

ENGINEERING
TOMORROW



Technical Information

Proportional Valve Group

PVG 16



Revision history

Table of revisions

Date	Changed	Rev
February 2017	Major update.	0401
March 2016	Minor update in PVHC technical characteristics	0303
March 2016	Updated to Engineering Tomorrow design.	0302
February 2016	Drawing was updated in topic: How to select the correct spool	0301
September 2015	PVG 16 Step II	0200
March 2015	PVH, PVMD changed under Modules	BF
February 2015	Seal kit added for PVB + PVM	BE
December 2014	PVHC section updated	BD
August 2014	PVEO pin descriptions updated	BC
January 2014	Converted to Danfoss layout – DITA CMS	BB
February 2013	Major layout revision, drawings change	BA
October 2012	New Edition	AA

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Order specification

Reference

Literature reference for PVG products

Literature reference

Literature title	Type	Order number
PVG 32 Proportional Valve Group	Technical Information	520L0344
PVG 100 Proportional Valve Group	Technical Information	520L0720
PVG 120 Proportional Valve Group	Technical Information	520L0356
PVG 32 Metric ports	Technical Information	11051935
PVE Series 4	Technical Information	520L0553
PVED-CC Electro-hydraulic actuator	Technical Information	520L0665
PVED-CX Electro-hydraulic actuator	Technical Information	11070179
PVE-CI	Technical Information	L1505234
Basic module for PVBZ	Technical Information	520L0721
PVSK module with integrated diverter valve and P-disconnect function	Technical Information	520L0556
PVPV / PVPM pump side module	Technical Information	520L0222
Combination module PVGI	Technical Information	520L0405
PVSP/M Priority module	Technical Information	520L0291
Hitch Control	System Description	11036124
	User Manual	11033753
PVBZ	Data Sheet	520L0681
PVBZ-HS	Data Sheet	520L0956
PVBZ-HD	Data Sheet	11035599
MC024-010 and MC024-012 Controllers	Data Sheet	520L0712

General Information

PVG 16 introduction

The PVG 16 is a hydraulic load sensing proportional valve group designed to give maximum flexibility in design and build concept. The PVG 16 is designed as a load sensing directional control valve which will lead to increased application efficiency, reducing cooling requirements and fuel saving compared to conventional directional control valves. When the pump is started and the main spools in the individual basic modules (6) (see [PVG 16 sectional view](#) on page 7) are in the neutral position, oil flows from the pump, through connection P, across the pressure adjustment spool (4) to tank. The spring in the pressure adjustment spool determines the pump pressure (stand-by pressure) in neutral.

When one or more of the main spools are actuated, the highest load pressure is fed through the shuttle valve circuit to the spring chamber behind the pressure adjustment spool (4), and completely or partially closes the connection to tank. Pump pressure is applied to the right-hand side of the pressure adjustment spool (4). The pressure relief valve (1) will open should the load pressure exceed the set value, diverting pump flow back to tank.

With a non pressure-compensated basic module incorporating a load drop check valve (8) in channel P, the check valve prevents return oil flow.

The basic module can be supplied without the load drop check valve in channel P for functions with over-centre valves.

The shock and suction valves PVLP (7) with fixed setting on ports A and B are used for the protection of the individual working function against overload and/or cavitation.

In the closed center version an orifice (3) and a plug (5) have been fitted instead of the plug (2). This means that the pressure adjustment spool (4) will only open to tank when the pressure in channel P exceeds the set value of the pressure relief valve (1).

Alternatively a dedicated PVPV inlet for variable displacement pumps can be used. In load sensing systems the load pressure is led to the pump regulator via the LS connection. In the neutral position the pump control sets the displacement so that leakage in the system is compensated for, to maintain the set stand-by pressure.

When a main spool is actuated the pump regulator will adjust the displacement so that the set differential pressure between P and LS is maintained. The pressure relief valve (1) in PVP should be set at a pressure of approx. 30 bar [435 psi] above maximum system pressure (set on the pump or external pressure relief valve).

The PVG 16 is part of a whole family of PVG valves spanning a wide range of flow options. A common feature is the modular build concept combining stacks of flexible slice-sections across the families thus making it possible to build up a valve group to meet requirements exactly. The width and height of the valve remain unchanged whatever combination is specified.

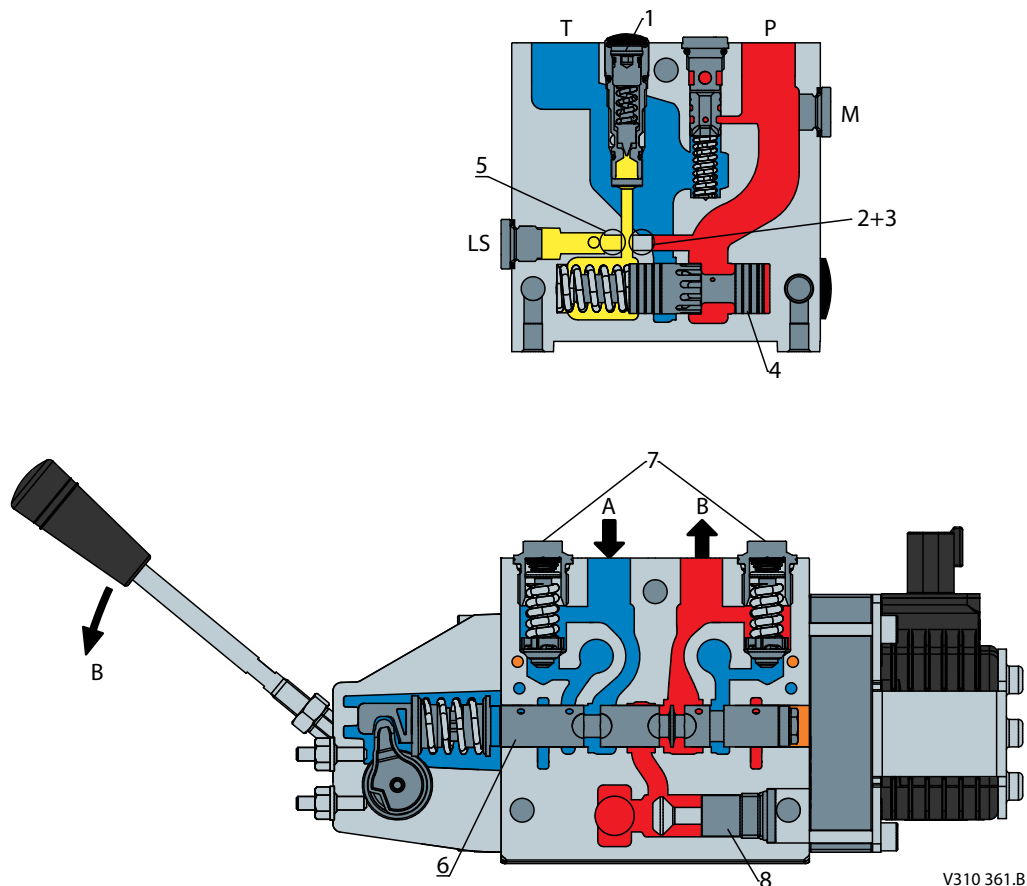
The PVB 16 is available as a compensated basic module giving the features of load-independent flow control:

- Oil flow to an individual work function is independent of the load pressure of this function
- Oil flow to one function is independent of the load pressure of other functions.

The PVB 16 employs the same compensation principle as the proven technology of the PVB 32 - the compensator maintains a constant pressure drop across the main spool (PVBS).

General Information

PVG 16 sectional view



- Legend:**
- 1. Pressure relief valve
 - 2. Plug, open center
 - 3. Orifice, closed center
 - 4. Pressure adjustment spool
 - 5. Plug, closed center
 - 6. Main spool
 - 7. Shock and suction valve, PVLP
 - 8. Compensator or load drop check valve
(Figure shown is a load drop check valve)

PVG 16 general features

- Load sensing directional control:
 - Proportional control of oil flow to a work function
- Modular build concept:
 - Up to 12 basic modules per PVG 16 valve group
 - Different, interchangeable spool variants
 - System pressure up to 350 bar [5075 psi]
 - Several types of port connection threads
 - Possible combination with the rest of the PVG family either PVG 32, PVG 100 or PVG 120

General Information

PVP and PVS from PVG 32 portfolio

The PVG 16 interfaces directly with the PVG 32 product line. The PVG 16 valve is designed to be used with the existing PVP and PVS in the product portfolio from the PVG 32 family. When specifying a PVG 16 valve stack please refer to *PVG 32 Technical Information, 520L0344* for detailed information on PVP and/or PVS.

Standard build (stack) of PVG 16 valve

Inlet section (PVP reused from the PVG 32 portfolio), 1–12 work sections (PVB) with individual flow controlling spools and end section (PVS reused from the PVG 32 portfolio). Each work section is actuated by manual lever, (PVM), electrical control signal (PVE) or hydraulic control signal (PVH).

Combining PVG family into a single valve stack

The PVG 16 can be used in conjunction with the other valves in the PVG family by combining them into a single valve stack. Hence a valve stack of PVG 32/16, PVG 100/16 or PVG 120/16 can be assembled. In a PVG 32/16 build no interface module is required as a PVG 16 slice can replace a PVG 32 slice. In a PVG 100/16 or PVG 120/16 build the standard interface modules known today (PVTI and PVGI respectively) are used.

PVG 16 Technical data

PVG 16 Technical data

Maximum pressure	Port P Continuous	350 bar ¹⁾	[5075 psi] ¹⁾
	Port P Intermittent	400 bar	[5800 psi]
	Port A/B Continuous	380 bar	[5510 psi]
	Port A/B Intermittent	420 bar	[6090 psi]
	Port T, static/dynamic	25/40 bar	[365/580 psi]
Oil Flow Rated	Port P	140/230 l/min	[37/61 US gal/min]
	Port A/B	65 l/min @ 10 bar pressure drop	[17 US gal/min @ 145 psi pressure drop]
Spool Travel	Deadband	± 1.5 mm	[± 0.06 in]
	Proportional range	± 5.0 mm	± 0.2 in]
	Float position	± 7.5 mm	[± 0.3 in]
Minimum Internal leakage at 100 bar [1450 psi] and 21 mm²/s [102 SUS]	A/B → T without shock valve	20 cm ³ /min	[1.85 in ³ /min]
	A/B → T with shock valve (system setting 30 bar [435 psi])	25 cm ³ /min	[2.15 in ³ /min]
Oil temperature (inlet)	Recommended range	30 → 60 °C	[86 → 140 °F]
	Minimum	-30 °C	[-22 °F]
	Maximum	90 °C	[194 °F]
Ambient Temperature		-30 → 60 °C	[-22 → 140 °F]
Oil Viscosity	Operating range	12 - 75 mm ² /s	[65 - 347 SUS]
	Minimum	4 mm ² /s	[39 SUS]
	Maximum	460 mm ² /s	[2128 SUS]
Filtration	Maximum contamination (ISO 4406)	23/19/16	
PVM regulating range	Proportional	13.9°	
	Float position	22.3°	

General Information

PVG 16 Technical data (continued)

PVM operating force	PVM + PVMD PVM + PVE²⁾	Neutral	2.2 ±0.2 N•m	[5.0 ± 1.8 lbf•in]
		Maximum stroke	2.8 ±0.2 N•m	[6.3 ± 1.8 lbf•in]
	PVM + PVH	Neutral	2.7 ±0.2 N•m	[23.9 ± 1.8 lbf•in]
		Maximum stroke	7.1 ±0.2 N•m	[62.8 ± 1.8 lbf•in]
PVH pressure	Regulating range	5 – 15 bar	[75 – 220 psi]	
	Maximum pilot pressure	30 bar	[435 psi]	
	Maximum pressure on T-port	10 bar	[145 psi]	
PVE Input Voltage³⁾	Supply	11 – 32 V _{DC}		
	Regulating range	25 – 75% of Supply voltage		
PVE SP pin output voltage³⁾	Float	0.5 V _{DC}		
	Flow to B-port	1.25 – 2.5 V _{DC}		
	Neutral	2.5 V _{DC}		
	Flow to A-port	2.5 – 3.75 V _{DC}		
	Error	5 V _{DC}		

¹⁾ With PVS1 end plate. Using PVS end plate maximum 300 bar [4351 psi].

²⁾ PVE without voltage.

³⁾ Voltage is measured between spool output pin and ground (GND)

Safety in systems

General safety considerations

All types and brands of control valves, including proportional valves, can fail. Therefore, the necessary protection against the serious consequences of a functional failure should always be built into the system. For each application an assessment should be made for the consequences of the system in case of pressure failure and uncontrolled or blocked movements.

Warning

It is the sole responsibility of the machine manufacturer to ensure that all performance, safety, and warning requirements of the application are met in his selection of products. The process of choosing the control system and subsequent safety levels is governed by the machine directive EN 13849.

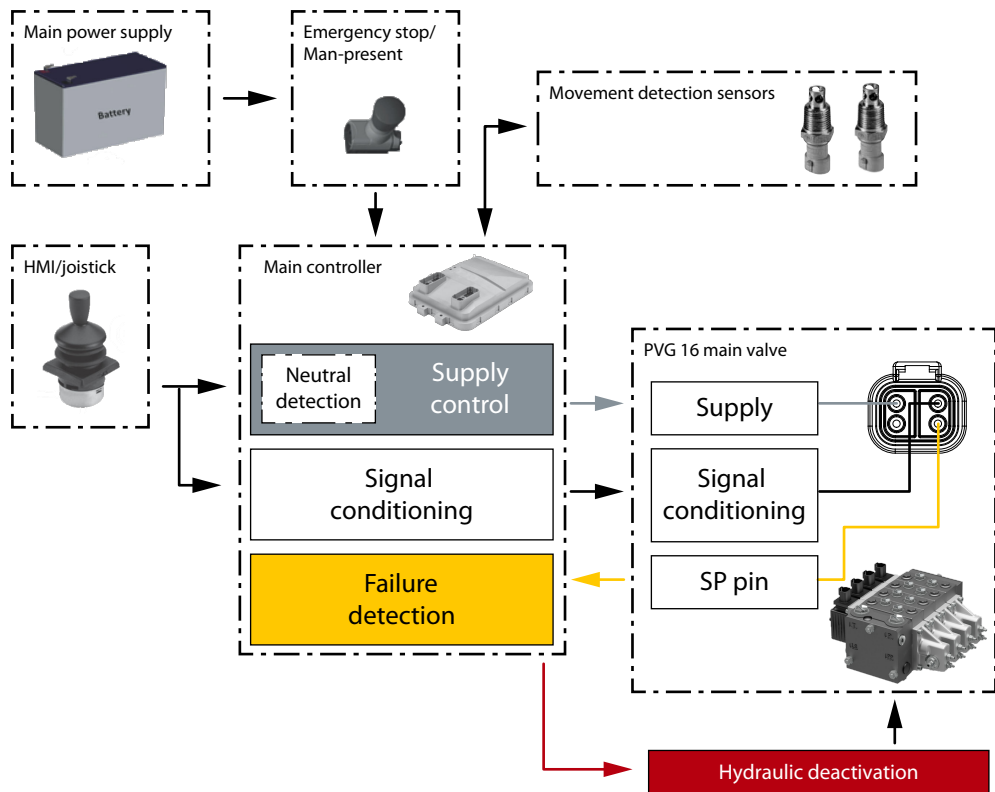
Control system example

An example of a control system using an aerial lift is shown below. Even though many Danfoss components are shown the example is concentrating on the PVG 16 control system.

This example breaks down the control system into smaller bits explaining the architecture in depth.

The function of the control system is to use the output from the PVEA Series 6 together with other external sensors to ensure the PLUS+1® main controllers correct function of the aerial lift.

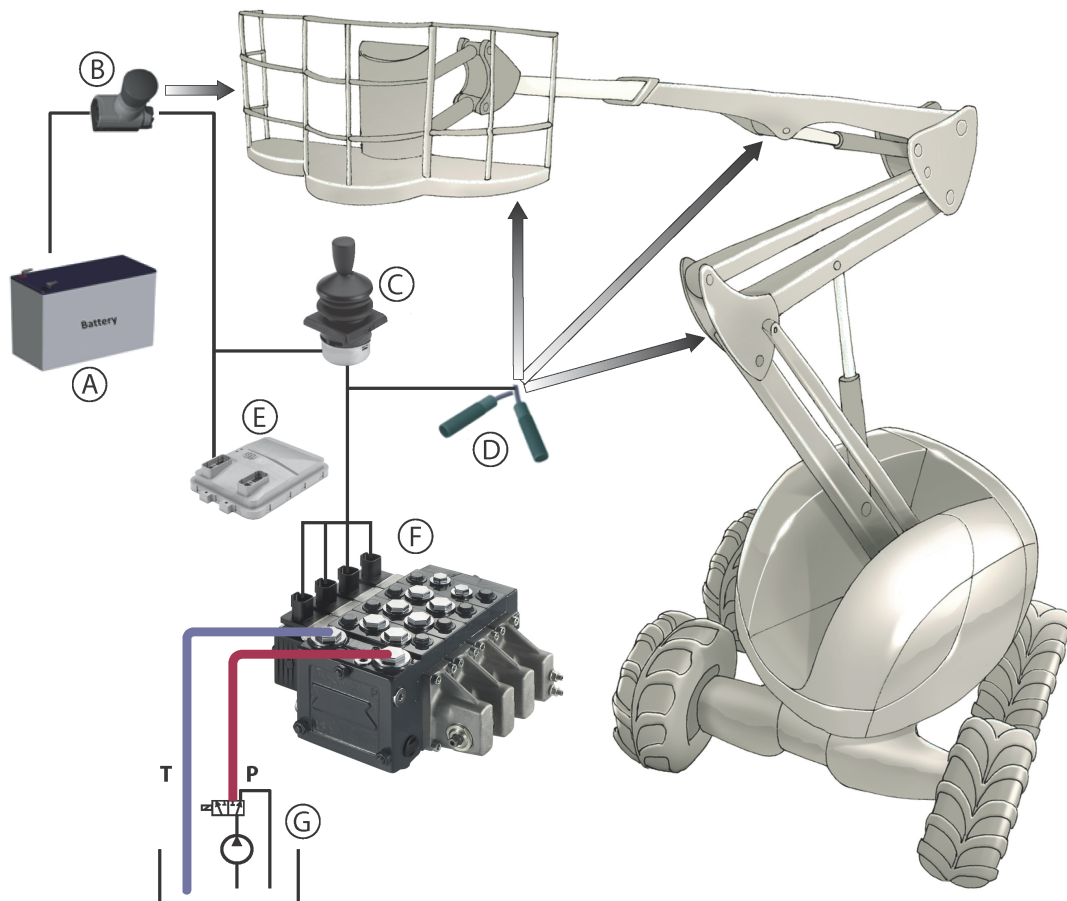
Electrical block diagram for the illustration below



P301 877.A

Safety in systems

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.



- A:** Main power supply
- B:** Emergency stop/man-present switch
- C:** HMI/Joystick control
- D:** Movement detection sensors
- E:** Main controller
- F:** PVG 16 valve group
- G:** Hydraulic supply with deactivation

⚠ Warning

The equipment manufacturer is responsible for declaring that the control system used in the machine conforms with the relevant machinery directives.

PVB – basic modules (work sections)

PVB work ports, interchangeable spools

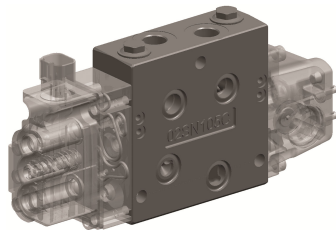
The PVB (work section) is dedicated to distribute the oil flow coming from the inlet section through the P-gallery across the flow regulating main spool (PVBS) to work port A or B. Furthermore, the PVB returns the flow coming from the implement (motor or cylinder) through the work port A or B across the main spool to the T-gallery.

The PVB is available with two different work port threads:

- 3/8" BSP
- 3/4"–16 UNF (SAE-8)

Due to the modular concept of the PVG valves, the PVG 16 main spool (PVBS) can be interchanged by any other version of the PVG 16 main spool.

PVB work ports (A and B)



Versions available:

1. Compensated PVB 16 modules:

- Basic module
- Basic module with facilities for shock and anti-cavitation valves (PVL/PVLA)
- Basic module with one common LS for port A and port B

2. Non-compensated PVB 16 modules:

- Basic module
- Basic module with P-channel check valve
- Basic module with facilities for shock and anti-cavitation valves (PVL/PVLA)
- Basic module with both P-channel check valve and facilities for shock and anti-cavitation valves (PVL/PVLA)

3. P-channel check valve

4. Shock valves (PVL/P)

Warning

Activation of many functions simultaneously can cause a reduced operating speed in sections with high load.

Activation of a section with high pressure requirement in the same time as a section with low load can increase operating speed in the second section.

P-channel check valve

To prevent return oil flow, thereby lowering the load P-channel check valve can be incorporated.

For applications with over-center valves versions without the P-channel check valve are also available.

Shock valves (PVL/P)

Shock valves (PVL/P) with fixed pressure setting are used for protection of the individual work function against overload by removing any transient pressure spikes generated by the load.

PVB – basic modules (work sections)

PVB Basic Work Modules – hydraulic schematics and code numbers

PVB Compensated Basic work module

Hydraulic schematics and code numbers

Symbol	PVB description / Port	Code number
<p>P301 831.A</p>	Compensated PVB	3/8" BSP 11130976
		3/4" -16 UNF (SAE-8) 11130977
<p>P301 832.A</p>	Compensated PVB with facilities for shock and anti-cavitation valves (PVL/PVLA)	3/8" BSP 11130978
		3/4" -16 UNF (SAE-8) 11130979
<p>P301 833.A</p>	Compensated PVB with one common adjustable LS valve for port A and port B	3/8" BSP 11130982
		3/4" -16 UNF (SAE-8) 11130983

PVB Non-compensated Basic work module

Hydraulic schematics and code numbers

Symbol	PVB description / Port	Code number
<p>V310 412.A</p>	Basic work module without P-channel check valve without Shock valves (PVL/P)	3/8" BSP 11101421
		3/4" -16 UNF (SAE-8) 11101423
	Basic work module without P-channel check valve with Shock valves (PVL/P)	3/8" BSP 11106754
		3/4" -16 UNF (SAE-8) 11106755

PVB – basic modules (work sections)

Hydraulic schematics and code numbers (continued)

Symbol	PVB description / Port		Code number
	Basic work module with P-channel check valve without Shock valves (PVLV)	3/8" BSP	11106801
		3/4" -16 UNF (SAE-8)	11106797
	Basic work module with P-channel check valve with Shock valves (PVLV)	3/8" BSP	11101424
		3/4" -16 UNF (SAE-8)	11101425

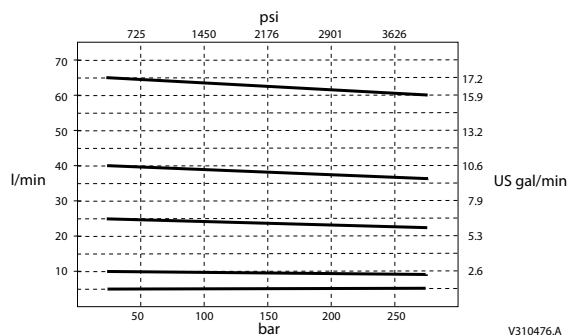
PVB – basic modules (work sections)

PVB oil flow characteristics

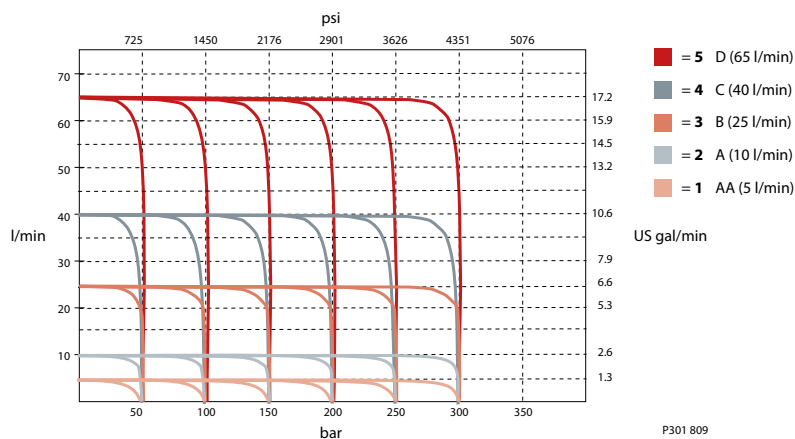
The oil flow from the work ports depends on the type of pump and in turn pump module. The difference is fixed displacement (Open Center) or variable displacement (Closed Center).

The letters AA, A, B, C and D denotes the spool flow sizes ranging from 5 l/min to 65 l/min [from 1.32 to 17.17 US gal/min]. All tests are done by using Tellus32 @ 21 mm²/s.

Load-independent oil flow characteristic, pressure-compensated PVB

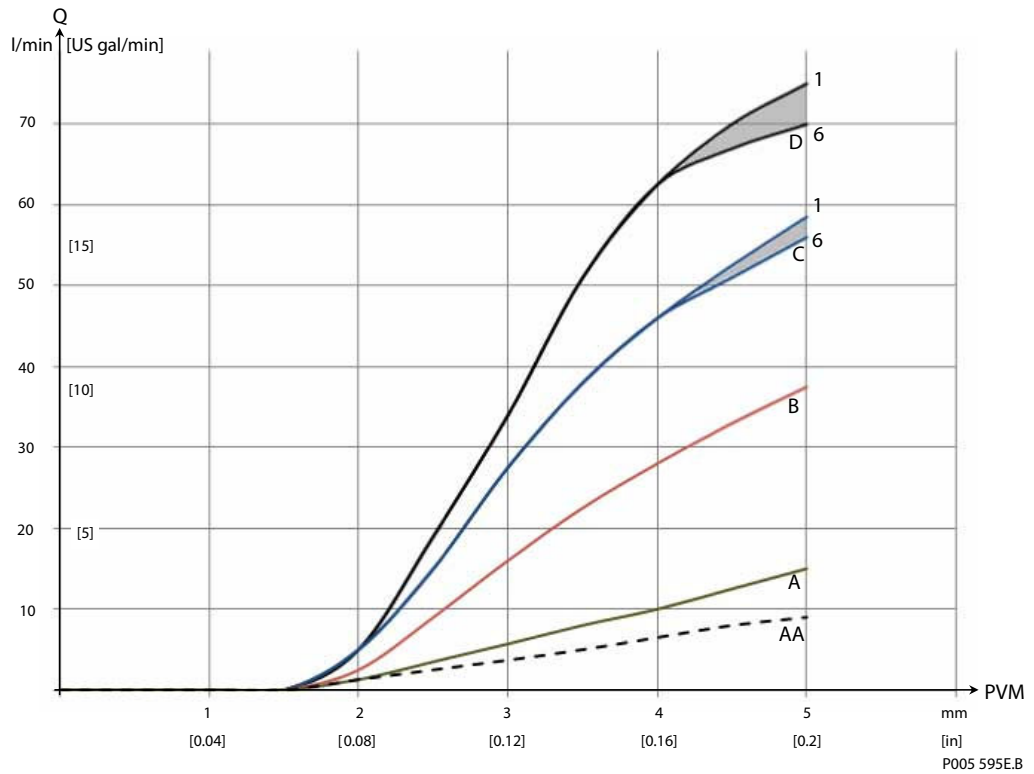


LS pressure limiting



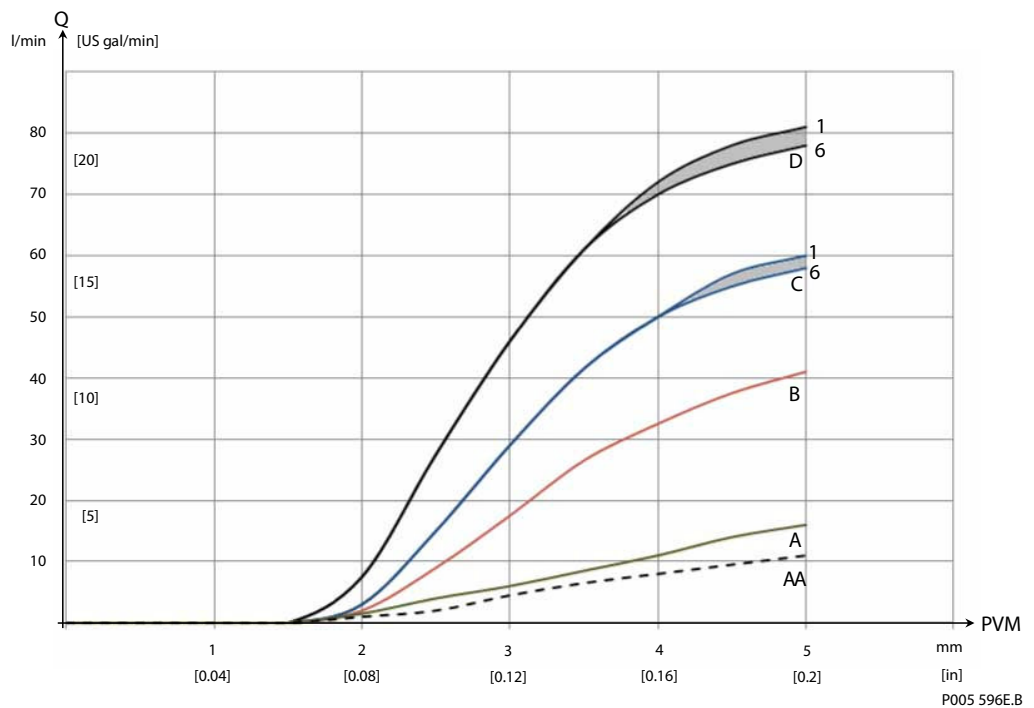
PVB – basic modules (work sections)

Oil flow as a function of spool travel with Open Center PVP



The flow is dependent on the supplied flow, Q_p .
 The characteristics apply to supply oil of 130 l/min [34.3 US gal/min].
 The numbers 1 and 6 refer to the position of the PVB in the valve stack.

Oil flow as a function of spool travel with Closed Center PVP



PVB – basic modules (work sections)

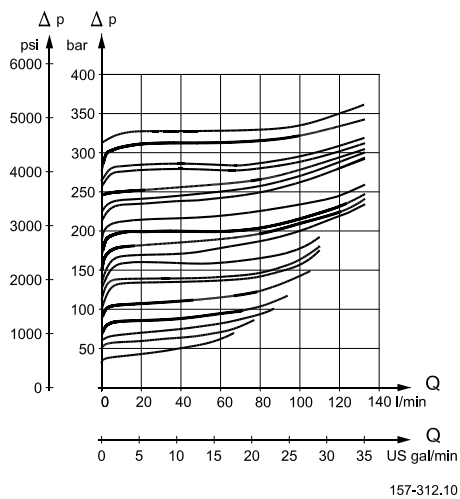
The flow is dependent on the pressure difference between the pump pressure and the LS signal.
 Normally the pressure difference is set at the LS pump regulator.

Set pressure difference between pump pressure and LS signal = 20 bar [290 psi].

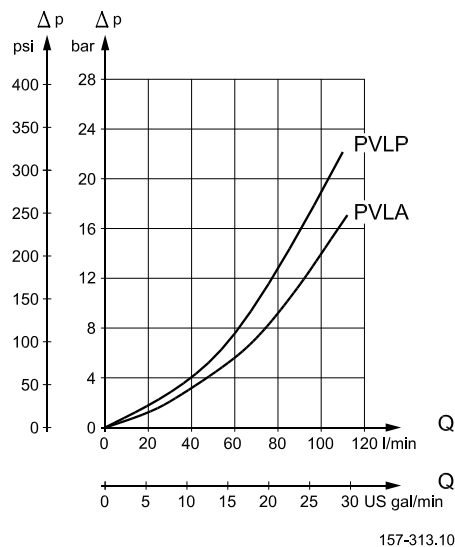
PVLP is set at an oil flow of 10 l/min [2.6 US gal/min]. The shock valve PVLP is designed to absorb shock effects. Consequently, it should not be used as a pressure relief valve.

Oil flow characteristics – PVLP/PVLA, PVP

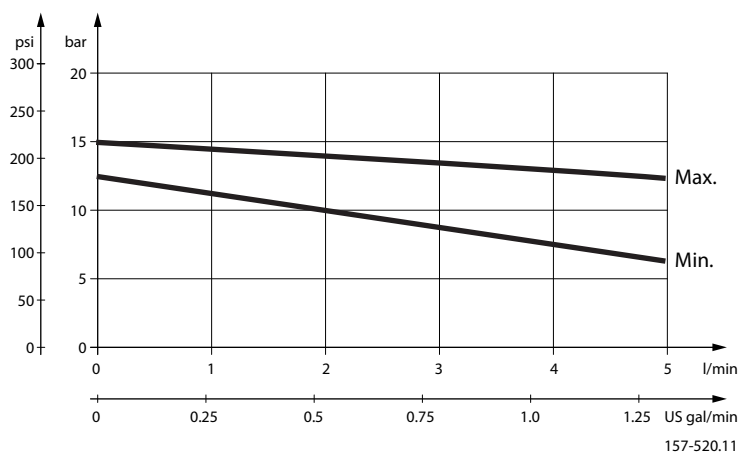
PVLP shock valve



PVLP/PVLA suction valve

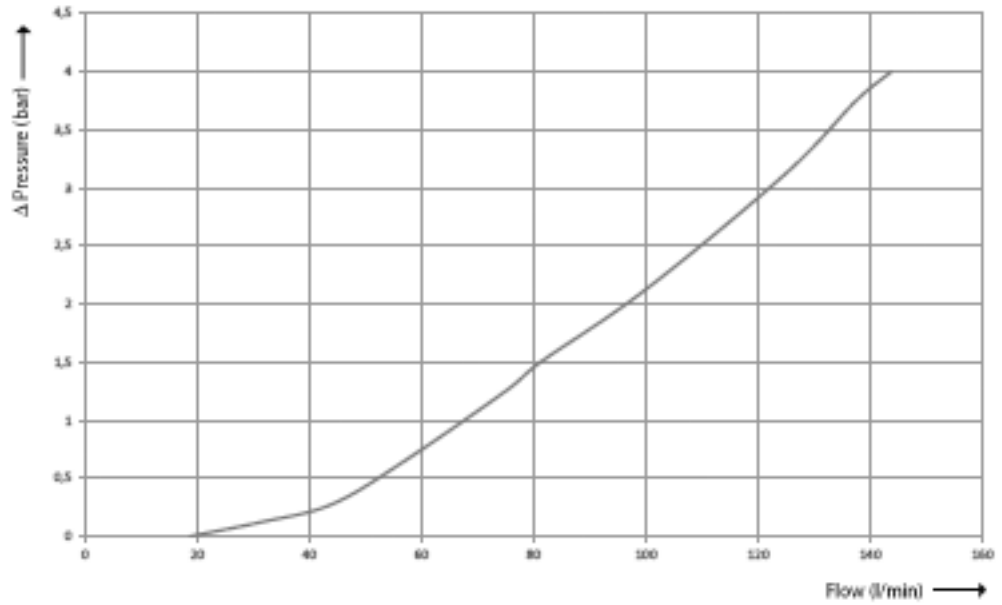


PVP modules, Pilot pressure curves

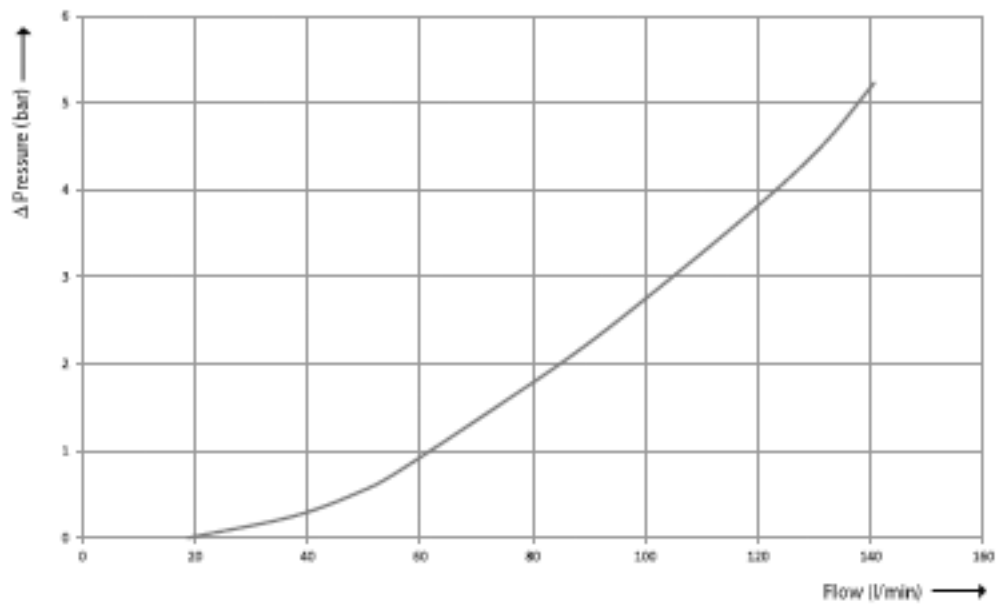


PVB – basic modules (work sections)

Pressure drop through P-line

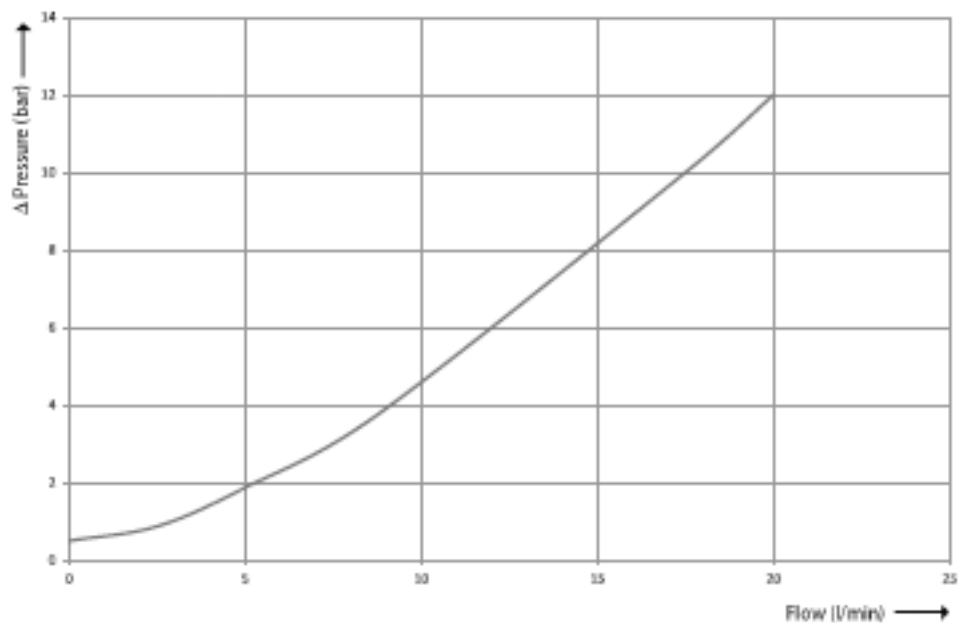


Pressure drop through T-line



PVB – basic modules (work sections)

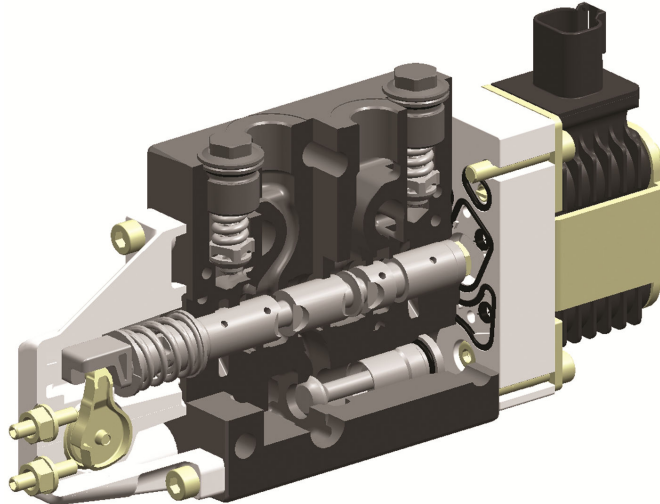
Pressure drop through Pp-line



PVBS – main spool

PVBS sectional view

PVBS (spool shown)



Flow control, spool characteristic

The spool is directly controlling the oil flow to and from the work ports. This flow is directly proportional with the spool travel. The spool travel is made up of 1.5 mm [0.06 in] dead band and 3.5 mm [0.14 in] active region in each direction giving 0-full flow.

An additional 2.5 mm [0.1 in] travel in one direction in order to accommodate float functionality can be used dependant on choice of PVM.

Flow control

The spools are designed in such a way that the oil flow coming from the pump to the work ports are controlled by the spool travel. When the spool is moved it forms a variable orifice between the P-gallery and one work port and between the other work port and the T-gallery. The size of the orifice is directly linked to the traveled distance of the spool.

Spools characteristic

The spools characteristic is linear with a soft start. The spool will have a progressive behavior from neutral to 10% of the full flow. From there it will be linear all the way to maximum flow.

Versions available:

1. Different flow versions
2. Open/closed in neutral
3. Float
4. Asymmetric spools

PVBS spool – Different flow versions

All the spools are flow controlled 4/4 spools. The spool comes in 5 different flow versions, all with a symmetrical flow:

- 5 l/min [1.32 US gal/min],
- 10 l/min [2.64 US gal/min],
- 25 l/min [6.60 US gal/min],

PVBS – main spool

- 40 l/min [10.57 US gal/min],
- 65 l/min [17.17 US gal/min]

The flow specified is at 10 bar [145 psi] with 21 mm²/ sec [97 SUS].

PVBS spool – Open/closed in neutral versions

The main spools for the PVG 16 are available with two different functions in neutral – open or closed.

Open in neutral	means that there is a throttled open connection across the main spool from both work ports A and B to the T-gallery. Open in neutral is generally used together with hydraulic motors.
Closed in neutral	means that there is no connection from work port A or B to the T-gallery across the main spool. Closed in neutral spools are generally used together with cylinders.

Warning

Using *Closed in neutral* spools together with a hydraulic motor can cause a sudden and abrupt stop of the rotation.

PVBS spool – Float versions

A spool with float function as well as normal actuation is capable of opening a connection between both work ports A and B to the T-gallery. This makes it possible for the oil in the e.g. cylinder to flow freely to the tank and the oil in the tank to flow freely from the tank to the work ports.

This connection is opened when actuating 7.5 mm to the B direction (normal proportional control ends at 5 mm).

Float is used if an application is to move freely back and forth to e.g. follow rough terrain.

PVBS spool – Asymmetrical versions

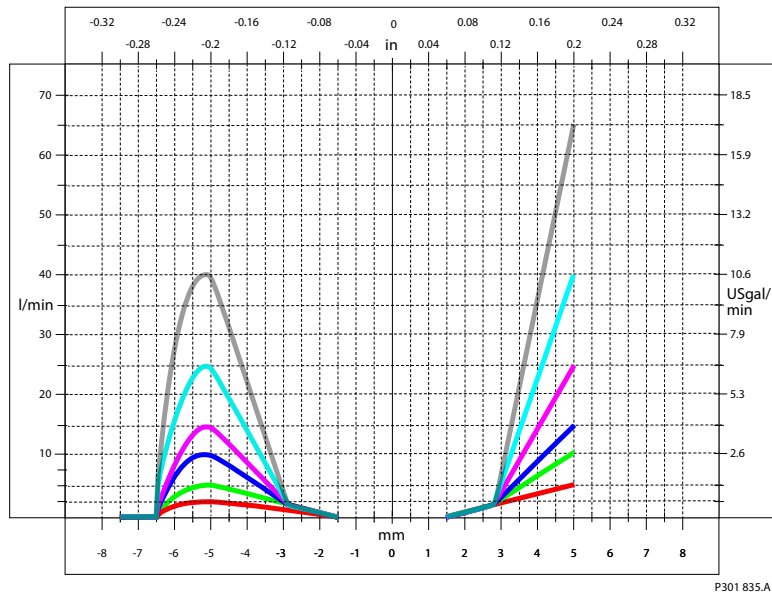
Asymmetrical main spools are designed for use with cylinders whose rod and piston sides differ greatly in volume. When operating with a symmetrical main spool, the difference in volume causes the cylinder's speed to be different in lifting versus lowering situations, given the same set point.

If you want the same speed both in lifting and in lowering situations, you need an asymmetrical main spool.

Asymmetrical spools have a linear flow characteristic with a progressive soft start. The soft start guarantees a good resolution in the low flow area where fine metering is needed.

PVBS – main spool

Asymmetrical spools linear flow characteristics with a progressive soft start

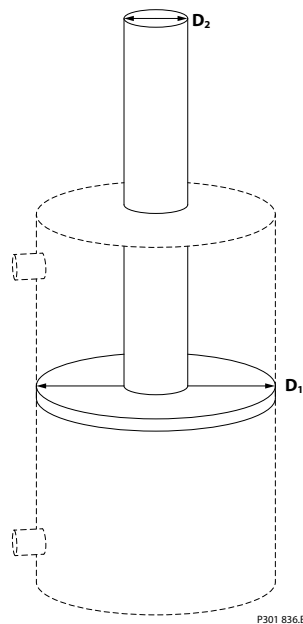


How to select correct PVBS main spool

How to select PVBS main spool - Calculate your cylinder's piston-rod ratio using the formula.

1. Calculate your cylinder's piston-rod ratio using the formula below.

$$\frac{D_1^2}{D_1^2 - D_2^2}$$



Example conditions (use with PVE):

- Flow request = 25 l/min
- Piston diameter $D_1 = 150$ mm
- Rod diameter $D_2 = 100$ mm

PVBS – main spool

$$\frac{D_1^2}{D_1^2 - D_2^2} = \frac{(150 \text{ mm})^2}{(150 \text{ mm})^2 - (100 \text{ mm})^2} = 1.8$$

2. Find the right asymmetrical main spool according to the result in the table.

A piston-rod ratio of 1.8 for spools with a 25 l/min flow cannot be found in the table with code numbers, see [PVBS hydraulic schematics, code numbers](#) on page 23. Therefore, we round to the nearest ratio (1.6).

The spool with a 25 l/min flow and a cylinder ratio of 1.6 has the code number **11109645**.

PVBS Actuation

The main spool in the PVG 16 can be actuated by one of three means:

1. by a lever for a manual actuation
2. by a PVE for an electrical actuation
3. by a PVH for a hydraulic actuation

By actuating the main spool with a PVM or PVE the return spring of the spool will act with a force equivalent to 77 N [12.5 bar].

By actuating the main spool with a PVH the return spring will act with a force equivalent to 268 N [23 bar].

PVBS hydraulic schematics, code numbers

Symmetrical PVBS main spools, (with float in B-direction)

Symbol	Description	Code number according to flow, l/min [US gal/min]				
		5 [1.32]	10 [2.64]	25 [6.60]	40 [10.57]	65 [17.17]
	Throttled open neutral position PVM/PVE actuation	11105537	11105538	11105539	11105540	11105541
	Throttled open neutral position PVH actuation	11109637	11109638	11109639	11109640	11109641
	Closed neutral position PVM/PVE actuation	11105532	11105533	11105534	11105535	11105536
	Closed neutral position PVH actuation	11109632	11109633	11109634	11109635	11109636

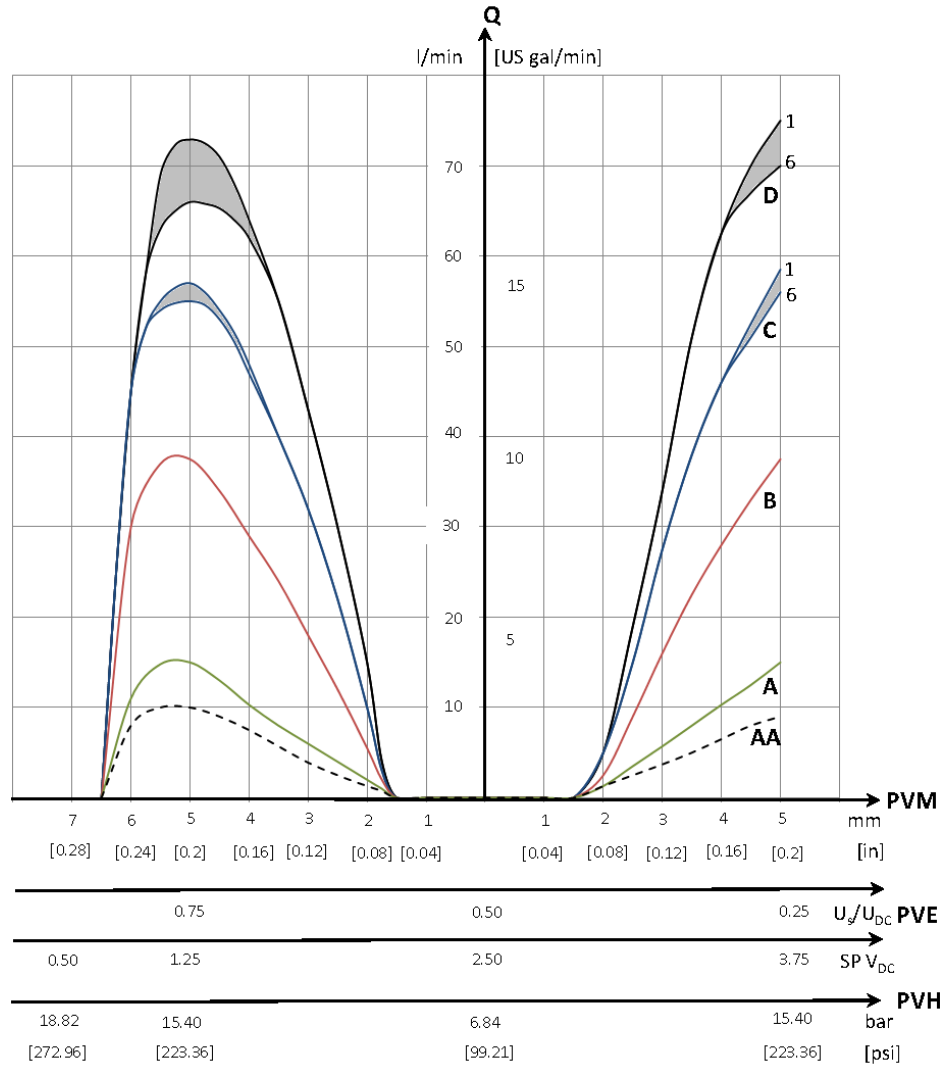
Asymmetrical PVBS main spools, (with float in B-direction)

Symbol	Description	Code number according to flow, l/min [US gal/min]					
		5/2.5 [1.32/0.66]	10/5 [2.64/1.32]	25/10 [6.60/2.64]	25/15 [6.60/3.96]	40/15 [10.57/3.96]	40/25 [10.57/6.60]
		Cylinder ratio	2.0	2.0	2.5	1.6	2.7
	Closed neutral position PVM/PVE actuation	11109642	11109643	11109644	11109645	11109646	11109647
	Closed neutral position PVH actuation	11146752	11146753	11146754	11146755	11146756	11146757

PVBS – main spool

PVBS oil flow characteristics

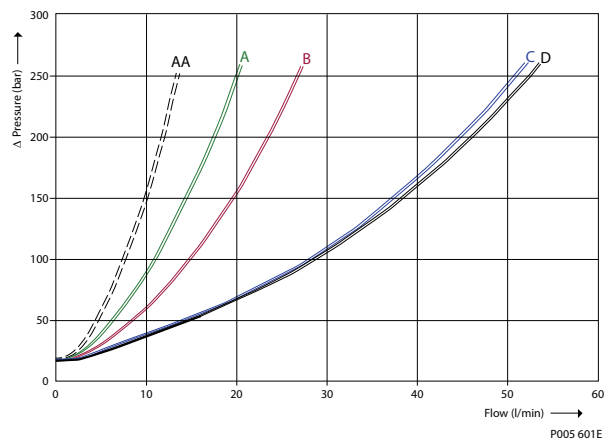
Oil flow as a function of spool travel



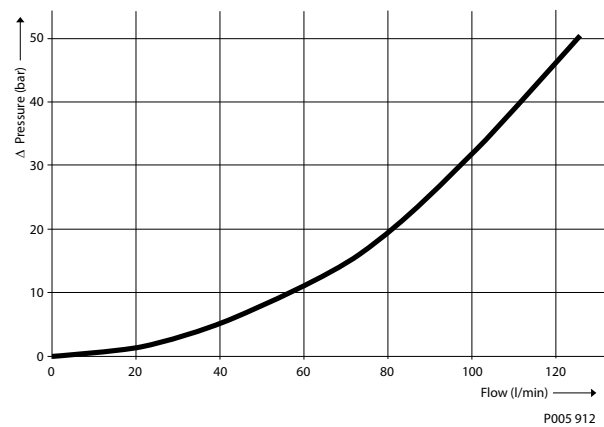
The letters AA, A, B, C and D denotes the spool flow sizes ranging from 5 l/min to 65 l/min [1.32 to 17.17 US gal/min]. All tests are done by using Tellus32 @ 21mm²/s.

PVBS – main spool

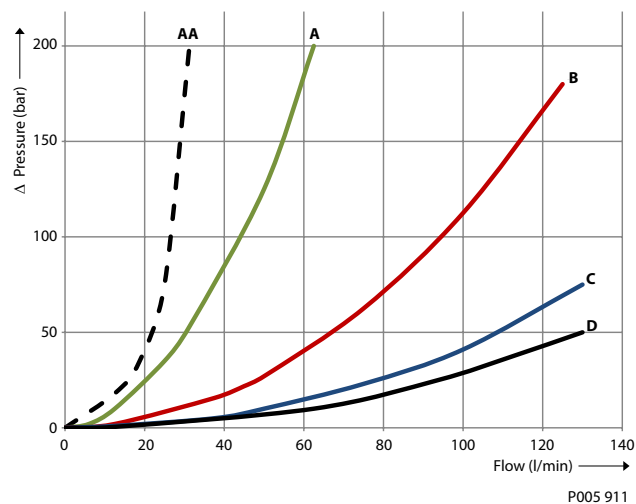
Pressure drop to tank for open spool in neutral



Pressure drop at full spool stroke



Pressure drop in float



PVM and PVH – mechanical actuation modules

PVM and PVH general information

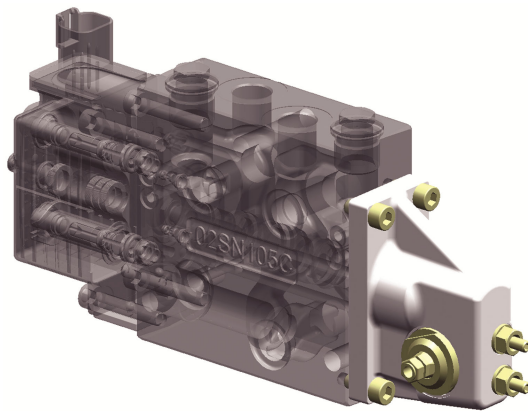
The PVM and PVH are two ways of mechanically controlling the flow from the work ports. The flow is controlled either by an operator using a lever or from a distance by a hydraulic joystick.

These are types of mechanical actuation modules for the PVG 16:

1. PVM – a fully manual lever controlled module
 - PVM with float control
 - PVM without adjustment screws
 - PVM with adjustment screws

2. PVH – a hydraulic controlled module

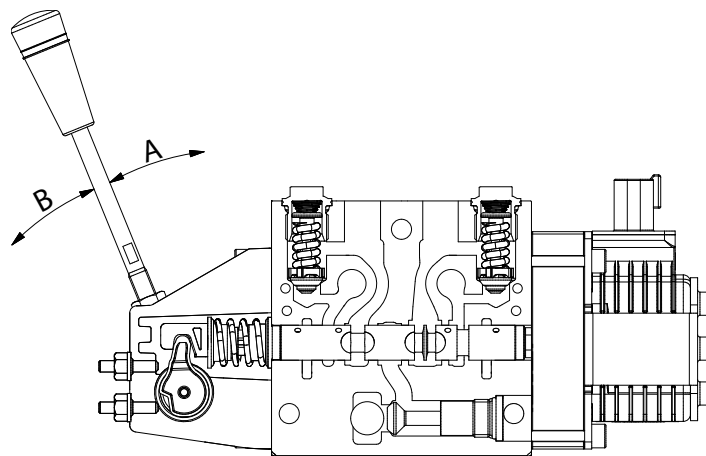
PVM sectional view (PVMD - cover)



PVM actuation module

The PVM consists of an aluminum base mounted on the end of the valve slice and a lever. When actuating the lever the operator is directly pulling or pushing on the main spool inside the valve hence controlling the flow. The lever has a travel of 16° in either direction from neutral. Actuating the lever will fully move the spool all 5 mm and give full flow. The lever can be mounted / removed without having to remove the PVM base. The PVM can be combined with any PVE, PVH or PVMD (cover).

PVM actuation module



Versions available:

PVM with float control

If an application with float functionality is needed this PVM is used. It is used when float position is with manual operator actuation. There are no adjustment screws

PVM and PVH – mechanical actuation modules

available for this PVM version. The setting of this PVM is 5 mm spool travel in the A direction and 7.5 mm spool travel in the B direction giving float.

PVM without adjustment screws

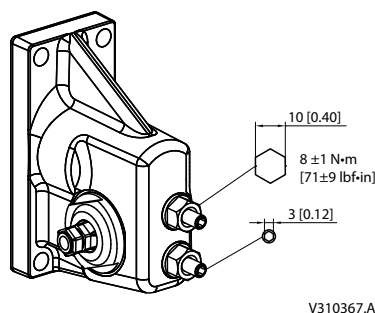
The standard PVM without adjustment screws will allow a spool travel of 5 mm in either direction. Full lever movement to one side will give full flow to the work ports. When the spool is moved 5 mm it will stop due to a mechanical limitation build into the PVM base.

PVM with adjustment screws

The standard PVM without adjustment screws will allow a spool travel of 5 mm in either direction. The spool travel in either direction can be limited by the adjustment screws. This will limit the flow out of the work ports thereby reducing the speed of an application.

The spool travel is adjusted by first loosening the nut then adjusting the pinol screw. After adjustment the nut must be tightened again.

PVM tightening data



PVH actuation module

The PVH is an aluminum plate with two threaded connections. When applying pressure through one of the ports, one side of the spool is pushed to one direction hence flow is coming from the work ports.

The PVH is available in two types of connector thread types:

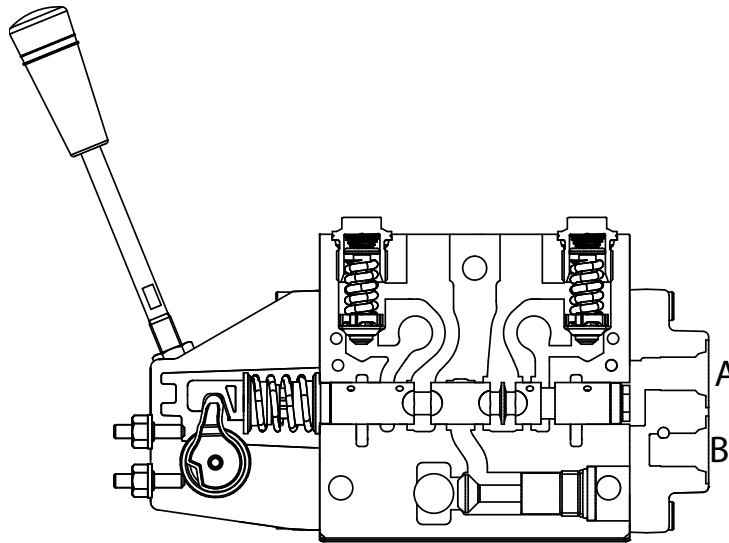
- 1/4 BSP
- 1/2" –20 UNF

When using the PVH a spool designed for hydraulic actuation must be chosen. These spools have a stiffer spring designed for the higher actuation pressure used in systems with hydraulic controls.

The PVH is to be combined with a PVM.

PVM and PVH – mechanical actuation modules

PVH actuation module



V310363.B

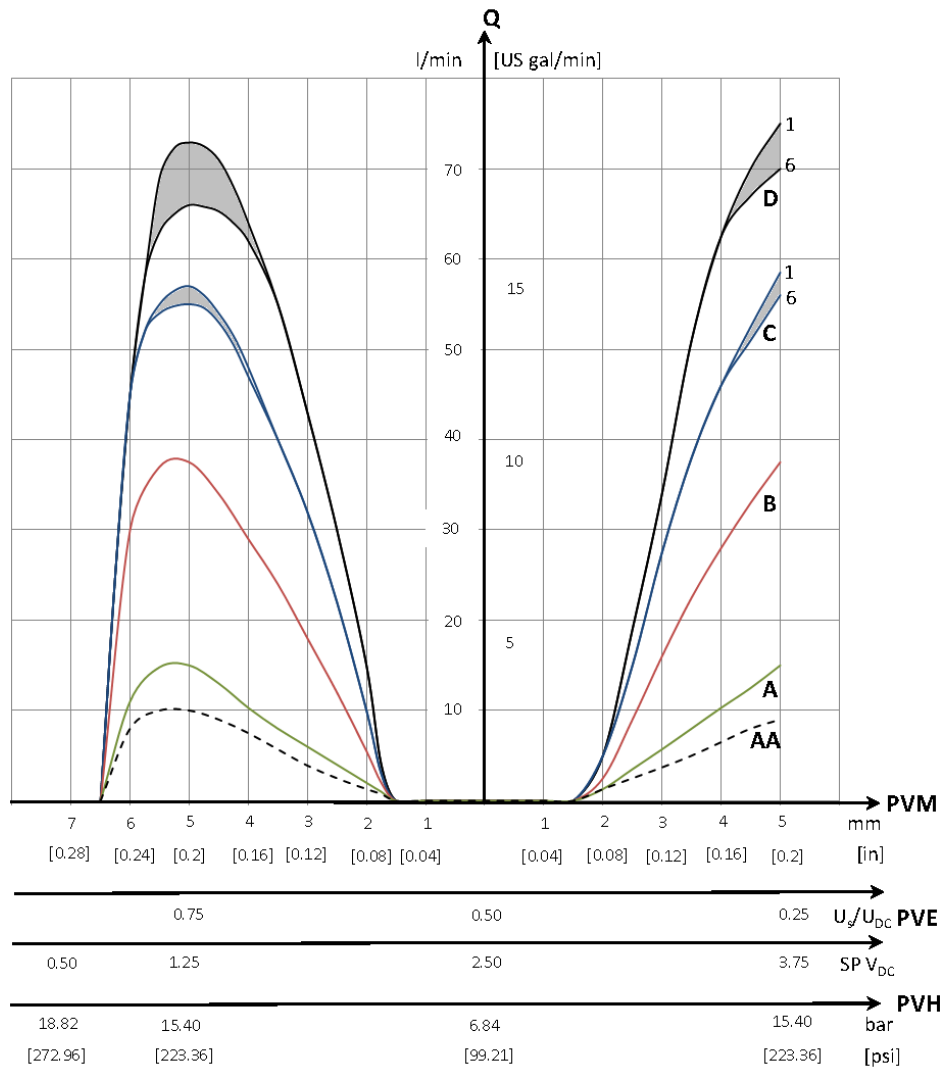
PVM/PVH hydraulic symbols and code numbers

Symbol	Description	Comments	Code number
<p>157-10.10</p>	PVM Manual actuation Without adjustment screws Without float	Without lever	11107505
		With lever	11107333
	PVM Manual actuation Without adjustment screws With float	Without lever	11107506
		With lever	11107335
	PVM Manual actuation With adjustment screws Without float	Without lever	11107507
		With lever	11107332
<p>157-199.11</p>	PVH Hydraulic cover	¼" BSP	11108380
		UNF ½" -20	11108381
-	PVMD Cover for PVM		11105518

PVM and PVH – mechanical actuation modules

PVM/PVH oil flow characteristics

Oil flow as a function of spool travel

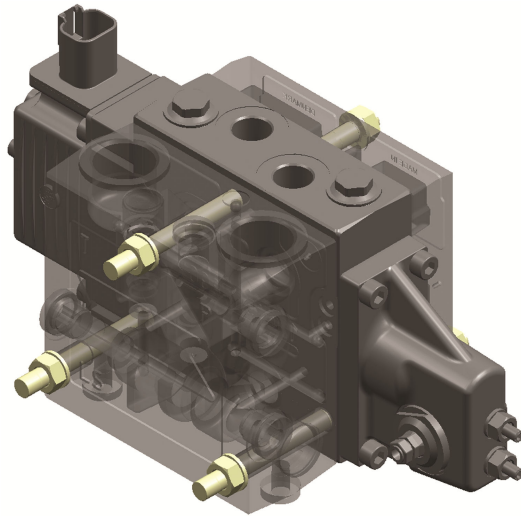


The letters AA, A, B, C and D denotes the spool flow sizes ranging from 5 l/min to 65 l/min [1.32 to 17.17 US gal/min]. All tests are done by using Tellus32 @ 21 mm²/s.

PVAS

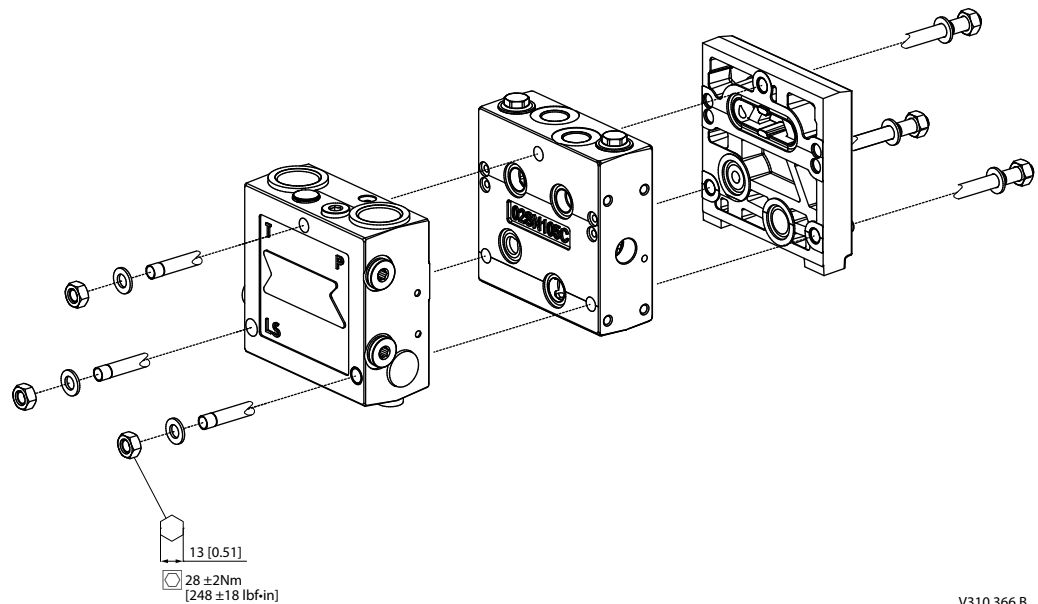
PVAS design

The PVAS consists of three tie rods, six washers and six nuts. The tie rods are inserted through the entire length of the PVG valve stack. The nuts are tightened at the pump side and the end plate.



For certain combinations with PVG 100/16, PVG 120/16 and some PVS 32 the tie rod are thread-mounted into the interface.

Technical characteristics for PVAS



PVAS

Module selection guide

Module type according to module width

Module type	Module width
PVB 32 / PVP / PVSK	48 mm [1.89 in]
PVB 16	40 mm [1.57 in]
PVS	23 mm [0.91 in]

PVAS modules according to accumulated module width interval

PVAS code numbers

Accumulated module width interval				PVAS code number
Metric (mm)		Imperial [in]		
Minimum	Maximum	Minimum	Maximum	
48	72	[1.89]	[2.83]	157B8000
73	96	[2.87]	[3.78]	157B8031
97	120	[3.82]	[4.72]	157B8001
121	144	[4.76]	[5.67]	157B8021
145	168	[5.71]	[6.61]	157B8002
169	192	[6.65]	[7.56]	157B8022
193	216	[7.60]	[8.50]	157B8003
217	240	[8.54]	[9.45]	157B8023
241	264	[9.49]	[10.39]	157B8004
265	288	[10.43]	[11.34]	157B8024
289	312	[11.38]	[12.28]	157B8005
313	336	[12.32]	[13.23]	157B8025
337	360	[13.27]	[14.17]	157B8006
361	384	[14.21]	[15.12]	157B8026
385	408	[15.16]	[16.06]	157B8007
409	432	[16.10]	[17.01]	157B8027
433	456	[17.05]	[17.95]	157B8008
457	480	[17.99]	[18.90]	157B8028
481	504	[18.94]	[19.84]	157B8009
505	528	[19.88]	[20.79]	157B8029
529	552	[20.83]	[21.73]	157B8010
553	576	[21.77]	[22.68]	157B8030
577	600	[22.72]	[23.62]	157B8061
601	624	[23.66]	[24.57]	157B8081
625	648	[24.61]	[25.51]	157B8062
649	672	[25.55]	[26.46]	157B8082

PVG 100 and PVG 120 have their own tie rod portfolio and is not included in the table above.

PVAS

PVAS (Standard) modules according to PVG 32/PVG 16 configuration

PVAS standard code numbers – 157B8xxx

No. of PVB32	No. of PVB 16 modules – 157B8xxx															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	000	001	002	022	023	024	005	006	007	027	028	029	010	061	062	082
1	001	002	003	023	024	025	006	007	008	028	029	030	061	062	-	-
2	002	003	004	024	025	026	007	008	009	029	030	081	062	-	-	-
3	003	004	005	025	026	027	008	009	010	030	081	082	-	-	-	-
4	004	005	006	026	027	028	009	010	061	081	082	-	-	-	-	-
5	005	006	007	027	028	009	010	061	062	082	-	-	-	-	-	-
6	006	007	008	028	009	010	061	062	-	-	-	-	-	-	-	-
7	007	008	009	029	030	081	062	-	-	-	-	-	-	-	-	-
8	008	009	029	030	081	082	-	-	-	-	-	-	-	-	-	-
9	009	010	061	081	082	-	-	-	-	-	-	-	-	-	-	-
10	010	061	062	082	-	-	-	-	-	-	-	-	-	-	-	-
11	061	062	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

PVAS (Mid-inlet) modules according to PVG 32/PVG 16 configuration

PVAS mid-inlet code numbers – 157B8xxx

No. of PVB32	No. of PVB 16 modules – 157B8xxx															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
0	031	021	022	003	004	005	025	026	027	008	009	010	030	081	082	
1	021	022	023	004	005	006	026	027	028	009	010	061	081	082	-	
2	022	023	024	005	006	007	027	028	029	010	061	062	082	-	-	
3	023	024	025	006	007	008	028	029	030	061	062	-	-	-	-	
4	024	025	026	007	008	009	029	030	081	062	-	-	-	-	-	
5	025	026	027	008	009	010	030	081	082	-	-	-	-	-	-	
6	026	027	028	009	010	061	081	082	-	-	-	-	-	-	-	
7	027	028	029	010	061	062	082	-	-	-	-	-	-	-	-	
8	028	029	030	061	062	-	-	-	-	-	-	-	-	-	-	
9	029	030	081	062	-	-	-	-	-	-	-	-	-	-	-	
10	030	081	082	-	-	-	-	-	-	-	-	-	-	-	-	
11	081	082	-	-	-	-	-	-	-	-	-	-	-	-	-	
12	082	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

PVAS

PVAS PVSK modules according to PVG 32/PVG 16 configuration

PVAS mid-inlet code numbers – 157B8xxx

No. of PVB32	No. of PVB 16 modules – 157B8xxx														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	031	021	022	003	004	005	025	026	027	008	009	010	030	081	082
1	021	022	023	004	005	006	026	027	028	009	010	061	081	082	–
2	022	023	024	005	006	007	027	028	029	010	061	062	082	–	–
3	023	024	025	006	007	008	028	029	030	061	062	–	–	–	–
4	024	025	026	007	008	009	029	030	081	062	–	–	–	–	–
5	025	026	027	008	009	010	030	081	082	–	–	–	–	–	–
6	026	027	028	009	010	061	081	082	–	–	–	–	–	–	–
7	027	028	029	010	061	062	082	–	–	–	–	–	–	–	–
8	028	029	030	061	062	–	–	–	–	–	–	–	–	–	–
9	029	030	081	062	–	–	–	–	–	–	–	–	–	–	–
10	030	081	082	–	–	–	–	–	–	–	–	–	–	–	–
11	081	082	–	–	–	–	–	–	–	–	–	–	–	–	–
12	082	–	–	–	–	–	–	–	–	–	–	–	–	–	–

PVAS modules according to PVG 100/16 or PVG 120/16 configuration

PVAS part numbers – 157B8xxx

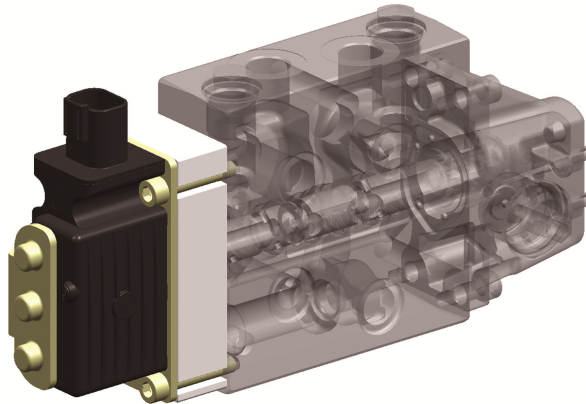
No. of PVB32	No. of PVB 16 modules – 157B8xxx															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	–	000	001	021	022	023	004	005	006	026	027	028	009	010	061	081
1	000	001	002	022	023	024	005	006	007	027	028	029	010	061	062	082
2	001	002	003	023	024	025	006	007	008	028	029	030	061	062	–	–
3	002	003	004	024	025	026	007	008	009	029	030	081	062	–	–	–
4	003	004	005	025	026	027	008	009	010	030	081	082	–	–	–	–
5	004	005	006	026	027	028	009	010	061	081	082	–	–	–	–	–
6	005	006	007	027	028	029	010	061	062	082	–	–	–	–	–	–
7	006	007	008	028	029	030	061	062	–	–	–	–	–	–	–	–
8	007	008	009	029	030	081	082	–	–	–	–	–	–	–	–	–
9	008	009	010	030	081	082	–	–	–	–	–	–	–	–	–	–
10	009	010	061	081	082	–	–	–	–	–	–	–	–	–	–	–
11	010	061	062	082	–	–	–	–	–	–	–	–	–	–	–	–
12	061	062	–	–	–	–	–	–	–	–	–	–	–	–	–	–

PVE – electrical actuation modules

PVE features

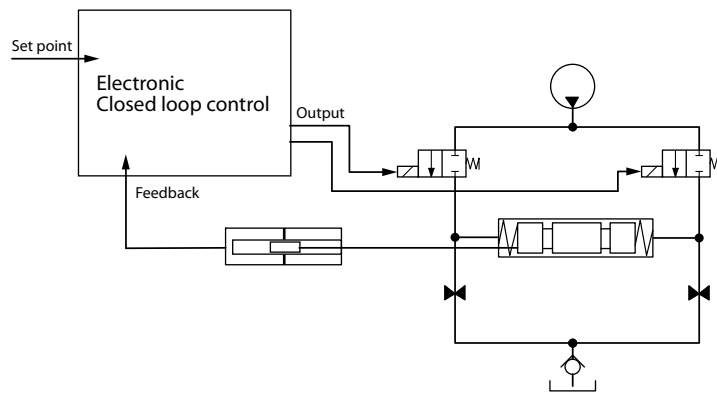
- Electrical actuation
- Spool position output
- Fault monitoring
- Power save

PVE actuation module



The PVE is a means of controlling the flow of the work ports at a distance from the physical valve. The flow is controlled by sending a control signal to the PVE. Result is the spool position being proportional to the electric signal.

PVEO/A/-F hydraulic subsystem



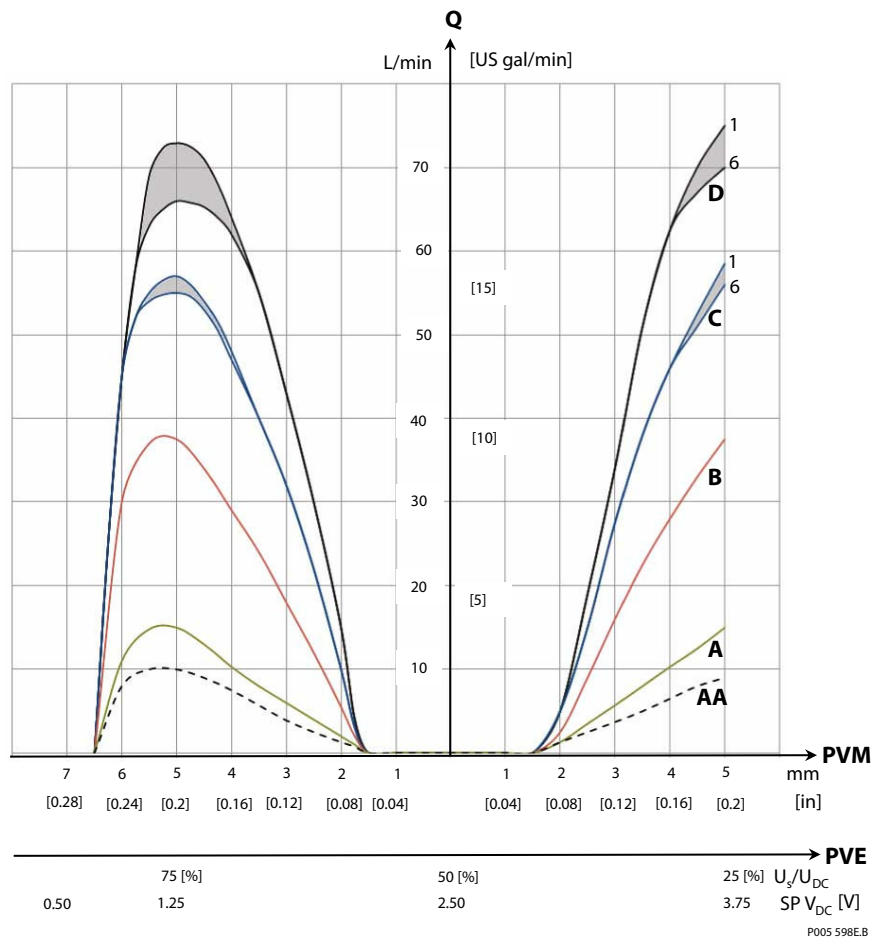
P301 876.A

Electrical actuation

The PVEA is powered by the DC voltage source available on the application with any voltage between 11 and 32 V_{DC} inclusive. The control signal for the PVEA is a ratio-metric signal with reference to the supply voltage.

PVE – electrical actuation modules

Oil flow as a function of spool travel



Giving the PVEA a control signal of 50% of supply voltage will make it place the spool in its neutral position, hence no flow to the work ports. A signal (U_s , U_{DC}) between 25-50% or between 50-75% will make the spool move in either direction. At 25 and 75% the spool will be at full stroke at either side.

The PVEA and PVEA-F features an integrated feedback transducer that measures spool movement in relation to the input signal. This feedback is part of the closed loop control of the spool position making the PVEA and PVEA-F capable of compensating for changes in the flow forces on the spool, pilot pressure or the viscosity of the oil.

The PVEO is powered by a fixed voltage of either 12 or 24 V_{DC}. Applying this voltage to one of two pins will make the PVEO actuate the spool to full stroke. When removing the voltage again the spool will return to neutral position.

Spool position output

The PVEA has a build in spool monitoring circuit. This circuit is communicating to the surroundings by an analogue 0-5 V_{DC} pin. The translation between a voltage out on the pin to spool movement can be found in the technical characteristics section of this chapter.

The voltage outputted between 1.25 to 2.5 V_{DC} and 2.5 to 3.75 V_{DC} is directly proportional to the position of the spool and therefore the flow.

The PVEO has no spool position output pin.

PVE – electrical actuation modules

Fault monitoring

When the voltage on the SP-pin goes to 5 V_{DC} the PVEA has detected an error. The error detection is monitoring the sanity of the command signal, comparing the spool position with the command signal and the closed loop control.

Besides outputting 5 V_{DC} on the spool position pin the PVEA will change the color of the LED for visual recognition of the error. Normally the LED would light green, but in case of a command signal error the LED will be flashing red. If any of the other two errors occur the LED will change its color to constant red.

[The PVEO has no fault monitoring.](#)

Power save

The PVEA has a power save mode. This mode is entered when the command signal to the PVEA is below 15% of the supply voltage. Entering power save mode will turn off the power to the solenoid valves. Power save mode can be identified by the LED blinking green at 1 Hz.

[The PVEO has no power save mode.](#)

PVEO/A code numbers

PVEO/A versions and code numbers

Description		Code number
PVEO, electrical actuation, ON/OFF control	12 V _{DC} control signal	11106793
	24 V _{DC} control signal	11106794
PVEA, electrical actuation, proportional control		11103692
PVEA-F, electrical actuation, proportional control, with float in B-direction		11106795

PVE-CI code numbers

PVE-CI versions and code numbers

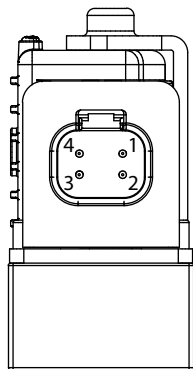
Description		Code number
PVEO-CI	J1939/ISObus	11124002
PVEA-CI		11121945
PVEO-CI	CANopen	11149443
PVEA-CI		11149437

[Refer to PVE-CI, Series 6, Technical Information L1505234 for further information.](#)

PVEA pin connector layout

The PVEA is available as the PVE for proportional control of the spool. It has a 4 pin DEUTSCH connector.

PVE – electrical actuation modules



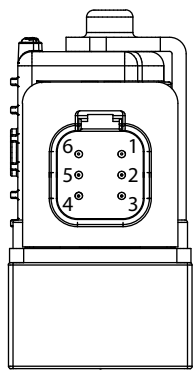
V310 358.A

Legend:

- 1. Vi (signal pin)
- 2. Sp (spool position)
- 3. Vneg (÷)
- 4. Vbat (+)

PVEA-F pin connector layout

The PVEA-F is available for float options. It has a 6 pin DEUTSCH connector where the float command has a dedicated pin. All features in the PVEA is also in the PVEA-F.



V310 359.A

Legend:

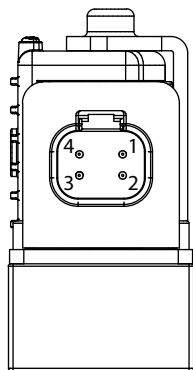
- 1. Vi (signal pin)
- 2. NC (not connected)
- 3. Vf (float)
- 4. Sp (spool position)
- 5. Vneg (÷)
- 6. Vbat (+)

Warning

When PVEA-F is given float command it will actuate the spool into float state no matter what position in spool has or set point given to PVEA-F.

PVEO pin connector layout

The PVEO is available for simple ON/OFF actuation of the main spool. It has a 4 pin DEUTSCH connector.



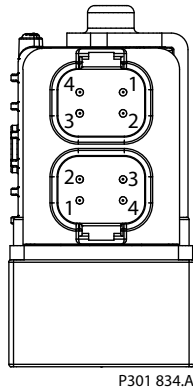
V310 358.A

Legend:

- 1. Supply Vbat when flow is wanted in A direction
- 2. Vneg (÷)
- 3. Vneg (÷)
- 4. Supply Vbat when flow is wanted in B-direction

PVE – electrical actuation modules

PVE-CI pin connector layout



- Legend:*
1. CAN_H
2. CAN_L
3. Vbat (+)
4. Vneg (-)

PVE technical characteristics

PVEO Technical characteristics

Supply voltage U_{DC}	Rated	12 V _{DC}	24 V _{DC}
	Range	11 to 15 V _{DC}	22 to 30 V _{DC}
	Ripple	Maximum 5 %	
Current consumption at rated voltage		320 mA @ 12 V _{DC}	160 mA @ 24 V _{DC}
Power consumption at rated voltage		4 W	

PVEA / PVEA-F Technical characteristics

Supply voltage U_{DC}	Rated	11 to 32 V _{DC}
	Range	11 to 32 V _{DC}
	Ripple	Maximum 5 %
Current consumption at rated voltage		320 mA @ 12 V _{DC} 170 mA @ 24 V _{DC}
Power consumption at rated voltage		0.5 W
Signal voltage	Neutral	0.5 · U _{DC}
	A-port	0.25 · U _{DC}
	B-port	0.75 · U _{DC}
Signal current at rated voltage		0.25 to 70 mA
Input impedance in relation to neutral		12 kΩ
Input capacitor		100 μF
SP pin current		2 mA
SP pin resolution		250 steps from 0-5 V _{DC}

PVE-CI Technical characteristics

Supply voltage U_{DC}	Rated	11 to 32 V _{DC}
	Range	11 to 32 V _{DC}
	Ripple	Maximum 5 %

PVE – electrical actuation modules

PVE-CI Technical characteristics (continued)

Current consumption at rated voltage	320 mA @ 12 V _{DC} 170 mA @ 24 V _{DC}
Power consumption at rated voltage	0.5 W

For more information, see *PVE-CI, Series 6, Technical Information*, <http://files.danfoss.com/documents/L1505234.pdf>.

SP pin

Voltage	Translation
0.5 V _{DC}	Float (B-direction)
1.25 V _{DC}	Full flow B-port
2.5 V _{DC}	Neutral
3.75 V _{DC}	Full flow A-port
5.0 V _{DC}	Error

Reaction time for A/B direction

Reaction time	PVEO/PVEO-CI	PVEA/PVEA-F/PVEA-CI
Neutral to full spool stroke (Power-ON)	170 ms	180 ms
Full spool stroke to neutral (Power-ON)	550 ms	125 ms
Full spool stroke to neutral (Power-OFF)	—	550 ms

Oil consumption

	PVEO	PVEA/PVEA-F
Neutral position	0.04 l/min [0.01 US gal/min]	0.04 l/min [0.01 US gal/min]
Actuating to full stroke	0.6 l/min [0.16 US gal/min]	1.0 l/min [0.26 US gal/min]
Full flow steady state	1.0 l/min [0.26 US gal/min]	1.3 l/min [0.34 US gal/min]

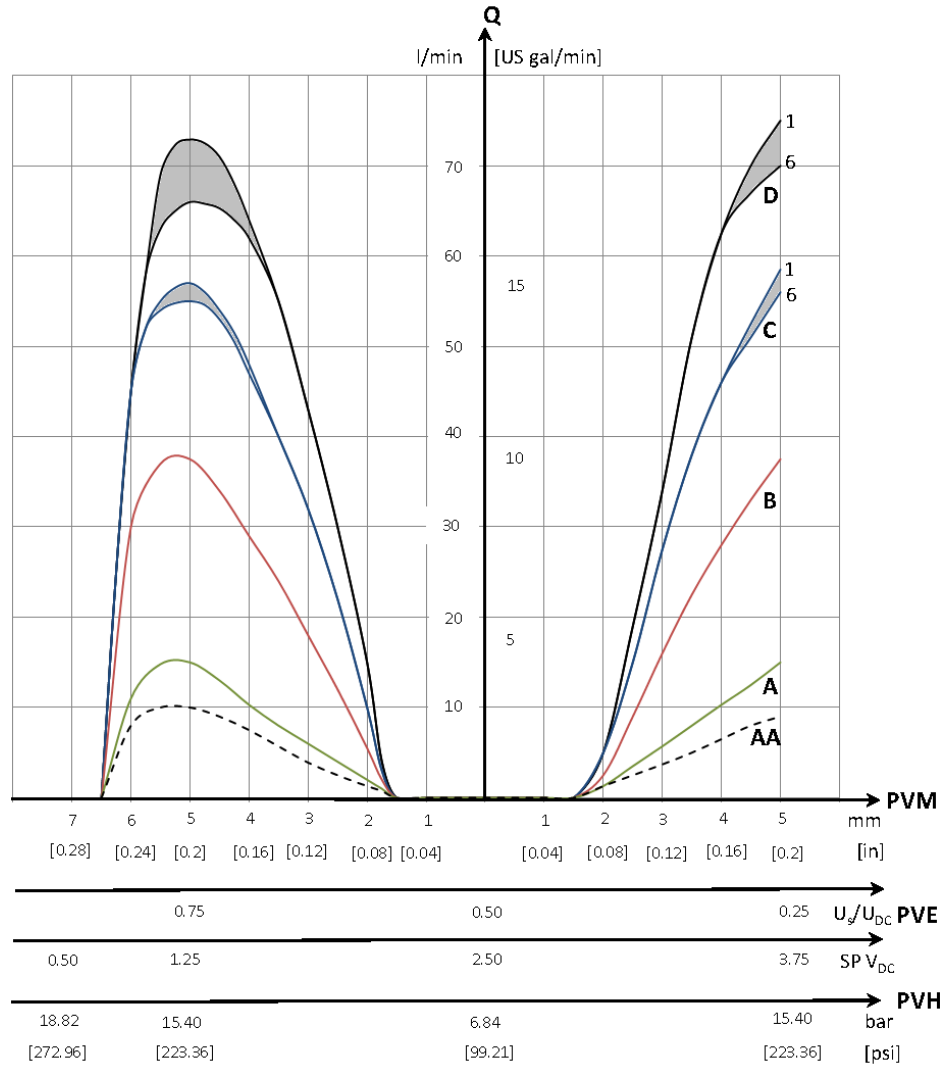
Fault monitoring overview

PVE	Fault monitoring	Delay before Error out	Error mode	LED light
PVEA	Passive	250 ms	No fault	Green
			Input signal faults	Red – Flashing
			Transducer (LVDT)	Red – Constant
			Close loop fault	
PVEO		No Fault monitoring		

PVE – electrical actuation modules

PVE oil flow characteristics

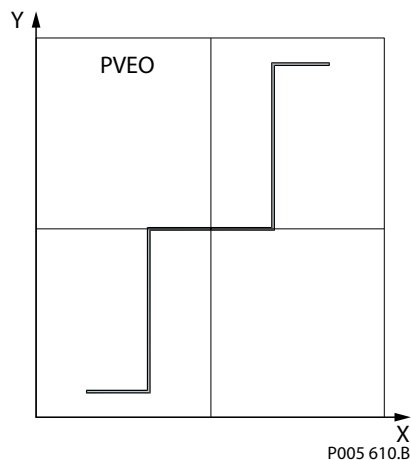
Oil flow as a function of spool travel



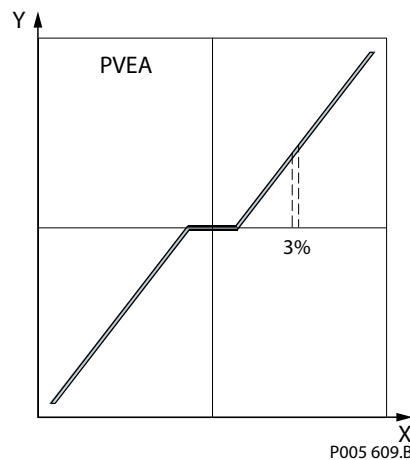
The letters AA, A, B, C and D denotes the spool flow sizes ranging from 5 l/min to 65 l/min [1.32 to 17.17 US gal/min]. All tests are done by using Tellus32 @ 21mm²/s.

PVE – electrical actuation modules

PVEO and PVEO-CI voltage-position diagram



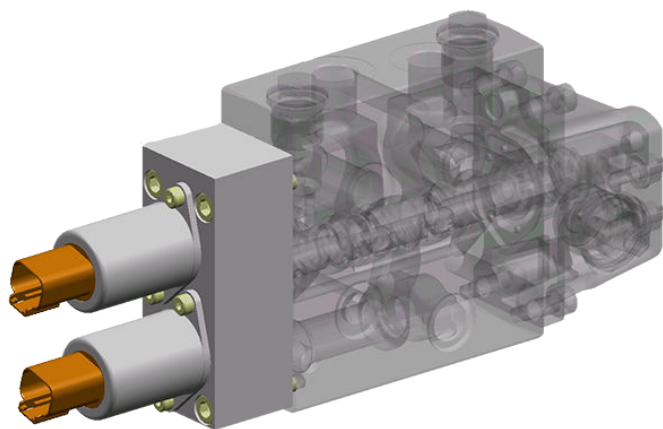
PVEA/PVEA-F and PVEA-CI voltage-position diagram



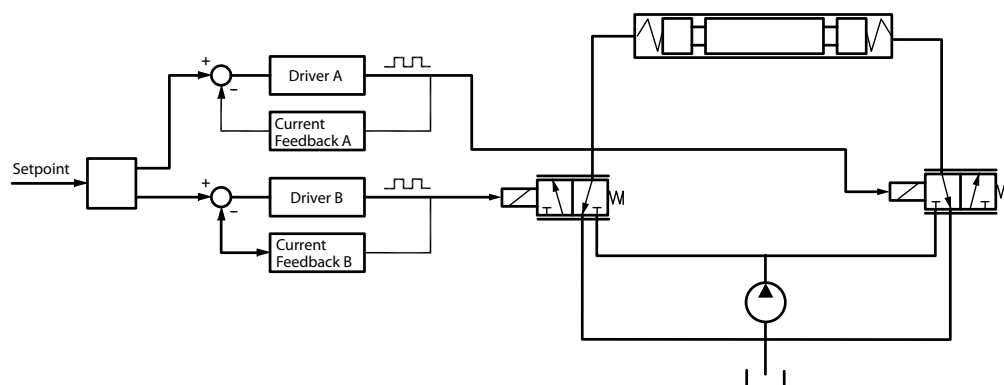
PVHC, high current actuation module – electrical

The PVHC is a means of controlling the flow of the work ports at a distance from the physical valve. The flow is controlled by sending a PWM signal to the one of two pressure reduction valves. Result is the spool position being proportional to the current.

PVHC high current actuator



PVHC hydraulic subsystem



V310 434

PVE – electrical actuation modules

The PVHC needs 25 bar pilot pressure and is therefore used together with PVBS and PVP for hydraulic (PVH) actuation.

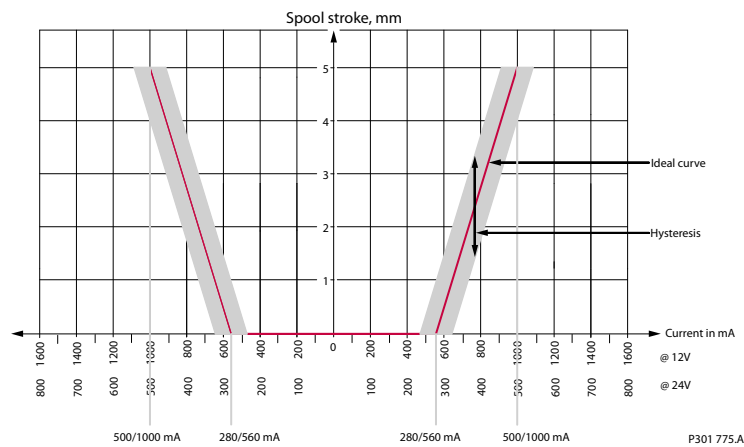
PVHC code numbers

Description	Code number	
	12 V _{DC}	24 V _{DC}
PVHC, electrical actuation, proportional control	11126941	11127535

PVHC electrical actuation

The PVHC is powered and controlled by a PWM DC voltage source available on the application with either 12 or 24 V_{DC} dependent on the type of PVHC.

PVHC characteristic

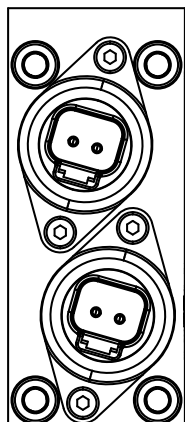


Giving the PVHC a PWM signal with a current of 0 mA will make it place the spool in its neutral position, hence no flow to the work ports. Increasing the current on one of the two pressure reduction valves will make the spool move in one direction.

The PVHC does not feature any integrated feedback transducer to measure the spool position. Therefore it does not feature any closed loop control of the spool.

PVHC connector pin layout

PVHC pin layout – DEUTSCH version



V310 435

PVE – electrical actuation modules

PVHC technical characteristics

PVHC Technical characteristics

Supply voltage U_{DC}	12 V _{DC}	24 V _{DC}
Controller output current	0 – 1200 mA	0 – 600 mA
Resistance	4.75 Ω ±5%	20.8 Ω ±5%
Pilot pressure control range	20 – 25 bar [290 – 363 psi]	
Recommended dither frequency	40 Hz	
Recommended amplitude	250 mA	

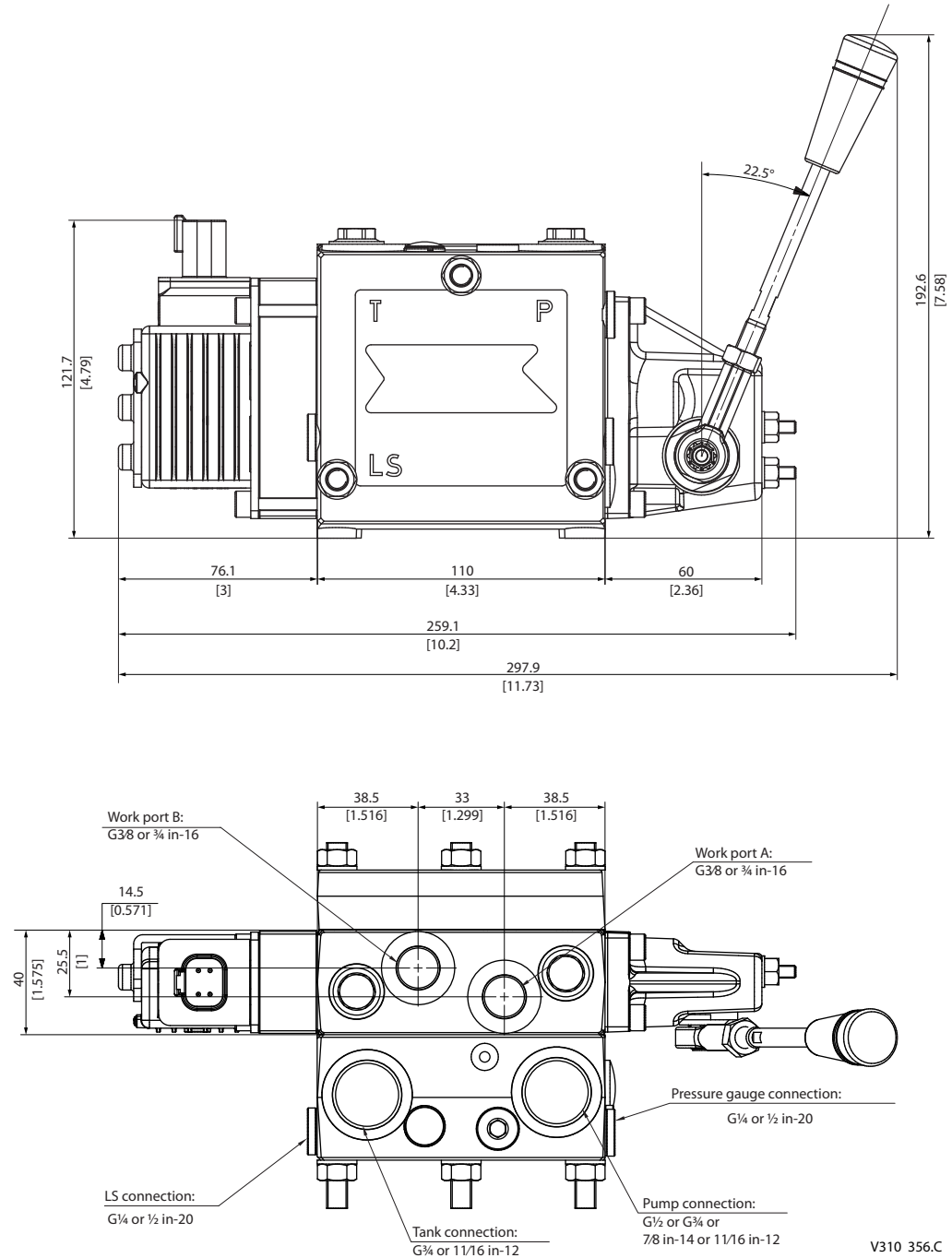
PVHC Reaction time

From neutral position to max. spool travel at Power-ON	A/B-direction	<90 ms
From max. spool travel to neutral position at Power-OFF	A/B-direction	<90 ms

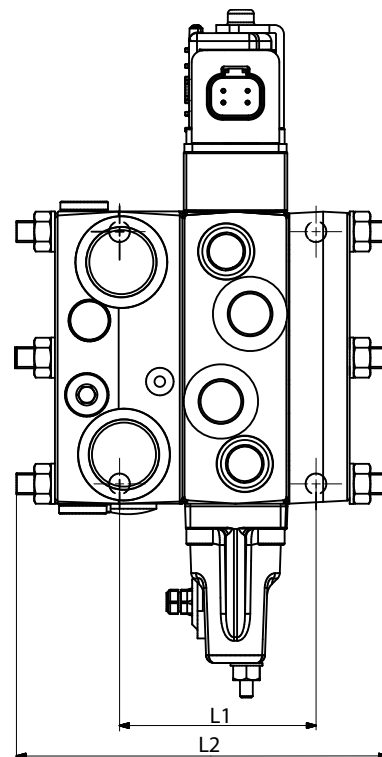
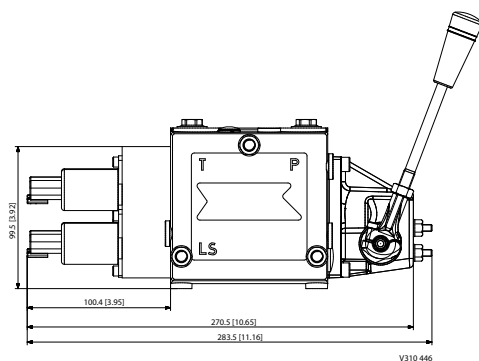
PVG 16 dimensions

PVG 16

PVG 16 dimensions



PVG 16 dimensions



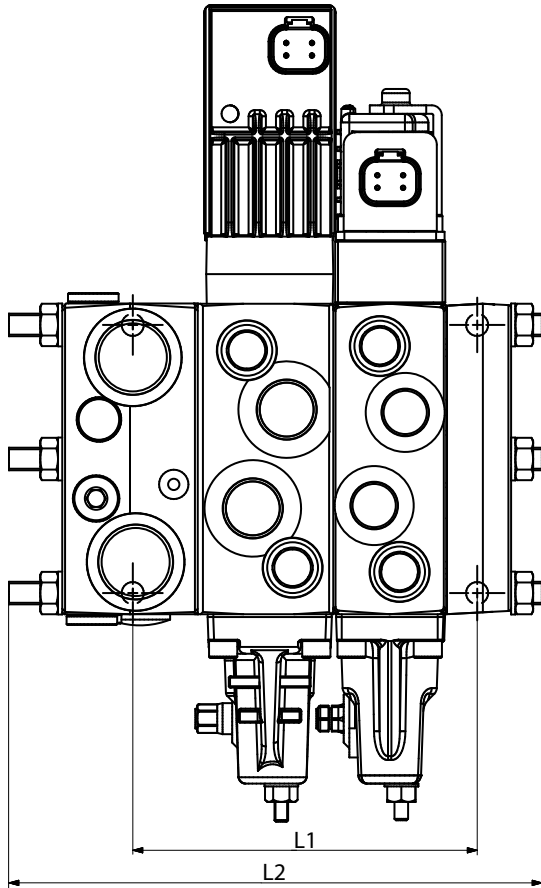
PVB 16 dimensions (12 sections)

Number of PVB 16		1	2	3	4	5	6	7	8	9	10	11	12
L1	mm	74	114	154	194	234	274	314	354	394	434	474	514
	[in]	[2.91]	[4.49]	[6.06]	[7.64]	[9.21]	[10.79]	[12.36]	[13.94]	[15.51]	[17.09]	[18.66]	[20.24]
L2	mm	140	189	213	262	311	336	385	434	458	507	551	576
	[in]	[5.51]	[7.44]	[8.39]	[10.31]	[12.24]	[13.23]	[15.16]	[17.09]	[18.03]	[19.96]	[21.69]	[22.68]

PVG 16 dimensions

PVG 32/16

PVB 32/16 combination valve stack dimensions



PVB 32/16 combination valve stack dimensions

Number of PVB 32 (down)			Number of PVB 16										
			1	2	3	4	5	6	7	8	9	10	11
1	L1	mm	122	162	202	242	282	322	362	402	442	482	522
		[in]	[4.80]	[6.38]	[7.95]	[9.53]	[11.10]	[12.68]	[14.25]	[15.83]	[17.40]	[18.98]	[20.55]
	L2	mm	189	238	262	311	360	385	434	483	507	551	600
		[in]	[7.44]	[9.37]	[10.31]	[12.24]	[14.17]	[15.16]	[17.09]	[19.02]	[19.96]	[21.69]	[23.62]
2	L1	mm	170	210	250	290	330	370	410	450	490	530	570
		[in]	[6.69]	[8.27]	[9.84]	[11.42]	[12.99]	[14.57]	[16.14]	[17.72]	[19.29]	[20.87]	[22.44]
	L2	mm	238	287	311	360	409	434	483	507	551	600	646
		[in]	[9.37]	[11.30]	[12.24]	[14.17]	[16.10]	[17.09]	[19.02]	[19.96]	[21.69]	[23.62]	[25.43]
3	L1	mm	218	258	298	338	378	418	458	498	538	578	618
		[in]	[8.58]	[10.16]	[11.73]	[13.31]	[14.88]	[16.46]	[18.03]	[19.61]	[21.18]	[22.76]	[24.33]
	L2	mm	287	336	360	409	458	483	527	576	600	646	694
		[in]	[11.30]	[13.23]	[14.17]	[16.10]	[18.03]	[19.02]	[20.75]	[22.68]	[23.62]	[25.43]	[27.32]

PVG 16 dimensions

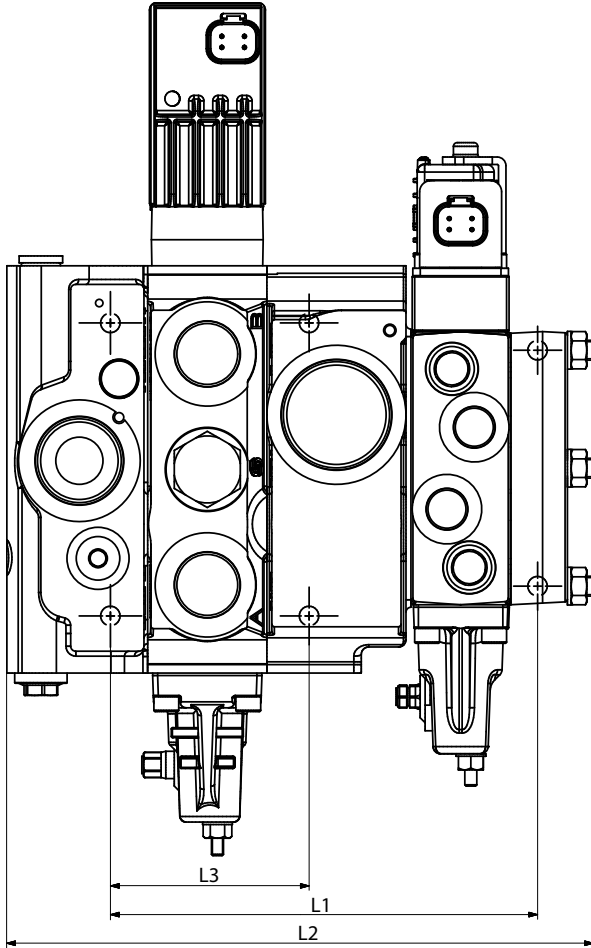
PVB 32/16 combination valve stack dimensions (continued)

Number of PVB 32 (down)			Number of PVB 16										
			1	2	3	4	5	6	7	8	9	10	11
4	L1	mm	266	306	346	386	426	466	506	546	586	626	-
		[in]	[10.47]	[12.05]	[13.62]	[15.20]	[16.77]	[18.35]	[19.92]	[21.50]	[23.07]	[24.65]	-
	L2	mm	336	385	409	458	483	527	576	622	646	694	-
		[in]	[13.23]	[15.16]	[16.10]	[18.03]	[19.02]	[20.75]	[22.68]	[24.49]	[25.43]	[27.32]	-
5	L1	mm	314	354	394	434	474	514	554	594	634	-	-
		[in]	[12.36]	[13.94]	[15.51]	[17.09]	[18.66]	[20.24]	[21.81]	[23.39]	[24.96]	-	-
	L2	mm	385	434	458	507	551	576	622	670	694	-	-
		[in]	[15.16]	[17.09]	[18.03]	[19.96]	[21.69]	[22.68]	[24.49]	[26.38]	[27.32]	-	-
6	L1	mm	362	402	442	482	522	562	602	-	-	-	-
		[in]	[14.25]	[15.83]	[17.40]	[18.98]	[20.55]	[22.13]	[23.70]	-	-	-	-
	L2	mm	434	483	507	551	600	622	670	-	-	-	-
		[in]	[17.09]	[19.02]	[19.96]	[21.69]	[23.62]	[24.49]	[26.38]	-	-	-	-
7	L1	mm	410	450	490	530	570	610	-	-	-	-	-
		[in]	[16.14]	[17.72]	[19.29]	[20.87]	[22.44]	[24.02]	-	-	-	-	-
	L2	mm	483	527	551	600	646	670	-	-	-	-	-
		[in]	[19.02]	[20.75]	[21.69]	[23.62]	[25.43]	[26.38]	-	-	-	-	-
8	L1	mm	458	498	538	578	618	-	-	-	-	-	-
		[in]	[18.03]	[19.61]	[21.18]	[22.76]	[24.33]	-	-	-	-	-	-
	L2	mm	527	576	600	646	694	-	-	-	-	-	-
		[in]	[20.75]	[22.68]	[23.62]	[25.43]	[27.32]	-	-	-	-	-	-
9	L1	mm	506	546	586	626	-	-	-	-	-	-	-
		[in]	[19.92]	[21.50]	[23.07]	[24.65]	-	-	-	-	-	-	-
	L2	mm	576	622	646	694	-	-	-	-	-	-	-
		[in]	[22.68]	[24.49]	[25.43]	[27.32]	-	-	-	-	-	-	-
10	L1	mm	554	594	634	-	-	-	-	-	-	-	-
		[in]	[21.81]	[23.39]	[24.96]	-	-	-	-	-	-	-	-
	L2	mm	622	670	694	-	-	-	-	-	-	-	-
		[in]	[24.49]	[26.38]	[27.32]	-	-	-	-	-	-	-	-
11	L1	mm	602	-	-	-	-	-	-	-	-	-	-
		[in]	[23.70]	-	-	-	-	-	-	-	-	-	-
	L2	mm	670	-	-	-	-	-	-	-	-	-	-
		[in]	[26.38]	-	-	-	-	-	-	-	-	-	-

PVG 16 dimensions

PVG 100/16

PVB 100/16 combination valve stack dimensions



PVB 100/16 combination valve stack dimensions

Number of PVB 100 (down)		Number of PVB 16											
		1	2	3	4	5	6	7	8	9	10	11	
1	L1	mm	172	212	252	292	332	372	412	452	492	532	572
		[in]	[6.77]	[8.35]	[9.92]	[11.50]	[13.07]	[14.65]	[16.22]	[17.80]	[19.37]	[20.94]	[22.52]
	L2	mm	236	285	311	358	407	432	481	530	554	603	652
		[in]	[9.29]	[11.22]	[12.24]	[14.09]	[16.02]	[17.01]	[18.94]	[20.87]	[21.81]	[23.74]	[25.67]
	L3	80 mm [3.15 in]											
	2	L1	mm	220	260	300	340	380	420	460	500	540	580
[in]			[8.66]	[10.24]	[11.81]	[13.39]	[14.96]	[16.54]	[18.11]	[19.69]	[21.26]	[22.83]	[24.41]
L2		mm	284	333	359	406	455	480	529	578	602	651	700
		[in]	[11.18]	[13.11]	[14.13]	[15.98]	[17.91]	[18.90]	[20.83]	[22.76]	[23.70]	[25.63]	[27.56]
L3		128 mm [5.04 in]											

PVG 16 dimensions

PVB 100/16 combination valve stack dimensions (continued)

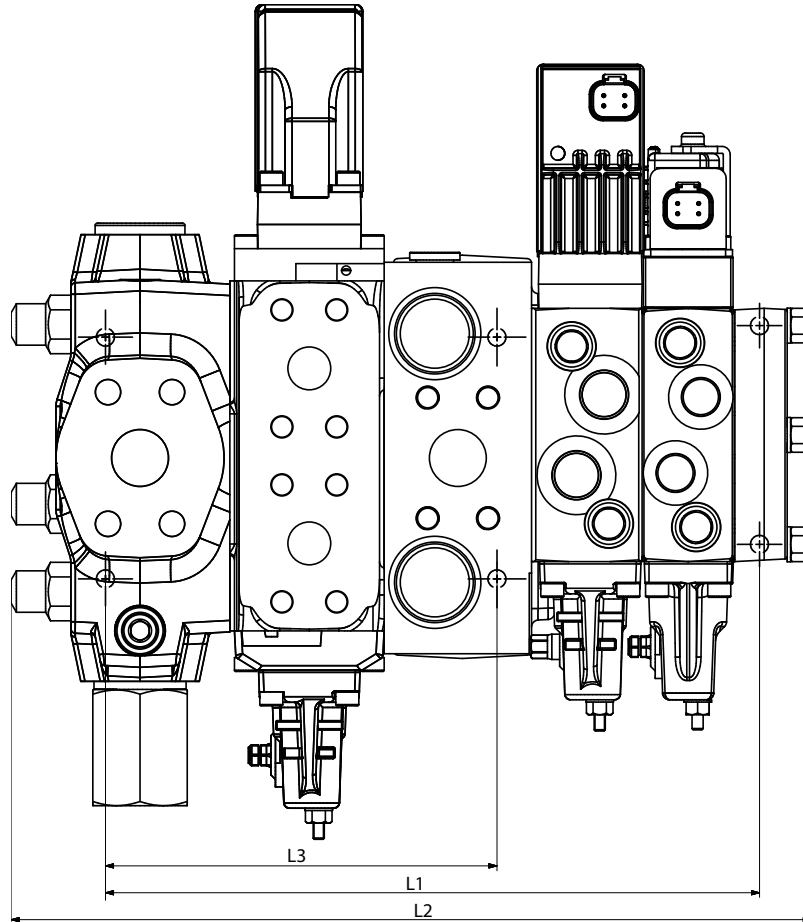
Number of PVB 100 (down)			Number of PVB 16										
			1	2	3	4	5	6	7	8	9	10	11
3	L1	mm	268	308	348	388	428	468	508	548	588	628	668
		[in]	[10.55]	[12.13]	[13.70]	[15.28]	[16.85]	[18.43]	[20.00]	[21.57]	[23.15]	[24.72]	[26.30]
	L2	mm	332	381	407	454	503	528	577	626	650	699	748
		[in]	[13.07]	[15.00]	[16.02]	[17.87]	[19.80]	[20.79]	[22.72]	[24.65]	[25.59]	[27.52]	[29.45]
	L3	176 mm [6.93 in]											
	4	L1	mm	316	256	396	436	476	516	556	596	636	676
[in]			[12.44]	[10.08]	[15.59]	[17.17]	[18.74]	[20.31]	[21.89]	[23.46]	[25.04]	[26.61]	[28.19]
L2		mm	380	429	455	502	551	576	625	674	698	747	796
		[in]	[14.96]	[16.89]	[17.91]	[19.76]	[21.69]	[22.68]	[24.61]	[26.54]	[27.48]	[29.41]	[31.34]
L3		224 mm [8.82 in]											
5		L1	mm	364	404	444	484	524	564	604	644	684	724
	[in]		[14.33]	[15.91]	[17.48]	[19.06]	[20.63]	[22.20]	[23.78]	[25.35]	[26.93]	[28.50]	[30.08]
	L2	mm	428	477	503	550	599	624	673	722	746	795	844
		[in]	[16.85]	[18.78]	[19.80]	[21.65]	[23.58]	[24.57]	[26.50]	[28.43]	[29.37]	[31.30]	[33.23]
	L3	272 mm [10.71 in]											
	6	L1	mm	412	452	492	532	572	612	652	692	732	772
[in]			[16.22]	[17.80]	[19.37]	[20.94]	[22.52]	[24.09]	[25.67]	[27.24]	[28.82]	[30.39]	[31.97]
L2		mm	476	525	551	598	647	672	721	770	794	843	892
		[in]	[18.74]	[20.67]	[21.69]	[23.54]	[25.47]	[26.46]	[28.39]	[30.31]	[31.26]	[33.19]	[35.12]
L3		320 mm [12.60 in]											
7		L1	mm	460	500	540	580	620	660	700	740	780	820
	[in]		[18.11]	[19.69]	[21.26]	[22.83]	[24.41]	[25.98]	[27.56]	[29.13]	[30.71]	[32.28]	[33.86]
	L2	mm	524	573	599	646	695	720	769	818	842	891	940
		[in]	[20.63]	[22.56]	[23.58]	[25.43]	[27.36]	[28.35]	[30.28]	[32.20]	[33.15]	[35.08]	[37.01]
	L3	368 mm [14.49 in]											
	8	L1	mm	508	548	588	628	668	708	748	788	828	868
[in]			[20.00]	[21.57]	[23.15]	[24.72]	[26.30]	[27.87]	[29.45]	[31.02]	[32.60]	[34.17]	[35.75]
L2		mm	572	621	647	694	743	768	817	866	890	939	988
		[in]	[22.52]	[24.45]	[25.47]	[27.32]	[29.25]	[30.24]	[32.17]	[34.09]	[35.04]	[36.97]	[38.90]
L3		416 mm [16.38 in]											

There is a horizontal difference of 23.5 mm [0.93 in] in the mounting plane of the PVG 100/PVG 16.

PVG 16 dimensions

PVG 120/16

PVB 120/16 combination valve stack dimensions



There is a horizontal difference 62.5 mm [2.46 in] in the mounting plane of the PVG 120/PVG 16.

Due to the large size of the PVG 120 interface-module it is necessary to have at least one PVG 32 module between the PVGI and the first PVG 16 slice.

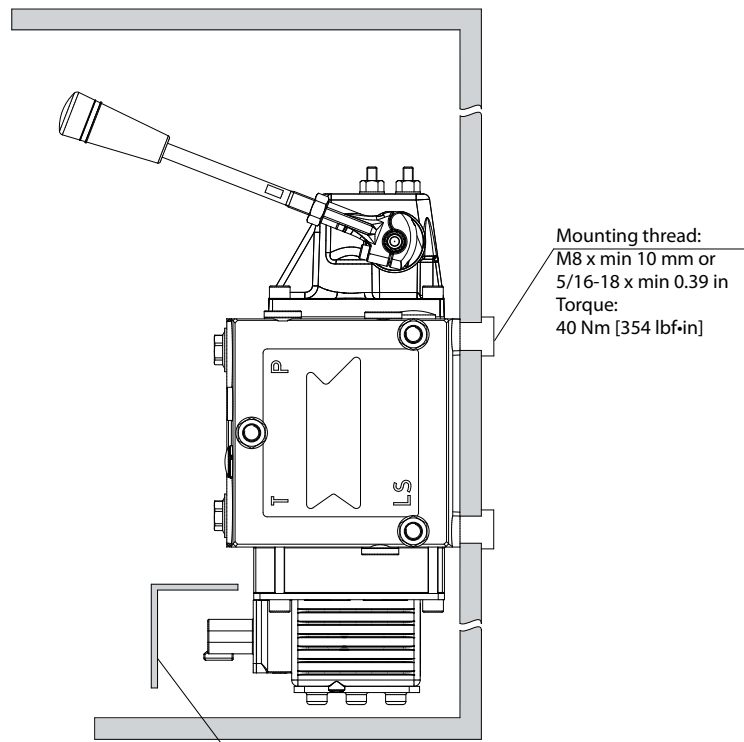
PVG 16 dimensions

PVB 120/16 combination dimensions

No. PVB 120	Dimension		Number of PVB 16 modules										
			1	2	3	4	5	6	7	8	9	10	11
1	L1	mm	284	324	364	404	444	484	524	564	604	644	684
		[in]	[11.18]	[12.76]	[14.33]	[15.91]	[17.48]	[19.06]	[20.63]	[22.20]	[23.78]	[25.35]	[26.93]
	L2	mm	348	397	421	470	519	544	593	642	666	715	759
		[in]	[13.70]	[15.63]	[16.57]	[18.50]	[20.43]	[21.42]	[23.35]	[25.28]	[26.22]	[28.15]	[29.88]
	L3	170 mm [6.69 in]											
	2	L1	mm	351	391	431	471	511	551	591	631	671	711
[in]			[13.82]	[15.39]	[16.97]	[18.54]	[20.12]	[21.69]	[23.27]	[24.84]	[26.42]	[27.99]	[29.57]
L2		mm	413	462	486	535	584	609	658	707	731	780	824
		[in]	[16.26]	[18.19]	[19.13]	[21.06]	[22.99]	[23.98]	[25.91]	[27.83]	[28.78]	[30.71]	[32.44]
L3		237 mm [9.33 in]											
3		L1	mm	418	458	498	538	578	618	658	698	738	778
	[in]		[16.46]	[18.03]	[19.61]	[21.18]	[22.76]	[24.33]	[25.91]	[27.48]	[29.06]	[30.63]	[32.20]
	L2	mm	478	527	551	600	649	674	723	772	796	845	889
		[in]	[18.82]	[20.75]	[21.69]	[23.62]	[25.55]	[26.54]	[28.46]	[30.39]	[31.34]	[33.27]	[35.00]
	L3	304 mm [11.91 in]											
	4	L1	mm	485	525	565	605	545	685	725	765	805	845
[in]			[19.09]	[20.67]	[22.24]	[23.82]	[21.46]	[26.97]	[28.54]	[30.12]	[31.69]	[33.27]	[34.84]
L2		mm	543	592	616	665	714	739	788	837	86	910	954
		[in]	[21.38]	[23.31]	[24.25]	[26.18]	[28.11]	[29.09]	[31.02]	[32.95]	[3.39]	[35.83]	[37.56]
L3		371 mm [14.61 in]											
5		L1	mm	552	592	632	672	712	752	792	832	872	912
	[in]		[21.73]	[23.31]	[24.8]	[26.46]	[28.03]	[29.61]	[31.18]	[32.76]	[34.33]	[35.91]	[37.48]
	L2	mm	608	657	681	730	779	804	853	902	926	975	1019
		[in]	[23.94]	[25.87]	[26.81]	[28.74]	[30.67]	[31.65]	[33.58]	[35.51]	[36.46]	[38.39]	[40.12]
	L3	438 mm [17.24 in]											
	6	L1	mm	619	659	699	739	779	819	859	899	939	979
[in]			[24.37]	[25.94]	[27.52]	[29.09]	[30.67]	[32.24]	[33.82]	[35.39]	[36.97]	[38.54]	[40.12]
L2		mm	673	722	746	795	844	869	918	967	991	1040	1084
		[in]	[26.50]	[28.43]	[29.37]	[31.30]	[33.23]	[34.21]	[36.14]	[38.07]	[39.02]	[40.94]	[42.68]
L3		505 mm [19.88 in]											
7		L1	mm	686	726	766	806	846	886	926	966	1006	1046
	[in]		[27.01]	[28.58]	[30.16]	[31.73]	[33.31]	[34.88]	[36.46]	[38.03]	[39.61]	[41.18]	[42.76]
	L2	mm	738	787	811	860	909	934	983	1032	1056	1105	1149
		[in]	[29.06]	[30.98]	[31.93]	[33.86]	[35.79]	[36.77]	[38.70]	[40.63]	[41.57]	[43.50]	[45.24]
	L3	572 mm [22.52 in]											
	8	L1	mm	753	793	833	873	913	953	993	1033	1073	1113
[in]			[29.65]	[31.22]	[32.80]	[34.37]	[35.94]	[37.52]	[39.09]	[40.67]	[42.24]	[43.82]	[45.39]
L2		mm	803	852	876	925	974	999	1048	1097	1121	1170	1214
		[in]	[31.61]	[33.54]	[34.49]	[36.42]	[38.35]	[39.33]	[41.26]	[43.19]	[44.13]	[46.06]	[47.80]
L3		639 mm [25.16 in]											

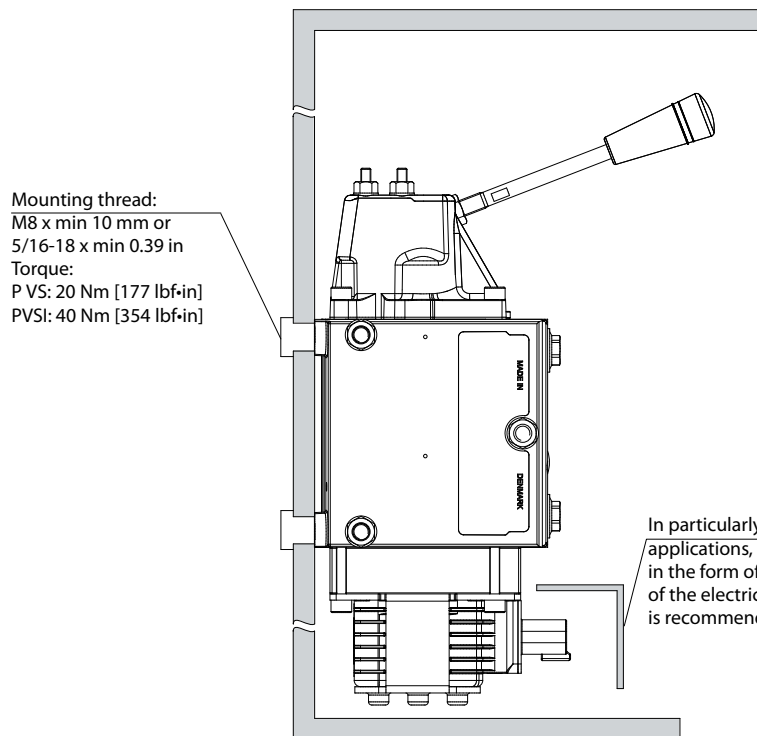
Installation

PVG 16 installation



Mounting thread:
 M8 x min 10 mm or
 5/16-18 x min 0.39 in
 Torque:
 40 Nm [354 lbf-in]

In particularly exposed applications,
 protection in the form of screening
 of the electrical actuator is recommended.



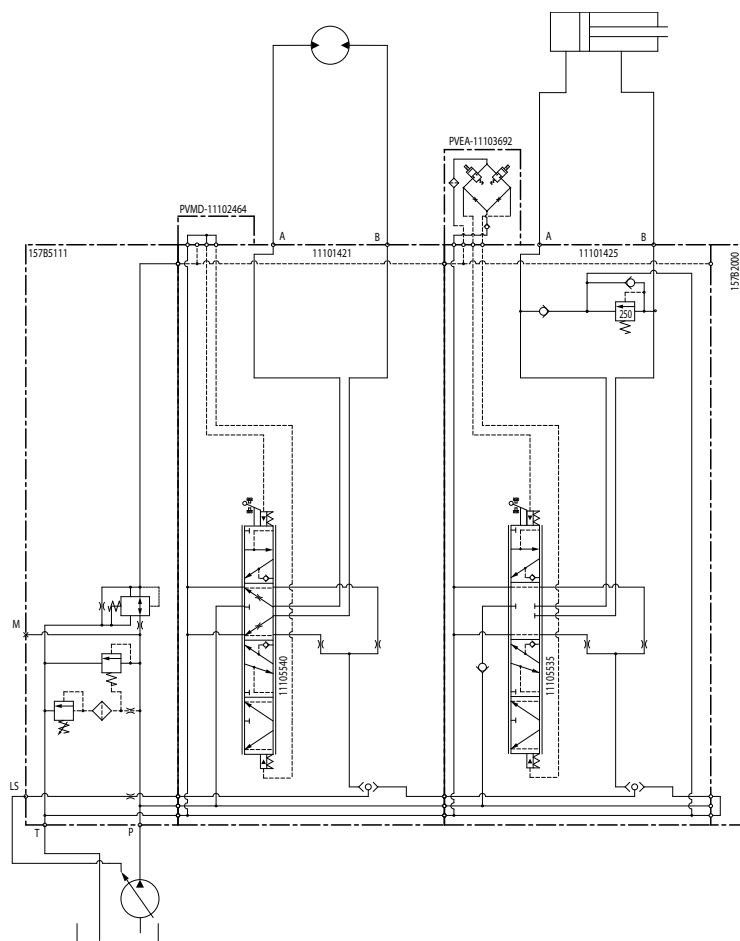
Mounting thread:
 M8 x min 10 mm or
 5/16-18 x min 0.39 in
 Torque:
 P VS: 20 Nm [177 lbf-in]
 PVS1: 40 Nm [354 lbf-in]

In particularly exposed
 applications, protection
 in the form of screening
 of the electrical actuator
 is recommended.

V310 365.C

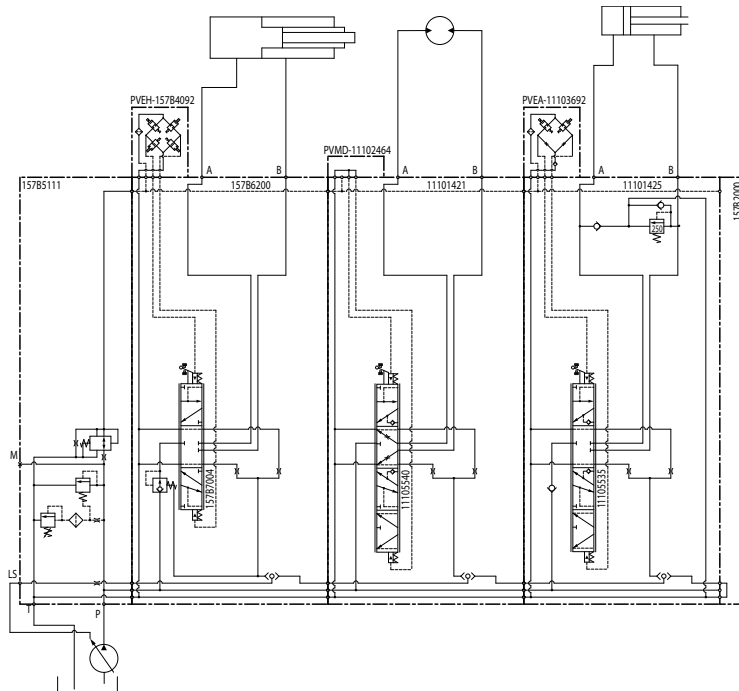
Application examples

PVG 16 application schematic

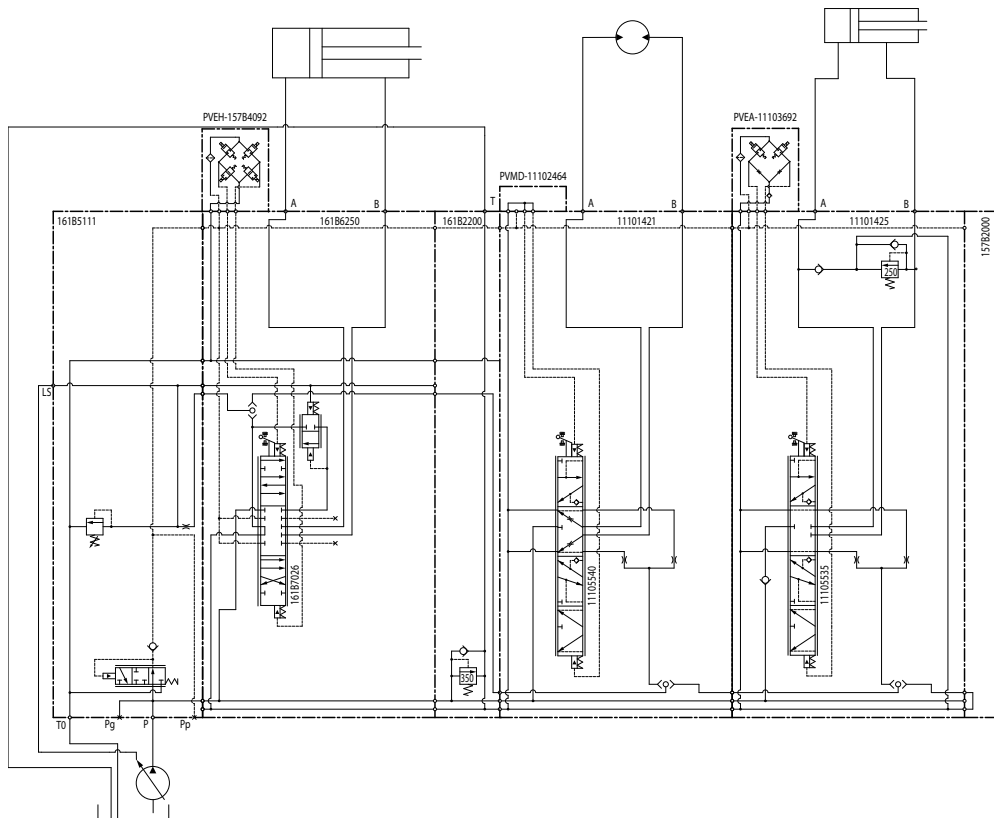


Application examples

PVG 32/16 application schematic

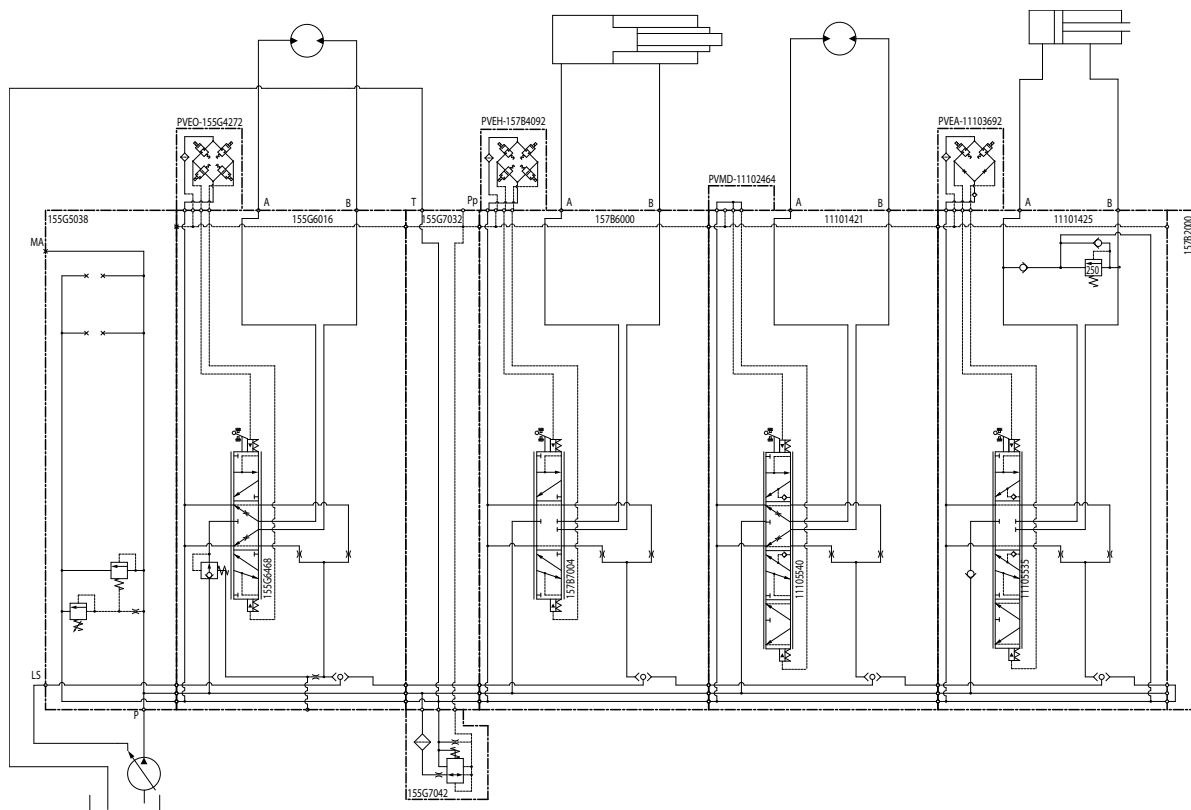


PVG 100/16 application schematic



Application examples

PVG 120/16 application schematic



Due to the large size of the PVG 120 interface-module it is necessary to have at least one PVG 32 module between the PVGI and the first PVG 16 slice.

Hydraulic system

Hydraulic system efficiency

A complete hydraulic system can be implemented in many different ways. There is no sole answer to: which system solution is the right one? The solution will depend on what is the aim of the vehicle manufacturers, if they are aiming for high productivity, and/or a low fuel consumption, and/or a compact design, and/or a high operator comfort, etc.

An important topic to consider when it comes to system design is *energy efficiency*. Components in a system have their individual efficiency and as such the components contribute to the total energy consumption. This energy consumption is directly proportional with the emission of the application and the operating costs.

The power needed to generate the flow and pressure for each system function is vital as surplus energy used to generate excess flow and pressure is converted into heat and thereby loss.

There are generally three types of mobile hydraulic systems:

- Fixed displacement with constant flow,
- Variable displacement with constant pressure and
- Variable displacement with load sense (LS).

Fixed displacement system with constant flow

Uses a pump with fixed displacement to generate a fixed flow to the system. In standby the flow is sent from the pump through the valve and back into the reservoir. Whenever a consumer requests a portion of the flow to perform a work function, the fixed displacement system brings the entire flow up to the load pressure. The valve will then divide the flow into work port flow and surplus flow sending this back to the reservoir.

The efficiency of a fixed displacement system is directly proportional to the percentage of the total flow used by the consumer. If the consumer uses 10% of the total flow available the fixed displacement system is 10% efficient. If the consumer uses 75% of the total available flow the system is 75% efficient.

Variable displacement system with constant pressure

Uses a variable displacement pump to regulate the flow to system consumer needs. The flow is always pressurized to the setting of the pump pressure compensator independent of the consumer(s) pressure need. In standby the pressure remains at full system pressure and only leakage flow is circulated back to the reservoir. Whenever a consumer request a flow to perform a work function the pump will deliver this flow only, but at full system pressure, independent of the function pressure need.

The efficiency of a fixed displacement system is directly proportional to the percentage of the total pressure needed to perform the work, If 10% of the pressure is needed the fixed displacement system is 10% efficient. If 75% of the pressure is needed the fixed displacement system is 75% efficient.

Variable displacement system with load sense

Uses a variable displacement pump to give the consumer the requested flow at the needed pressure. In standby only pump leakage is circulated back to reservoir – at only margin pressure. Whenever a consumer requests a flow the pump delivers this flow at needed pressure plus a margin pressure to compensate internal resistance and system control.

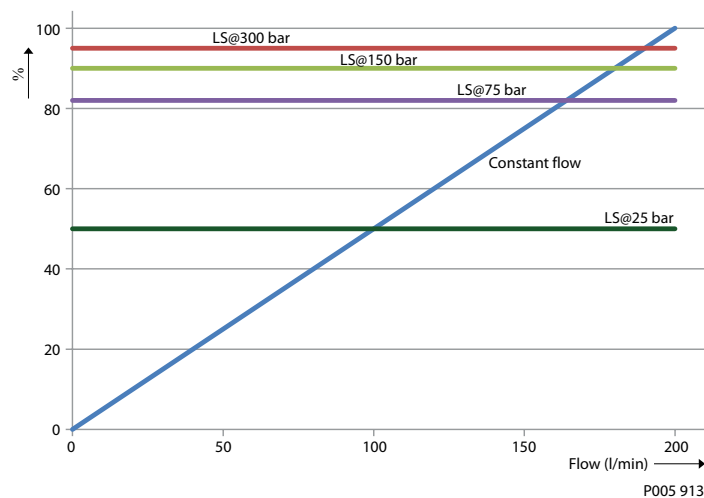
The efficiency of a LS system, despite its pressure control, is not proportional to the flow or pressure but a result of the pump margin pressure setting.

The easiest way to compare the efficiencies of the systems is to make an example. Considering a pump with a maximum flow rate of 200 l/min [52.8 US gal/min] and a system pressure of 300 bar [4351 psi].

A comparison of fixed and variable displacement systems gives the LS system a huge efficiency advantage over the fixed displacement system, especially in the high pressure and low-to-medium flow applications.

Hydraulic system

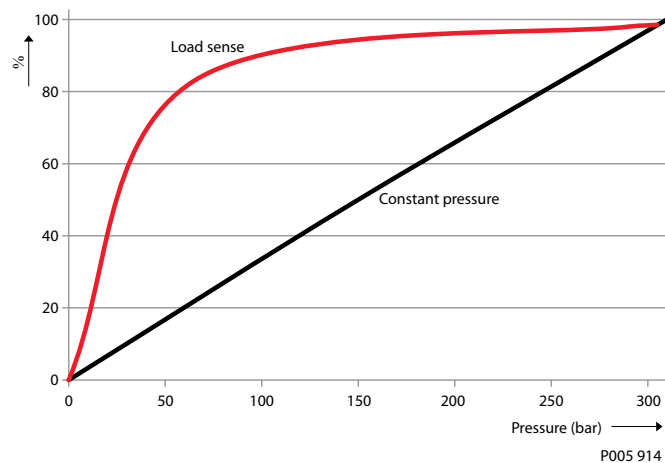
Fixed vs variable displacement system



Considering multiple consumers where the high flow work functions are seldom used, the LS system will increase the advantage over the fixed displacement system.

A comparison of fixed and variable displacement systems gives the variable displacement system an efficiency advantage over the fixed displacement system in the lower pressure range of an application.

Fixed vs variable displacement system



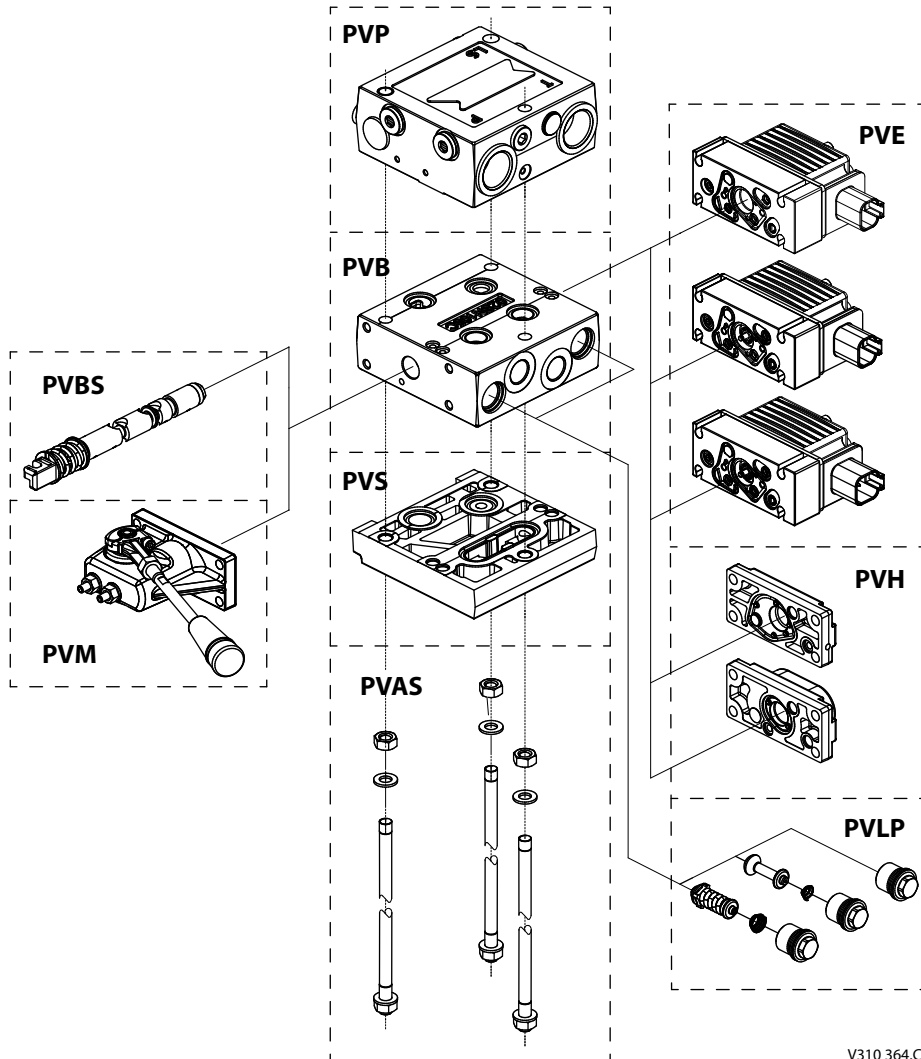
Considering multiple consumers at different pressures the variable displacement system will increase the efficiency over the fixed displacement system.

Although the variable displacement system is the most complex of the three systems it potentially offers great advantages in terms of efficient use of energy and in turn the compliance with power management requirements. The PVG family offers products for both constant flow and load sense systems for the best solution for the mobile hydraulic system.

PVG 16 modules and code numbers

PVG 16 modules assembly

PVG modules (exploded view)



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Ports connections:

- P = G ½ in; 14 mm deep or G ¾ in; 16 mm deep [7/8–14; 0.65 in deep or 1 1/16–12; 0.75 in deep]
- LS, M = G ¼ in; 12 mm deep [½–20; 0.47 in deep]
- T = G ¾ in; 16 mm deep [1 1/16–12; 0.75 in deep]

PVG 16 modules and code numbers

PVP – Pump side modules code numbers

PVP – Pump side modules for pumps with fixed displacement

PVP – Pump side modules code numbers

Description	Thread	Code number
Open centre pump side module For mechanically actuated valve groups only	P = G 1/2; T = G 3/4	157B5000
	P = 7/8–14; T = 1 1/16–12	157B5200
	P, T = G 3/4	157B5100
	P, T = 1 1/16–12	157B5300
Open centre pump side module With pilot oil supply for electrically actuated valves	P = G 1/2; T = G 3/4	157B5010
	P = 7/8–14; T = 1 1/16–12	157B5210
	P, T = G 3/4	157B5110
	P, T = 1 1/16–12	157B5310
Open centre pump side module With pilot oil supply for electrically actuated valves Connection for LS unloading valve, PVPX	P = G 1/2; T = G 3/4	157B5012
	P = 7/8–14; T = 1 1/16–12	157B5212
	P, T = G 3/4	157B5112
	P, T = 1 1/16–12	157B5312
Open centre pump side module For mechanically actuated valve groups only Connection for LS unloading valve, PVPX	P, T = G 3/4	157B5102
Open centre pump side module With pilot oil supply for electrically actuated valves Connection for pilot oil pressure	P, T = G 3/4	157B5180
	P, T = 1 1/16–12	157B5380
Open centre pump side module With pilot oil supply for electrically actuated valves Connection for pilot oil pressure	P, T = G 3/4	157B5190
	P, T = 1 1/16–12	157B5390
Open centre pump side module With pilot oil supply for electrically actuated valves With damped pressure adjustment spool	P, T = G 3/4	11008849
Open centre pump side module With pilot oil supply for hydraulically actuated valves With damped pressure adjustment spool	P, T = G 3/4	11008851

PVP – Pump side modules for pumps with variable displacement

PVP – Pump side modules code numbers

Description	Thread	Code number
Closed centre pump side module For mechanically actuated valve groups only	P = G 1/2; T = G 3/4	157B5001
	P = 7/8–14; T = 1 1/16–12	157B5201
	P, T = G 3/4	157B5101
	P, T = 1 1/16–12	157B5301
Closed centre pump side module With pilot oil supply for electrically actuated valves	P = G 1/2; T = G 3/4	157B5011
	P = 7/8–14; T = 1 1/16–12	157B5211
	P, T = G 3/4	157B5111
	P, T = 1 1/16–12	157B5311
Closed centre pump side module With pilot oil supply Connection for LS unloading valve, PVPX	P = G 1/2; T = G 3/4	157B5013
	P = 7/8–14; T = 1 1/16–12	157B5213
	P, T = G 3/4	157B5113
	P, T = 1 1/16–12	157B5313

PVG 16 modules and code numbers

PVP – Pump side modules code numbers (continued)

Description	Thread	Code number
Closed centre pump side module For mechanically actuated valve groups only Connection for LS unloading valve, PVPX	P, T = G ¾	157B5103
Closed centre pump side module With pilot oil supply for electrically actuated valves Connection for pilot oil pressure	P, T = G ¾	157B5181
	P, T = 1 1/16–12	157B5381
Closed centre pump side module With pilot oil supply for hydraulically actuated valves Connection for pilot oil pressure	P, T = G ¾	157B5191
	P, T = 1 1/16–12	157B5391

PVB – Basic work modules code numbers

PVB – compensated modules code numbers

Description		Code number
Compensated basic module	3/8" BSP	11130976
	3/4"–16UNF	11130977
Compensated basic module with facilities for shock and anti-cavitation valves (PVL/PVLA)	3/8" BSP	11130978
	3/4"–16UNF	11130979
Compensated basic module with one common adjustable LS valve for port A and port B	3/8" BSP	11130982
	3/4"–16UNF	11130983

PVB – non-compensated basic modules code numbers

Description		Code number	
		With check valve	Without check valve
No facilities for shock valves	3/8" BSP	11106801	11101421
	3/4"–16UNF	11106797	11101423
Facilities for shock valves	3/8" BSP	11101424	11106754
	3/4"–16UNF	11101425	11106755

PVE – Electrical actuation modules code numbers

PVE code numbers

Description	12 V _{DC}	24 V _{DC}
PVEO, ON/OFF control	11106793	11106794
PVHC Proportional control	11126941	11127535
PVEA Proportional control	11103692	
PVEA-F Proportional control, with float in B-direction	11106795	

PVE-CI code numbers

Description		Code number
PVEO-CI	J1939/ISOBus	11124002
PVEA-CI		11121945
PVEO-CI	CANopen	11149443
PVEA-CI		11149437

PVG 16 modules and code numbers

PVBS – Main spools code numbers

PVBS – Symmetrical main spools code numbers

Description	Code number according to flow – in l/min [US gal/min]				
	5 [1.32]	10 [2.64]	25 [6.60]	40 [10.57]	65 [17.17]
Open neutral, use with PVE	11105537	11105538	11105539	11105540	11105541
Open neutral, use with PVH	11109637	11109638	11109639	11109640	11109641
Closed neutral, use with PVE	11105532	11105533	11105534	11105535	11105536
Closed neutral, use with PVH	11109632	11109633	11109634	11109635	11109636

PVBS – Asymmetrical main spools code numbers

Description	Code number according to flow – in l/min [US gal/min]					
	5/2.5 [1.32/0.66]	10/5 [2.64/1.32]	25/10 [6.60/2.64]	25/15 [6.60/3.96]	40/15 [10.57/3.96]	40/25 [10.57/6.60]
Cylinder ratio	2.0	2.0	2.5	1.6	2.7	1.6
Closed neutral, use with PVE	11109642	11109643	11109644	11109645	11109646	11109647
Closed neutral, use with PVH	11146752	11146753	11146754	11146755	11146756	11146757

PVLP – Shock and Anti-cavitation valves code numbers

PVLP – Shock and Anti-cavitation valves code numbers

Code number	157B2032	157B2050	157B2063	157B2080	157B2100	157B2125	157B2140	157B2150	157B2160	157B2175	157B2190	
Settings	bar	32	50	63	80	100	125	140	150	160	175	190
	[psi]	[460]	[725]	[914]	[1160]	[1450]	[1813]	[2031]	[2175]	[2320]	[2538]	[2755]

PVLP – Shock and Anti-cavitation valves code numbers (continued)

Code number	157B2210	157B2230	157B2240	157B2250	157B2265	157B2280	157B2300	157B2320	157B2350	157B2380	157B2400	
Settings	bar	210	230	240	250	265	280	300	320	350	380	400
	[psi]	[3045]	[3335]	[3480]	[3625]	[3845]	[4061]	[4351]	[4641]	[5075]	[5511]	[5801]

PVLA – Anti-cavitation valve code numbers

Description	Code number
Plug A or B	157B2002
Valve A or B	157B2001

PVG 16 modules and code numbers

PVAS – Assembly kits code numbers

PVAS code numbers according to accumulated module length interval

Accumulated module length interval		Code number
Metric (mm)	Imperial [in]	
55 – 72	[2.17 – 2.83]	157B8000
79 – 96	[3.11 – 3.78]	157B8031
103 – 120	[4.06 – 4.72]	157B8001
127 – 144	[5.00 – 5.67]	157B8021
151 – 168	[5.49 – 6.61]	157B8002
175 – 192	[6.89 – 7.56]	157B8022
199 – 216	[7.83 – 8.50]	157B8003
223 – 240	[8.78 – 9.45]	157B8023
247 – 264	[9.72 – 10.39]	157B8004
271 – 288	[10.67 – 11.34]	157B8024
295 – 312	[11.61 – 12.28]	157B8005
319 – 336	[12.56 – 13.23]	157B8025
343 – 360	[13.50 – 14.17]	157B8006
367 – 384	[14.45 – 15.12]	157B8026
391 – 408	[15.39 – 16.06]	157B8007
415 – 432	[16.34 – 17.00]	157B8027
439 – 456	[17.28 – 17.95]	157B8008
463 – 480	[18.23 – 18.90]	157B8028
487 – 504	[19.17 – 19.84]	157B8009
511 – 528	[20.12 – 20.79]	157B8029
535 – 552	[21.06 – 21.73]	157B8010
559 – 576	[22.00 – 22.68]	157B8030
583 – 600	[22.95 – 23.62]	157B8061
607 – 624	[23.90 – 24.57]	157B8081
631 – 648	[24.84 – 25.51]	157B8062
655 – 672	[25.79 – 26.46]	157B8082

PVG 16 modules and code numbers

PVS – End plate code numbers

PVS code numbers

Description	Thread	Code number
PVS, aluminum end plate	Foot = M8	157B2000
	Foot = 5/16-18	157B2020
PVS, aluminum end plate with LX-connection	LX = G1/8; Foot = M8	157B2011
	LX = 3/8-24; Foot = 5/16-18	157B2021
PVS, cast iron end plate	Foot = M8	157B2014
	Foot = 5/16-18	157B2004
PVS, cast iron end plate with LX-connection	LX = G1/4; Foot = M8	157B2015
	LX = 1/2-20; Foot = 5/16-18	157B2005
PVS, cast iron end plate, with P-, T-, LX- and M-connection	P = 3/8; T = 1/2; LX = 1/4; M = 1/4; Foot = M8	157B2920
PVST, iron end plate with T-connection	T = 1/2; Foot = M8	157B2500
	T = 7/8-14; Foot = 5/16-18	157B2520

PVM – Mechanical actuation modules code numbers

PVM code numbers

Description	Code number	
	With lever	Without lever
Without adjustment screws, without float	11107333	11107505
Without adjustment screws, with float	11107335	11107506
With adjustment screws, without float	11107332	11107507

PVH, PVMD code numbers

PVH and PVMD code numbers

Description	Code number	
PVH, Hydraulic actuation	G 1/4 BSP	11108380
	9/16-18 UNF	11108381
PVMD, Cover for PVM		11105518

Accessories code numbers

Seal kit

Description	Code number
Seal kit for PVE and PVHC	11133165
Seal kit for one work section	157B8999
Seal kit for seven work sections	11156335
PVM seal kit	157B3999
Loop cable 175 mm, DEUTSCH 4-pin	11095622
Cable 4 m, DEUTSCH 4-pin	11095741

PVG 16 modules and code numbers

Seal kit (continued)

Description	Code number
CG 1502*	11153051
120 Ω terminator	11007561

* Only to be used with PLUS+1® Service Tool version 7.1.10 or newer.

Order specification

	PVG16		
Subsidiary/Dealer		PVG No.	
Customer		Customer Part No.	
Application		Revision No.	

Section v	Function	A-Port v			B-Port v	
1			PVP p = bar			
2	a PVM	PVB	PVBS		PVE/PVH/PVMD	c
	b PVLP/PVLA	LS _A	bar	LS _B	bar	PVLP/PVLA b
3	a PVM	PVB	PVBS		PVE/PVH/PVMD	c
	b PVLP/PVLA	LS _A	bar	LS _B	bar	PVLP/PVLA b
4	a PVM	PVB	PVBS		PVE/PVH/PVMD	c
	b PVLP/PVLA	LS _A	bar	LS _B	bar	PVLP/PVLA b
5	a PVM	PVB	PVBS		PVE/PVH/PVMD	c
	b PVLP/PVLA	LS _A	bar	LS _B	bar	PVLP/PVLA b
6	a PVM	PVB	PVBS		PVE/PVH/PVMD	c
	b PVLP/PVLA	LS _A	bar	LS _B	bar	PVLP/PVLA b
7	a PVM	PVB	PVBS		PVE/PVH/PVMD	c
	b PVLP/PVLA	LS _A	bar	LS _B	bar	PVLP/PVLA b
8	a PVM	PVB	PVBS		PVE/PVH/PVMD	c
	b PVLP/PVLA	LS _A	bar	LS _B	bar	PVLP/PVLA b
9	a PVM	PVB	PVBS		PVE/PVH/PVMD	c
	b PVLP/PVLA	LS _A	bar	LS _B	bar	PVLP/PVLA b
10	a PVM	PVB	PVBS		PVE/PVH/PVMD	c
	b PVLP/PVLA	LS _A	bar	LS _B	bar	PVLP/PVLA b
11	End section		PVS			
12	PVAS section		PVAS			
Comments:						
Filled in by:					Date:	

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Local address:

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

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

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

Danfoss Power Solutions Trading (Shanghai) Co., Ltd.
Building #22, No. 1000 Jin Hai Rd
Jin Qiao, Pudong New District
Shanghai, China 201206
Phone: +86 21 3418 5200

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