 65 | Active | Standard |
| 11166832[1] | PVEH-U | 1x4 AMP | 66 | Passive | Fixed US 0-10 V dc |
| 11166821[1] | PVEH-U | 1x4 AMP | 66 | Active | Fixed US 0-10 V dc |
| 11166770[1] | PVEH-U | 1x4 DIN | 65 | Passive | Fixed US 0-10 V dc |
| 11166772[1] | PVEH-U | 1x4 DIN | 65 | Active | Fixed US 0-10 V dc |
| 11166840 | PVEH-FLB | 1x4 DEU | 67 | Passive | Float B-port |
| 11166742 | PVEH-FLB | 1x4 DEU | 67 | Active | Float B-port |
| 11166839 | PVEH-FLB | 1x4 DIN | 65 | Active | Float B-port |
| 11166841[2] | PVEH-FLA | 1x6 DEU | 67 | Active | Float A-port |
| 11168738[2] | PVEH-FLA | 1x6 AMP | 66 | Passive | Float A-port |
| 11168739[2] | PVEH-FLA | 1x6 AMP | 66 | Active | Float A-port |
| 11166773[3] | PVEH-SP | 1x6 DEU | 67 | Active | Standard |

## PVEH

*PVG 32/100 variants (continued)*

| Part number | Type | *Connector* | IP | *Fault monitoring* | *Functionality* |
|---|---|---|---|---|---|
| 11166750[4] | PVEH-NP | 1x6 DEU | 67 | Fast active | Standard |
| 11166835[5] | PVEH-DI | 2x4 DEU | 67 | Active | Standard |
| 11166820[5] | PVEH-DI | 2x4 AMP | 66 | Passive | Standard |
| 11166819[5] | PVEH-DI | 2x4 AMP | 66 | Active | Standard |

[1] Includes *Disable Mode* special feature

[2] Includes *Dedicated Float Pin (UF)* special feature

[3] Includes *Spool Position* special feature

[4] Includes *Neutral Power-Off* special feature

[5] Includes *Direction Indication* special feature

*PVG 120 variants*

| Part number | Type | *Connector* | IP | *Fault monitoring* | *Functionality* |
|---|---|---|---|---|---|
| 11166760 | PVEH | 1x4 DEU | 67 | Passive | Standard |
| 11166814 | PVEH | 1x4 AMP | 66 | Passive | Standard |
| 11166801 | PVEH | 1x4 AMP | 66 | Active | Standard |
| 11166813 | PVEH | 1x4 DIN | 65 | Passive | Standard |
| 11166777 | PVEH | 1x4 DIN | 65 | Active | Standard |
| 11166771[1] | PVEH-U | 1x4 DIN | 65 | Passive | Fixed US 0-10 V dc |
| 11166767[1] | PVEH-U | 1x4 DIN | 65 | Active | Fixed US 0-10 V dc |

[1] Includes *Disable Mode* special feature

*PVG 128/256 variants*

| Part number | Type | *Connector* | IP | *Fault monitoring* | *Functionality* |
|---|---|---|---|---|---|
| 11186325 | PVEH | 1x4 DEU | 67 | Passive | Standard |
| 11186326 | PVEH | 1x4 DEU | 67 | Active | Standard |
| 11186321 | PVEH | 1x4 DIN | 65 | Passive | Standard |
| 11186322 | PVEH | 1x4 DIN | 65 | Active | Standard |
| 11186323[1] | PVEH-U | 1x4 DIN | 65 | Passive | Fixed US 0-10 Vdc |
| 11186324[1] | PVEH-U | 1x4 DIN | 65 | Active | Fixed US 0-10 Vdc |
| 11186327[2] | PVEH-FLA | 1x6 DEU | 67 | Active | Float A-port |

[1] Includes *Disable Mode* special feature

[2] Includes *Dedicated Float Pin (UF)* special feature

*PVG 60 variants*

| Part number | Type | *Connector* | IP | *Fault monitoring* | *Functionality* |
|---|---|---|---|---|---|
| 11166910 | PVEH | 1x4 DIN | 65 | Active | Float B-port |

## PVES

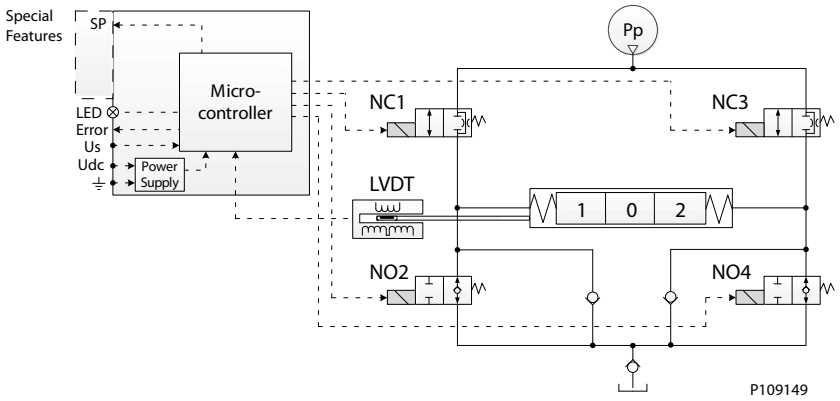
The PVES actuator is a proportional control actuator with closed-loop spool control primarily used to control work functions with very high performance requirements.

The PVES functionality includes an electric circuit with a closed-loop logic. An embedded micro-controller processes the signal voltage and the LVDT feedback signal and regulates the solenoid valves accordingly. Features such as active or passive fault monitoring, LED indicating fault state, error output pin and Power Save are all default PVEH features.

A continuous modulation of solenoid valves NC1 and NO4 together with a simultaneous energization of NO2 and de-energization of NC3 causes the main spool to move to the right direction and vice versa. When the main spool is stroked to the far right, a simultaneous energization of both NO2 and NO4 and de-energization of both NC1 and NC3 balances the main spool in its stroked position. An emergency stop activated when the spool is stroked will cause all solenoid valves to de-energize causing the main spool to move back to its neutral position by means of the main spool neutral spring and the hydraulic principle.

*Functionality*

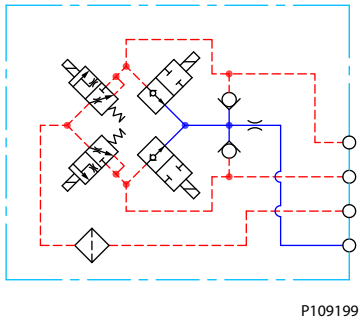
**PVES**




## PVES Schematics and Dimensions

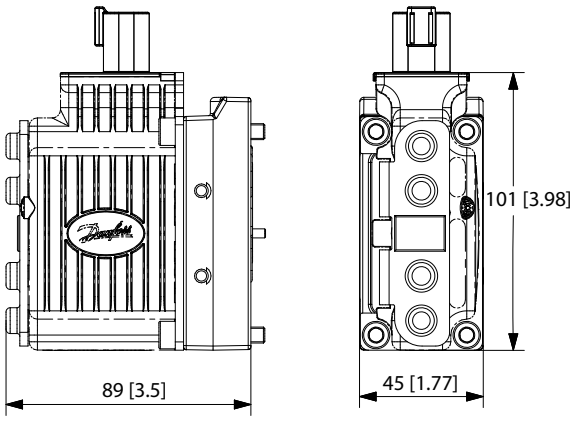
*Schematic*

**PVES**



## PVES

*Dimensions*

| PVES | Connector height |
|---|---|
|  | DEU = 30 mm [1.2 in]<br>AMP = 38 mm [1.5 in]<br>DIN = 40 mm [1.6 in] |

For information on dimensions, see *Dimension Overview*.

## PVES Technical Data

*Control Specification*

| Description | Type | Value |
|---|---|---|
| Supply Voltage (Udc) | Rated | 11 to 32 Vdc |
| | Range | 11 to 32 Vdc |
| | Max. ripple | 5% |
| *Signal Voltage (Us)* | Neutral | Us = 0.5 Udc |
| | Q: P to A | Us = (0.5 to 0.25) · Udc |
| | Q: P to B | Us = (0.5 to 0.75) · Udc |
| *Signal Voltage PWM (Us)* | Neutral | Us = 50% DUT |
| | Q: P to A | Us = 50% to 25% DUT |
| | Q: P to B | Us = 50% to 75% DUT |
| *PWM Frequency (Us)* | Recommended | > 1000 Hz |
| *Current Consumption* | @ 12 Vdc | 560 mA |
| | @ 24 Vdc | 280 mA |
| Input Impedance | Rated | 12 kΩ |
| Input Capacitance | Rated | 100 nF |

*Operating Conditions*

| Description | Type | Value | |
|---|---|---|---|
| Pilot Pressure | Nominal | 13.5 bar | [196 psi] |
| | Minimum | 10.0 bar | [145 psi] |
| | Maximum | 15.0 bar | [220 psi] |
| *Oil Consumption* | Neutral | 0.3 l/min | [0.0 gal/min] |
| | Locked Position | 0.1 l/min | [0.0 gal/min] |
| | Actuating | 0.8 l/min | [0.24 gal/min] |

## PVES

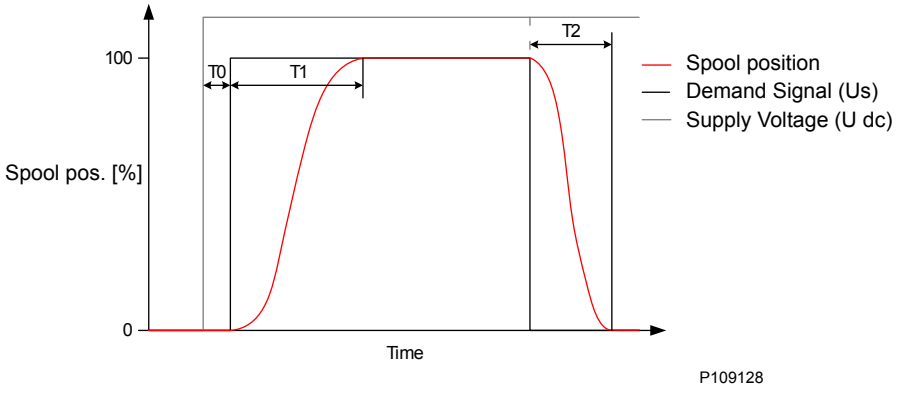
*Operating Conditions (continued)*

| Description | Type | Value | |
|---|---|---|---|
| Storage Temperature | Ambient | -50 to +90°C | [-58 to +194°F] |
| Operating Temperature | Ambient | -40 to +90°C | [-40 to +194°F] |
| Oil Viscosity | Recommended | 12 to 75 cSt | [65 to 347 SUS] |
| | Minimum | 4 cSt | [39 SUS] |
| | Maximum | 460 cSt | [2128 SUS] |
| Oil Cleanliness | Maximum | 18/16/13 (according to ISO 4406) | |

*LED Characteristic*

| Color | LED Characteristic | Description |
|---|---|---|
| Green | | Actuating |
| Green @ 1.5 Hz | | Neutral - *Power Save* |
| Red | | Internal fault |
| Red @ 1.5 Hz | | External or float fault |
| Yellow | | *Disable Mode* |

### PVES Reaction Times



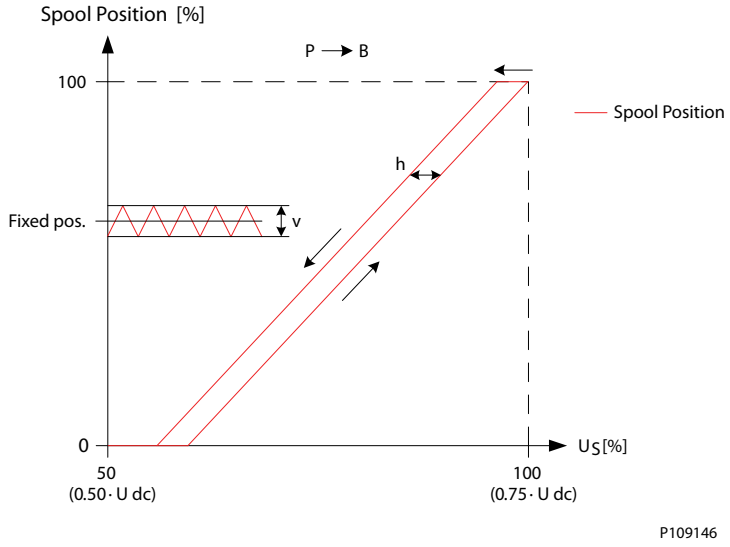

| Reaction | PVES |
|---|---|
| T0 – Boot-up [ms] | 15 |
| T1 – Neutral to max. spool stroke @ Power ON [ms] | 125 |
| T2 – Max. spool stroke to neutral @ Power OFF [ms] | 110 |
| T1 – Neutral to max. spool stroke @ Constant UDC [ms] | 110 |
| T2 – Max. spool stroke to neutral @ Constant UDC [ms] | 90 |

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

For more information on reaction time, see *Reaction Times* on page 51

## PVES

### PVES Hysteresis and Ripple




| Description | Type | PVES |
|---|---|---|
| Hysteresis (h) | Rated [%] | <0.5 |
| Steady state ripple @ fixed US (v) | Rated [mm] | 0.2 |

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

For more information on hysteresis and ripple, see *Hysteresis and Ripple*.

### PVES Variants for PVG

*PVG 32/100 variants*

| Part number | Type | *Connector* | IP | *Fault monitoring* | *Functionality* |
|---|---|---|---|---|---|
| 11166748 | PVES | 1x4 DEU | 67 | Passive | Standard |
| 11166864 | PVES | 1x4 DEU | 67 | Active | Standard |
| 11166859 | PVES | 1x4 AMP | 66 | Passive | Standard |
| 11166858 | PVES | 1x4 AMP | 66 | Active | Standard |
| 11166849 | PVES | 1x4 DIN | 65 | Passive | Standard |
| 11166857 | PVES | 1x4 DIN | 65 | Active | Standard |
| 11166745[1] | PVES-U | 1x4 DEU | 67 | Passive | Fixed Us 0-10 Vdc |
| 11166747[1] | PVES-U | 1x4 AMP | 66 | Active | Fixed Us 0-10 Vdc |
| 11166752[2] | PVES-SP | 1x6 DEU | 67 | Passive | Standard |

[1] Includes *Disable Mode* special feature

[2] Includes *Spool Position* special feature

*PVG 120 variants*

| Part number | Type | *Connector* | IP | *Fault monitoring* | *Functionality* |
|---|---|---|---|---|---|
| 11166761 | PVES | 1x4 DEU | 67 | Passive | Standard |
| 11166762 | PVES | 1x4 DIN | 65 | Passive | Standard |

## Connector Overview

### Connector Overview

*PVEO/PVEO-R/PVEO-HP*

| Connector | Pin 1 | Pin 2 | Pin 3 | Pin 4 |
|---|---|---|---|---|
| 1x4 AMP | Udc_A | Udc_B | GND | GND |
| 1x4 DEU | Udc_A | GND | GND | Udc_B |
| 1x4 DIN | Udc_A | Udc_B | | GND |

*PVEO-DI*

| Connector | Pin 1 | Pin 2 | Pin 3 | Pin 4 |
|---|---|---|---|---|
| 2x4 AMP (A) | Udc_A | Udc_B | GND | GND |
| 2x4 AMP (B) | DI-B | DI-A | GND | $Udc_2$ |

*PVEM*

| Connector | Pin 1 | Pin 2 | Pin 3 | Pin 4 |
|---|---|---|---|---|
| 1x4 DIN | Udc | Us | Error | GND |

*PVEA/PVEH/PVES*

| Connector | Pin 1 | Pin 2 | Pin 3 | Pin 4 |
|---|---|---|---|---|
| 1x4 AMP | Us | Udc | GND | Error |
| 1x4 DEU | Us | Error | GND | Udc |
| 1x4 DIN | Udc | Us | Error | GND |

*PVEA-DI/PVEH-DI*

| Connector | Pin 1 | Pin 2 | Pin 3 | Pin 4 |
|---|---|---|---|---|
| 2x4 AMP (A) | Us | Udc | GND | Error |
| 2x4 AMP (B) | DI-A | DI-B | GND | $Udc_2$ |
| 2x4 DEU (A) | Us | Error | GND | Udc |
| 2x4 DEU (B) | $Udc_2$ | GND | DI-A | DI-B |

*PVEH-FLA*

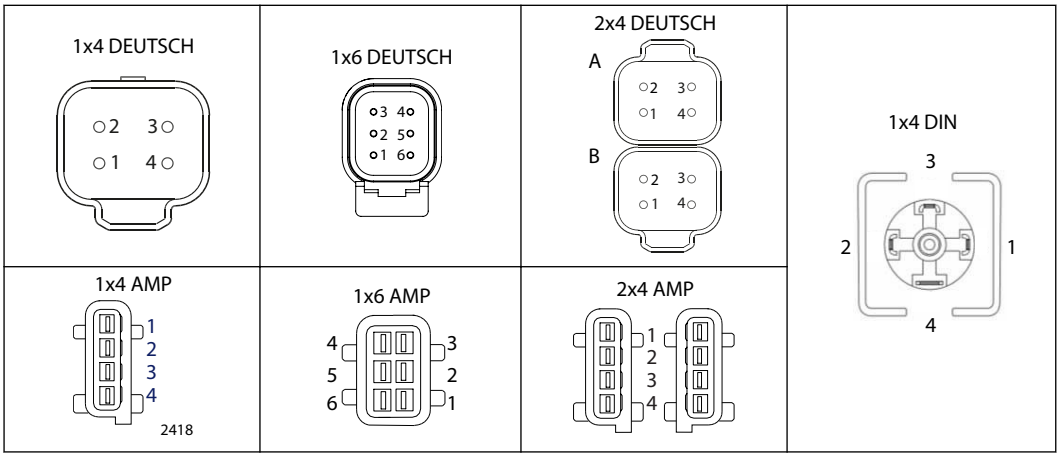
| Connector | Pin 1 | Pin 2 | Pin 3 | Pin 4 | Pin 5 | Pin 6 |
|---|---|---|---|---|---|---|
| 1x6 AMP | Us | Udc | GND | Error | Float | |
| 1x6 DEU | Us | Error | Float | | GND | Udc |

*PVEH-SP/PVES-SP*

| Connector | Pin 1 | Pin 2 | Pin 3 | Pin 4 | Pin 5 | Pin 6 |
|---|---|---|---|---|---|---|
| 1x6 DEU | Us | Error | | SP | GND | Udc |

## Connector Overview

*Connector diagrams*



## Fault Monitoring and Fault Reaction

All proportional control PVE Series 7 actuators feature an integrated fault monitoring, detecting spool stroke inconsistencies, internal hardware defects and demand signal inconsistencies.

The actuators feature a generic fault reaction and specific fault reactions depending on the type of fault monitoring, either passive or active. Passive and active fault monitoring refers to whether or not the actuator is reacting on the error when it is detected.

### Active

With an active fault monitoring, no matter what kind of error is detected, the solenoid valves will be disabled and the operation that the valves/spool controls will stop immediately. Active fault monitoring keeps a "memory" of the error, even if it is no longer registered. The active fault monitoring does not have Auto Recovery because of this "memory" and a reboot/restart will therefore be required to reactivate the solenoid valves.

With an active fault monitoring the following scenarios will take place when an error is detected/occurs:

- The LED light will switch from green to red and the error pin output will go high
- The solenoid valves will be disabled and the operation that the valves/spool controls will stop immediately
- The active fault monitoring does not have Auto Recovery, so when the error is fixed/no longer is registered a reboot/restart of the PVE is required to reactivate it.

### Passive

Passive fault monitoring does not disable the solenoid valves when an error is detected. It will continue to operate despite that an error was detected. When the error no longer is registered the passive fault monitoring will "forget" the error and continue as if the error was never there.

With a passive fault monitoring the following conditions will happen when an error is detected/occurs:

- The LED light will switch from green to red and the error pin output will go high
- The solenoid valves will continue operating at the set point given at the time of the error
  - Only exception is if the error is caused by the supply voltage (Udc) being either above or below the allowed range or if the temperature measured on the internal electronics board is higher than allowed. In these cases, the solenoid valves will be disabled.

An overview of the error states and the reaction to the errors can be seen in the table *Fault Reaction Overview* on page 36.

### Generic Fault Reaction

All PVE's with fault monitoring are triggered by the following four main events:

| | |
|---|---|
| **Control Signal Monitoring** | The Control signal voltage (Us) is continuously monitored. The permissible range is between 15% and 85% of the supply voltage (U dc). Outside this range the PVE will switch into an error state. A disconnected Us pin (floating) is recognized as a neutral set point. |
| **Transducer/LVDT Supervision** | The internal LVDT wires are monitored. If the signals are interrupted or short-circuited, the PVE will switch into an error state. |
| **Supervision of Spool Position** | The actual position must always correspond to the demanded position (Us). 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." |
| **Float Position Monitoring** | Float position must be entered or left within a time limit. On the 1x6 pin float PVE's a too high delay will cause an error state – this is only relevant for the 1x6 pin PVEH-F actuators. |
| **Temperature Monitoring** | When the temperature is too high the PVE's LED will light constant red and solenoid valves will be disabled. |

## Fault Monitoring and Fault Reaction

### Fault Reaction Overview

All entries have an Auto Recovery feature unless marked otherwise.

| Description | Monitoring | LED | Solenoid valves | Error pin output | Fault reaction time | |
|---|---|---|---|---|---|---|
| | | | | | PVEM/H/S | PVEA |
| Spool not at setpoint | Active* |  | Disabled | High | 500 | 750 |
| | Passive |  | - | High | 250 | 750 |
| Unable to reach float position | Active* |  | Disabled | High | 1000 | 1000 |
| | Passive |  | - | High | 1000 | 1000 |
| U dc > max. | Active |  | Disabled | - | - | - |
| | Passive |  | Disabled | - | - | - |
| U dc < min. | Active |  | Disabled | - | - | - |
| | Passive |  | Disabled | - | - | - |
| Us out of range | Active* |  | Disabled | High | 500 | 750 |
| | Passive |  | - | High | 250 | 750 |
| LVDT error | Active* |  | Disabled | High | 500 | 750 |
| | Passive |  | - | High | 250 | 750 |
| Temp > max. | Active* |  | Disabled | High | 250 | 750 |
| | Passive |  | Disabled | High | 250 | 750 |

* Does not have Auto Recovery

### Error Pin Specification

All proportional control PVE Series 7 actuators feature an error pin, indicating when an error is detected/ occurs, according to the Fault Reaction Overview table. The specifications of the error pin is shown below.

| Description | No error | Error |
|---|---|---|
| Output state | Low | High |
| Output voltage | <2 Vdc | ~Udc |
| Output current | Max. 100 mA | |

## Functionality Overview

### Standard and Fixed US 0-10 Vdc

All standard proportional actuator variants (PVEM/PVEA/PVEH/PVES) can be controlled by an analog signal voltage (Us) or a PWM controlled signal voltage (Us) proportional to the supply voltage (Udc).

*PVEO*

| Description | Type | Value | |
|---|---|---|---|
| Supply voltage (Udc) | Rated | 12 Vdc | 24 Vdc |
| | Range | 11 to 15 Vdc | 22 to 30 Vdc |
| | Max. ripple | 5% | |

*PVEM/PVEA/PVEH/PVES*

| Description | Type | Value |
|---|---|---|
| Supply voltage (Udc) | Rated | 11 to 32 Vdc |
| | Range | 11 to 32 Vdc |
| | Max. ripple | 5% |
| Signal voltage (Us) | Neutral | Us = 0.5 · Udc |
| | Q: P to A | US = (0.5 to 0.25) · Udc |
| | Q: P to B | US = (0.5 to 0.75) · Udc |

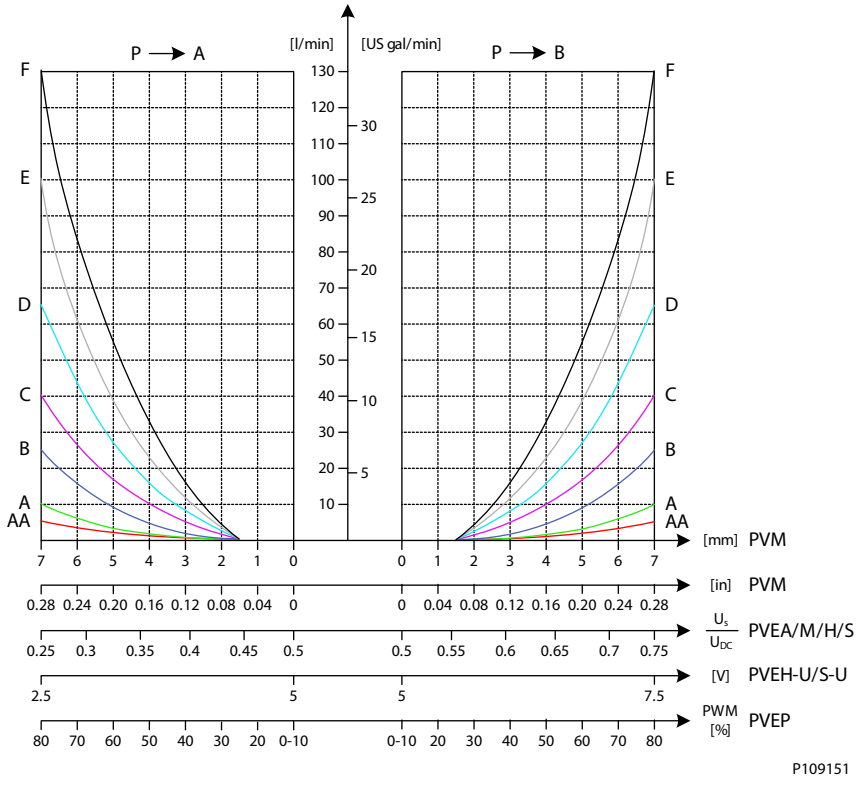
The PVEH-U and PVES-U variants are controlled by a fixed 0-10 Vdc signal voltage (Us), directly compatible with standard PLC control.

*PVEH-U*

| Description | Type | Value |
|---|---|---|
| Supply voltage (Udc) | Rated | 11 to 32 Vdc |
| | Range | 11 to 32 Vdc |
| | Max. ripple | 5% |
| Signal voltage (Us) | Neutral | Us = 5 V |
| | Q: P to A | 5 V to 2.5 V |
| | Q: P to B | 5 V to 7.5 V |

## Functionality Overview

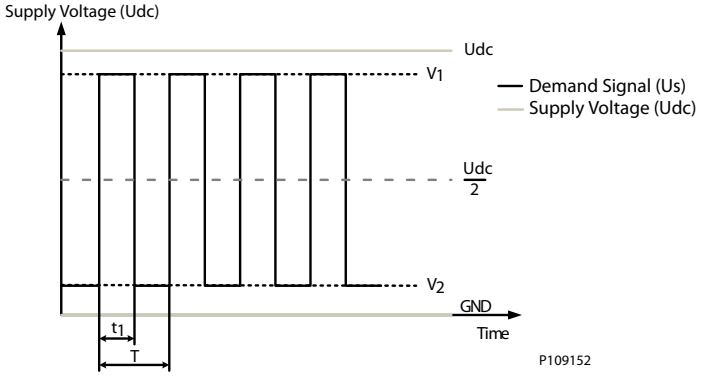
**Performance**




### PWM Voltage Control

The PVEM/PVEA/PVEH/PVES actuator variants can be controlled by a PWM controlled signal voltage (Us) proportional to the supply voltage (Udc).

The $V_1$ and $V_2$ must be symmetrical around Udc/2 and $V_1$ must be equal to or less than Udc.




*PVEM Control Specification*

| Description | Type | Value |
|---|---|---|
| Supply Voltage (Udc) | Rated | 11 to 32 Vdc |
| | Range | 11 to 32 Vdc |
| | Max. ripple | 5% |

## Functionality Overview

*PVEM Control Specification (continued)*

| Description | Type | Value |
|---|---|---|
| Signal Voltage PWM (Us) | Neutral | Us = 50% DUT |
| | Q: P to A | Us = 50% to 25% DUT |
| | Q: P to B | Us = 50% to 75% DUT |
| PWM Frequency (Us) | Recommended | > 200 Hz |

*PVEA/PVEH/PVES Control specification*

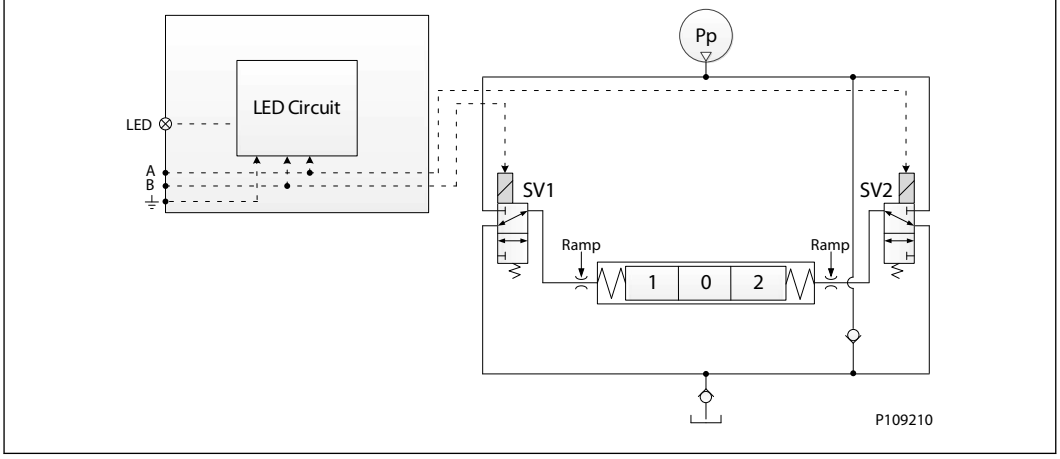
| Description | Type | Value |
|---|---|---|
| Supply Voltage (Udc) | Rated | 11 to 32 Vdc |
| | Range | 11 to 32 Vdc |
| | Max. ripple | 5% |
| Signal Voltage PWM (Us) | Neutral | Us = 50% DUT |
| | Q: P to A | Us = 50% to 25% DUT |
| | Q: P to B | Us = 50% to 75% DUT |
| PWM Frequency (Us) | Recommended | > 1000 Hz |

## Functionality Overview

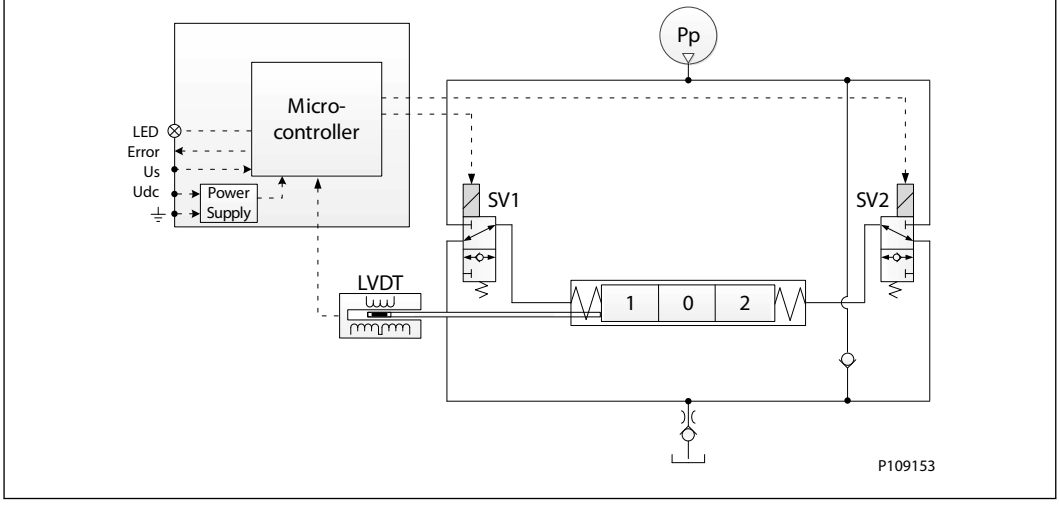
### Ramp (-R)

The Ramp functionality is a rate limitation of the spool stroke, resulting in extended reaction times and in some cases a smoother control of the main spool compared to the standard PVEO variant. The Ramp functionality of a PVEO-R variant is achieved purely hydraulically by implementing two orifices working on both sides of the main spool (integrated in the actuator). The Ramp functionality of a PVEM-R variant is achieved in the regulation principle.

***PVEO-R***




***PVEM-R***



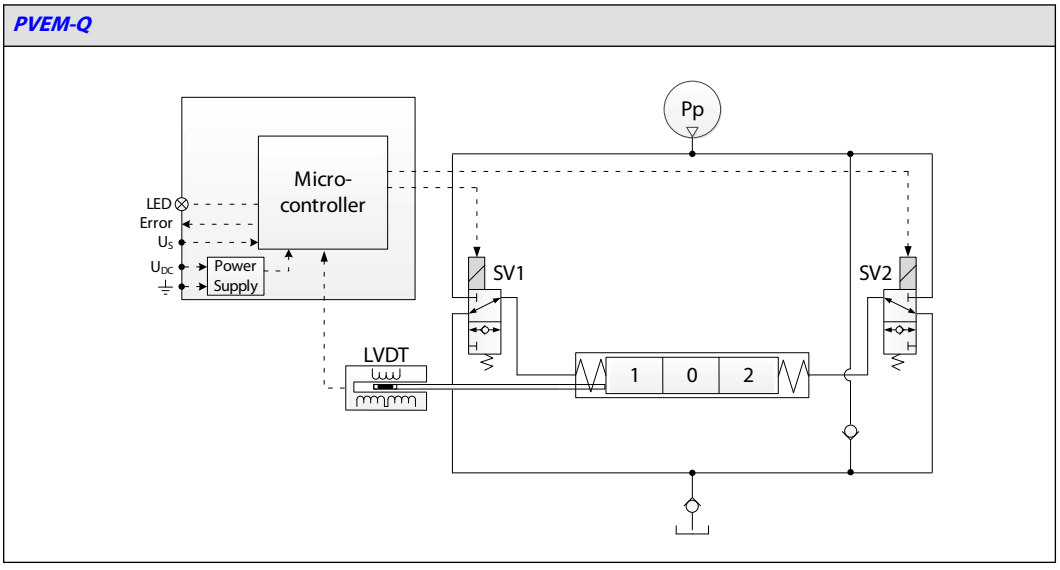

For reaction times, see *Reaction Times* on page 51

## Functionality Overview

### Quick Reaction (-Q)

The Quick Reaction functionality of the PVEM-Q variant results in shorter reaction times and a more rapid or aggressive control of the main spool compared to the standard PVEM variant. The Quick Reaction functionality of a PVEM-Q is achieved by replacing the combined orifice and check valve with a check valve in the connection to tank and changing the regulation principle.

***PVEM-Q***



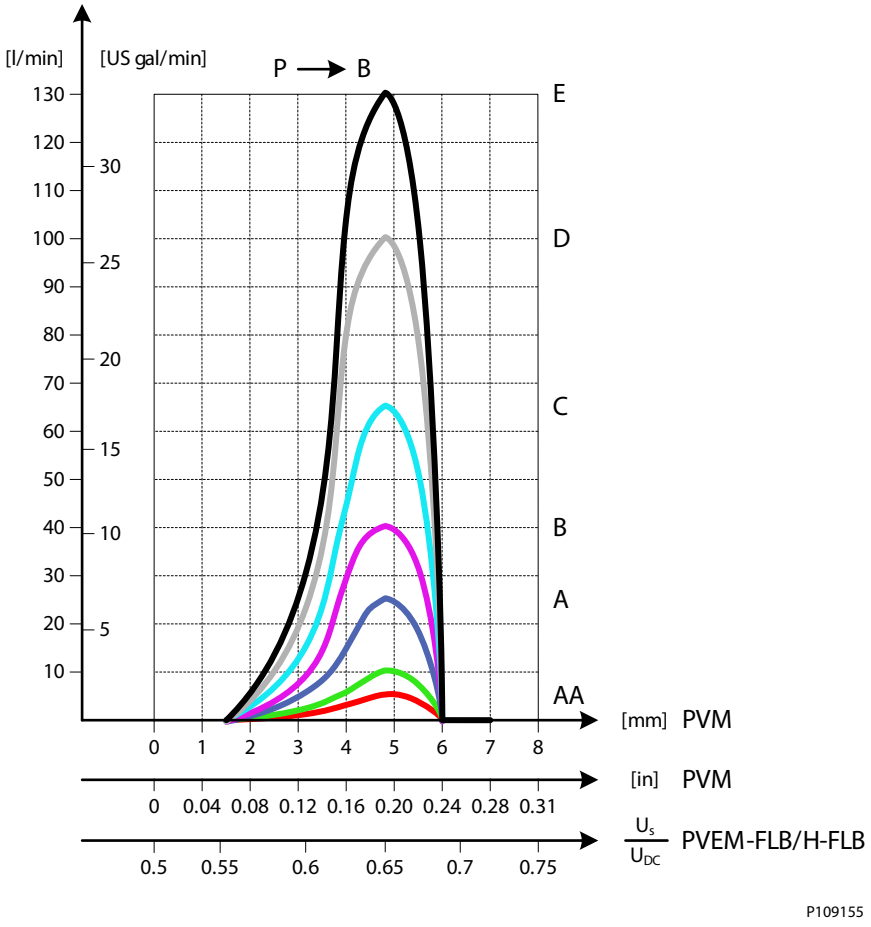

For reaction times, see *Reaction Times* on page 51.

## Functionality Overview

### Float B-Port (-FLB)

The Float B-Port functionality enables the proportional PVEM-FLB/PVEH-FLB actuator variants to enter the main spool into a float position. The PVE actuators with Float B-Port functionality is compatible with the dedicated main spools with electronic float in B-port.

| PVE Type | PVBS Type | Standard Flow Control | Float Control |
|---|---|---|---|
| *PVEM-FLB* (1x4 pin) | Deadband 1.5 mm | Us = (0.35 → 0.65) · Udc | Us = 0.75 · Udc |
| *PVEH-FLB* (1x4 pin) | Max. B-port flow 4.8 mm | | |

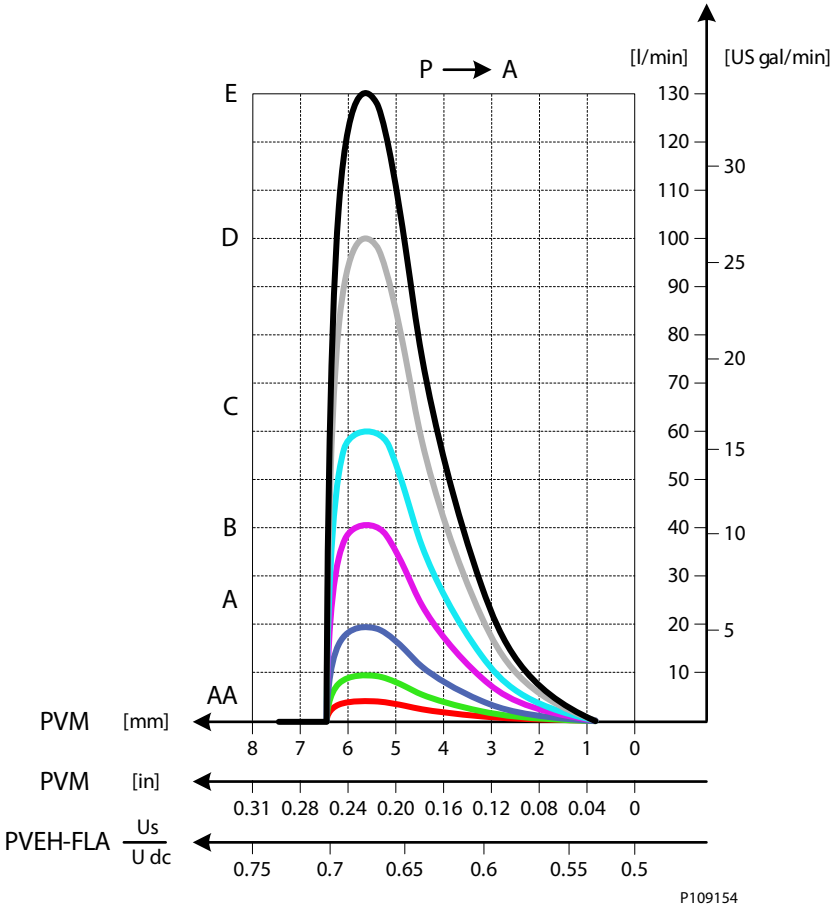


## Functionality Overview

### Float A-Port (-FLA)

The Float A-Port functionality enables the proportional PVEH-FLA actuator variants to enter the main spool into a float position. The PVE actuators with Float A-Port functionality is compatible with the dedicated main spools with electronic float in A-port.

| PVE Type | PVBS Type | Standard Flow Control | Float Control |
|---|---|---|---|
| PVEH-FLA (1x6 pin) | Deadband 1.7 mm | Us = (0.25 → 0.75) · Udc | U dc to dedicated float pin (UF) |
| | Max. B-port flow 8.0 mm | | |




### Power Save

All proportional actuator variants (PVEM/PVEA/PVEH/PVES) feature a Power Save mode, de-energizing the solenoid valve bridge. The Power Save mode is entered when the signal voltage (Us) and the LVDT spool position has been in neutral for 750 ms. As soon as the signal voltage (Us) or the LVDT spool position is out of neutral the PVE will leave its Power Save mode and re-energize the solenoid valve bridge as usual.

The Power Save mode results in increased power efficiency by reducing the current consumption of the PVE actuators in neutral position. The Power Save mode has no effect on the performance of the PVE actuator.

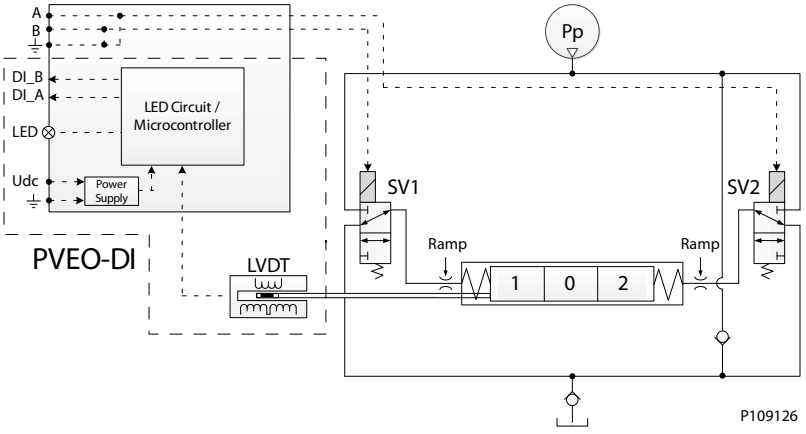
For current consumption values, please see chapter *Current Consumption*.

## Special Features

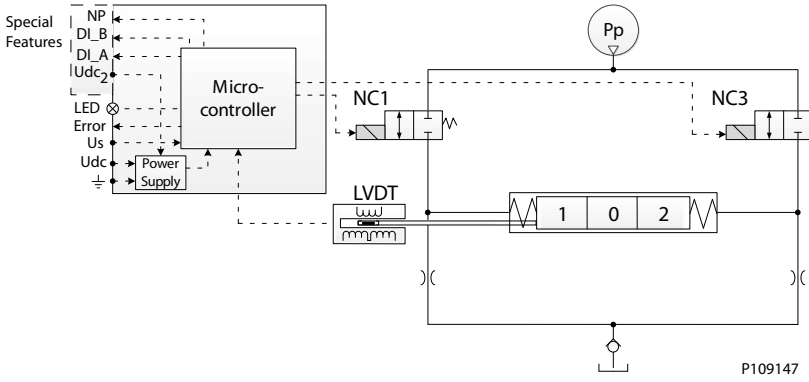
### Direction Indication (-DI)

The PVEO-DI/PVEA-DI/PVEH-DI actuator variants feature an integrated Direction Indication output derived from the LVDT spool position, indicating the state of the main spool (neutral, A-port or B-port).

***PVEO-DI***

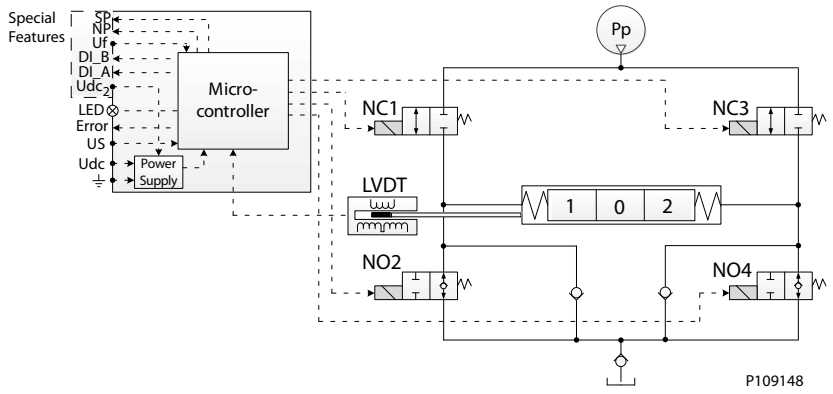



***PVEA-DI***



## Special Features

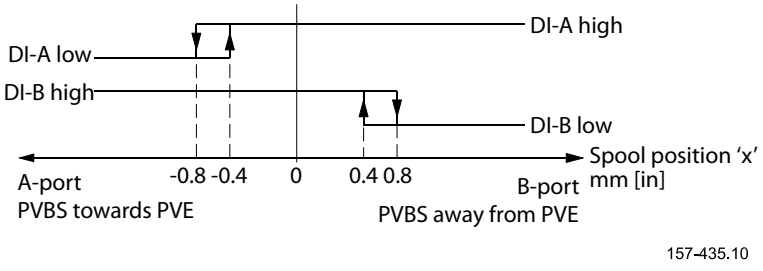
***PVEH-DI***




The Direction Indication feature uses a dual power supply with the 2x4 pin AMP and DEUTSCH connectors as shown in the chapter *Connector Overview* on page 33.

When both DI_A and DI_B signals are High the main spool is in its neutral position. When the DI_A signal goes Low and the DI_B signal stays High the main spool is moving in the A-port direction, and vice versa. The relation between the direction indication feedback and the output signal is shown below.

*Direction indication feedback*



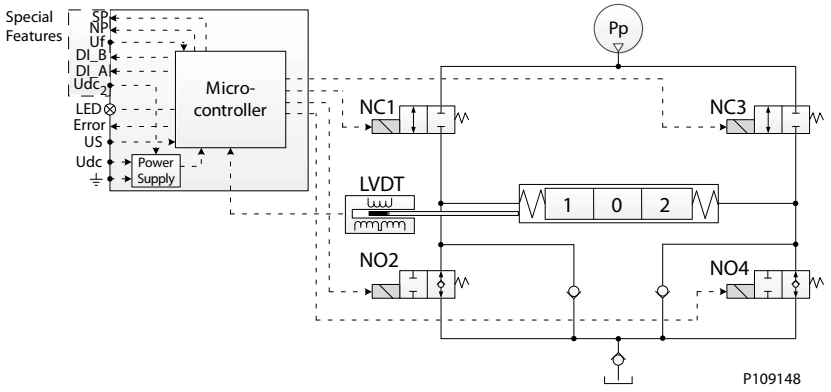

| | A-Port | B-Port |
|---|---|---|
| DI signals a1, a2 | -0.8 mm ± 0.4 mm | 0.8 mm ± 0.4 mm |
| Max. DI load | 200 mA | |
| DI High @ 20 mA | > U dc – 1.5 V dc | |
| DI High @ 100 mA | > U dc – 2.0 V dc | |
| DI Low | < 0.2 V dc | |

## Special Features

### Dedicated Float Pin (UF)

The Dedicated Float Pin (UF) feature is related to the PVEH-FLA actuator variant described in the chapter *Float A-Port*. The PVEH-FLA uses 1x6 pin AMP or DEUTSCH connectors, as shown in the chapter *Connector Overview*, enabling the user to move the main spool into its float position by powering a dedicated float pin (UF).

***PVEH-FLA***




*Dedicated Float Pin (UF) Specification*

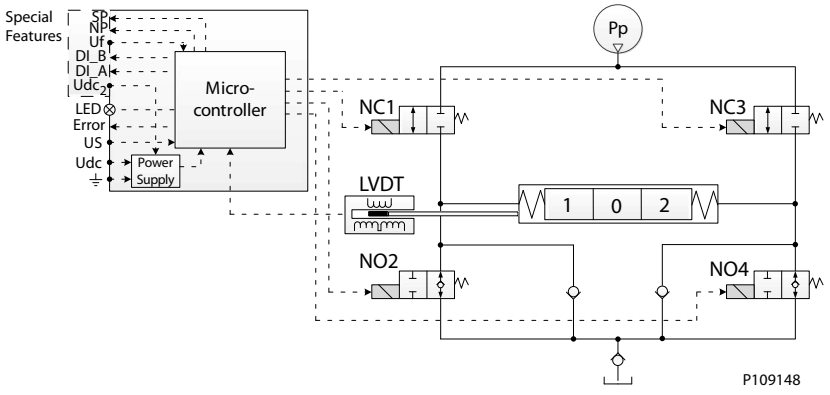
| | |
|---|---|
| Low or not connected | Normal operation |
| High | Float |
| Input range | Udc |
| Max. voltage | 32 Vdc |

## Special Features

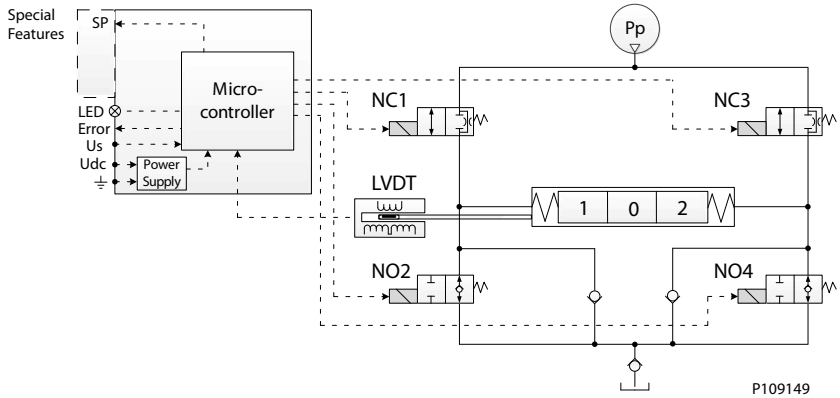
### Spool Position (-SP)

The Spool Position (SP) feature available in the PVEH-SP/PVES-SP actuator variants enables the user to derive the position of the main spool by means of an analog voltage signal on the dedicated spool position (SP) output pin. The spool position output is derived from the LVDT spool position. The PVEH-SP/PVES-SP uses a 1x6 DEUTSCH connector. For more information on connectors, please see the chapter *Connector Overview* on page 33.

***PVEH-SP***

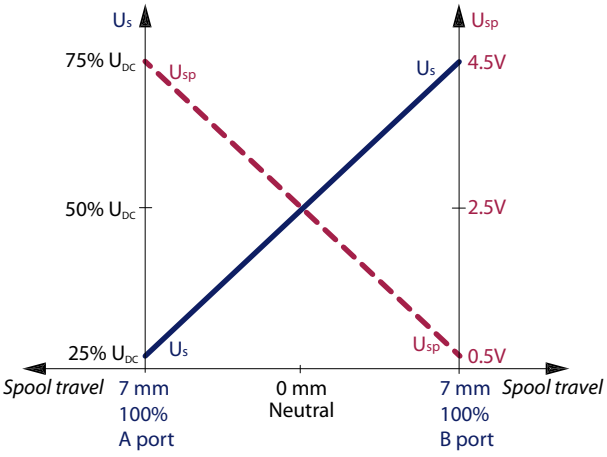



***PVES-SP***



## Special Features

*Spool position feedback (-SP)*




The Spool Position (SP) feedback signal is a 0.5 Vdc to 4.0 Vdc signal, inverted in direction relative to Us with 2.5 Vdc as the neutral value.

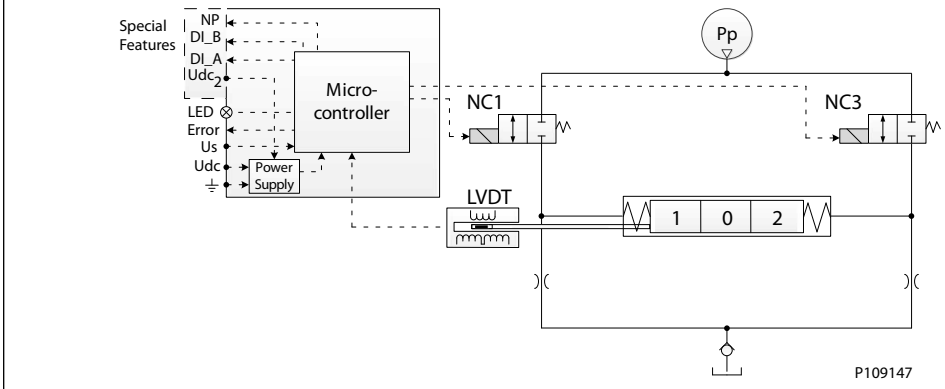
| | **A-Port** | **B-Port** |
|---|---|---|
| Spool position | Neutral to max. stroke [mm] | Neutral to max. stroke [mm] |
| Max. SP load | 0.5 mA | |
| Output range | 2.5 – 1.25 Vdc | 2.5 – 3.75 Vdc |

## Special Features

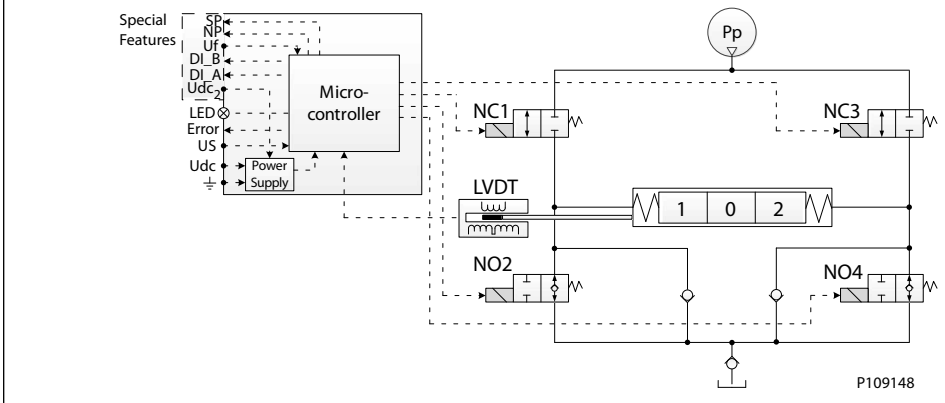
### Neutral Power-OFF (-NP)

The Neutral Power-OFF (NP) feature available in the PVEA-NP/PVEH-NP actuator variants enables the user to identify whether the solenoid valves in the actuator are energized or de-energized via a dedicated neutral power-OFF (NP) output pin. The PVEA-NP/PVEH-NP uses a 1x6 DEUTSCH connector. For more information on connectors, please see the chapter *Connector Overview* on page 33.

***PVEA-NP***

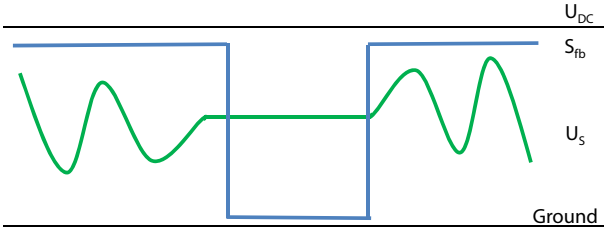



***PVEH-NP***




The Neutral Power-OFF (NP) signal is defined as shown below.

*Solenoid disabling function (-NP) curves*




*Neutral Power-OFF (NP) Specification*

| | |
|---|---|
| Normal operation | > Udc to 2 Vdc |
| Power Save | < 1 Vdc (solenoid valves de-energized) |
| Max. NP load | 50 mA |

## Special Features

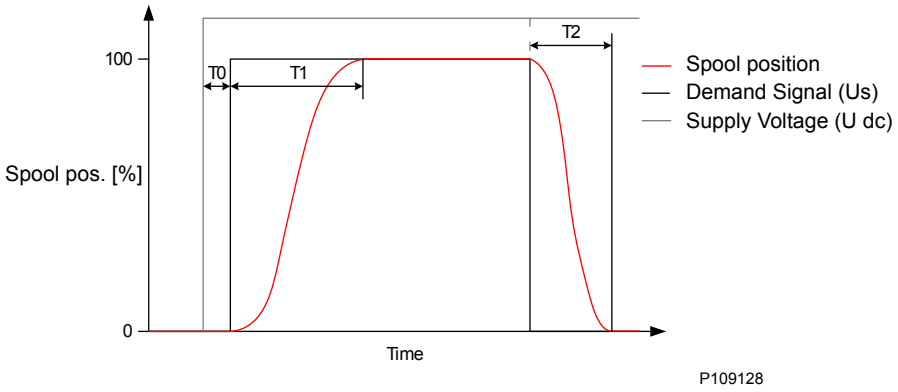
### Disable Mode

The PVEH-U/PVES-U actuator variants controlled by a fixed 0-10 Vdc signal voltage (Us), feature the ability to enter a disable mode, deactivating the counteracting force on the main spool created by the solenoid valve bridge, when using manual override (hand operational mode). The disable mode is entered by sending a signal voltage (Us) of 16.2% of 10 Vdc when in Power Save.

For more information, please see *Power Save*.

## Performance Overview

### Reaction Times




| Reaction |
|---|
| T0 – Boot-up [ms] |
| T1 – Neutral to max. spool stroke |
| T2 – Max. spool stroke to neutral |
| T1 – Neutral to max. spool stroke |
| T2 – Max. spool stroke to neutral |

*PVG 32/100 reaction times*

| Reaction | *PVEO* | *PVEO-R* | *PVEO-HP* | *PVEM* | *PVEM-R* |
|---|---|---|---|---|---|
| T0 [ms] | 0 | 0 | 0 | 15 | 15 |
| T1 @ Power ON [ms] | 110 | 300 | 90 | 225 | 325 |
| T2 @ Power OFF [ms] | 110 | 110 | 70 | 110 | 110 |
| T1 @ Constant U dc [ms] | 110 | 300 | 90 | 210 | 310 |
| T2 @ Constant U dc [ms] | 110 | 110 | 70 | 90 | 90 |

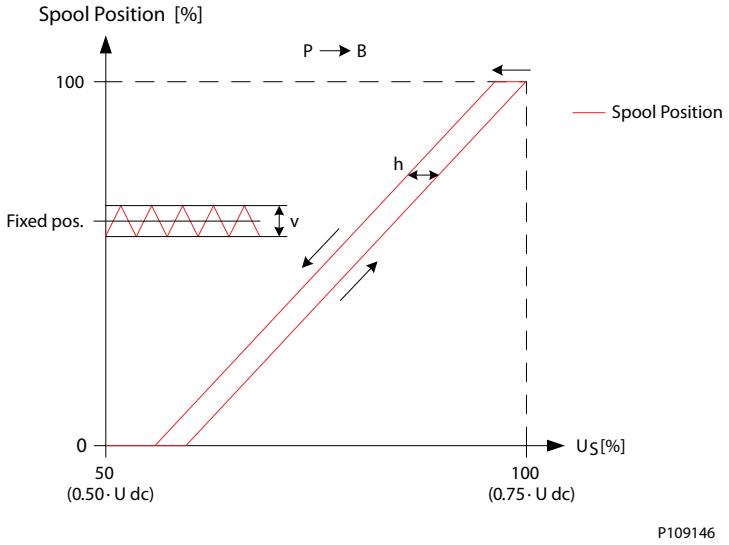
*PVG 32/100 reaction times (continued)*

| Reaction | *PVEM-Q* | *PVEA* | *PVEH* | *PVES* |
|---|---|---|---|---|
| T0 [ms] | 15 | 15 | 15 | 15 |
| T1 @ Power ON [ms] | 125 | 280 | 125 | 125 |
| T2 @ Power OFF [ms] | 110 | 200 | 110 | 110 |
| T1 @ Constant U dc [ms] | 110 | 265 | 110 | 110 |
| T2 @ Constant U dc [ms] | 90 | 200 | 90 | 90 |

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

## Performance Overview

### Hysteresis and Ripple




| Type | Hysteresis (h) | Steady state ripple @ fixed Us (v) |
|---|---|---|
| | Rated [%] | Rated [mm] |
| *PVEM* | 15 | 0.0 |
| *PVEM-R* | 15 | 0.0 |
| *PVEM-Q* | 15 | 0.0 |
| *PVEA* | 2 | 0.3 |
| *PVEH* | 4 | 0.0 |
| *PVEH 256* | 1.5 | 0.0 |
| *PVES* | 0 | 0.2 |

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

### Current Consumption

| Type | Typical | Minimum | Maximum |
|---|---|---|---|
| | [mA] | | |
| *PVEO @ 12 Vdc* | 480 | 430 | 950 |
| *PVEO @ 24 Vdc* | 250 | 220 | 480 |
| *PVEO-HP @ 12 Vdc* | 750 | 660 | 1460 |
| *PVEO-HP @ 24 Vdc* | 380 | 340 | 740 |

| Type | @ 12 Vdc | @ 24 Vdc |
|---|---|---|
| | [mA] | |
| *PVEM* | 690 | 350 |
| *PVEA* | 290 | 150 |
| *PVEH* | 540 | 270 |
| *PVES* | 560 | 280 |

The stated values are preliminary values and can be subject to change once an increased statistical basis is achieved.

## Performance Overview

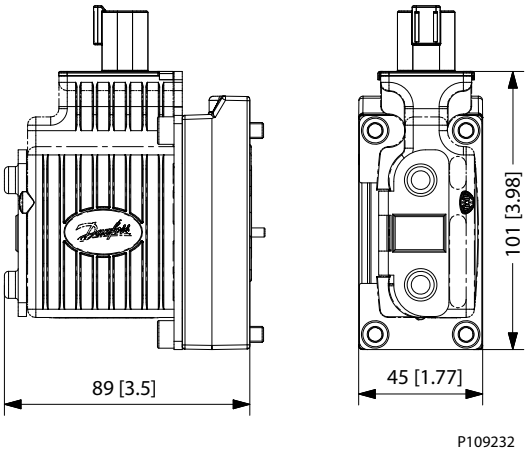
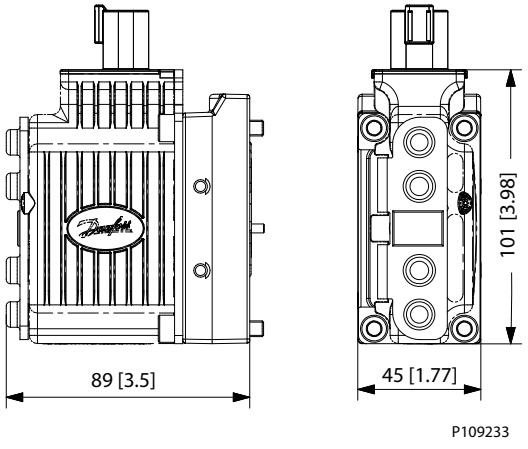
### Oil Consumption

| Type | Neutral | Locked position | Actuating |
|---|---|---|---|
| | [l/min] | | |
| *PVEO* | 0.0 | 0.0 | 0.9 |
| *PVEO-R* | 0.0 | 0.0 | 0.3 |
| *PVEO-HP* | 0.0 | 0.0 | 0.9 |
| *PVEM* | 0.0 | 0.0 | 0.5 |
| *PVEM-R* | 0.0 | 0.0 | 0.3 |
| *PVEM-Q* | 0.0 | 0.0 | 0.3 |
| *PVEA* | 0.0 | 0.4 | 1.0 |
| *PVEH* | 0.0 | 0.0 | 0.7 |
| *PVES* | 0.3 | 0.1 | 0.8 |

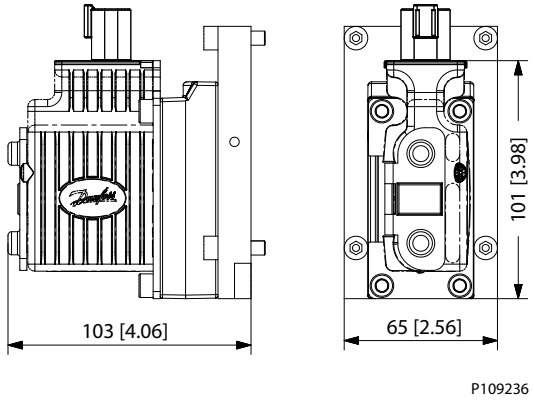
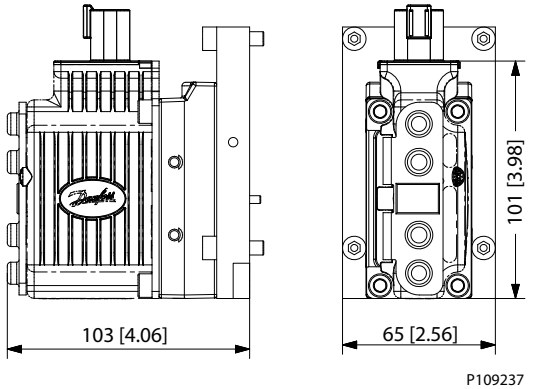
## Dimension Overview

### Dimension Overview

*PVG 32/100 variants*

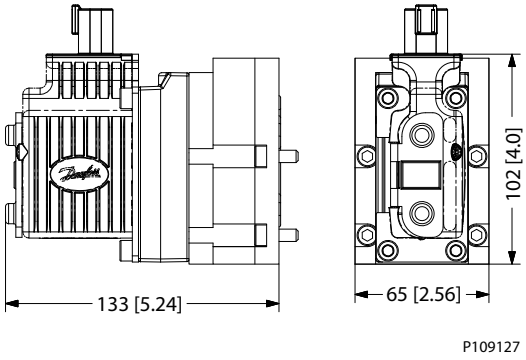
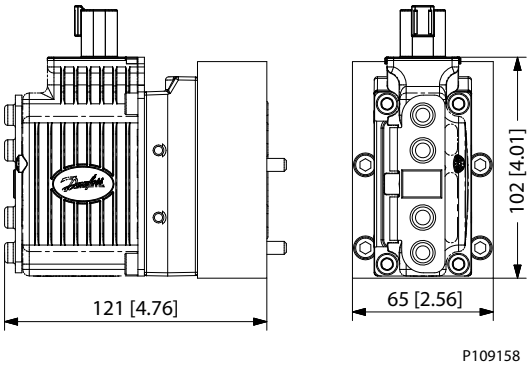
| PVEO/PVEM/PVEA | PVEH/PVES | Connector Height |
|---|---|---|
|  |  | DEU = 30 mm [1.2 in]<br>AMP = 38 mm [1.5 in]<br>DIN = 40 mm [1.6 in] |

*PVG 120 variants*

| PVEO | PVEH/PVES | Connector Height |
|---|---|---|
|  |  | DEU = 30 mm [1.2 in]<br>AMP = 38 mm [1.5 in]<br>DIN = 40 mm [1.6 in] |

## Dimension Overview

*PVG 128/256 variants*

| PVEO | PVEH | Connector Height |
|---|---|---|
|  |  | DEU = 30 mm [1.2 in]<br>AMP = 38 mm [1.5 in]<br>DIN = 40 mm [1.6 in] |

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