Service Manual

Danfoss Axispro
Servo conversion instructions

How to get servo valve-like performance from a servo-performance Proportional valve

The AxisPro™ proportional industrial valve is a cost-effective and reliable alternative to the traditional servo valve.

AxisPro™ four-way solenoid-operated proportional valves offer high dynamic performance which enables them to be used in closed loop motion control applications previously only possible using conventional servo valves. Compared to servo valves, AxisPro proportional valves offer excellent performance and better reliability at a significantly lower price point.

Servo valves: expensive with limited availability

Servo valves provide excellent accuracy and high repeatability. Servo valve technology has been in constant use for over 70 years. But servo valves are typically more expensive than other valves: they require elaborate production methods (involving machining and assembling two stages). And when placed into service, servo valves require sophisticated electronic control cards—adding additional costs. In addition, servo valves require use of a pilot-filter (typically) supplied by the manufacturer, which can become contaminated and require costly maintenance.

The new AxisPro™ line of proportional directional valves provide a cost-effective alternative to traditional nozzle-flapper servo valves. Proportional valves, like AxisPro, benefit from a simpler mechanical design that costs less to manufacture, while utilizing onboard integrated electronics and feedback to achieve servo-quality spool control performance. Plus, since the AxisPro power stage directly drives the spool, there is increased robustness to contamination (no need for pilot stage filtration to protect the fragile nozzle-flapper interface of a traditional servo valve).

Converting to AxisPro servo-performance valves: step-by-step

NNote: Thisconversion process applies to A xisPro Level 1 valves. Contact your Danfoss representative for information about converting to AxisPro Level 2 and Level 3 valves.

Converting to the AxisPro valve requires a simple six-step process:

Sotp 1. Determine maximum flow rate of the servo valve

Sotp 2. Choose the proper replacement AxisPro valve

Sotp 3. Define parameters

Sotp 4. Determine where motion control is handled

Sotp 5. Mount AxisPro Valve

Sotp 6. W ire AxisPro Valve

You will find model codes, installation dimensions and other useful information in the appendix.

Step 1: Determine maximum flow r ate o f t he servo valve

Maximum flow and pressure rating is typically listed as part of the model code and appears on the on the model code/serial number label (Figure 1).

Note: TheA xisPro valve is not recommended for pressure ratings higher than 350 bar.

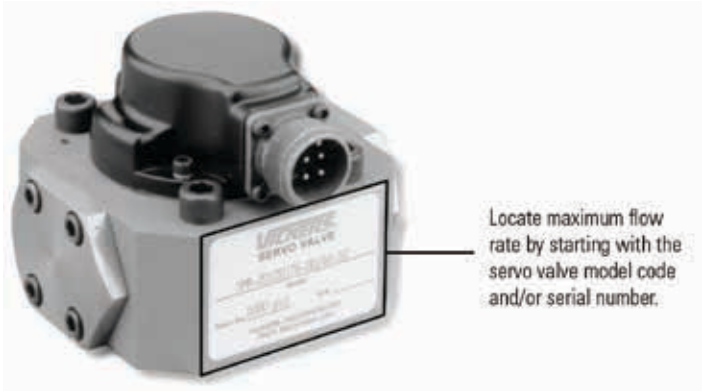


Figure 1. Locate serial numberto determine flow rating.

Step 2: Choose the proper AxisPro Replacement valve

Choose the proper AxisPro Level 1 replacement valve according to desired flow (note single-stage AxisPro valves have flows rated at 1000 psid pressure drop across the valve, i.e. 500 psi per metering edge):

- Flow < 10 gpm: choose the Danfoss KBS1-3 proportionaldirectional valve Size D03 mounting pattern
- Flow > 10 gpm: choose the Danfoss KBS1-5 proportionaldirectional valve Size D05 mounting pattern

To assist in choosing the right AxisPro model configuration, please refer to the appropriate AxisPro product catalogs.

Step 3: Define conditions, output and Electrical connections

1. **Define the AxisPro valve failsafe condition:** Servo valves typically define the failsafe condition as all ports blocked in the neutral position. Because proportional valves are driven by a solenoid in only one direction, it is necessary to match the correct failsafe condition of the servo valve in the AxisPro valve. Choose the forced position as an all ports blocked position for the new AxisPro valve.
2. **Select the AxisPro valve spool and sleeve:**Spool/sleeve settings will vary according to the flow rate of the valve. Choose the correct flow when setting the valve by determining these parameters:
   a. Symmetric vs. Asymmetric (valves are typically symmetric, but verify with your valve)
   b. Correct failsafe position
   c. Select flow rate. Using the spool sleeve codes, choose the correct flow rate that allows for at least the desired flow
3. **Select command signal**
   a. Select 1: +/- 10V Voltage command signal
   b. Select 2: 4-20mA current command signal
   c. Select 3: +/-10mA current command signal
   d. Select 4: +/-15mA current command signal
   e. Select 5: +/-20mA current command signal
4. **Select monitor output:** Use monitor output to locate the position of the valve spool for the PLC. Typical monitor output involves using the +/- 10V voltage feedback signal. The spool position may or may not be used in the existing System – ignore if not used/needed by the PLC. The AxisPro valve internally controls spool position, this external feedback is optional only for monitoring purposes.
   a. Select 1: +/- 10V voltage feedback signal
   b. Select 2: 4-20mA current feedback signal
5. **Select electrical connection:**Typical use involves the 7 pin Connector with plug
   a. Select E: 7 pin connector with plug

Step 4: Determine where motion control is handled: PLC or card

Motion is typically controlled through the servo card or through the PLC.

- If motion is controlled through the servo card, talk to your Danfoss representative about using an AxisPro level 2 valve as a replacement valve
- If motion is controlled through the PLC:
  - Ensure the PLC parameter scaling is equivalent to the AxisPro valve parameters
  - Verify that the PLC PID parameters are performing well/as expected

Step 5: Mount the AxisPro valve in place of the servo valve

1. Verify installation dimensions for desired AxisPro valve model code
   a. AxisPro valves may require a larger size envelope than servo valves
   b. Verify there is adequate space to accommodate the AxisPro valve by measuring space around the mounted servo valve (Figure 2)

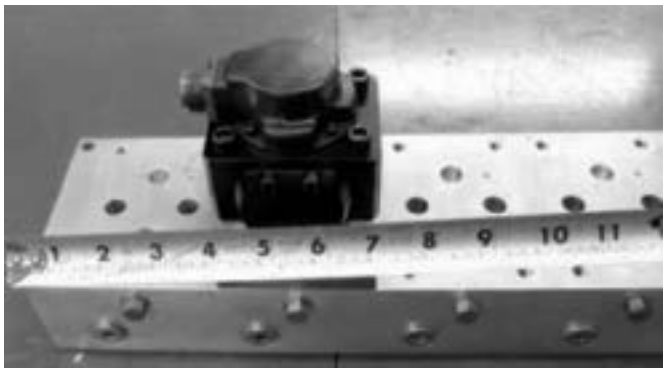


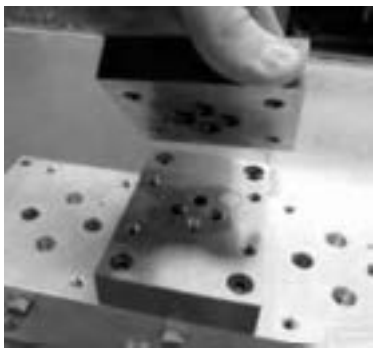
Figure 2. Verify adequate space to accommodate the AxisPro valve.

2. Determine required adapter plate
   a. An AxisPro KBS1-3 valve requires a D03-to-S04 manifold adapter plate
      1. Order a D03-to-S04 manifold adapter plate
      2. Order four mounting screws:
         a. UNC #10-24 x 1.00 long SHCS, or
         b. ISO 6H M5-0.8 x 25mm SHCS mounting screws
      3. Order four O-rings (typically Viton 75 Durometer-012)
   b. An AxisPro KBS1-5 valve requires a D05-to-S04-manifold adapter plate is required
      1. Order a D05-to-S04 manifold adapter plate
      2. Order four mounting screws, either:
         a. UNC #10-24 x 1.00 long SHCS, or
         b. ISO 6H M5-0.8 x 25mm SHCS
   c. Order four O-rings (typically Viton 75 Durometer-014)

3. Remove servo valve by removing the 4 mounting bolts (Figure 3)

Figure 3. Remove the four mounting bolts to remove the servo valve.

4. Mount the adapter plate where the servo valve had been located (Figure 4)



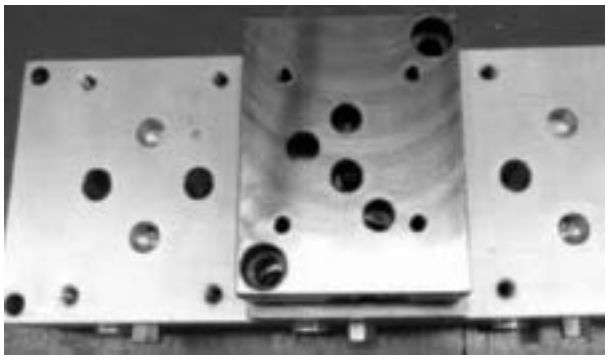
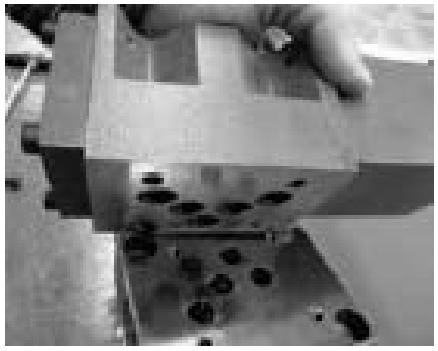


Figure 4. Mount adaptor plate to servo valve location.

5. Mount the AxisPro valve to the adapter plate (Figure 5)



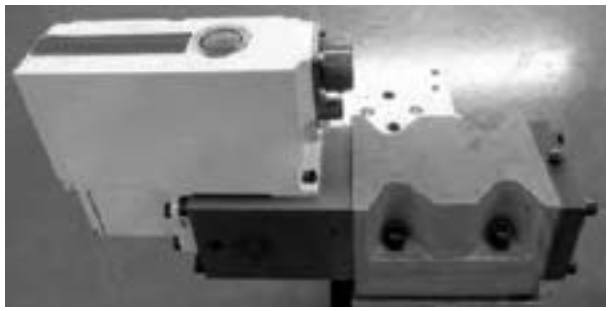


Figure 5. Mount the AxisPro valve to the adaptor plate.

Step 6. Wire the AxisPro valve

Note: While no external amplifier card is needed, the AxisPro valve does require a 24VDC power supply.

1. Supply 24V volts (DC) and rated to 3.5 Amps to AxisPro valve (Figure 6 and Figure 7).
   a. Recommended power cable sizes for 24V are 0.75 mm2 (18 AWG) up to 20m (65 ft.) and 1.00 mm2 (16 AWG) up to 40 m (130 ft.).

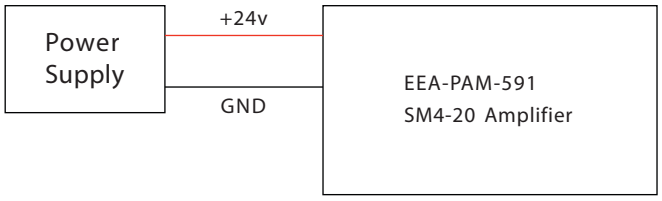


Figure 6. Wiring prior to mountingthe AxisPro valve.

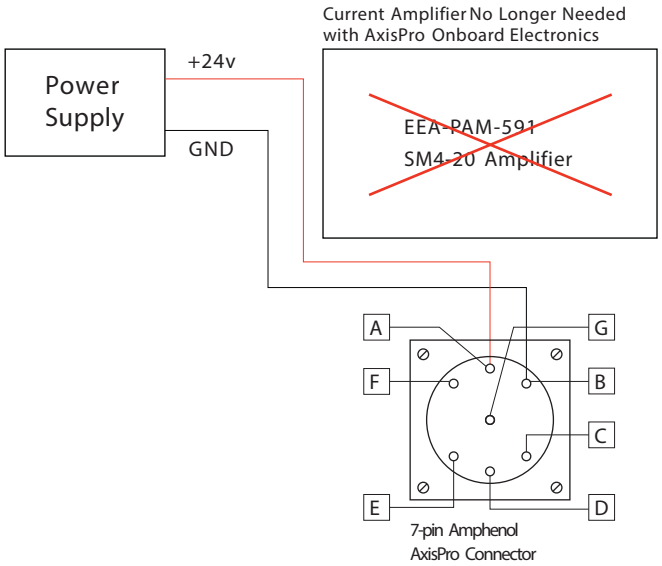


Figure 7. Wiring after mountingthe AxisPro valve.

2. Connect input command signal from PLC to AxisPro valve.
   a. Command signal goes to pin D with a ground reference at pin E (Figure 8 and Figure 9).

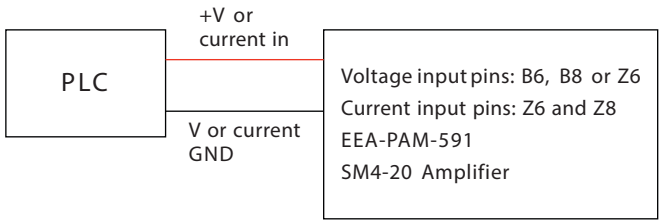


Figure 8. Before mountingthe AxisPro valve, with no external feedback.

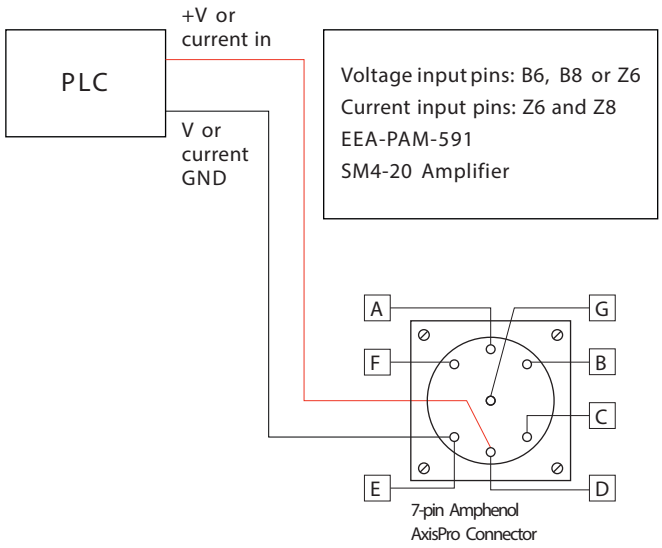


Figure 9. After mountingthe Level 1 AxisPro valve.

Model Code

KBS1 - 03 - ** - NS - ** - * - NS - 004 - 11

1 2 3 4 5 6 7 8 13 14 15

1 **Valve Type**

KBS – Servo performance proportional valve with integral amplifier and electronic feedback

2 **Control Level**

Level 1

3 **Interface**

03 – ISO 4401, size 03-02-0-94 ANSI/B93.7M-D03

4 **Spool/Sleeve**

1 – Symmetric -40ℓ/min - At Failsafe -all ports blocked (legacy 92L40)
2 – Symmetric -24ℓ/min - At Failsafe -all ports blocked (legacy 92L24)
3 – Symmetric -12ℓ/min - At Failsafe -all ports blocked (legacy 92L12)
4 – Symmetric -05ℓ/min - At Failsafe -all ports blocked (legacy 92L05)
5 – Symmetric -40ℓ/min - At Failsafe -P port blocked, A,B,T connected (legacy 96L40)
6 – Symmetric -24ℓ/min - At Failsafe -P port blocked, A,B,T connected (legacy 96L24)
7 – Symmetric -12ℓ/min - At Failsafe -P port blocked, A,B,T connected (legacy 96L12)
8 – Symmetric -05ℓ/min - At Failsafe -P port blocked, A,B,T connected (legacy 96L05)
9 – Symmetric -40ℓ/min - At Failsafe reduced flow A connected to T and B connected to P(legacy 94L40)
13 – Symmetric -40ℓ/min – reduced pressure at null - At Failsafe -P port blocked, A,B,T connected (legacy 86L40)
17 – Asymmetric -40ℓ/min A; 20ℓ/min B - At Failsafe -all ports blocked (legacy 92L40N20)
18 – Asymmetric -40ℓ/min A; 10ℓ/min B - At Failsafe -all ports blocked (legacy 92L40N10)
19 – Asymmetric -24ℓ/min A; 12ℓ/min B - At Failsafe -all ports blocked (legacy 92L24N12)
20 – Asymmetric -40ℓ/min A; 20ℓ/min B - At Failsafe -P port blocked, A,B,T connected (legacy 96L40N20)
21 – Asymmetric -40ℓ/min A; 10ℓ/min B - At Failsafe -P port blocked, A,B,T connected (legacy 96L40N10)
22 – Asymmetric -24ℓ/min A; 12ℓ/min B - At Failsafe -P port blocked, A,B,T connected (legacy 96L24N12)
23 – 2-gain Symmetric – 4ℓ/min @ 40% - 40ℓ/min @100% - At Failsafe -all ports blocked (legacy 92L04T40)
24 – 2-gain Symmetric – 2.4ℓ/min @ 60% -24ℓ/min @100% - At Failsafe -all ports blocked (legacy 92L02T24)
25 – 2-gain Symmetric – 1.5ℓ/min @ 60% -15ℓ/min @100% - At Failsafe -all ports blocked (legacy 92L01T15)
26 – 2-gain Symmetric – 4.0ℓ/min @ 40% -40ℓ/min @100% - @Failsafe -P port blocked, A,B,T connected (legacy 96L04T40)
27 – 2-gain Symmetric – 2.4ℓ/min @ 60% -24ℓ/min @100% - @Failsafe -P port blocked, A,B,T connected (legacy 96L02T24)
28 – 2-gain Symmetric – 1.5ℓ/min @ 60% -15ℓ/min @100% - @Failsafe -P port blocked, A,B,T connected (legacy 96L01T15)
29 – 2-gain Symmetric – 2.4ℓ/min @ 40% -24ℓ/min @100% - @Failsafe -P port blocked, A,B,T connected
30 – 2-gain Symmetric – 1.5ℓ/min @ 40% -15ℓ/min @100% - @Failsafe -P port blocked, A,B,T connected
31- symmetric 40 lpm 8% overlap failsafe P, A, B, blocked
32- symmetric 20 lpm 8% overlap failsafe P, A, B, blocked
33 - symmetric 10 lpm 8% overlap failsafe P, A, B, blocked
34- symmetric 05 lpm 8% overlap failsafe P, A, B, blocked
35 - symmetric 40 lpm 8% overlap failsafe P, blocked A, B, T connected
36 - symmetric 20 lpm 8% overlap failsafe P, blocked A, B, T connected
37- symmetric 10 lpm 8% overlap failsafe P, blocked A, B, T connected
38- symmetric 05 lpm 8% overlap failsafe P, blocked A, B, T connected
39- symmetric 14 lpm 8% overlap failsafe P, A, B, blocked
40 - symmetric 14 lpm 8% overlap failsafe P, P, blocked A, B, T connected

5 **Valve Special Feature**

NS – Not Selected

6 **Command Signal**

1 – +/- 10V voltage command signal
2 – +/- 4-20mA current command signal
3 – +/- 10mA current command signal
4 – +/- 15mA current command signal
5 – +/- 20mA current command signal

7 **Monitor Output**

1 – ±10V voltage feedback signal
2 – 4-20mA current feedback signal

8 **Electrical Connection**

C – 7 pin connector without plug
E – 7 pin connector with plug
H – As E but with pin "C" used for enable signal
R – As C but with pin "C" used for enable signal

13 **Electrical Special Feature**

NS – Not Selected

14 **Software Revision**

XXX – Software Revision

15 **Design Number**

11 series

To find available product configurations go to www.danfoss.com

Model Code

KBS1 - 05 - ** - NS - ** - * - NS - 004 - 11

1 2 3 4 5 6 7 8 13 14 15

1 **Valve Type**

KBS – Servo performance proportional valve with integral amplifier and electronic feedback

2 **1 –** Level 1

3 **Interface**

05 – ISO 4401, size 05-04-0-05 ANSI/B93.7M-D05

4 **Spool/Sleeve**

1 – Symmetric -100ℓ/min - At Failsafe -all ports blocked (legacy 92L100)
2 – Symmetric - 80ℓ/min - At Failsafe -all ports blocked (legacy 92L80)
3 – Symmetric - 50ℓ/min - At Failsafe -all ports blocked (legacy 92L50)
4 – Symmetric - 25ℓ/min - At Failsafe -all ports blocked (legacy 92L25)
5 – Symmetric -100ℓ/min - At Failsafe -P port blocked, A,B,T connected (legacy 96L100)
6 – Symmetric - 80ℓ/min - At Failsafe -P port blocked, A,B,T connected (legacy 96L80)
7 – Symmetric - 50ℓ/min - At Failsafe -P port blocked, A,B,T connected (legacy 96L50)
8 – Symmetric - 25ℓ/min - At Failsafe -P port blocked, A,B,T connected (legacy 96L25)
17 – Asymmetric -100ℓ/min A; 70ℓ/min B - At Failsafe -all ports blocked (legacy 92L100N70)
18 – Asymmetric -100ℓ/min A; 50ℓ/min B - At Failsafe -all ports blocked (legacy 92L100N50)
19 – Asymmetric -100ℓ/min A; 25ℓ/min B - At Failsafe -all ports blocked (legacy 92L100N25)
20 – Asymmetric - 50ℓ/min A; 25ℓ/min B - At Failsafe -all ports blocked (legacy 92L50N25)
21 – Asymmetric -100ℓ/min A; 70ℓ/min B - At Failsafe -P port blocked, A,B,T connected (legacy 96L100N70)
22 – Asymmetric -100ℓ/min A; 50ℓ/min B - At Failsafe -P port blocked, A,B,T connected (legacy 96L100N50)
23 – Asymmetric -100ℓ/min A; 25ℓ/min B - At Failsafe -P port blocked, A,B,T connected (legacy 96L100N25)
24 – Asymmetric - 50ℓ/min A; 25ℓ/min B - At Failsafe -P port blocked, A,B,T connected (legacy 96L50N25)
25 – 2-gain Symmetric –10ℓ/min @ 40% -100ℓ/min @100%-@Failsafe -all ports blocked (legacy 92L10T100)
26 – 2-gain Symmetric – 5ℓ/min @ 40% - 50ℓ/min @100%-@Failsafe -all ports blocked (legacy 92L05T50)
27 – 2-gain Symmetric –10ℓ/min @ 40% -100ℓ/min @100%-@Failsafe -P port blocked, A,B,T connected (legacy 96L10T100)
28 – 2-gain Symmetric – 5ℓ/min @ 40% - 50ℓ/min @100%-@Failsafe -P port blocked, A,B,T connected (legacy 96L05T50)

5 **Valve Special Feature**

NS – Not Selected

6 **Command Signal**

1 – +/- 10V voltage command signal
2 – +/- 4-20mA current command signal
3 – +/- 10mA current command signal
4 – +/- 15mA current command signal
5 – +/- 20mA current command signal

7 **Monitor Output**

1 – ±10V voltage feedback signal
2 – 4-20mA current feedback signal

8 **Electrical Connection**

C – 7 pin connector without plug
E – 7 pin connector with plug
H – As E but with pin "C" used for enable signal
R – As C but with pin "C" used for enable signal

13 **Electrical Special Feature**

NS – Not Selected

14 **Software Revision**

XXX – Software Revision

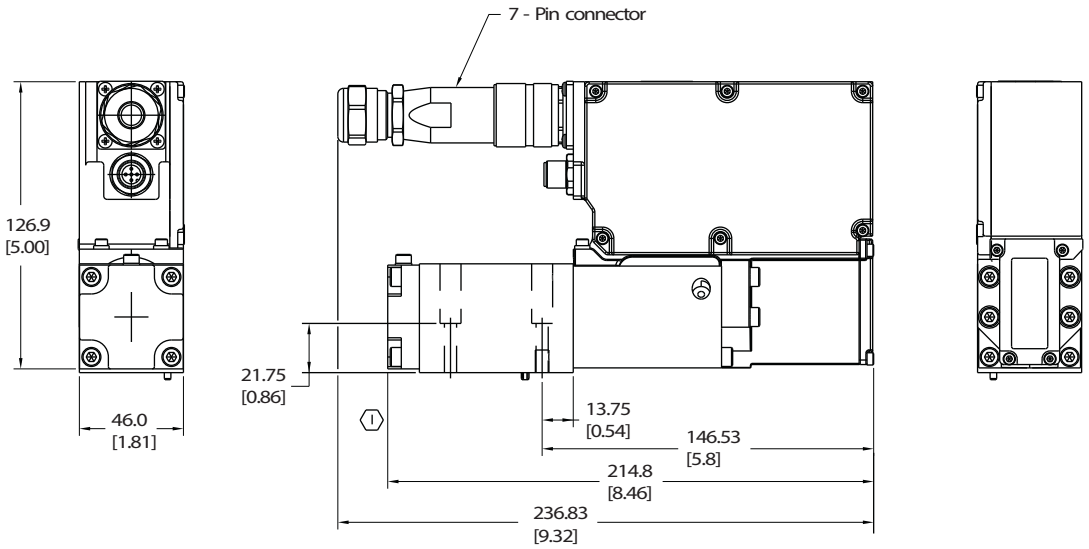
15 **Design Number**

11 series

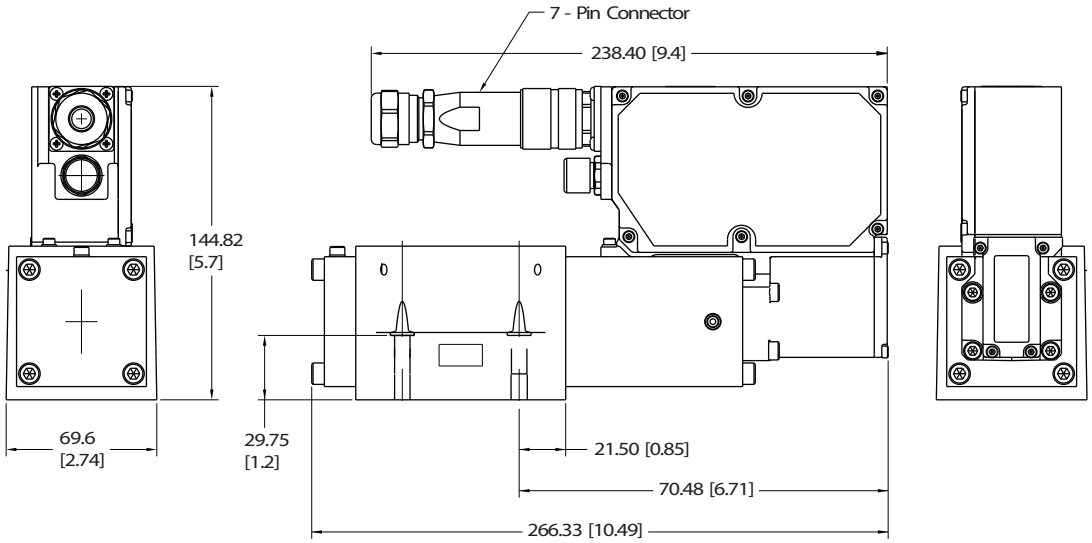
To find available product configurations go to www.danfoss.com

Installation dimensions

KBS1-03



KBS1-05



Mountingsurfaces

KBS1-03

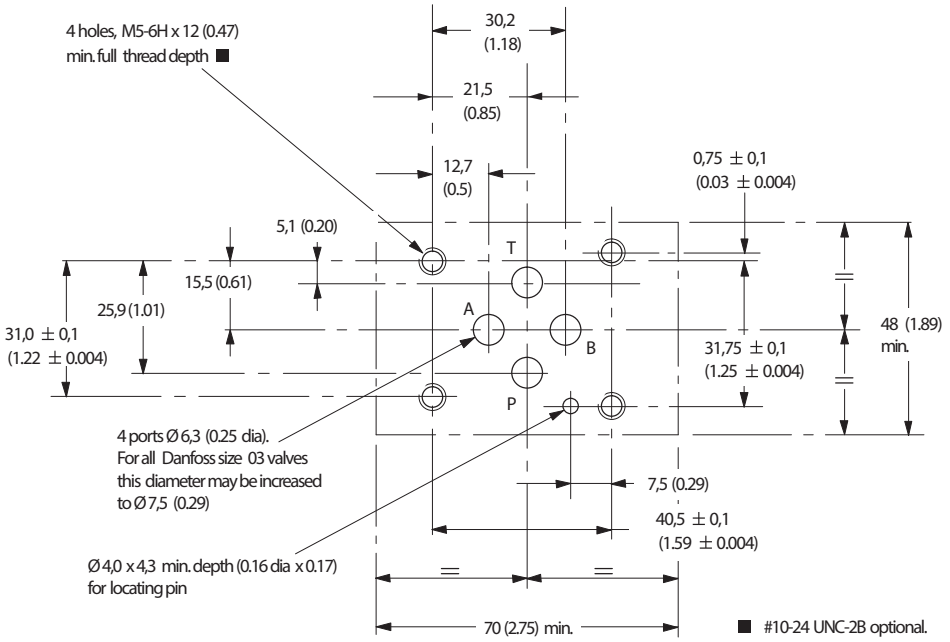
Mounting Surfaces to ISO 4401 (Size 03)

This interface conforms to: ISO 4401-03-02-0-94 plus location pin hole

ANSI/B93.7M (and NFPA) size 03

CETOP R35H4.2-4-03, plus location pin hole

DIN 24340 Form A6 plus location pin hole



KBS1-05

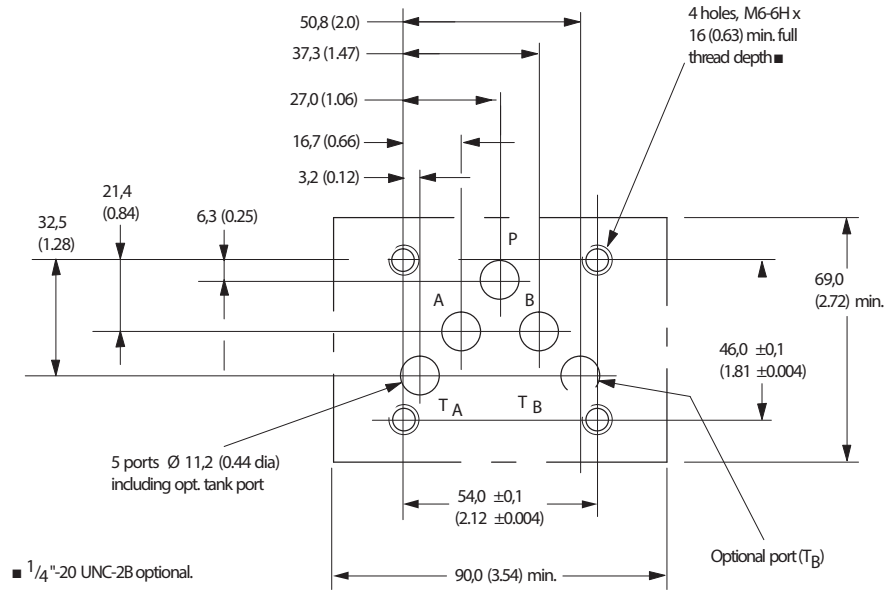
Mounting Surface Interface to ISO 4401 (Size 05)

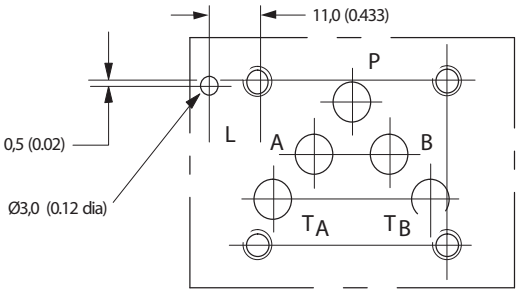
This interface conforms to: ISO 4401-05-04-0-05

ANSI/B93.7M (and NFPA) size 05

CETOP R35H4.2-05

DIN 24340 Form A10

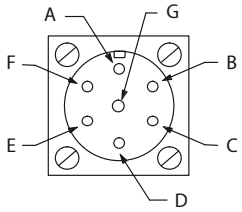




Operating Data

Connector Details

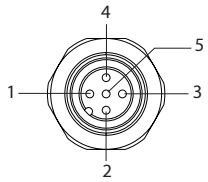
7-pin plug connector



Pin	Description
A	Power supply positive (+)
B	Power supply 0V and current command return
C	Not connected (Field 8 = C,E)
C	Valve enable (Field 8 = H,R)
D	Command signal (+V or current in)
E	Command signal (-V or current GND)
F	Output monitor
G	Protective earth

Note:
Present at location 1 of the electronics enclosure (see figure 1 below).
To ensure EMI protection use only metal shielded mating connectors. Mating 7-pin (connector) is Danfoss part number 934939

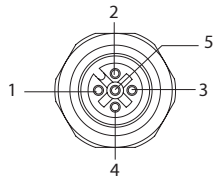
M12 5-pin CAN Connector (Male)



Pin	Description
1	CAN shield
2	Not Connected
3	Power supply 0V
4	CAN High
5	CAN Low

Note:
Present at location 2 and 4 of the electronics enclosure (see figure 1 below). Selection based on model code field number 9, present when CO option enabled.
To ensure EMI protection use only metal shielded mating connectors
Use only shielded twisted pair (STP) cables for mating connection.

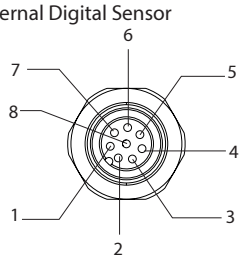
M12 5-pin CAN Connector (Female)



Pin	Description
1	CAN shield
2	Not Connected
3	Power supply 0V
4	CAN High
5	CAN Low

Note:
Present at location 5 of the electronics enclosure (see figure 1 below). Selection based on model code field number 9, present when CO option enabled.
To ensure EMI protection use only metal shielded mating connectors
Use only shielded twisted pair (STP) cables for mating connection.

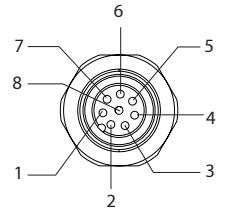
M12 8-pin External Digital Sensor



Pin	Description
1	Power supply 0V
2	+24V Supply
3	CLK-
4	DATA-
5	DATA+
6	Not Connected
7	CLK+
8	Not Connected

Note:
Present at location 3 of the electronics enclosure (see figure 1 below). Selection based on model code field number 10, present when D option enabled.
To ensure EMI protection use only metal shielded mating connectors
24V to Power supply 0V (pin 2, 1) short circuit protected (max current 1.5 A).
Use only shielded twisted pair (STP) cables for mating connection.

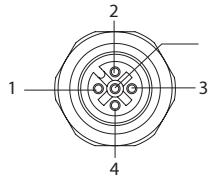
M12 8-pin External Analog Sensor Port



Pin	Description
1	Speed Sensor Input1
2	Speed Sensor Input2
3	4-20mA External Sensor Signal1
4	+15V Supply
5	4-20mA External Sensor Signal2
6	Power supply 0V
7	4-20mA External Sensor Signal3
8	4-20mA External Sensor Signal4

Note:
Present at location 3 of the electronics enclosure (see figure 1 below). Selection based on model code field number 10, present when A option enabled.
To ensure EMI protection use only metal shielded mating connectors
15V to Power supply 0V (pin 4, 6) short circuit protected (max current 500 mA).

M12 4-pin Ethernet Connector (Female)



Pin	Description
1	TxD+
2	RxD+
3	TxD-
4	RxD-

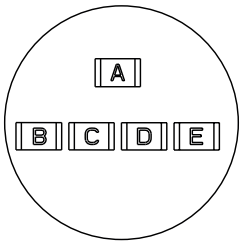
Note:
Present at location 4 and 5 of the electronics enclosure (see figure 1 below). Selection based on model code field number 9, present when PN,EC or ET option enabled.
Location 4 is Ethernet Channel 0 Location 5 is Ethernet Channel 1
M12 connector is D-Coded

To ensure EMI protection use only pre made CAT5 or CAT 6 cable

Operating Data

Data is typical, with fluid at 32 cST (150 SUS) and 40°C (104°F)

Diagnostic



Color	Description CO	PN	ET	EC
A [Green]	Power	Power	Power	Power
B [Red]	CAN Error	PN Diagnostic (SF)	ET Module Status	EC Error
C [Green]	CAN Run	Valve Diagnostic	Valve Diagnostic	EC Run
D [Red]	Diagnostic	PN Network Status (BF)	ET Network Status	Valve Diagnostic
E [Green]	Status	Valve Status	Valve Status	Valve Status

Note:

1. Figure to the left references the clear plastic window on the top of the valve.

LED status depends on Network option choosen (CO/PN/ET/EC.

Electromagnetic compatibility (EMC):	IEC61326-1 2021
Monitor Points Signal: Voltage mode Current mode Output impedance	 ±10V DC 4 to 20 mA 10 kΩ
Power stage PWM frequency	20 kHz nominal
Reproducibility, valve-to-valve (at factory settings): Flow gain at 100% command signal	 ≤5%
Protection: Electrical	 Reverse polarity protected between pin A and B of the 7 pin plug connector
Ambient air temperature range for full performance Oil temperature range for full performance	–25°C to +85°C (–13°F to +185°F) CN version -25°C to 70°C PN version 0°C to +60°C (32°F to +140°F)
Minimum temperature at which valves will work at reduced performance	 –20°C (–4°F)
Storage temperature range	–25°C to +85°C (–13°F to +185°F)
Power supply	24V DC (18V to 36V including 10% peak-to-peak max ripple) max current 3,7A
Command Signal: Voltage mode Input impedance Voltage between Pin D and B Voltage between Pin E and B Current mode Max differential voltage to pin E to pin B	 –10V to +10V DC 13 bit resolution, ± 1% Field 6 = 1: 47kΩ, Field 6 = 2,3,4,5: 100Ω Field 6 = 1:18v (max) Field 6 = 1:18v (max) Field 6 = 2,3,4,5: 13 bit resolution based on ±20mA, ±1%Field 6 = 2,3,4,5: 100 mV
Valve enable signal for model code field 8 = H or R Enable Disable Input impedance	 Disable <6.5V Enable Signal >8.5V (max 36V) 10 kΩ
Sensor Resolution: External Sensor Port	 4-20 mA: 0-20mA 12 bit resolution ± 1%, 3mA cable break detect, 22mA overcurrent detect. Speed, independent frequency mode: 10Hz to 100 kHz. Speed, incremental count and direction + frequency mode: signed 32bit count, 0 to 100 kHz. Speed, quadrature phase A&B + frequency mode: signed 32 bit count, 0 to 100 kHz. SSI: binary or gray code, 32bits max, adjustable resolution and zero offset.
Integrated Pressure and Temperature Sensors	Integrated PCB temperature sensor accuracy: ± 2°C For Level 3 valves: Integrated Pressure sensors on all ports Pressure sensors rated to 400bar Integrated Pressure sensors accuracy: ± 0.5% of full scale Bandwidth: >100 Hz Integrated temperature sensor on tank port Accuracy: ± 5°C Bandwidth: ~1 Hz
Amplifier Temperature Sensing	1°C (1.8°F) resolution, -25°C (-13°F) undertempdetect, 125°C (257°F) overtemp detect
Power Supply Detect	18-36Vdc, 0.01 V resolution ± 1%, 19V under voltage detect, 36V overvoltage

Operating Data

KBS*-03 Valves (all valves)	
Relative duty factor	Continuous rating (ED = 100%)
Hysteresis	<0.1%
Mass	2.49 kg (5.5 lb) approx.
Environmental	IP65 and IP67 rated when using a similarly rated connector Location 2, 3, 4 and 5 connectors have IP65 and IP67 rated shipping covers
Step response:	
Step, % Flow	ms
0% to 100%, 100% to 0%	8.0
10% to 90%, 90% to 10%	8.0
-10% to 10%, 10% to -10%	7.0
25% to 75%, 75% to 25%	7.0
Parts Information:	
Interface Seal Kits	02-147573
Mating Electrical 7-pin Connector	934939

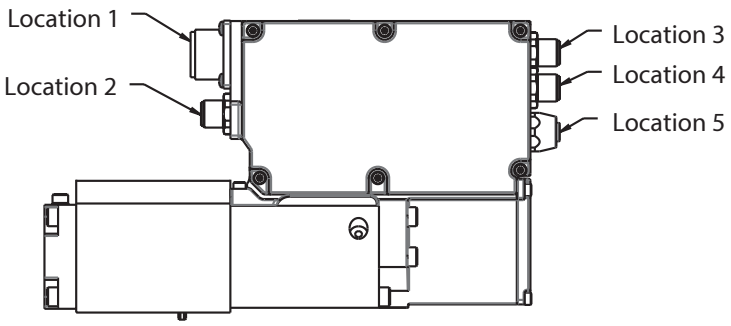


Figure 1

Note: See above for connector plugs specifications.

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