

Pro-FX[®] Configure

KBSD14, KBFD/TG4 & KBHD15 configuration and commissioning guide

June 2025

Version 1.1



Contents

1 General Information 6

1.1 How to Use this Guide 6

1.2 AxisPro Product Overview 6

1.3 Potential Platforms 6

2 Product Information 6

2.1 Introduction 6

2.2 General Description 7

2.3 Unique benefits from AxisPro 7

2.4 Software Information 7

3 Pro-FX™ Installation/Uninstallation Guide 7

3.1 System Requirements 7

3.2 Installation Guide 7

3.3 Uninstallation Guide 9

4 Overview of Pro-FX Configure for AxisPro 9

5 AXISPRO CONFIGURATION 10

5.1 AxisPro Configuration with Pro-FX™ Configure Wizard 11

5.1.1 Launch Pro-FX™ 11

5.1.2 Device Info 12

5.1.3 Command and Monitor 13

5.1.4 Ramp 14

5.1.5 Flow Shaping 15

5.1.6 Gain deadband 15

5.1.7 Dither 16

5.1.8 Remote Start 16

5.2 Backup Configuration File 17

5.3 Advance Mode 17

5.4 Restore All Parameters To Factory Default 18

5.5 TPDO and RPDO Configuration for CANopen Communication 18

6 Cables and connections 19

6.1 Primary Connector 19

6.2 CAN bus Connections 20

6.2.1 Node-ID [2002s1] and Bitrate [2002s2] 20

6.2.2 Heartbeat and Life-guarding (node-guarding) Protocols 20

7 NMT Startup [1F80s0] 21

8 Process Data Objects (PDO)s 21

8.1 Mapping and Communication Objects 22

8.1.1 RPDO Communication objects [14xx] 22

8.1.2 RPDO Mapping objects [16xx] 22

8.1.3 TPDO Communication objects [18xx] 23

8.1.4 TPDO Mapping objects [1Axx] 24

9 Other Sensors 25

9.1	Electronic Temperature	25
9.2	Power Supply Voltage.....	26
9.3	Drive voltage.....	26
10	LED Indicators	27
10.1	CANopen LED indication details	27
10.2	Profinet LED indication details	28
10.3	Ethernet/IP LED indication details.....	29
10.4	EtherCAT LED indication details	30
11	Diagnostics Functions	30
11.1	Standard Diagnostics [5B00]	31
11.1.1	Enables [5B00s2] : Diagnostics Voltages LVDT Coils.Voltages LVDT & Coils Enable Word..	31
11.1.2	Enables [5B00s3] : Diagnostics PCB temperature, Controller internal temperature, spool position and monitor output voltage Enable Word.....	32
11.1.3	Enables [5B00s4] : Diagnostics Safety relay. Enable ACK and error out Enable Word.....	32
11.1.4	Enables [5B00s5] : Diagnostics Custom faults Enable Word	33
12	Fault Management.....	33
12.1	Error Status Bits [3E6F] and Error Codes	33
12.2	Error Status Bits [3E6F] and Error Codes	33
12.3	Error Fields [1003]	35
12.4	Emergency messages.....	35
12.5	Abort codes	35
13	Device Control Modes Details.....	36
13.1	Device Control Mode – None [4102s0 = 0].....	36
13.2	Device Control Mode – Valve Current Control – VCC [4102s0 = 1]	36
13.3	Device Control Mode – Valve Spool Control – VSC [4102s0 = 2].....	36
13.3.1	Valve Spool Control CAN setpoint Value [3016s02]	36
13.3.2	Valve Spool Control Feedback value [3052s01].....	36
13.3.3	Valve Spool Control DVG Demand value [3D00s1C].....	36
13.3.4	VSC Reference value (100% of physical capabilities) for direction A & B [4D11s01].....	37
13.3.5	VSC DVG Upper Limit value [4D20s01]	37
13.3.6	VSC DVG Lower Limit value [4D21s01]	37
13.3.7	VSC DVG Demand Ramp Type [4D30s0]	37
13.3.8	VSC DVG Ramp Type 3 Positive Input Accel value [4D32s1]	37
13.3.9	VSC DVG Ramp Type 3 Negative Input Accel value [4D33s1].....	37
13.3.10	VSC DVG Ramp Type 3 Positive Input DeCell value [4D35s1].....	37
13.3.11	VSC DVG Ramp Type 3 Negative Input DeCell value [4D36s1]	37
13.3.12	VSC DVG Directional Dependent Gain Type [4D40s0].....	38
13.3.13	VSC DVG Directional Dependent Gain Factor	38
13.3.14	VSC Dither Type [4D60s0]	38
13.3.15	VSC Dither Amplitude [4D61s1]	38
13.3.16	VSC Dither Frequency [4D62s1]	39
14	Miscellaneous Options.....	39

14.1	Save parameters to EEPROM [1010s1]	39
14.2	Restore factory defaults [1011s1]	39
14.3	Service Key/Password [2000s2].....	39
14.4	Valve Enable-Input Enable [4005s1].....	40
14.4.1	Pin C state machine logic activation	40
14.4.2	Pin C logic function	40
14.4.3	Pin C additional logic.....	40
14.5	Valve Enable Threshold [4005s7]	40
14.6	Signal Generator Functions	40
14.6.1	Signal Shape [4013s1]	41
14.6.2	Amplitude [4013s2]	42
14.6.3	Frequency [4013s3]	42
14.6.4	DC Offset [4013s4]	42
14.7	Monitor Output Functions.....	42
14.7.1	Monitor Output Type [4C00s1].....	42
14.7.2	Monitor Output Mode [4C00s2]	43
14.7.3	Monitor Output Monitored Object Dictionary Index [4C00s3]	43
14.7.4	Monitor Output Monitored Object Dictionary Subindex [4C00s4]	43
14.7.5	Monitor Output Max Voltage Signal [3E7Fs1]	43
14.7.6	Monitor Output Min Voltage Signal [3E7Fs2].....	43
14.7.7	Monitor Output Mid Voltage Signal [3E7Fs3].....	43
14.7.8	Monitor Output Max Current Signal [3E7Fs4]	43
14.7.9	Monitor Output Min Current Signal [3E7Fs5].....	43
14.7.10	Monitor Output Mid Current Signal [3E7Fs6].....	43
15	Device state machine.....	44
15.1	Device Control Word [4100s0]	44
15.2	Device Status Word [3100s0]	44
15.3	Setpoint Interface Reference	45
15.4	Device Control Mode [4102s0].....	45
15.5	Device Error Code [3E5Fs1]	46
15.6	Device Local [4101s0]	46
15.7	Device Code Number [5100s4].....	46
15.8	Device Model Description [6054s0]	46
15.9	Device Capability [605Fs0]	46
15.10	PDO Mapping	47
15.11	Failsafe to active valve state	47

Warnings and Cautions

The description and specifications contained in this service publication are current at the time of printing.

Danfoss reserves the right to discontinue or modify its models and/or procedures and to change specifications at any time without notice.

Any reference to brand name in this publication is made as an example of the types of tools and materials recommended for use and should not be considered an endorsement. Equivalents may be used.

WARNING

Warning indicates severe injury, or death may result if the indicated procedure is not followed.

CAUTION

Caution indicates an immediate hazard, which could result in severe personal injury if the indicated procedure is not followed.

IMPORTANT

Important indicates vehicle or property damage could occur if the indicated procedure is not followed.

Note: Note indicates additional details that will aid in the service or repair of components or systems.

Warnings and
Cautions

1 General Information

1.1 How to Use this Guide

This Danfoss publication is intended to be a reference guide for the application of the AxisPro product. This information benefits the installer by providing the correct application requirements and component specifications to ensure the utmost in satisfactory operation and performance.



Attention: Risk of voiding warranty.

This Application Guide provides application requirements and recommendations which are collectively required and necessary for the proper functioning of AxisPro Application. Failure to follow these procedures, recommendations, and requirements will void the warranty in certain cases. Please contact your Danfoss representative before taking any action departing from this application guide.

1.2 AxisPro Product Overview

In today’s competitive environment, manufacturers need to build machines that maximize efficiency, reliability and throughput for their customers. And they’re developing smart machines to do it.

As part of our advanced class of Pro-FX™ Ready products, AxisPro hydraulic valves out-perform traditional valves by offering innovative design with intelligent controls and onboard diagnostics built right into the valve. This eliminates the need to order and integrate them, which makes the entire system easier to set up, commission, tune and troubleshoot.

AxisPro proportional hydraulic valves are quick and easy to configure, allowing changes to be made in real time, giving you the flexibility to create custom solutions for the most sophisticated, demanding applications. Three levels of control are available – from basic onboard electronics for traditional applications, to onboard motion control that increases dynamic performance and simplifies PLC requirements.

AxisPro hydraulic valves help you get the best, most efficient system performance possible – while saving time, energy and money – helping you stay ahead of the curve, and the competition.

1.3 Potential Platforms

Example platforms are shown below:

- Plastics Machinery
 - Injection molding machine
 - Blow molding machine
- Primary Metal
- Industrial Machinery
- Press Machines
- Test Equipment and Simulation
- Machine Tooling
- Turbine Control
- Wood Processing

2 Product Information

2.1 Introduction

AxisPro is a game changing machine control valve. Its embedded intelligence simplifies traditionally complex control practices. Plug and play design reduces machine build time, and its ability to predict potential maintenance issues increases machine reliability.

2.2 General Description

Built on the proven KBS servo Proportional Valve technology, the AxisPro Proportional Valve provides a range of control capabilities in a modular design.

These four-way solenoid operated proportional valves offer high dynamic performance which enables them to be used in closed-loop control applications previously only possible using servo valves. Best-in-class ingress protection rated to IP65 and IP 67, combined with up to 85°C (185°F) ambient temperature allows operation in demanding environments.

2.3 Unique benefits from AxisPro

Reliable, extended uptime is enabled by valve and systems diagnostics capability. LEDs provides on-valve diagnostics information for valves. Access to systems and machine health data can be made available via CANopen and Ethernet networked valves.

Leverage inventory of AxisPro valves by configuration through software. One valve SKU can serve multiple needs: Valves can be configured via Danfoss’s Pro-FX™ Configure software tool for optional command signal: Voltage or current, as well as activating the “enable”-pin. Valves can also have CAN and Industrial Ethernet bus activated and control modes selected and configured.

2.4 Software Information

- Analog commanded spool control.
- Analog command source configuration options.
- Monitor output signal configuration options.
- Enable input signal enable/disable option.
- valve spool position control (VSC).
- CANopen DSP306 compliant electronic data sheet (EDS).
- Diagnostic configuration options.

3 **Pro-FX™ Installation/Uninstallation Guide**

This section provides general software usage information for version 2.6.1 of Pro-FX™ Configure for AxisPro.

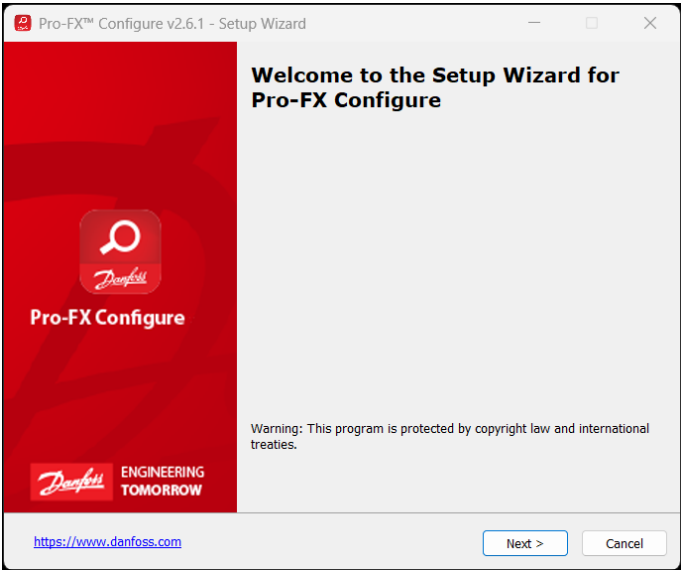
3.1 System Requirements

To successfully run the software, the following environments are supported:

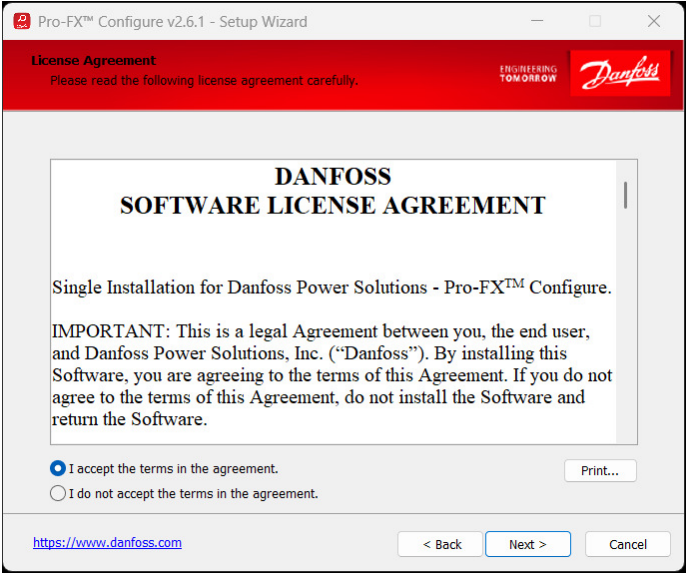
- Processor –1 gigahertz (GHz) or faster processor
- RAM – 1 gigabyte (GB)
- Hard Disk Drive – 16 GB
- USB port
- Operating system –Windows 10 or Windows 11
- Communication Adapters
 - CAN Adapters
 - PCAN
 - VALUECAN
 - CG150
 - KVASER
 - SOFTING
 - Ethernet cable
 - Serial cable

3.2 Installation Guide

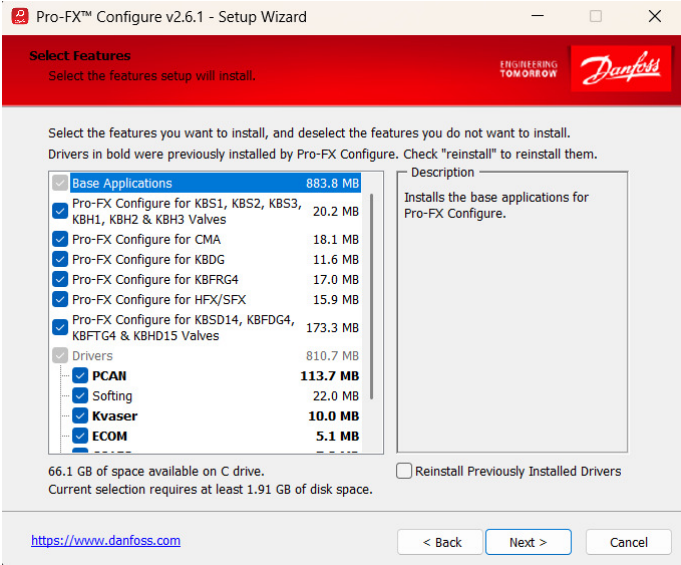
1. Launch the “Pro-FX_Configure_v2.6.1.exe”.
2. Click Next from the Welcome screen.



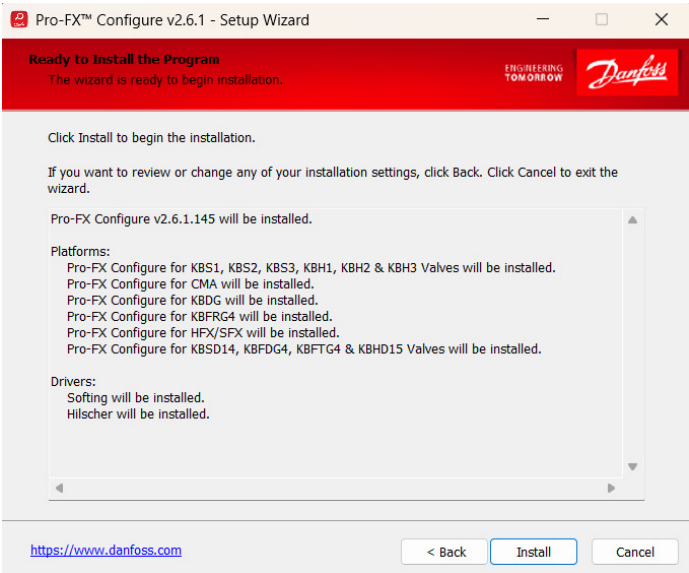
3. Agree to the software license and click Next.



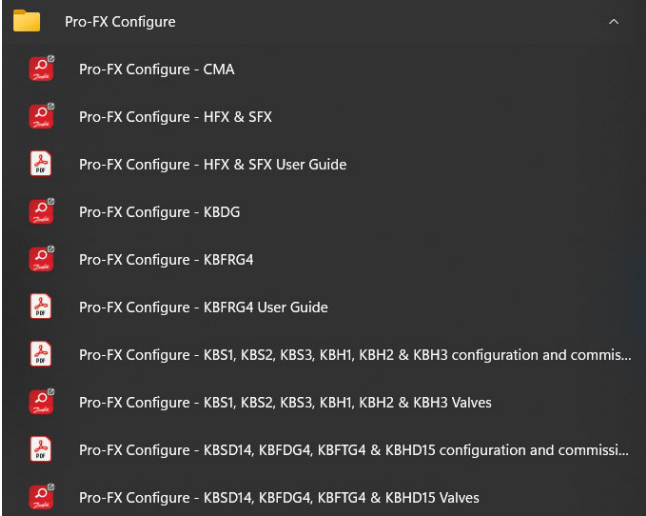
4. Choose Packages that you want to install or just click on Next button and all the packages will get installed.



5. Click Install from the Ready to Install dialog.

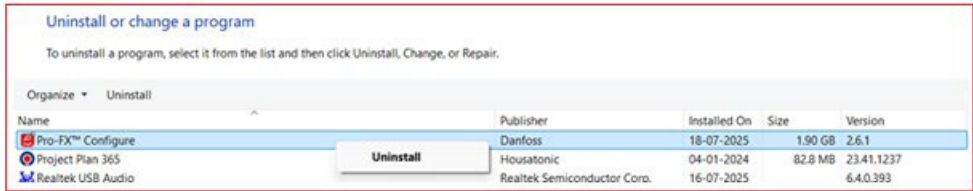


Once the installation is complete, desktop shortcuts for the applications will be created as well as Start Menu shortcuts



3.3 Uninstallation Guide

To uninstall Pro-FX™ Configure, go to Control Panel ->Programs -> Programs and Features-> select Pro-FX™ Configure and click Uninstall.



4 Overview of Pro-FX™ Configure for AxisPro

Please use the following link to download the User Guide:
<https://assets.danfoss.com/documents/latest/526007/AU532919060887en-000101.pdf>

5 **AXISPRO CONFIGURATION**



Introducing the next generation of Pro-FX™ Configure for AxisPro, Danfoss’s software for configuring and tuning advanced valves. Pro-FX™ Configure 2.0 features a complete wizard-based setup as well as parameter-based tuning, enabling users to quickly and easily configure AxisPro valves. A streamlined, step-by-step workflow takes the user through valve setup for the specified control mode. Gone are the OD tables of the past (don’t worry, they’re still available in advanced mode). And while there are still help links, users may find them unnecessary, unlike previous versions.

The guided process and simplified on-screen graphics significantly improve ease-of-use. Pro-FX™ Configure 2.0 is valve configuration software the way it should be: smarter, faster, easier. The program simplifies everything from setup to tuning to commissioning, helping you get the machine to the customer faster.

Benefits

- Intuitive, user-friendly interface enables quick, simple configuration
- No need to tune PID controller for most applications, saving time

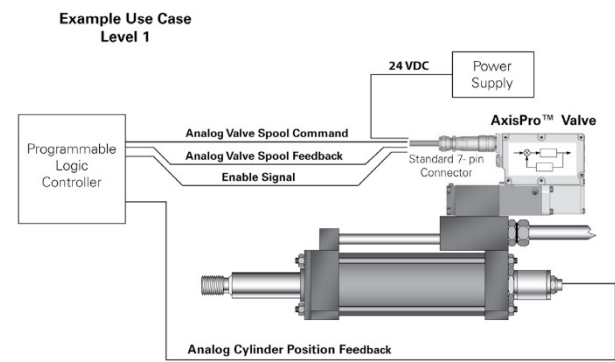
Features

- 100% wizard-based setup
- Parameter-based tuning
- Expanded, improved alert library for diagnostics
- Identifies firmware version and prompts update
- Enables data plotting to help tune the application

Note: All parameters mentioned in this document are referenced using CANopen addresses. For parameter addresses corresponding to other protocols, please refer to the document below.

Link:

5.1 AxisPro Configuration with Pro-FX™ Configure Wizard



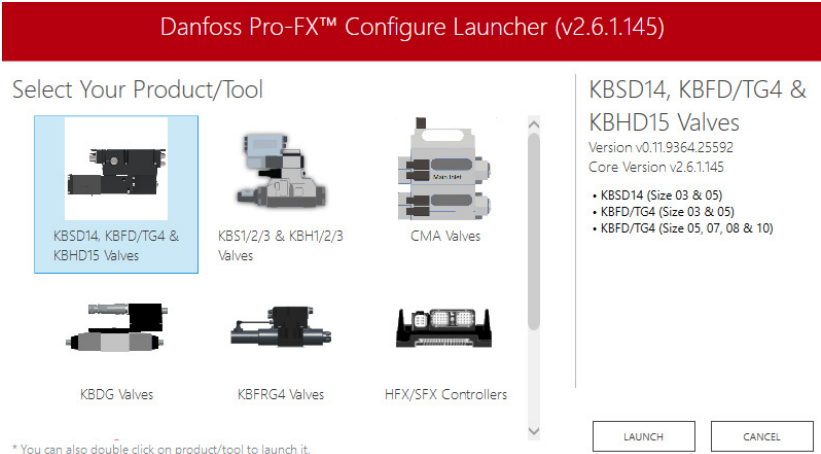
AxisPro valves, such as KBS1-03 (ISO size 3), can be used to control machine motions in open loop or closed loop control applications. The valve receives its analog command input on the 7-pin, main, connector from an external axis control device.

IMPORTANT

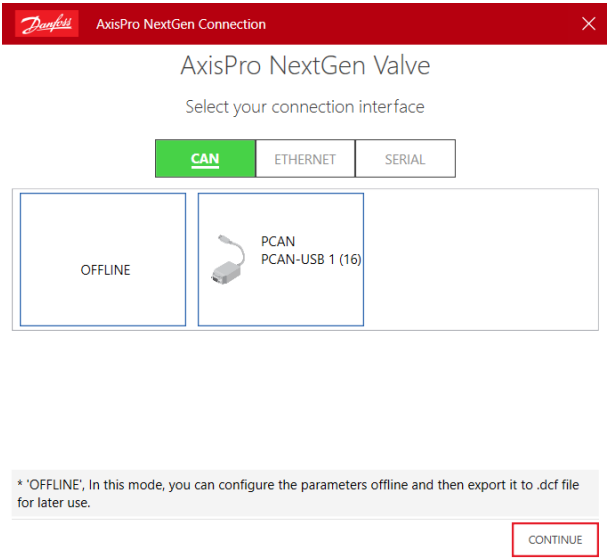
Primary control type for AxisPro valves can only be spool positon control (VSC).

5.1.1 Launch Pro-FX™

Installation process will create desktop icon to launch the application. After launch, the user needs to select the required device platform. This user manual is intended for AxisPro valves (KBSD14, KBFD/TG4 & KBHD15), users need to select this platform as shown in image here:



Next window will provide the communication interface to select. AS per the selected communication, user needs to select the interface on that window.

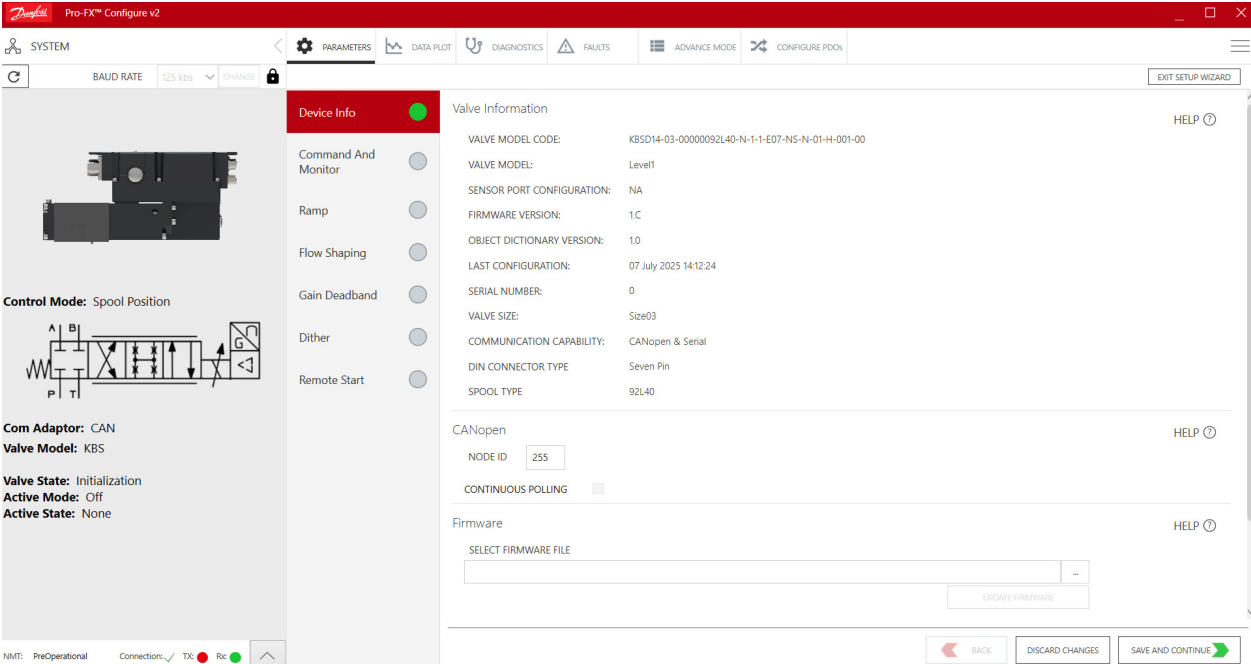


5.1.2 Device Info

Below information can be found on device info tab:

- Valve Information
 - Valve model code
 - Valve model: Level of the AxisPro valve
 - Firmware version
 - Object dictionary version
 - Last configuration
 - Serial number
 - Valve size
 - Communication capability
 - DIN connector type
 - Spool type
- CANopen
 - Node ID: CAN device node id can be configured (default: 255)
 - Baud Rate: CAN device communication speed can be configured (default: 125 kbps)
- Firmware
 - Select Firmware File: For updating firmware

Note: Baud rate should not change from Advance Mode even if it's read-write parameter.



5.1.3 Command and Monitor

Below information can be found on command and monitor tab:

Pin Configuration

Use enable pin: Enable pin can be activated or deactivated. The AxisPro valves are usable with or without enable pin regarding application needs independent of valve model code. Valve model code indicates default features of valve.

Primary Command

Input:

Command I/P Pin D/E states command signal from 7-pin plug connector.

Command I/P pins 4&5 command signals from 12 -pin plug connector.

Input Range: Type of analog command signal

- 0-10 V
- +/- 10 V
- 4-20 mA
- +/- 10 mA
- +/- 15 mA
- +/- 20 mA

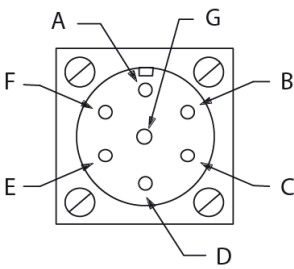
Filter Time Constant: This parameter is adjusting the time constant of a 1st order low-pass filter applied to the input signal. Setting the time constant to 0 disables the filter.

Monitor

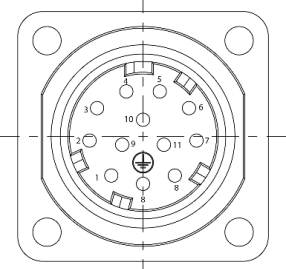
Monitor Over Command I/P pin F: Type of analog monitor signal

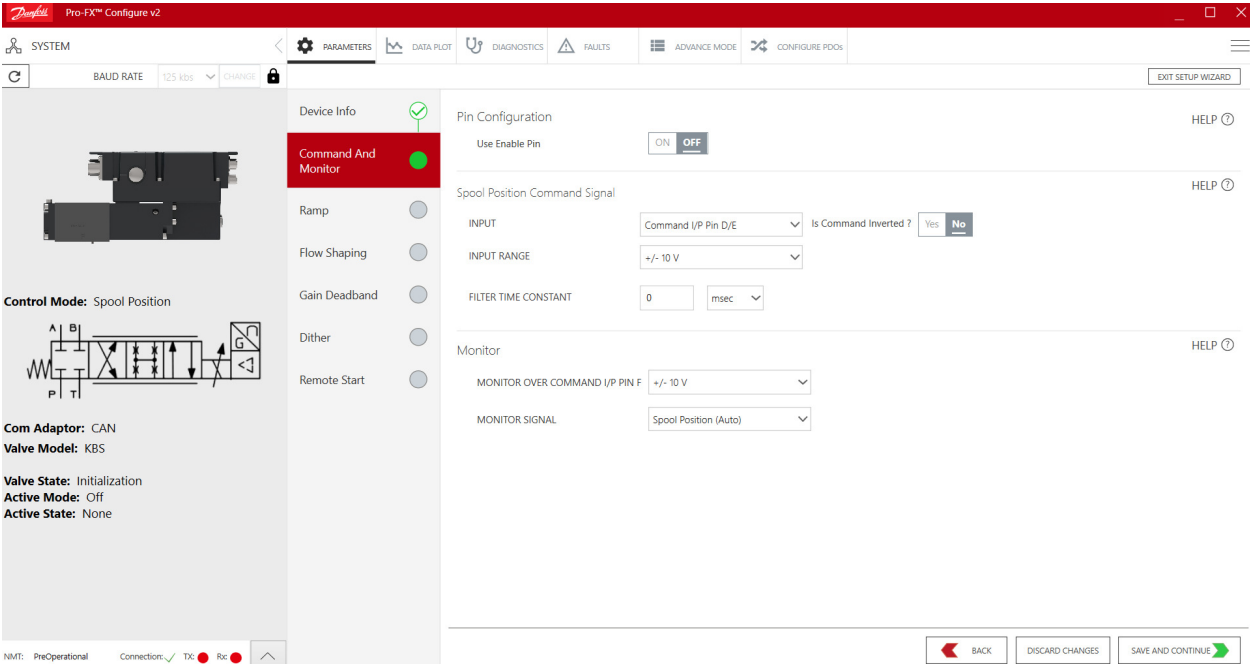
- +/- 10 V
- 4-20 mA
- Disabled
- Monitor Signal: Spool position output signal

7- Pin Plug Connector Command I/P



Pin	Description
A	Power supply +24V
B	Power 0V/Current Return
C	Positive Enable Voltage
D	Positive Voltage Input/Current Input
E	Negative Voltage Input/Current GND
F	Monitor Output
G	Protective

12- Pin Plug Connector Command I/P	
	
Pin	Description
1	+24V
2	Power 0V/Current Return
3	Positive Enable Voltage
4	Positive Voltage Input/Current Input
5	Negative Voltage Input/Current GND
6	Monitor Output
7	NC
8	Enable Acknowledgment(24V)
9	+24V Power Supply
10	Ground
11	Error Output Signal
12	Protective



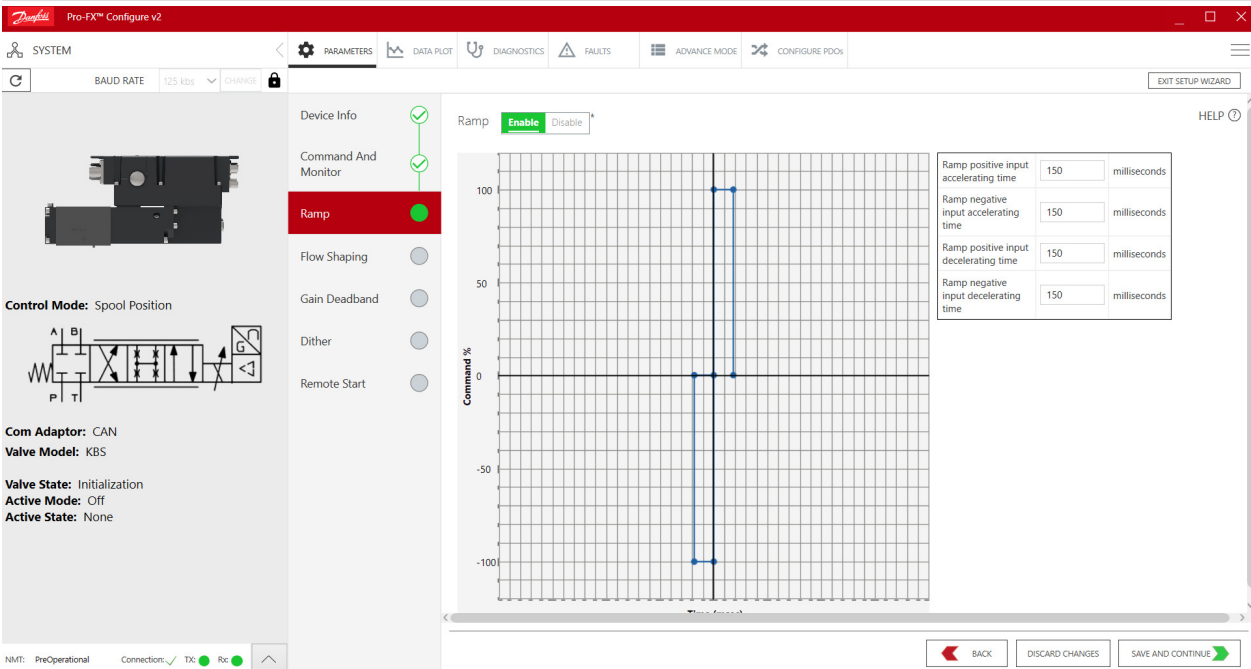
5.1.4 Ramp

The Ramp feature can be used to shape the input command to the valve from a step input to a ramped input. This can be used to better account for system dynamics within the valve response.

Input Limits: 0 to 65535 milliseconds

There are four points that can be adjusted:

- For positive delta commands in the range of 0% - 100%, the positive input accelerating time is adjusted to speed up or slow down the time it takes to achieve the input command.
- For negative delta commands in the range of 0% - 100% the positive input decelerating time is adjusted to speed up or slow down the time it takes to achieve the input command.
- For negative delta commands in the range of 0% - -100% the negative input accelerating time is adjusted to speed up or slow down the time it takes to achieve the input command
- For positive delta command in the range of 0% - -100% the negative input decelerating time is adjusted to speed up or slow down the time it takes to achieve the input command.



5.1.5 Flow Shaping

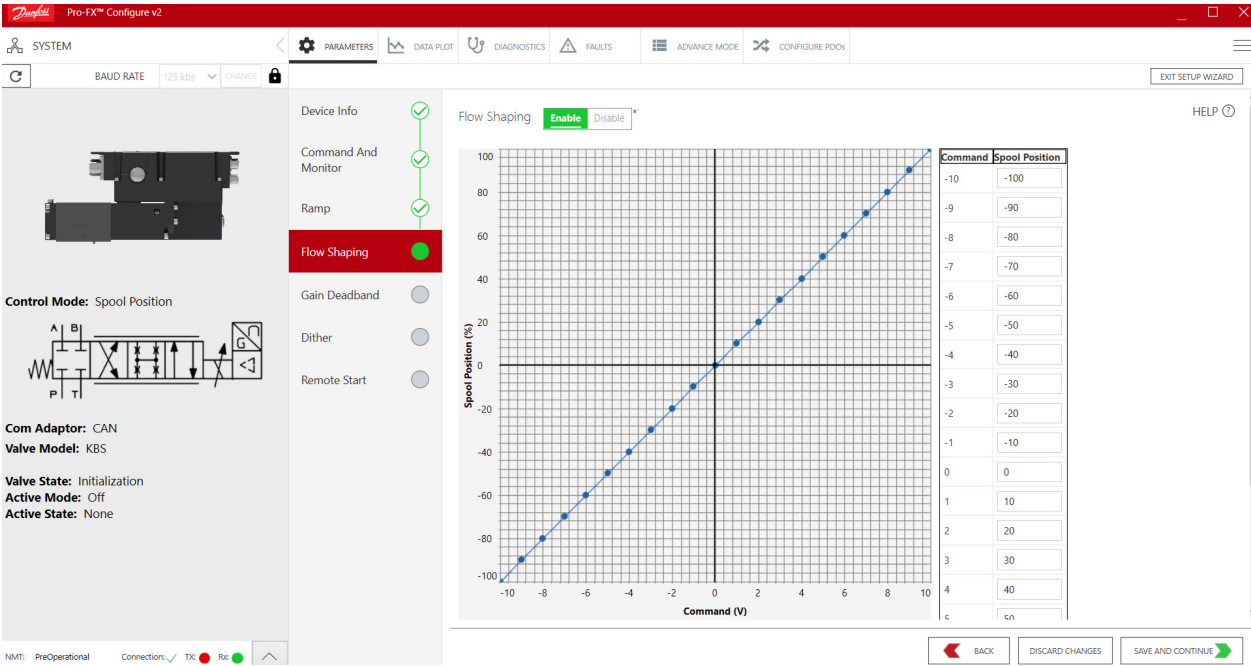
Below information can be found on flow shaping tab:

Flow Shaping: This feature can be enabled for creating different spool configurations electronically. Flow shaping provides customized spool characteristics for application specific needs (cylinder area ratio, two stage gain, zero correction offset, etc.).

Input limits: -100% to 100%

Customized 4:1 asymmetric spool characteristic

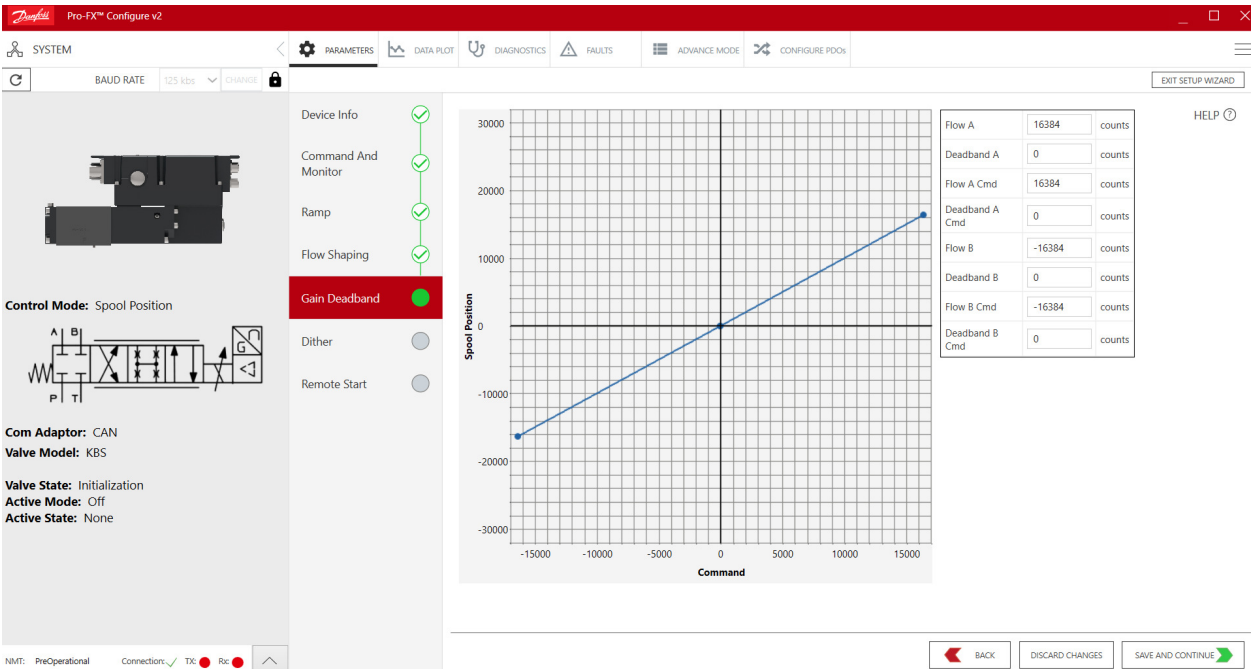
Customized high gain for positive direction and low gain for negative direction spool characteristic. (customized 0/-1 V deadband area)



5.1.6 Gain deadband

The flow gain and deadband for the valve may be modified here. All valves are pre-calibrated to meet the advertised flow gain and are not typically recommended to change. The Flow A value will be the spool position required to meet the 100% flow rating. The Flow B value will be the spool position required to meet the -100% flow rating. However, if a slightly different flow is desired it can be achieved by modifying the Flow A (for command affecting P-A flow) and Flow B (for command affecting P-B flow) values. *WARNING! Modifying these values will affect the advertised flow gain curve of the valve and may have an impact on the performance of the valve.*

The deadband values can be used to add an offset to the spool position command around null – Deadband A (for command affecting P-A flow) and deadband B (for command affecting P-B flow). These values can be adjusted to achieve slightly more or slightly less deadband. *WARNING! Modifying these values will affect the advertised flow gain curve of the valve and may have an impact on the performance of the valve.*



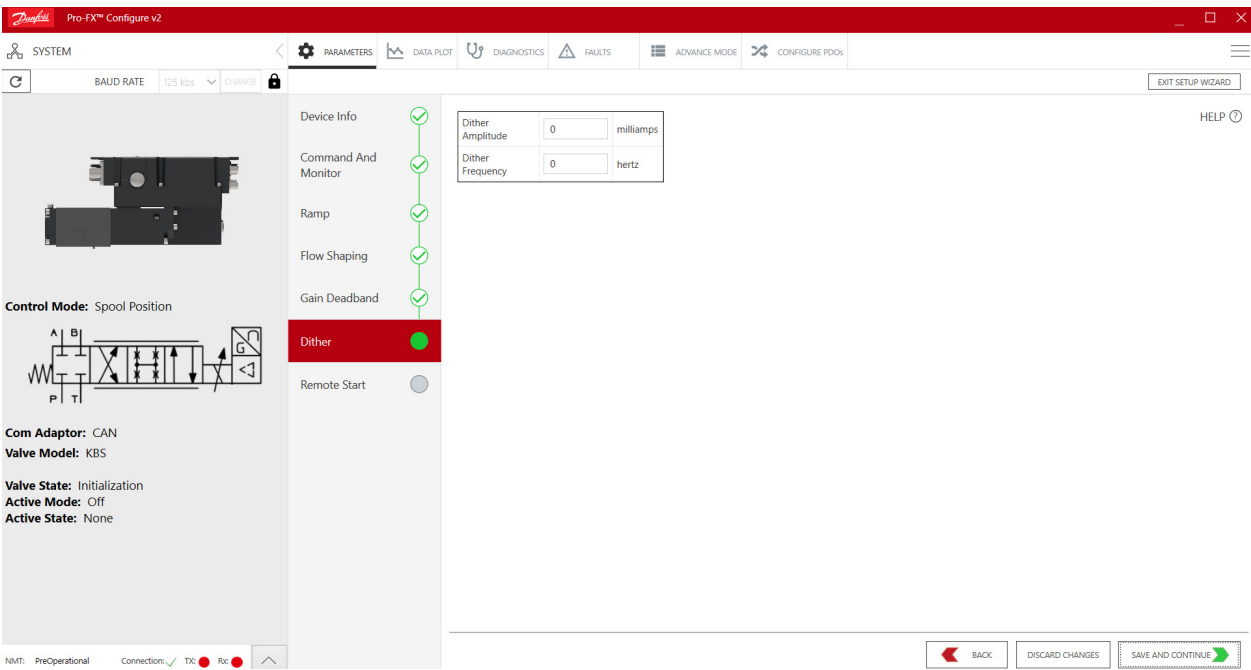
5.1.7 Dither

Dither may be added to the spool position command of the calve. This adds a set amount of noise to the command signal.

Below information can be found Dither table:

Dither Amplitude

Dither Frequency



5.1.8 Remote Start

Below information can be found on remote start tab:

Startup Mode:

LOCAL CONTROL: The valve will go active on power-up without any additional commands.

CANOPEN REMOTE START: The valve will require a NMT start message and the Control word needs to be set to go Active.

After completing setup wizard the valve is ready for using, advanced configuration, internal control on data plot and diagnostics.

5.2 Backup Configuration File

File segment under the hamburger menu  button has import and export section. You can save configuration file (.dcf) and you can import it to valve when you need to return to your first backup setting.

5.3 Advance Mode

You can find the all parameter of valve in the advance mode tab. All parameters has OD index, OD Subindex, Name, Value, Status, Access, Protection Mode, Unit and Description.

Note: You need engineering log-in for accessing Factory Write Only parameters.

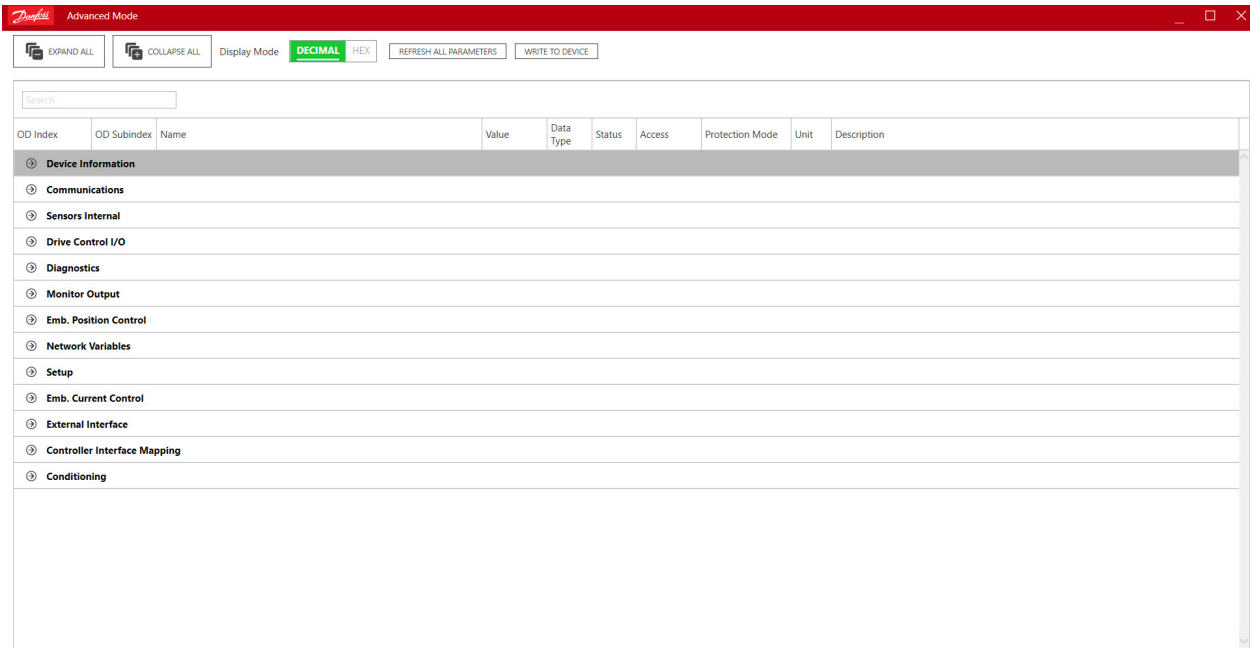
WARNING

Only experts should change advance parameter of valve. Incorrect parameter changes can occur undesirable results.

Note: Parameters display mode can be selected as decimal / hex.

Below information can be found on advance mode tab:

- Device Information
- Communications
- Sensors Internal
- Drive Control I/O
- Diagnostics
- Monitor Output
- Emb. Position Control
- Network Variables
- Setup
- Emb. Current Control
- External Interface
- Controller Interface Mapping
- Conditioning



5.4 Restore All Parameters To Factory Default

All parameters can be restored to factory default values in advance mode.

Communication

- Restore: All parameters restore – write ASCII characters load (0x6C6F6164) to this index to restore factory default values to RAM and EEPROM for all parameters. Read returns 0x01 to indicate ability to restore this section. Node-id and baudrate are not restored. Service key is restored to default value.

Restore							
1011	1	Restore Parameters.Restore All Factory Default Parameters	1	UInt	Saved	Read/Write	Read Any

5.5 TPDO and RPDO Configuration for CANopen Communication

Necessary parameter can be received and transmitted to controller or another CANOpen devices with CAN bus protocol. AxisPro has already prepared TPDO and RPDO mapping for the default application. But it can be arranged for needs of application in advance mode.

The below picture shows the default configuration of TPDO-1. (Display mode is HEX)

Pro-FX™ Configure Pdo Configuration

Transmit PDOs

Receive PDOs

Search

TPDO Number	COB ID	Inhibit Time	Event Rate	Mapped Entries No	Mapped Entries	Edit
TPDO 1	40000180	0	100	2	3100Sub0 3101Sub0	EDIT
TPDO 2	40000280	0	100	2	3D00Sub1C 3405Sub0	EDIT
TPDO 3	C0000380	0	100	0		EDIT
TPDO 4	C0000480	0	0	0		EDIT
TPDO 5	C00001A0	0	0	0		EDIT
TPDO 6	C00002A0	0	0	0		EDIT
TPDO 7	C00003A0	0	0	0		EDIT
TPDO 8	C00004A0	0	15	0		EDIT

Subindex 0 indicates how many mapped objects are available in this PDO. The above example is have two mapped objects in TPDO-1. Each PDO can only hold 64-bit s total from all 8 slots. For example three 32-bit objects will not fit in a PDO.

Example of mapped object in TPDO:

TPDO1.Mapping 0 is 31000010.

Description of value is shown below.

Name	Index	Sub Index	Bit length	
Device Status Word	3100	00	10	HEX

Adding a new object to TPDO:

Out of default parameters can be added to TPDO or RPDO mapping.

For example, AxisPro has internal voltage sensor to monitor the power supply. The below picture shows the details of the parameters.

Internal Voltages							
3050	1	Supply Voltage	0	UInt16	Saved	Read	Read Any
3050	2	Supply Voltage ADC Value	0	UInt16	Saved	Read	Read Any

After the correct parameters are found in advance mode, this parameter must be added to PDO mapping. Index, Subindex and Bit length of parameter must be known for adding parameter to PDO mapping.

Index	Subindex	Bit length	Value
-------	----------	------------	-------

3050	01	10	30500110
------	----	----	----------

Note: The above values are HEX format. The bit length of parameter is 16 bit. Converted parameter value to HEX is 10. And also you should define the number of mapped objects.

☒ Communications							
☒ TPDO Map Objects							
1A02	0	Number of Mapped Objects	1	UInt8	Dirty	Read/Write	Read Any
1A02	1	Mapping 0	30500110	UInt	Dirty	Read/Write	Read Any

6 Cables and connections

Additional documentation of all ports, cables, pinouts, and wiring guidelines can be found in the valve catalog descriptions or supplied installation information.

6.1 Primary Connector

Power and I/O options are provided to the valve via the 7-pin plug connector. The 7-pin plug connector is considered connector location 1. *AxisPro* valves require a regulated 24VDC supply with a minimum 5-amp capability.

Pin	Signal	Interface
A	24V supply	-
B	Ground	-
C	Enable input	5
D	+VE input	0
E	-VE input	
F	Monitor output	-

Table 6-1 7-pin Plug Pinout

Code	Pin C
PC7/PE7	High impedance (0-10V) input, interface 5
PH7/PR7	Valve Enable-Input function

Table 6-2 7-pin Plug Pin C (Enable) Model Options

Code	Pin D/E
M1	+/-10Vdc
M2	4-20mA
M3	+/-10mA
M4	+/-15mA
M9	Pins not used (CAN bus cmd)
Not encoded	+/-20mA
Not encoded	+10V

Table 6-3 7-pin Plug Pin D/E (+/- Analog Command) Model Options

Code	Pin F
F1	+/-10V
F2	4-20mA
F9	Disabled
Not encoded	Custom configs

Table 6-4 7-pin Plug Pin F (Monitor output) Model Options

6.2 CAN bus Connections

CAN bus communication requires a connection from one of the available 5-pin M12 CAN bus ports to the available CAN bus network or adapter connected to a PC. AxisPro male and female CAN bus ports have identical pinout.

Pin	Signal
1	gnd
2	----
3	gnd
4	CAN high
5	CAN low

Table 6-5 CAN bus M12 Pinout

Typically, PC CAN bus adapters incorporate a standard male DB9 connector with pins 7 and 2 as CAN high and CAN low respectively.

All CAN bus networks require the use of 120 ohm terminating resistors between CAN high and CAN low signal wires at the extents of the physical bus. This includes the simple network formed by a single valve to PC CAN bus adapter for Pro-FX™: Configure parameterization. Communication without a terminating resistor should be expected to be unreliable. As cable length increases, bit rate is increased, or different devices are networked together, the need for termination becomes critical. Longer physical bus lengths also require slower bit rates to be used for all devices. For further information on wiring and terminating CAN bus networks see CiA DS102.

6.2.1 Node-ID [2002s1] and Bitrate [2002s2]

Rather than edit these objects directly, it is recommended to use the CANopen Layer Setting Service (LSS) to initialize a network by a network master. This will not disrupt a working network when new devices are added, or existing device is reconfigured.

LSS supported from **CiA DS 301** are:

- Switch state global – LSS device state machine command
 - switch to configuration state
 - switch to waiting state - on demand (only) and an automatic NMT Reset Communications is executed.
- Inquire node-ID – request node-ID of the device
- Configure node-ID – change node-ID of the device
 - valid values: 1 to 127, 255
- Configure bit timing parameters – configure bitrate using standard enumeration
 - 0 = 1000 Kbps
 - 2 = 500 Kbps
 - 3 = 250 Kbps
 - 4 = 125 Kbps
- Store configuration protocol – save node-ID and bitrate parameters as configured

6.2.2 Heartbeat and Life-guarding (node-guarding) Protocols

The AxisPro supports heartbeat and node-guarding protocols. These protocols are mutually exclusive, one or the other can be active at a time.

6.2.2.1 Heartbeat Protocol

Heartbeat Protocol involves a broadcast transmitted from the AxisPro. Other devices act based on the reception of the broadcast or absence of the broadcast.

The valve transmits a ‘heartbeat’ message via CAN bus at a specified frequency. The message contains the device’s present NMT state. A network master or other devices can receive heartbeat messages and be informed that the device is still on the network and operating with a particular NMT state or act when the message is not received when expected.

Heartbeat messages are transmitted with identifier 0x700 + device’s Node-ID.

Heartbeat Producer Time [1017s0] –

Parameter [1017s0] configures the time between heartbeat message transmissions in milliseconds. If the value is 0, heartbeat protocol is disabled.

6.2.2.2 Life-Guard Protocol (a.k.a. Node-guarding)

Life-Guarding Protocol involves a confirmed reply to a life-guard message received by the AxisPro to determine if the valve is still connected to the bus as well as AxisPro monitoring for reception of the life-guard message.

If Heartbeat Producer Time [1017s0] value is 0, life-guarding protocol may be enabled by setting the node guard time [100Cs0] and lifetime factor [100Ds0] to non-zero values. Life-guarding is disabled in the AxisPro when the Heartbeat Producer Time is non-zero.

A network master or other device transmits a life-guard message on the bus cyclically. The AxisPro, with Life-Guarding enabled, will monitor the life-guard message and respond. If the AxisPro does not receive the node-guard message within the allowed maximum lifetime, it generates an error and attempts to transmit an emergency message indicating life-guard error.

Node Guard Time [100Cs0] –

Time (in ms) which is multiplied by the lifetime factor to result in the maximum allowed (life) time between reception of life guard messages before an error is generated and an emergency message is transmitted by the AxisPro. If node guard time is zero, life guarding is not performed in the AxisPro.

Lifetime factor [100Ds0] –

Multiplier of node guard time to result in maximum lifetime between receptions of lifeguard messages before an error is generated and an emergency message is transmitted by the AxisPro. If lifetime factor is zero, life guarding is not performed in the AxisPro

Ex. node-guard time = 100 (ms)

 Lifetime factor = 1

 Max time allowed between life-guard messages = 100 x 1 = 100 ms

7 NMT Startup [1F80s0]

For small networks where a full network manager is not needed, or devices are allowed to begin using the network without waiting for the network manager to issue the NMT startup parameter can configure the AxisPro to enter NMT Operational state on boot-up.

Value	Behavior
0	Start Normal – wait for NMT manager to issue NMT commands to start the network
8	Start Automatically – Upon boot-up attempt to enter NMT Operational state

Table 7-1 NMT Startup Behaviors

8 Process Data Objects (PDO)s

The AxisPro CANopen operations allow OD parameters to be mapped to PDO channels. The AxisPro supports 8 channels of Transmit PDO (TPDO) and 8 channels of Receive PDO (RPDO). Each channel can have up to 64-bits of data mapped in 8-bit increments for a maximum of 8 mappings per channel.

8x TPDOs (TPDO1... TPDO8)

8x RPDOs (RPDO1... RPDO8)

See DS408 automapping for important capabilities and restrictions on RPDO1, RPDO2, TPDO1, and TPDO2.

8.1 Mapping and Communication Objects

All PDOs contain Mapping parameter objects and Communication parameter objects.

Communication Objects determine if the channel is enabled or disabled, transmission type, transmission identifier, and message cycle options.

8.1.1 RPDO Communication objects [14xx]

RPDO channels have these Communication Object subindices.

Subindex 1 - COB-ID - enables/disables the channel and sets the channel identifier for received messages.

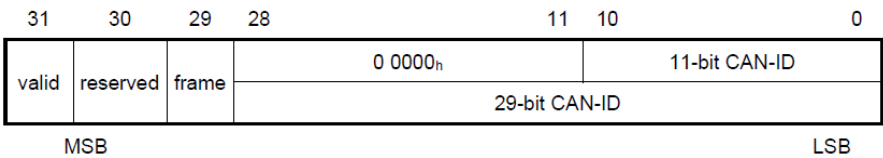


Table 8-1 RPDO COB-ID 32-bit structure

Bit(s)	Value	Description
valid	0 _b	PDO exists / is valid
	1 _b	PDO does not exist / is not valid
reserved	x	do not care
frame	0 _b	11-bit CAN-ID valid (CAN base frame)
	1 _b	29-bit CAN-ID valid (CAN extended frame)
29-bit CAN-ID	x	29-bit CAN-ID of the CAN extended frame
11-bit CAN-ID	x	11-bit CAN-ID of the CAN base frame

Table 8-2 RPDO COB-ID bit descriptions

Subindex 2 - Transmission type - AxisPro supports these transmission types for RPDOs.

Value	Description
00 _h	synchronous
....	
F0 _h	synchronous
F1 _h	reserved
....	
FD _h	reserved
FE _h	event-driven (manufacturer-specific)
FF _h	event-driven (device profile and application profile specific)

Table 8-3 RPDO Transmission Types

- Synchronous means that the CANopen device shall actuate the received data with the reception of the next SYNC.
- Event-driven means that the PDO may be received at any time. The CANopen device will actualize the data immediately.

8.1.2 RPDO Mapping objects [16xx]

RPDO channels have these Mapping Object subindices:

Subindex 0 - Number of Mapped Objects – activates channel mapping by specifying the number of mappings that are in use.

Subindex 1 to 8 - Individual object mapping slots.

To change mappings:

- 1. (recommended) Set NMT state of the valve to pre-operational.
- 2. (recommended) Disable the channel via the channel’s Communication Object – COB-ID.
- 3. Change the number of mapped objects for the channel to 0. Note: This clears all previous mappings.
- 4. Change the mapping slots with desired parameter values as follows

<index><subindex><bitsize> where

Index = Object index to be mapped in hexadecimal format (16-bits).

Subindex = Object subindex to be mapped in hexadecimal format (8-bits).

Bitsize = Size in bits of the object that is being mapped in hexadecimal format (8-bits).

Ex. To map the Device Control Word [4100s0] the mapping becomes:

Index 0x4100

Subindex 0x00

Bitsize 0x10 (16-bits)

Mapping slot = 0x60400010

Note that each channel can only hold 64-bits from all 8 slots. E.g. three 32-bit slots will not fit in one channel. The AxisPro validates mappings for max length of 64-bits.

- 5. Update the number of mapped objects for the channel based on how many mapping slots were configured.

8.1.3 TPDO Communication objects [18xx]

TPDO channels have these Communication Object sub index.

Subindex 1- COB-ID - enables/disables the channel and sets the channel identifier for transmitted messages.

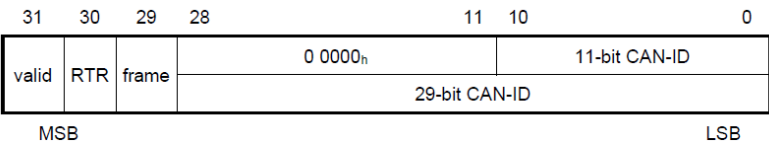


Table 8-4 TPDO COB-ID 32-bit structure

Bit(s)	Value	Description
valid	0 _b	PDO exists / is valid
	1 _b	PDO does not exist / is not valid
RTR	0 _b	RTR allowed on this PDO
	1 _b	no RTR allowed on this PDO
frame	0 _b	11-bit CAN-ID valid (CAN base frame)
	1 _b	29-bit CAN-ID valid (CAN extended frame)
29-bit CAN-ID	x	29-bit CAN-ID of the CAN extended frame
11-bit CAN-ID	x	11-bit CAN-ID of the CAN base frame

Table 8-5 TPDO COB-ID bit descriptions

Subindex 2 - Transmission type – triggering mode for sending TPDO messages.

Value	Description
00 _h	synchronous (acyclic)
01 _h	synchronous (cyclic every sync)
02 _h	synchronous (cyclic every 2 nd SYNC)
03 _h	synchronous (cyclic every 3 rd SYNC)
04 _h	synchronous (cyclic every 4 th SYNC)
.....	
F0 _h	synchronous (cyclic every 240 th SYNC)
F1 _h	reserved
.....	
FB _h	reserved
FE _h	event-driven (manufacturer-specific)
FF _h	event-driven (device profile and application profile specific)

Table 8-6 TPDO Transmission Types

- Synchronous means that the PDO is transmitted after the SYNC. The CANopen device will start sampling of the data with the reception of the SYNC. In case it is acyclic the CANopen device internal event is given and with the next SYNC the sampling is started and the PDO is transmitted afterwards. In case it is cyclic the sampling is started with the reception of every SYNC, every 2nd SYNC, every 3rd SYNC, depending on the given value and the PDO is transmitted afterwards.
- RTR-only means that the PDO is not transmitted normally it shall be requested via RTR. In case it is synchronous the CANopen device will start sampling with the reception of every SYNC and then will buffer the PDO. In case it is event-driven the CANopen device will start sampling with the reception of the RTR and will transmit the PDO immediately.
- Event-driven means that the PDO may be transmitted at any time based on the occurrence of a CANopen device internal event. The definition of the event does not fall into the scope of this specification and may be specified in device profiles and application profiles.

Subindex 3 - Inhibit Time – Time (in µs) which must elapse before the next message can be transmitted. Set to 0 to disable inhibit.

Subindex 5 - Event Time – Periodic time (in ms) which generates a transmission event. If transmission type is 254, setting event time greater than 0 results in cyclic transmission instead of transmission on change in the mapped data value. The minimum event time that can be set is 1ms.

Note: Care must be taken to determine appropriate bus loading and bandwidth when multiple messages are configured for low event times (more frequent transmissions). Bus loading must consider all messages from all networked devices. It is possible to overload the bus to the point where messages begin to be lost or unable to be transmitted due to higher priority messages taking too much bus bandwidth. Higher network bitrates, larger PDO event times, staggered synchronous PDO transmissions, and shorter PDOs help relieve network bandwidth issues.

8.1.4 TPDO Mapping objects [1Axx]
TPDO channels have these Mapping Object subindices

Subindex 0 - Number of Mapped Objects – activates channel mapping by specifying the number of mappings that are in use

Subindex 1 to 8 - Individual object mapping slots.

To change mappings:

- 1. (recommended) Set NMT state of the valve to pre-operational
- 2. (recommended) Disable the channel via the channel’s Communication Object – COB-ID.
- 3. Change the number of mapped objects for the channel to 0. Note: This clears all previous mappings.
- 4. Change the mapping slots with desired parameter values as follows

<index><subindex><bitsize> where
Index = Object index to be mapped in hexadecimal format (16-bits)
Subindex = Object subindex to be mapped in hexadecimal format (8-bits).
Bitsize = Size in bits of the object that is being mapped in hexadecimal format (8-bits)

Ex. To map the Device Status Word [3100s0] the mapping becomes:

Index 0x3100
Subindex 0x00
Bitsize 0x10 (16-bits)
Mapping slot = 0x60400010

Note that each channel can only hold 64-bits from all 8 slots. E.g. three 32-bit slots will not fit in one channel. The AxisPro validates mappings for max length of 64-bit s.

- 5. Update the number of mapped objects for the channel based on how many mapping slots were configured.

9 Other Sensors

9.1 Electronic Temperature

Each valve has a temperature sensor placed on one of the internal electronic PCBs to allow monitoring of the electronics enclosure internal temperature. The electronics enclosure temperature should be assumed to have some additional offset from the external ambient temperature due to power being consumed by the electronic components within the enclosure and conducted heat from the attached valve body.

Input Type	Temperature (electronics PCB)
Range	-40°C to 125°C
Resolution	1 C° (1.8 F°)
Accuracy	+/-4 C°
Sampling Frequency (max)	1KHz
Operation	-25°C (-13°F) under temperature detect
	125°C (257°F) over temperature detect
	User configurable fault limit and criticality triggering

Table 9-1 Electronic Temperature Sensor Capability

Temperature									
3051	1	Electronics Temperature	33.4267	Float	Saved	Read	Read Any	celsius	Temperature from Electronic PCB sensor
3051	2	Electronics Temperature ADC value	1010	UInt16	Saved	Read	Read Any	counts	Raw ADC value of temperature sensor in the electronic enclosure (14bit resolution)
3055	F	PCB Temperature ADC Raw Count	1000	UInt16	Saved	Read	Read Any	counts	PCB Temperature ADC Raw Count
3055	12	Controller internal temperature ADC Raw Count	988	UInt16	Saved	Read	Read Any	counts	Controller internal temperature ADC Raw Count
3056	F	PCB Temperature ADC Signal Value	31.49271	Float	Saved	Read	Read Any	celsius	PCB Temperature ADC Signal Value
3056	12	Controller internal temperature ADC Signal Value	35.39877	Float	Saved	Read	Read Any	celsius	Controller internal temperature ADC Signal Value
3057	F	PCB Temperature User scale value	8324.027	Float	Saved	Read	Read Any	counts	PCB Temperature User scale value
3057	12	Controller internal temperature User scale value	9297.666	Float	Saved	Read	Read Any	counts	Controller internal temperature User scale value
3058	F	PCB Temperature Filtered value	32.21796	Float	Saved	Read	Read Any	celsius	PCB Temperature Filtered value
3058	12	Controller internal temperature Filtered value	40.55212	Float	Saved	Read	Read Any	celsius	Controller internal temperature Filtered value
5051	1	Electronics Temperature Offset	50	Float	Saved	Read/Write	Factory Write Only		offset(b) parameter of the PcbTemp Y=mX+b
5051	2	Electronics Temperature Gain	34	Float	Saved	Read/Write	Factory Write Only		gain(m) parameter of the PcbTemp Y=mX+b

9.2 Power Supply Voltage

The main power supply to the valve can be monitored.

Input Type	Power Supply (internal sensor)
Range	0 to 36V
Resolution	0.01V
Accuracy	+/-1%
Sampling Frequency (max)	1KHz
Operation	19V undervoltage detect
	36V overvoltage detect

Table 9-2 Power Supply Sensing Capability

Internal Voltages									
3050	1	Supply Voltage	25130	UInt16	Saved	Read	Read Any	milliv...	Sensed voltage supplied to valve power
3050	2	Supply Voltage ADC Value	2323	UInt16	Saved	Read	Read Any	counts	Raw ADC value of supply voltage (14bit resolution)
3055	A	1.6V internal voltage ADC Raw Count	2184	UInt16	Saved	Read	Read Any	counts	1.6V internal voltage ADC Raw Count
3055	B	Safety Relay status ADC Raw Count	2145	UInt16	Saved	Read	Read Any	counts	Safety Relay status ADC Raw Count
3055	C	Positive 15V internal voltage ADC Raw Count	3818	UInt16	Saved	Read	Read Any	counts	Positive 15V internal voltage ADC Raw Count
3056	A	1.6V internal voltage ADC Signal Value	1667.725	Float	Saved	Read	Read Any	milliv...	1.6V internal voltage ADC Signal Value
3056	B	Safety Relay status ADC Signal Value	22084.81	Float	Saved	Read	Read Any	milliv...	Safety Relay status ADC Signal Value
3056	C	Positive 15V internal voltage ADC Signal Value	15570.97	Float	Saved	Read	Read Any	milliv...	Positive 15V internal voltage ADC Signal Value
3057	A	1.6V internal voltage User scale value	9100	Float	Saved	Read	Read Any	counts	1.6V internal voltage User scale value
3057	B	Safety Relay status User scale value	3427.023	Float	Saved	Read	Read Any	counts	Safety Relay status User scale value
3057	C	Positive 15V internal voltage User scale value	17546.72	Float	Saved	Read	Read Any	counts	Positive 15V internal voltage User scale value
3058	A	1.6V internal voltage Filtered value	1656.738	Float	Saved	Read	Read Any	milliv...	1.6V internal voltage Filtered value
3058	B	Safety Relay status Filtered value	21909.46	Float	Saved	Read	Read Any	milliv...	Safety Relay status Filtered value
3058	C	Positive 15V internal voltage Filtered value	15570.97	Float	Saved	Read	Read Any	milliv...	Positive 15V internal voltage Filtered value

9.3 Drive voltage

The drive voltage supply can be monitored.

Input Type	Drive voltage Supply (internal sensor)
Range	0 to 36V
Resolution	0.01V
Accuracy	+/-1%
Sampling Frequency (max)	1KHz
Operation	19V undervoltage detect
	36V overvoltage detect

Table 9-3 Drive Voltage Sensing Capability

Voltages									
3055	E	Drive Voltage ADC Raw Count	2358	UInt16	Saved	Read	Read Any	counts	Drive Voltage ADC Raw Count
3056	E	Drive Voltage ADC Signal Value	25191.56	Float	Saved	Read	Read Any	milliv...	Drive Voltage ADC Signal Value
3057	E	Drive Voltage User scale value	6545.92	Float	Saved	Read	Read Any	counts	Drive Voltage User scale value
3058	E	Drive Voltage Filtered value	25191.56	Float	Saved	Read	Read Any	milliv...	Drive Voltage Filtered value

10 LED Indicators

Diagnostic	Color	CANopen	Profinet	Ethernet/IP	EtherCAT
	[A] Green	CAN Connection status	Port 0 connection status	Module status	Run
	[A] Red	Not used	System error	Not used	Not used
	[B] Green	Device status	Device status	Device status	Device status
	[B] Red	Fault Manager	Fault Manager	Fault Manager	Fault Manager
	[C] Green	Not used	Port 1 connection status	Not used	Not used
	[C] Red	Communication error	Communication error	Network status	Error

Figure 10-1 LED Indicator Window

10.1 CANopen LED indication details

The valve supports the **CiA DR303-3** indicator specification with RED & GREEN LED’s for CANopen communication.

LED	Indication	Description
LED A GREEN	Single Flash (200ms ON, 1000ms OFF)	The CAN controller is in STOPPED state
	Flashing (2.5Hz ON/OFF rate, 200ms ON, 200ms OFF)	The CAN Controller is in the PREOPERATIONAL state
	On	The CAN Controller is in the OPERATIONAL state
LED A RED	OFF	Not used
LED B GREEN	Blinking (1Hz, 500ms ON, 500ms OFF)	No error
	OFF	Device error or in boot mode
LED B RED	OFF	No error
	Blinking (1Hz, 500ms ON, 500ms OFF)	Warning faults
	Fast blinking (2Hz, 250ms ON, 250ms OFF)	Critical faults
LED C GREEN	OFF	Not used
LED C RED	Off	The CAN controller is in working condition
	Single Flash (sequence of 200ms ON, 1000ms OFF)	At least one of the error counters of the CAN controller has reached the maximum error count
	Double Flash (Sequence of 200ms ON, 200ms OFF, 200msON, 1000ms OFF)	Node guard or heartbeat event has occurred

Table 10-2 CANopen LED

10.2 Profinet LED indication details

LED	Indication	Description
LED A GREEN	OFF	The device has no link to the port 0
	Flickering	The device sends/receives frames port 0
LED A RED	OFF	No error
	Flashing (1Hz, 3s)	DCP signal service is initiated via the bus
	ON	Watchdog timeout; channel, generic or extended diagnosis present; system error
LED B GREEN	Blinking (1Hz, 500ms ON, 500ms OFF)	No error
	OFF	Device error or in boot mode
LED B RED	OFF	No error
	Blinking (1Hz, 500ms ON, 500ms OFF)	Warning faults
	Fast blinking (2Hz, 250ms ON, 250ms OFF)	Critical faults
LED C GREEN	OFF	The device has no link to the port 1
	Flickering	The device sends/receives frames port 1
LED C RED	Off	No error
	Flashing (2HZ)	No data exchange
	Single flash (200ms ON, 1000ms OFF)	Device is in boot mode
	ON	No configuration; or low speed physical link; or no physical link

Table 10-3 Profinet LED

10.3 Ethernet/IP LED indication details

LED	Indication	Description
LED A GREEN	OFF	LED module status No power
	Blinking (10 Hz, 100ms ON, 100ms OFF)	LED module status self-test
	Blinking (2.5Hz, 400ms ON and 400ms OFF)	LED module standby activated
	Steady ON	LED module operational
LED A RED	OFF	Not used
LED B GREEN	Blinking (1Hz, 500ms ON, 500ms OFF)	No error
	OFF	Device error or in boot mode
LED B RED	OFF	No error
	Blinking (1Hz, 500ms ON, 500ms OFF)	Warning faults
	Fast blinking (2Hz, 250ms ON, 250ms OFF)	Critical faults
LED C GREEN	OFF	Not used
LED C RED	Off	LED network status indicator steady OFF or LED network status indicator connection time out
	Blinking 400ms	LED network status indicator No connection
	ON	LED network status indicator connected

Table 10-4 Ethernet/IP LED

10.4 EtherCAT LED indication details

LED	Indication	Description
LED A GREEN	OFF	Initialization
	Blinking	Pre-operational
	Single flash	safe-operational
	ON	Operational
LED A RED	OFF	Not used
LED B GREEN	Blinking (1Hz, 500ms ON, 500ms OFF)	No error
	OFF	Device error or in boot mode
LED B RED	OFF	No error
	Blinking (1Hz, 500ms ON, 500ms OFF)	Warning faults
	Fast blinking (2Hz, 250ms ON, 250ms OFF)	Critical faults
LED C GREEN	OFF	Not used
LED C RED	Off	No error
	Blinking	Invalid configuration
	Single flash	Unsolicited state change
	Double flash	Application watchdog timeout
	Flickering	Bootling error
	ON	PDI watchdog timeout

Table 10-5 EtherCAT LED

11 Diagnostics Functions

The valve will perform standard diagnostics such as monitoring internal voltages, CPU watchdog, and electronic temperature. In addition, custom diagnostics can be enabled.

When a diagnostic value exceeds the specified threshold the fault manager within the valve takes the appropriate action based on criticality level.

Criticality level of the diagnostic indicates the severity of the fault and determines the *AxisPro* reaction to the fault.

Criticality Level	Value	Behavior
None	0	Fault word is not updated. No emergency message transmitted. No effect on DS408 device state. Like disabling the diagnostic.
Info	1	Fault word is updated, but no emergency message is transmitted. No effect on DS408 device state
Warning	2	Fault word is updated. Emergency messages are transmitted. No effect on DS408 device state
Stored Warning	3	Fault word is updated. Emergency messages are transmitted. No effect on DS408 device state. The fault is noted in the Error Field and stored in non-volatile memory.
Fault Hold	4	Fault word is updated. Emergency messages are transmitted. The fault is appended to the Error Fields [1003s1+] and stored in non-volatile memory. The DS408 device state will transition from present state to “FAULT_HOLD” state.
Fault Shutdown	5	Fault word is updated. Emergency message transmitted. The fault is appended in the Error Field [1003s1+] and stored in non-volatile memory. The DS408 device state will transition from present state to “FAULT” state

Table 11-1 Diagnostics Criticality Levels

11.1 Standard Diagnostics [5B00]

Standard diagnostics are preconfigured to monitor critical valve operations. Some standard diagnostics can be disabled/enabled per user preference, but the associated threshold levels cannot be changed.

11.1.1 Enables [5B00s2] : Diagnostics Voltages LVDT Coils.Voltages LVDT & Coils Enable Word

Object [5B00s2] is a 32bit word with each bit representing an enable signal for each standard diagnostic. If a bit value is 1, that means the diagnostic is enabled, else the diagnostic is not enabled. This OD is for faults regarding Voltages LVDT and Coils Enable

bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7
V_SUP_High	V_SUP_Low	Reserved	Reserved	Reserved	Reserved	V_24V_Drive_High	V_24V_Drive_Low

- V_SUP_High : Supply Voltage upper limit diagnostic
- V_SUP_Low : Supply Voltage lower limit diagnostic
- V_24V_Drive_High: 24V drive voltage upper limit diagnostic
- V_24V_Drive_Low: 24V drive voltage lower limit diagnostic

bit 8	bit 9	bit 10	bit 11	bit 12	bit 13	bit 14	bit 15
V_15V_High	V_15V_Low	SPOOL_POS_Failsafe	LVDT_PRI	Reserved	Reserved	Sol_A_High	Sol_A_Low

- V_5VA_High: Internal pos 15V upper limit diagnostic
- V_5VA_Low: Internal pos 15V lower limit diagnostic
- SPOOL_POS_Failsafe : Spool position exceeds the failsafe value when device is disabled or initializing
- LVDT_PRI: LVDT Primary is disconnected
- Sol_A_High: Solenoid coil A current upper limit diagnostic
- Sol_A_Low: Solenoid coil A current lower limit diagnostic

bit 16	bit 17	bit 18	bit 19	bit 20	bit 21	bit 22	bit 23
Sol_B_High	Sol_B_Low	Enable_In_High	Enable_In_Low	Mon_Out_Curr_High	Mon_Out_Curr_Low	Pos_V_High	Pos_V_Low

- Sol_B_High: Solenoid coil B current upper limit diagnostic
- Sol_B_Low: Solenoid coil B current lower limit diagnostic
- Enable_In_High: Enable input upper limit diagnostic
- Enable_In_Low: Enable input lower limit diagnostic
- Mon_Out_Curr_High: Monitor output current upper limit diagnostic
- Mon_Out_Curr_Low: Monitor output current lower limit diagnostic
- Pos_V_High: Positive voltage command upper limit diagnostic
- Pos_V_Low: Positive voltage command lower limit diagnostic

bit 24	bit 25	bit 26	bit 27	bit 28	bit 29	bit 30	bit 31
Neg_V_High	Neg_V_Low	Pos_Curr_High	Pos_Curr_Low	Neg_Curr_High	Neg_Curr_Low	Sol_A_V_High	Sol_A_V_Low

- Neg_V_High: Negative voltage command upper limit diagnostic
- Neg_V_Low: Negative voltage command lower limit diagnostic
- Pos_Curr_High: Positive current command upper limit diagnostic
- Pos_Curr_Low: Positive current command lower limit diagnostic
- Neg_Curr_High: Negative current command upper limit diagnostic
- Neg_Curr_Low: Negative current command lower limit diagnostic
- Sol_A_V_High: Solenoid coil A voltage upper limit diagnostic
- Sol_A_V_Low: Solenoid coil A voltage lower limit diagnostic

11.1.2 Enables [5B00s3] : Diagnostics PCB temperature, Controller internal temperature, spool position and monitor output voltage Enable Word

Object [5B00s3] is a 32bit word with each bit representing an enable signal for each standard diagnostic. If a bit value is 1, that means the diagnostic is enabled, else the diagnostic is not enabled. This OD is for faults regarding Voltages LVDT and Coils Enable

bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7
LVDT_FBCK_High	LVDT_FBCK_Low	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

LVDT_FBCK_High: Mainstage LVDT feedback current upper limit diagnostic
LVDT_FBCK_LOW: Mainstage LVDT feedback current lower limit diagnostic

bit 8	bit 9	bit 10	bit 11	bit 12	bit 13	bit 14	bit 15
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

bit 16	bit 17	bit 18	bit 19	bit 20	bit 21	bit 22	bit 23
Reserved	Reserved	PCB_TEMP_HIGH	PCB_TEMP_LOW	Reserved	Reserved	CTRL_TEMP_HIGH	CTRL_TEMP_LOW

PCB_TEMP_HIGH: PCB temperature upper limit diagnostic
PCB_TEMP_LOW: PCB temperature lower limit diagnostic
CTRL_TEMP_HIGH: Controller internal temperature upper limit diagnostic
CTRL_TEMP_LOW: Controller internal temperature lower limit diagnostic

bit 24	bit 25	bit 26	bit 27	bit 28	bit 29	bit 30	bit 31
SPOOL_POS_HI GH	SPOOL_POS_LO W	MON_OUT_V_HI GH	MON_OUT_V_LO W	Reserved	Reserved	Reserved	Reserved

SPOOL_POS_HIGH: Spool position upper limit diagnostic
SPOOL_POS_LOW: Spool position lower limit diagnostic
MON_OUT_V_HIGH: Monitor output voltage upper limit diagnostic
MON_OUT_V_LOW: Monitor output voltage lower limit diagnostic

11.1.3 Enables [5B00s4] : Diagnostics Safety relay. Enable ACK and error out Enable Word

Object [5B00s4] is a 32bit word with each bit representing an enable signal for each standard diagnostic. If a bit value is 1, that means the diagnostic is enabled, else the diagnostic is not enabled. This OD is for faults regarding Voltages LVDT and Coils Enable

bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

bit 8	bit 9	bit 10	bit 11	bit 12	bit 13	bit 14	bit 15
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

bit 16	bit 17	bit 18	bit 19	bit 20	bit 21	bit 22	bit 23
Reserved	Reserved	Reserved	Reserved	SFTY_RLY_HIGH	SFTY_RLY_LOW	ENBL_ACK	ERR_OUT

SFTY_RLY_HIGH: Safety relay upper limit diagnostic
SFTY_RLY_LOW: Safety relay lower limit diagnostic
ENBL_ACK: Enable acknowledgment diagnostic
ERR_OUT: Error output pin diagnostic

bit 24	bit 25	bit 26	bit 27	bit 28	bit 29	bit 30	bit 31
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

11.1.4 Enables [5B00s5] : Diagnostics Custom faults Enable Word

Object [5B00s5] is a 32bit word with each bit representing an enable signal for each standard diagnostic. If a bit value is 1, that means the diagnostic is enabled, else the diagnostic is not enabled. This OD is for faults regarding Voltages LVDT and Coils Enable

bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

bit 8	bit 9	bit 10	bit 11	bit 12	bit 13	bit 14	bit 15
Reserved	Reserved	Reserved	Reserved	CSTM_VAR1_HIGH	CSTM_VAR1_LOW	CSTM_VAR2_HIGH	CSTM_VAR2_LOW

CSTM_VAR1_HIGH: Custom variable 1 upper limit diagnostic
CSTM_VAR1_LOW: Custom variable 1 lower limit diagnostic
CSTM_VAR2_HIGH: Custom variable 1 upper limit diagnostic
CSTM_VAR2_LOW: Custom variable 1 lower limit diagnostic

bit 16	bit 17	bit 18	bit 19	bit 20	bit 21	bit 22	bit 23
CSTM_VAR3_HIGH	CSTM_VAR3_LOW	CSTM_VAR4_HIGH	CSTM_VAR4_LOW	Reserved	Reserved	Reserved	Reserved

CSTM_VAR3_HIGH: Custom variable 3 upper limit diagnostic
CSTM_VAR3_LOW: Custom variable 3 lower limit diagnostic
CSTM_VAR4_HIGH: Custom variable 4 upper limit diagnostic
CSTM_VAR4_LOW: Custom variable 4 lower limit diagnostic

bit 24	bit 25	bit 26	bit 27	bit 28	bit 29	bit 30	bit 31
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

12 Fault Management

The fault manager controls the response and reporting of faults. The fault manager may issue emergency messages on the CAN bus, change device state, change LED indications, or store the occurrence of the fault. Sources of fault can be from the Diagnostics functions, CANopen functions or general operations.

12.1 Error Status Bits [3E6F] and Error Codes

The Error Status Bytes [3E6F] are interpreted in bitwise fashion. Each bit represents a source of fault which can be monitored by the fault management system.

When the bit is “1” a fault is presently occurring or occurred, and status has not been cleared automatically.

When the bit is “0” the issue is not present.

Error codes are assigned to a 16bit value per the following table.

12.2 Error Status Bits [3E6F] and Error Codes

The specific fault indications are represented by object [3E6F s1 to s4], where each bit from each object represents the status of a fault that may occur in the device. Each error status byte consists of 32 status bits. If a bit is one, the corresponding fault has occurred and has not cleared. If a bit is zero, the corresponding fault did not occur or has cleared. The tables below give detailed information about each bit.

Sr. No.	Error_Code	Index	Fault_Name	Error status	
1	0x0000	0x00	No Error	3E6Fsub1	bit0
2	0x8220	0x03	PDO mapping length exceeded	3E6Fsub1	bit3
3	0x5520	0x04	ERROR_SERIAL_FLASH_WRITE	3E6Fsub1	bit4
4	0x8140	0x09	CAN transmit bus is not active	3E6Fsub1	bit9
5	0x8120	0x0A	CAN transmit bus is in passive mode	3E6Fsub1	bit10
6	0x8200	0x0D	TPDO is outside SYNC window	3E6Fsub1	bit13
7	0x8170	0x0E	USB communications error	3E6Fsub1	bit14
8	0x8210	0x0F	RPDO message length is not valid	3E6Fsub1	bit15
9	0x8200	0x11	NMT command is not valid	3E6Fsub1	bit17
10	0x8200	0x12	Message received during inhibit time	3E6Fsub1	bit18
11	0x8130	0x15	CAN lifeguard error	3E6Fsub1	bit21
12	0x6010	0x16	Watchdog timer reset	3E6Fsub1	bit22
13	0x6100	0x17	ERROR_INIT_FAILED	3E6Fsub1	bit23
14	0x5050	0x18	Internal SPI communication error	3E6Fsub1	bit24
15	0x5051	0x19	Device capability mismatch fault	3E6Fsub1	bit25
16	0x6052	0x1A	ID Information mismatch fault	3E6Fsub1	bit26
17	0x3411	0x20	24V supply voltage limit exceeded	3E6Fsub2	bit0
18	0x3412	0x21	24V supply voltage limit exceeded	3E6Fsub2	bit1
19	0x3212	0x26	24V drive voltage limit exceeded	3E6Fsub2	bit6
20	0x3222	0x27	24V drive voltage limit exceeded	3E6Fsub2	bit7
21	0x3213	0x28	Internal Pos 15V limit exceeded	3E6Fsub2	bit8
22	0x3223	0x29	Internal Pos 15V limit exceeded	3E6Fsub2	bit9
23	0x8301	0x2A	Spool position exceeds the failsafe value when the device is disabled or initializing	3E6Fsub2	bit10
24	0x2310	0x2E	Solenoid coil A current limit exceeded	3E6Fsub2	bit14
25	0x2320	0x2F	Solenoid coil A current limit exceeded	3E6Fsub2	bit15
26	0x2310	0x30	Solenoid coil B current limit exceeded	3E6Fsub2	bit16
27	0x2320	0x31	Solenoid coil B current limit exceeded	3E6Fsub2	bit17
28	0x5235	0x32	Enable Input limit exceeded	3E6Fsub2	bit18
29	0x5245	0x33	Enable Input limit exceeded	3E6Fsub2	bit19
30	0x2311	0x34	Monitor Output current limit exceeded	3E6Fsub2	bit20
31	0x2322	0x35	Monitor Output current limit exceeded	3E6Fsub2	bit21
32	0x3421	0x36	Positive voltage command limit exceeded	3E6Fsub2	bit22
33	0x3422	0x37	Positive voltage command limit exceeded	3E6Fsub2	bit23
34	0x3421	0x38	Negative voltage command limit exceeded	3E6Fsub2	bit24
35	0x3422	0x39	Negative voltage command limit exceeded	3E6Fsub2	bit25
36	0x2112	0x3A	Positive current command limit exceeded	3E6Fsub2	bit26
37	0x2122	0x3B	Positive current command limit exceeded	3E6Fsub2	bit27
38	0x2113	0x3C	Negative current command limit exceeded	3E6Fsub2	bit28
39	0x2123	0x3D	Negative current command limit exceeded	3E6Fsub2	bit29
40	0x5231	0x40	Mainstage LVDT feedback current limit exceeded	3E6Fsub3	bit0
41	0x5241	0x41	Mainstage LVDT feedback current limit exceeded	3E6Fsub3	bit1
42	0x4211	0x52	PCB temperature limit exceeded	3E6Fsub3	bit18
43	0x4212	0x53	PCB temperature limit exceeded	3E6Fsub3	bit19
44	0x4231	0x56	Controller internal temperature limit exceeded	3E6Fsub3	bit22
45	0x4241	0x57	Controller internal temperature limit exceeded	3E6Fsub3	bit23
46	0x5011	0x58	Spool Position limit exceeded	3E6Fsub3	bit24
47	0x5021	0x59	Spool Position limit exceeded	3E6Fsub3	bit25
48	0x3310	0x5A	Monitor Output voltage limit exceeded	3E6Fsub3	bit26
49	0x3311	0x5B	Monitor Output voltage limit exceeded	3E6Fsub3	bit27
50	0x5010	0x74	Safety Relay limit exceeded	3E6Fsub4	bit20
51	0x5020	0x75	Safety Relay limit exceeded	3E6Fsub4	bit21
52	0x5030	0x76	Enable Acknowledgement fault	3E6Fsub4	bit22
53	0x5040	0x77	Error Output Pin fault	3E6Fsub4	bit23
54	0x8001	0x8C	Custom variable 1 limit exceeded	3E6Fsub5	bit12
55	0x8002	0x8D	Custom variable 1 limit exceeded	3E6Fsub5	bit13
56	0x8003	0x8E	Custom variable 2 limit exceeded	3E6Fsub5	bit14

Sr. No.	Error_Code	Index	Fault_Name	Error status	
57	0x8004	0x8F	Custom variable 2 limit exceeded	3E6Fsub5	bit15
58	0x8005	0x90	Custom variable 3 limit exceeded	3E6Fsub5	bit16
59	0x8006	0x91	Custom variable 3 limit exceeded	3E6Fsub5	bit17
60	0x8007	0x92	Custom variable 4 limit exceeded	3E6Fsub5	bit18
61	0x8008	0x93	Custom variable 4 limit exceeded	3E6Fsub5	bit19
62	0x5520	0x1B	ERROR_SERIAL_FLASH_READ	3E6Fsub1	bit27

Table 12-1 Error codes

12.3 Error Fields [1003]

Error Code occurrences are maintained in chronological order per the Error Fields of object [1003]. As new errors occur, they are inserted at the first subindex and older Error Codes are moved to the next higher subindex. A full list will have the next generated error code push the oldest code off the list.

12.4 Emergency messages

Emergency messages are transmitted to the CAN bus based on criticality of diagnostics. The telegram is sent once per each new occurrence of an error in the Device. Repeated occurrence of the same event that generated a telegram will not generate a new telegram unless the event had cleared.

The *AxisPro* message structure of 8 bytes is shown below.

COB-ID	Byte 0-1	Byte 2	Byte 3-7
0x80 + Node ID	Error Code	Error register	Manufacturer specific error register

Table 12-2 Emergency Message Structure

Each source of error is categorized and enumerated with an Error Code. This code is part of the transmitted emergency message. The number of errors currently present is saved in the object dictionary at [1003s0]. The Error Fields ([1003]) are listed in reverse order of their occurrence.

12.5 Abort codes

The Device sends the abort code if CANopen protocol violated or due to device internal state has not allowed accessing the objects.

Abort codes	Description
0x05030000	Toggle bit not alternated.
0x05040000	SDO protocol timed out.
0x05040001	Client/server command specifier not valid or unknown.
0x05040005	Out of memory.
0x06010000	Unsupported access to an object.
0x06010001	Attempt to read a write only object.
0x06010002	Attempt to write a read only object.
0x06020000	Object does not exist in the object dictionary.
0x06040041	Object cannot be mapped to the PDO.
0x06040042	The number and length of the objects to be mapped would exceed PDO length.
0x06040043	General parameter incompatibility reason.
0x06040047	General internal incompatibility in the device.
0x06070010	Data type does not match, length of service parameter does not match
0x06070012	Data type does not match, length of service parameter too high
0x06070013	Data type does not match, length of service parameter too low
0x06090011	Sub-index does not exist.
0x06090030	Value range of parameter exceeded (only for write access).

Abort codes	Description
0x06090031	Value of parameter written too high.
0x06090032	Value of parameter written too low.
0x06090036	Maximum value is less than minimum value.
0x060A0023	Resource unavailable, SDO connection
0x08000000	general error
0x08000020	Data cannot be transferred or stored to the application.
0x08000021	Data cannot be transferred or stored to the application because of a local control mechanism. Parameters are Factory protected can't read or write.
0x08000022	Data cannot be transferred or stored to the application because of the present device state.
0x08000024	No data available

Table 12-3 Abort codes

13 Device Control Modes Details

13.1 Device Control Mode – None [4102s0 = 0]

- controls are disabled.
- other functions of the valve continue to operate.

13.2 Device Control Mode – Valve Current Control – VCC [4102s0 = 1]

- valve current control (open-loop hydraulic flow control)
- Internal feedback via solenoid current sensing
- Current output is scaled to max mA resolution for positive setpoint range.
- Negative setpoints result in 0mA output.

13.3 Device Control Mode – Valve Spool Control – VSC [4102s0 = 2]

- valve closed-loop spool control (hydraulic flow control)
- Internal feedback via LVDT position sensing
- Analog command range is scaled to internal resolution +/-16384
- Bus command range is expected to be +/-16384 Spool position is controlled linearly from hydraulic null to max P to A opening for positive commands
- Spool position is controlled linearly from hydraulic null to max P to B opening for negative commands
- Depending on spool selection, de-energized solenoid results in a position outside the specified control range.

13.3.1 Valve Spool Control CAN setpoint Value [3016s02]

The spool control setpoint value is captured and converted to a demand value every 333us while the control is running. The control is considered running when the Device Status has moved to Device Mode Active, or Fault states. The VSC setpoint value is limited to a range of +/-16384.

13.3.2 Valve Spool Control Feedback value [3052s01]

The spool control feedback value is captured from the LVDT every 333us while the control is running. The control is considered running when the Device Status has moved to Device Mode Active, or Fault states. The feedback value is scaled to a working flow range of +/-16384 to match the setpoint. When the control is disabled the feedback value moves to failsafe position and thus is much lower than -16384 as the solenoid is de-energized and not controlled by the setpoint

13.3.3 Valve Spool Control DVG Demand value [3D00s1C]

Calculate demand from setpoint (output of demand value generator DVG). This value is compared with the conditioned feedback to create the control deviation/error term. The spool control demand value

matches the units of the feedback value as they are subtracted to create the control deviation/error value.

13.3.4 VSC Reference value (100% of physical capabilities) for direction A & B [4D11s01]

The positive and negative reference values are the same for VSC control. The value represents the maximum spool opening to the A and B ports using internal resolution units. The value is not changeable from 16384.

13.3.5 VSC DVG Upper Limit value [4D20s01]

The demand value generator can limit the generated demand by clipping the setpoint. The DVG has an upper and lower limit.

Ex. The upper limit can be set to 50% of the VSC Reference value to limit the demand to +50% and thus limit the maximum valve opening to the A port.

13.3.6 VSC DVG Lower Limit value [4D21s01]

The demand value generator can limit the generated demand by clipping the setpoint. The DVG has an upper and lower limit.

Ex. The lower limit can be set to -50% of the VSC Reference value to limit the demand to -50% and thus limit the maximum valve opening to the B port.

13.3.7 VSC DVG Demand Ramp Type [4D30s0]

The rate of change of the demand can be altered by applying a ramp to the setpoint

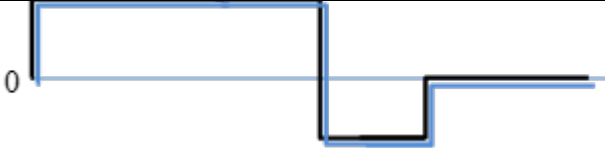
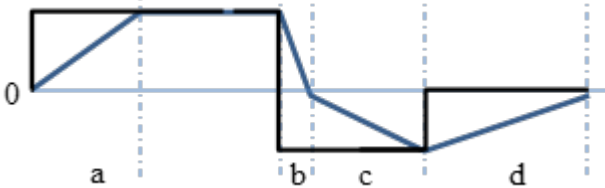
Value	Behavior	Example
0	No ramping. Setpoint is not rate limited as it is converted to the demand.	
3	Trapezoidal ramping. The generated demand is limited based on a four-quadrant ramping profile. The four quadrants in consideration are labeled: a) Positive input acceleration b) Positive input deceleration c) Negative input acceleration d) Negative input deceleration If the setpoint is never issued with a negative value the negative input rates will never be utilized. Similarly, if the setpoint is never issued with a positive value the positive input rates will never be utilized.	

Table 13-1 Ramp behavior

13.3.8 VSC DVG Ramp Type 3 Positive Input Accel value [4D32s1]

When Ramp type 3 is chosen, this value limits the rate of change of the positive, increasing demand.

13.3.9 VSC DVG Ramp Type 3 Negative Input Accel value [4D33s1]

When Ramp type 3 is chosen, this value limits the rate of change of negative, decreasing demand.

13.3.10 VSC DVG Ramp Type 3 Positive Input DeCell value [4D35s1]

When Ramp type 3 is chosen, this value limits the rate of change of positive, decreasing demand.

13.3.11 VSC DVG Ramp Type 3 Negative Input DeCell value [4D36s1]

When Ramp type 3 is chosen, this value limits the rate of change of negative, increasing demand.

13.3.12 VSC DVG Directional Dependent Gain Type [4D40s0]

The computed demand can be scaled based on the desired direction (sign) of the setpoint. For valve spool control this effectively limits the demand in one direction based on the Gain Factor[4D41s0]

Value	Behavior
0	Directional Dependent Gain is disabled
1	Directional Dependent Gain is applied based on the Gain Factor specified

Table 13-2 Gain behavior

13.3.13 VSC DVG Directional Dependent Gain Factor

The Directional Dependent Gain Factor is used when the Directional Dependent Gain Type is 1.

The 32bit gain factor must be thought of as a numerator and denominator (two numbers) in one variable location. The upper 16bits of the variable are decoded as the numerator of the factor. The lower 16bits of the variable are decoded as the denominator of the factor.

It is easiest to decode the Factor result in hexadecimal form.

If the Factor result is less than 1 and the setpoint is greater than 0 (demanding flow from Port A), the resulting VSC DVG Demand value [6310s1] is computed by multiplying the Factor Result by the setpoint. Thus the demand is limited (scaled down) in the A direction but not limited in the B direction.

If the Factor result is greater than 1 and the setpoint is less than 0 (demanding flow from Port B), the resulting VSC DVG Demand value [6310s1] is computed by inverting the Factor Result and multiplying by the setpoint. Thus the demand is limited (scaled down) in the B direction but not limited in the A direction.

For all other cases, the Factor Result is not applied.

Ex. a factor in hexadecimal form of 0x00010002 can be separated into upper and lower 16bit values.

Upper 16bits 0x0001 = 1 (decimal) = numerator of factor

Lower 16bits 0x0002 = 2 (decimal) = denominator of factor

Factor result is numerator/denominator (1/2) = 0.5

Port A flow demands will be rescaled by 0.5, Port B flow demands will not be rescaled.

Ex2. a factor in hexadecimal form of 0x000F0003 can be separated into upper and lower 16bit values

Upper 16bits 0x000F = 15 (decimal) = numerator of factor

Lower 16bits 0x0003 = 3 (decimal) = denominator of factor

Factor result is numerator/denominator (15/3) = 5.0

Factor result is larger than 1, therefore it is inverted and applied to Port B.

Port A flow demands will not be rescaled, Port B flow demands will be rescaled by (1/5) = 0.2

13.3.14 VSC Dither Type [4D60s0]

A dither can be applied to the spool control. This parameter enables or disables the dither function. 0 = no dither, 1= dither enabled.

13.3.15 VSC Dither Amplitude [4D61s1]

The amplitude of the periodic dither signal that is superimposed on the valve spool control solenoid current command when the dither function is enabled. The value is in mA.

13.3.16 VSC Dither Frequency [4D62s1]

The frequency of the periodic dither signal that is superimposed on the valve spool control solenoid current command when the dither function is enabled. The value is in milliHertz.

14 Miscellaneous Options

14.1 Save parameters to EEPROM [1010s1]

Parameters which are savable to EEPROM are not automatically saved upon successful write to the valve. A ‘save’ command must be issued to save parameters to the EEPROM.

Steps to save parameters to EEPROM:

- 1. Unlock service access, if needed.
- 2. Issue the “save all parameters” command by writing the ASCII characters “save” (value 0x65766173) to [1010s1].

14.2 Restore factory defaults [1011s1]

A valve can be recovered to the factory shipped settings by issuing the ‘load’ command to [1011s1].

Upon issuance of the command, all* parameter values will be loaded to RAM and those stored in EEPROM will be restored from an internal backup copy which was made prior to the valve being shipped from the factory.

- *All parameters are restored with two exceptions.
 - a) CANopen Node ID [2002s1] – this value will be retained after a restore.
 - b) CANopen Baud rate [2002s2] – this value will be retained after a restore.

Steps to restore factory defaults:

- 1. Issue the “load all parameters” command by writing the ASCII characters “load” (value 0x64616F6C) to [1011s1].
- 2. (Optional) Reset the valve. The set of parameters takes full effect after a reset by power cycle or NMT reset.

14.3 Service Key/Password [2000s2]

Many object dictionary entries have user level security which limits access. The user level may apply to read requests, write requests, or both.

- **Any user access** – parameters have no security and are accessible to all users.
- **Service user access** – parameters are not to be edited regularly or are to be prevented from read and/or write. The service access key code is required to be present in the object value below to allow access to service access parameters. Attempts to edit these parameters without the correct service access key code is responded to by the SDO abort code: “Unsupported object access”.

All protectable parameters are service protected simultaneously.

User level access is identified in the EDS file. For each object listed in the EDS file a field labeled “ODPwd” is appended. This field indicates if the object is password protectable with a specific user access level and the type of protection given (read or write access).

ODPwd values	Access
<blank>	No access restrictions. Any user access to this entry
_r	Read access may be restricted by service user password
_w	Write access may be restricted by service user password

Table 14-1 EDS file password protection indicators

To protect changes to parameters, the service password can be changed from the default value (Danfoss default service password) to a customer specified value. Storing the Danfoss default value to the service password [2000s2] in the AxisPro effectively disables service password protection.

Danfoss default service password: 43690 (0x0000AAAA)

Steps to change the service password:

1. Transmit the previously set service password to object [2000s2]. If the previously stored password is the Danfoss default value, this step can be skipped. This step unlocks the editing of the password.
2. Transmit the desired password to object [2000s2]. The password is stored as an unsigned 32bit value and should be transmitted as a 32bit number.
3. Issue the “save service password” command by writing the ASCII characters “save” (value 0x65766173) to [1010s7].
4. Reset the valve. The new service password is in effect after a reset by power cycle or NMT reset.

Steps to unlock the service password:

1. Enter the service password that was previously stored. If the previously stored password has never been changed or has been changed back to the Danfoss default, no password entry is necessary to have service access is unlocked. Once unlocked the valve remains unlocked until the device is reset (power cycle or NMT reset).

To remove service password protection, change the service password back to the Danfoss default service password using the steps above.

Forgotten/lost service password

If the service password is forgotten or lost, the available mechanism to recover and change service password settings in the valve is to restore factory defaults. This process resets parameters, including the service password, to factory shipped settings. See instructions regarding Restore Factory Defaults.

14.4 Valve Enable-Input Enable [4005s1]

Activates/Deactivates 7-pin plug pin C logic which affects the DS408 state machine transitions.

14.4.1 Pin C state machine logic activation

Deactivated ([4005s1] = 0) - pin C does not have the effect and can be used as an analog 10V input.

Active ([4005s1] = 1) – pin C is monitored for voltage level above or below a result in a “enable control” or “disable control” depending on high or low voltage on pin C respectively when compared to the Valve Enable Threshold [4005s7] value.

14.4.2 Pin C logic function

“enable control” - allows transition of the DS408 state machine from disabled state to Device Mode Hold or Device Mode Active when requested through Device Control Word value or Device Local being set to Local.

“disable control” - prevents transitioning above disabled state. If the DS408 state machine is already in Device Mode Hold state or Device Mode Active state, a “disable control” request transitions the DS408 state machine to Disable state. Transition to/from the Init state and Disable state is possible.

14.4.3 Pin C additional logic

When Device Local [4101s0] is set to ‘Local’ (1) the Pin C logic transition from “enable control” to “disable control” back to “enable control” while in Fault Hold or Fault Shutdown state will also attempt to transition the machine state to Disable from Fault Hold or Fault Shutdown and back to Device Mode Active state. During this transition faults are attempted to be cleared. If the fault condition still exists, the control will drop back into Fault Hold or Fault Shutdown.

14.5 Valve Enable Threshold [4005s7]

This parameter specifies the threshold of conversion of external analog voltage to Boolean enable/disable. Threshold value represents a sensed voltage with millivolt scaling 0 to 24000mVdc.

Sensed values below this level affect “disable” when [4005s1] is enabled. Sensed values above this level affect “enable” when [4005s1] is disabled.

14.6 Signal Generator Functions

The AxisPro can produce simple signal waveforms like stand-alone signal generator devices.

The signal generator can be selected as a Device Mode [4386s0] = 19.

The signal generator output [3013s1] can be selected as a monitor output signal (see monitor output functions).

14.6.1 Signal Shape [4013s1]

The signal type selects the base waveform shape to be generated, pauses, or stops the generated output.

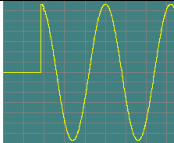
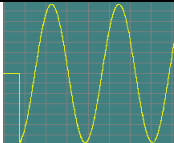
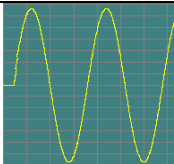
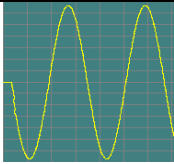
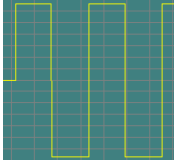
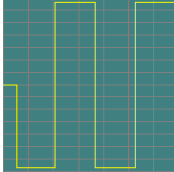
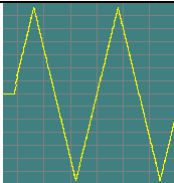
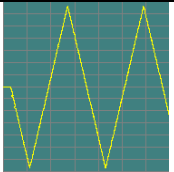
Type	Description	
0	Signal is off, output is set to 0.	
1	Signal generation is paused, output is held at the last value prior to being paused. When a non-zero type is selected after being paused, the sequence will resume generation of the signal with respect to where the output was in respect to the signal time-position.	
2	A cosine wave is generated as the base waveform	
3	An inverse cosine wave is generated as the base waveform	
4	A sine wave is generated as the base waveform	
5	An inverse sine wave is generated as the base waveform	
6	A square wave is generated as the base waveform	
7	An inverse square wave is generated as the base waveform	
8	A triangle wave is generated as the base waveform	
9	An inverse triangle wave is generated as the base waveform	

Table 14-2 Signal Generator Types

14.6.2 Amplitude [4013s2]

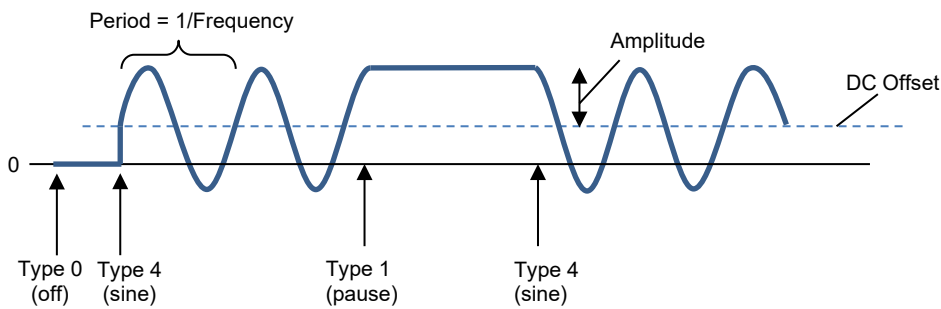
The amplitude of the base waveform. Amplitude is considered ½ peak to peak magnitude. Thus, an amplitude of 100 will have a peak to peak variation in the base waveform of 200 units.

14.6.3 Frequency [4013s3]

The frequency of the base waveform. Value is in milliHertz (mHz). The signal generator requires a non-zero frequency to calculate the waveform. If a single period of a waveform is needed, the on/off times can be configured to produce a single or fractional period.

14.6.4 DC Offset [4013s4]

The DC offset (shift) of the base waveform. Allows shifting the base waveform up or down.



14.7 Monitor Output Functions

The monitor output pin is an analog signal generation with either +/-10V or 4 to 20mA analog range. The configuration of the output can be determined automatically or customized and scaled to represent the magnitude of most parameters in the object dictionary.

Internally, a PWM generator produces the varying output (mV or mA).

14.7.1 Monitor Output Type [4C00s1]

The Monitor Output Type configures the output signal type which is output on pin F of the 7pin connector.

Value	Description
0	+/- 10 volt signal is generated
1	4-20mA signal is generated
4	Output is disabled

Table 14-3 Monitor Output Types

14.7.2 Monitor Output Mode [4C00s2]

The monitor output can be switched from an automated setup based on the Device Control Mode [4102s0] to monitoring of almost any variable and generating any output range to which the hardware is capable.

Value	Behavior
0 = Auto	For all other Device Control Modes [4102s0], the Monitor Output auto mode generates a signal proportional to the valve spool control feedback [3405s0] The minimum output signal (-10V or 4mA) is aligned with a feedback value reaching -16384. The midpoint of the output signal range (0V or 12mA) is aligned with the feedback of 0. The maximum output signal (+10V or 20mA) is aligned with a feedback value reaching +16384. Note: For KBS, KBF and KBFTG valve types, spool control feedback is pilot LVDT feedback. For KBH valve type, spool control feedback is mainstage LVDT feedback.
1 = Custom	Monitored index, subindex, min/mid/max monitored value, min/mid/max output duty cycle can be customized.

Table 14-4 Monitor Output Modes

14.7.3 Monitor Output Monitored Object Dictionary Index [4C00s3]

The monitored object dictionary index specifies the index of the parameter to monitor. When the Mode [4C00s2] is set to Auto, the index cannot be changed.

14.7.4 Monitor Output Monitored Object Dictionary Subindex [4C00s4]

The monitored object dictionary subindex specifies the subindex of the parameter to monitor. When the Mode [4C00s2] is set to Auto, the subindex cannot be changed.

14.7.5 Monitor Output Max Voltage Signal [3E7Fs1]

This parameter specifies the Max voltage monitor output with respect to 10V.

14.7.6 Monitor Output Min Voltage Signal [3E7Fs2]

This parameter specifies the Min voltage monitor output with respect to -10V.

14.7.7 Monitor Output Mid Voltage Signal [3E7Fs3]

This parameter specifies the Mid voltage monitor output with respect to 0V.

14.7.8 Monitor Output Max Current Signal [3E7Fs4]

This parameter specifies the Max current monitor output with respect to 20mA.

14.7.9 Monitor Output Min Current Signal [3E7Fs5]

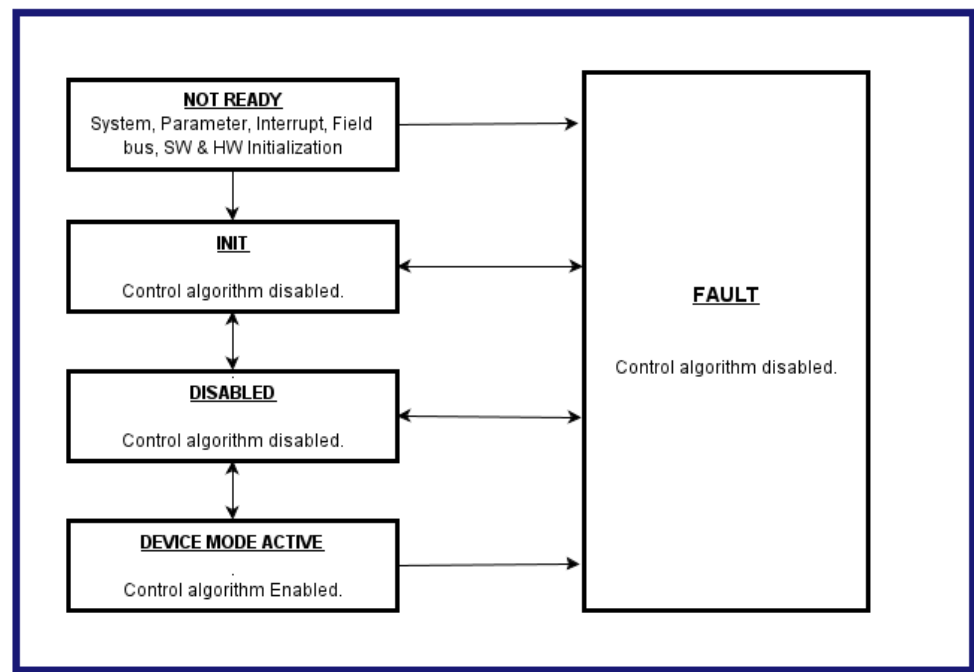
This parameter specifies the Min current monitor output with respect to 4mA.

14.7.10 Monitor Output Mid Current Signal [3E7Fs6]

This parameter specifies the Mid current monitor output with respect to midpoint of 4-20mA.

15 Device state machine

As per below digital state machine device operation can be controller each of that state is digitally controlled through the control word & status word.



15.1 Device Control Word [4100s0]

The Device Control Word commands the state machine and modal operations of the configured Device Control Mode. The lower 4-bit s of the Device Control Word are mutually dependent. The valid permutations of the lower 4-bit s are summarized in the following table.

Description	Device Status Word [4100] lower 4-bits
Request INIT state	0b0000
Request DISABLED state	0b0001
Request ACTIVE state	0b0111
Request FAULT_DISABLED to DISABLED transition	0b1001

Table 15-1 Device Control Word lower 4-bits

15.2 Device Status Word [3100s0]

The Device Status Word indicates the present device state (machine state) and other high-level status. As the valve is commanded to change state by the Device Control Word the Device Status Word reflects successful change to the commanded state or indicates fault state.

Bit 4 represents Local Control (0 = Device Control via Bus, 1 = Device Control Managed locally). The lower 4-bits of the Device Status Word are mutually dependent. The valid permutations of the lower 4-bits are summarized in the following table.

Description	Device Status Word [3100] lower 4 bits
The Device is in NOT Ready state	0b0000
The Device is in the INIT state	0b1000
The Device is in the DISABLED state	0b1001
The Device is in the ACTIVE state	0b1111
The Device is in the FAULT_DISABLED state	0b0001

Table 15-2 Device Status Word lower 4 bits

15.3 Setpoint Interface Reference

The Device Setpoint Interface Reference configures the source of the control setpoint.

Value (4386s0 - Spool Position Mode 4387s0 - Current Control Mode)	Device command mode
127	Unconfigured
0	Setpoint is derived from Pins D/E. Note: Demand references can be scaled to multiple setpoints ranges. Refer Table below.
19	Signal Generator
22	CAN Setpoint 1
24	Daughter board Setpoint 1
26	Serial Setpoint 1

Table 15-3 Setpoint Interface values

Input Range	Description	4000s1	4000s3	4000s4	4000s5	4000s6
0-10V	Setpoint is derived from Pins D/E (interface 0). Demand references are scaled to 0V to +10V.	0	0	-16384	10	16384
+/- 10V	Setpoint is derived from Pins D/E (interface 0). Demand references are scaled to -10V to +10V.	0	-10	-16384	10	16384
4-20mA	Setpoint is derived from Pins D/E (interface 0). Demand references are scaled to 4mA to 20mA.	1	4	-16384	20	16384
+ - 10mA	Setpoint is derived from Pins D/E (interface 0). Demand references are scaled to -10mA to +10mA.	1	-10	-16384	10	16384
+ - 15mA	Setpoint is derived from Pins D/E (interface 0). Demand references are scaled to -15mA to +15mA.	1	-15	-16384	15	16384
+ - 20mA	Setpoint is derived from Pins D/E (interface 0). Demand references are scaled to -20mA to +20mA.	1	-20	-16384	20	16384

Table 15-4 Device Mode values

15.4 Device Control Mode [4102s0]

Device Control Mode parameter selects the control logic to be used when the valve is commanded to Device Mode Active via the Device Control Word. Each mode’s features can be configured independently and switched by transitioning the Device Control Word to ‘disable’ and then making the change to this parameter.

Value	Description
0	Internal valve and drive controls are disabled
1	Valve Current Control of the solenoid
2	Valve Spool Position (KBS, KBF), Pilot Spool Position (KBH)
3	Two stage Spool Position (KBH)

Table 15-5 Device Control Mode Values

15.5 Device Error Code [3E5Fs1]

The parameter Device Error Code holds an encoded value for the presently occurring fault. If no fault is presently occurring, the value is 0. A value found in this location may not always be found in the Error Fields [1003] due to criticality set to a non-stored level for individual diagnostics.

15.6 Device Local [4101s0]

Device Local parameter determines the source of the Device Control Word [4100] which commands the device state.

Value	Description
0	Via CAN bus – value placed in Device Control Word location [4100] is used
1	Local – valve attempts to enter Device Mode Active

Table 15-6 Device Local values

15.7 Device Code Number [5100s4]

The Device Code Number is a freely editable number for storing any 32-bit unsigned value for reference or other purposes. Values 0 to 65535.

15.8 Device Model Description [6054s0]

The Device Model Description is a freely editable string for storing up to 64 characters of device model description or other user choice of entry.

15.9 Device Capability [605Fs0]

Device Capability is a 32-bit read-write parameter which describes the electronic subassembly hardware and software. The capability value is processed internally to enable/disable software behavior, communications, valve type, valve size and I/O options.

Bits	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Description	Reserved										DIN Connector	Spool/Sleeve Type				Communication type				Voltage Sensor	SSI Sensor	Current Sensor	Valve Size		Pressure Reducer	CODESYS enabled	Pressure Sensors	Drive Control Modes				

Valve Size	Bit values <4:7>	Description
KBS-03	b0001	Size 3 for KBS single-stage
KBS-05	b0010	Size 5 for KBS single-stage
KBH-05	b0011	Size 5 for KBH two-stage
KBH-07	b0100	Size 7 KBH two-stage
KBH-08	b0101	Size 8 KBH two-stage
KBH-10	b0110	Size 10 KBH two-stage
Reserved	b0111	Reserved
KBFDG4V-3	b1000	Size 3 KBFDG4V
KBFDG4V-5	b1001	Size 5 KBFDG4V

Table 15-7 Device Capability Valve Size Bits <4:7>

Value	Bit values <11:13>	Description
0x0	b000	Serial (UART) communication only
0x1	b001	CANopen and Serial
0x2	b010	Profinet TCP/IP and, Serial
0x3	b011	Ethernet/IP, TCP/IP, Serial
0x4	b100	EtherCAT, Serial
0x5	b101	TCP/IP, Serial (Reserved for Future use)

Table 15-8 Device Capability Valve Misc. Bits <11:13>

Misc.	Bit values <21>	Description
00	b0	7-pin DIN Type
20	b1	12-pin DIN Type

Table 15-9 Device Capability Valve Misc. Bits <21>

15.10 PDO Mapping

The valve will automatically map objects to the CANopen TPDO1, TPDO2, RPDO1, and RPDO2 channels for transmission and reception of data relevant to the selected control mode.

Channels TPDO3-TPDO8 and RPDO3-RPDO8 are open for user mapping.

Channel	Mapping of Message Bytes							
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
RPDO1	Device Command Word [4100s0]		Device Control Mode [4102s0]	-	-	-	-	-
RPDO2	CANbusFloatInput [3016s2]				-	-	-	-
TPDO1	Device Status Word [3100s0]		Control Mode [3101s0]			-	-	-
TPDO2	VSC Demand [3D00s1C]		LVDT Spool Position [3405s0]			-	-	-

Table 15-10 pre-defined for TPDO’s & RPDO’s

15.11 Failsafe to active valve state

To reduce the large overshoot during initial activation when the initial command point is null, failsafe ramp feature is added. This feature is disabled by default. Users can enable this by writing value 1 to parameter 0x4D38s01.

User can configure the failsafe ramp time from parameter 0x4D37s01.

Note: This failsafe ramp feature is not linked to valve ramp feature.

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