rexroth
A Bosch Company

Commissioning Instructions

Compact Hydraulic Power Unit

innoCube

RE 51045-IB, Edition 2026.04, Bosch Rexroth AG

The data specified only serve to describe the product. No statements concerning a certain condition or suitability for a certain application can be derived from our information.
The information given does not release the user from the obligation of own judgment and verification. It must be remembered that our products are subject to a natural process of wear and aging.

The cover shows an example configuration. The product delivered may differ from the image on the cover.

The original commissioning instructions were prepared in Chinese.

Contents

1. About this documentation

1.1 Validity of the documentation

The present documentation applies to the following products:

- Hydraulic power unit innoCube (for material numbers, refer to data sheet 51045)

This documentation is intended for operators, service engineers and system end-users and machine and system manufacturers.
This documentation contains important information on the commissioning of the hydraulic power unit, such as the installation of IndraWorks DS, the switching sequence, connection establishment, the IndraWorks DS, innoCube and protection functions, as well as diagnosis and troubleshooting.

▶ Prior to working with the product, read these operating instructions carefully, in particular the 02 Safety instructions chapter.

1.2 Required and amending documentation

▶ Before commissioning the product, make sure to have received and fully understood the documentations identified by the book symbol 🕮 and[YW3.1] observe the instructions included in these documentations.

Table 1: Required and amending documentation

	Title	Document number	Document type
🕮	**innoCube hydraulic power unit** Contains information on the safe and proper transport, assembly, commissioning, operation, use, maintenance, disassembly and simple troubleshooting of the hydraulic power unit.	RE 51045-B	Operating instructions
🕮	**innoCube hydraulic power unit** Includes technical data, operating conditions, performance limits and project planning information	RE 51045	Data sheet
🕮	**Sytronix FcP 5020, frequency-controlled pump drive system** Describes the functions of the frequency-controlled pump drive system FcP 5020.	R912006684	Quick start guide
🕮	**Frequency converters series VFC x615 and VFC 3615/VFC 5615** Describes the assembly, commissioning, use, maintenance, diagnosis and troubleshooting of the frequency converters.	R912009378	Operating instructions
🕮	**Frequency converters, multi-Ethernet card** Contains the data, information and descriptions required in connection with the MEP extension card (Multi-Ethernet Platform). This extension card is part of the accessories of the fieldbus communication module of the EFC x610 series frequency converter and is also applicable to the VFC x615 series frequency converter.	R912007826	Operating instructions

1.3 Representation of information

Uniform safety instructions, symbols, terms and abbreviations are used in this documentation so that you can work with your product quickly and safely with this documentation. For better understanding these are explained in the following sections.

1.3.1 Safety instructions

In this documentation, safety instructions are placed before a sequence of actions that involves the risk of personal injury or damage to property. The described measures for hazard avoidance must be observed.
Safety instructions are structured as follows:

⚠ SIGNAL WORD

Type and source of danger
Consequences of non-compliance
- ▶ Hazard avoidance measures
- ▶ <Enumeration>

- Warning sign: draws attention to the hazard
- Signal word: identifies the hazard level
- Type and source of danger: identifies the type and source of the danger
- Consequences: describes what occurs when the safety messages are not complied with
- Precautions: indicates how the hazard can be avoided

Table 2: Risk classes according to ANSI Z535.6-2006

Warning sign, signal word	Meaning
⚠ DANGER	Indicates a hazardous situation which, if not avoided, will result in death or severe injury.
⚠ WARNING	Indicates a hazardous situation which, if not avoided, will result in death or severe injury.
⚠ CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates damage to property: The product or the environment could be damaged.

1.3.2 Symbols

The following symbols identify information that is not safety-relevant, but that enhances the comprehensibility of the documentation.

Table 3: Meaning of the symbols

Symbol	Meaning
	When this information is not observed, optimum use or operation of the product cannot be ensured.
	Left mouse click
	Double-click
	Right mouse click
	Text input
	Order in picture
▶	Single, independent action
1. **2.** **3.**	Numbered instructions: The number indicates that the different actions are to be performed successively.

1.3.3 Screenshots

The screenshots were created with IndraWorks 14V24 and may differ from the current version.

1.3.4 Designations

The following designations are used in this documentation:

Table 4: Designations

Designation	Meaning
ASF	Technology function: Application firmware (firmware extension) for implementation of the hydraulic functions (Application Specific Firmware)
VFC 5615	Frequency converter installed in the innoCube
Firmware VFC 5615	Software running on the frequency converter
Firmware MEP	Software running on the multi-Ethernet extension card
IndraWorks Ds	Software for parameterization/commissioning
Sytronix FcP 5020	Frequency-controlled pump drive system

1.3.5 Abbreviations

The following abbreviations are used in this documentation:

Table 5: Abbreviations

Abbreviation	Meaning
S3	Communication protocol Sercos III
PN	Communication protocol PROFINET IO
EI	Communication protocol EtherNet/IP
EC	Communication protocol EtherCAT (CoE)
MB	Communication protocol Modbus/TCP
MEP	Multi-Ethernet Platform

2. Safety instructions

⚠ WARNING

Improper application, installation or operation!

Risk of injury! Damage to property!

- ▶ Before you work with the hydraulic power unit or control the hydraulic power unit, please read and take note of the following safety instructions:
  - – Safety instructions in operating instructions 51045-B, see chapter 1.2 Required and amending documentation.
  - – Safety instructions in the operating instructions for the machinery/system.

Activation of machine functions by means of commissioning!

Danger to life, risk of injury!

- ▶ Before commissioning the hydraulic power unit, make sure that all electrical, mechanical and hydraulic connections are properly installed and connected as described in the higher-level instructions of the machinery/system manufacturer.
- ▶ Make sure that the safeguards are activated.

Leakage of hydraulic fluid under high pressure due to faulty assembly of the hydraulic power unit!

Risk of injury, damage to property!

- ▶ Ensure that the hydraulic power unit has been mounted by an expert, completely and without any tension stress before commissioning the hydraulic power unit.

3. First step

3.1 Important information

NOTICE
Adjustment of motor parameters or settings not described in this documentation! Damage to property! ▶ Note that the innoCube is already delivered fully parameterized and functional, so there is no need to select the motor, change, optimize or adjust the motor parameters (such as the direction of rotation of the pump), or adjust the sensor technology.

In order to maintain the functionality of your innoCube, please refer to the following information:

- ▶ Never perform an auto-tuning.
- ▶ Do not change motor parameters or settings that are not described in this documentation.
- ▶ Do not reset the innoCube to factory settings as these are not the same as the condition as supplied.

3.2 Software installation

- ▶ Download the IndraWorks Ds software from the Bosch Rexroth website and install it.

  You can download the software with or without online help via the following link (once there, click Downloads): Search | Bosch Rexroth china

  If you are asked during the installation if you want to install a driver, please confirm this with yes.

3.3 innoCube switching sequence

Table 6: Sequence for error-free start-up

1.	Provide 24 V DC power supply (15X1)
2.	Provide AC power supply (12X1) [1)]

[1)] Power supply is also required to access all parameters with IndraWorks Ds.

The pressure sensor HM20, oil level and temperature sensor, etc. of the innoCube are supplied with 24 V DC via 15X1. The innoCube has a pressure sensor cable break detection system and level/temperature alarm detection system. If the innoCube is started without the 24 V DC power supply, the cable break detection is activated and the error "38 Aibe analog input broken wire detection", ASF alarm (low level, high fluid temperature alarm) is displayed on the operating panel. The error can be acknowledged via the reset input after the 24 V DC supply (15X1) has been switched on.。

3.4 Connection with innoCube (USB)

1. Connect your PC to the innoCube with a USB cable (14X1).
2. Start IndraWorks Ds.
   The connection selection window appears automatically, see Fig. 1: Connection selection.
3. Click there under the tab "Serial" on the drop-down menu of the interface, select "xFC (COMX)" and then click on "Connect".

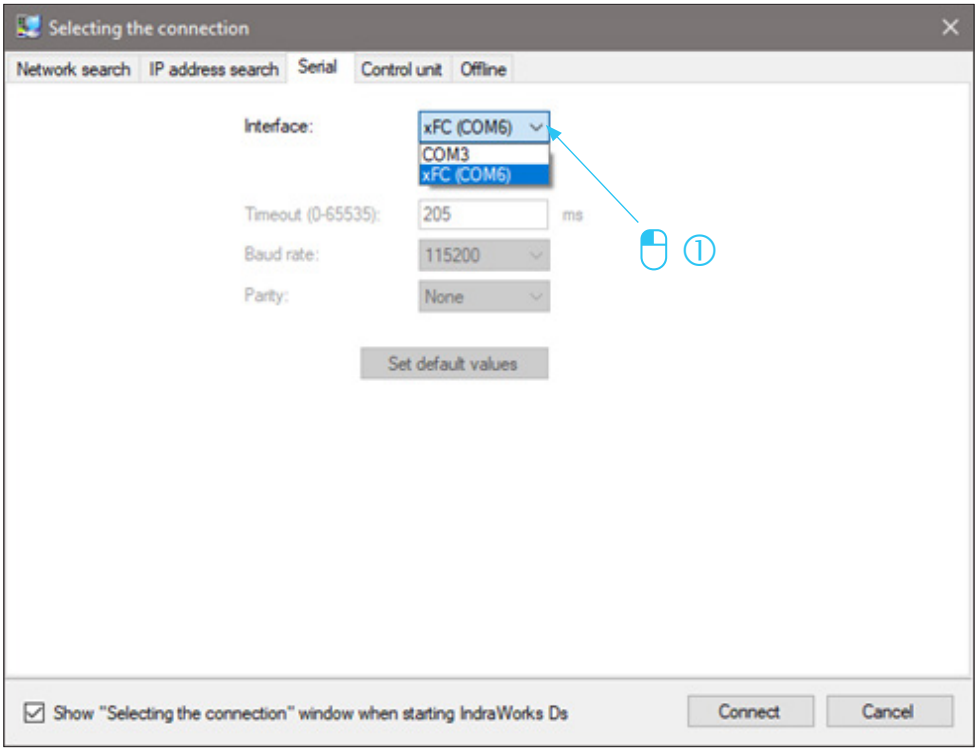


Fig. 1: Connection selection

– If the connection selection window does not appear, but the IndraWorks Ds start window does, click on the symbol 

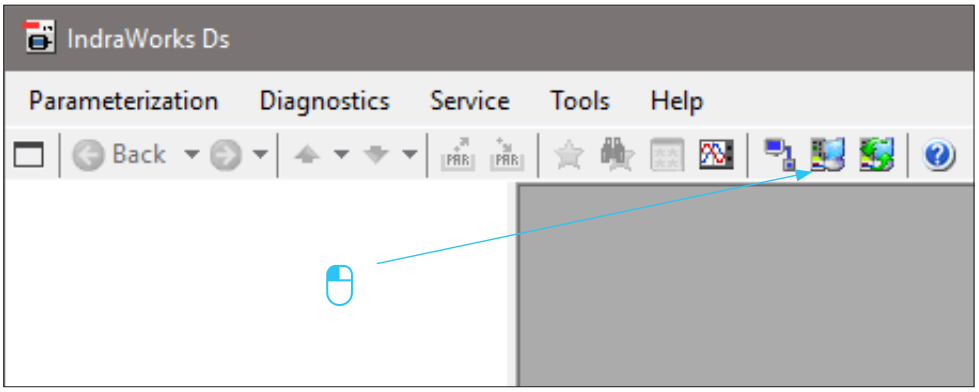


Fig. 2: Connection selection (alternatively)

– If "xFC" does not appear as an interface, disconnect the USB cable from the computer and reconnect it. Alternatively, you can deactivate the interface in the Windows device manager as shown in Fig. 3: USB port in device manager and then turn it back on.
– Close the connection selection and open it again.

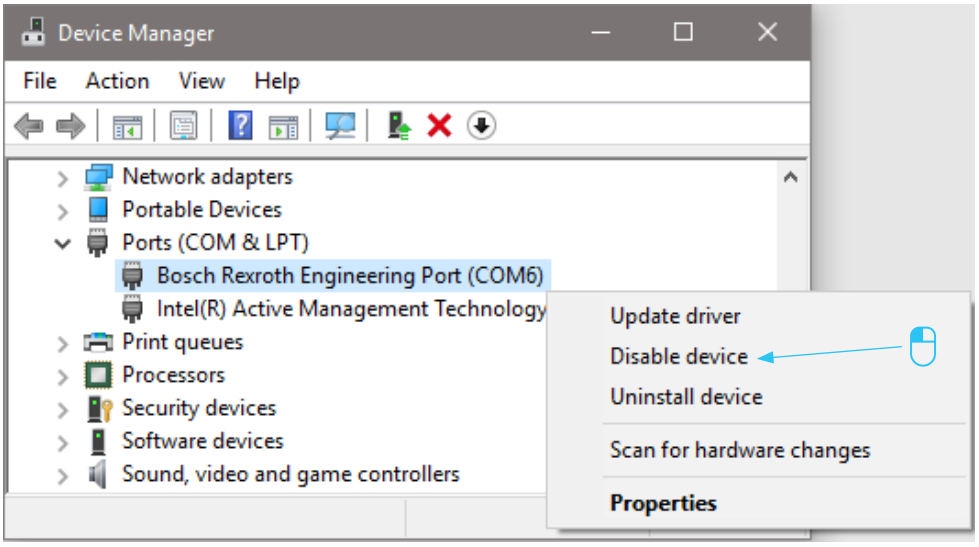


Fig. 3: USB port in device manager

3.5 Only Premium: Establishing a connection with innoCube (LAN)

You have the possibility of searching a network or an IP range. The network search is described below.

1. Connect your computer to the Ethernet interface of the innoCube with a suitable Ethernet cable (21X1).
2. Start IndraWorks Ds.
   The connection selection window appears automatically, see Fig. 4: Connection selection.

3. Click on the drop-down menu for the network adapter under the "Network Search" tab and select the corresponding network adapter you want to connect with and then click on "Connect".

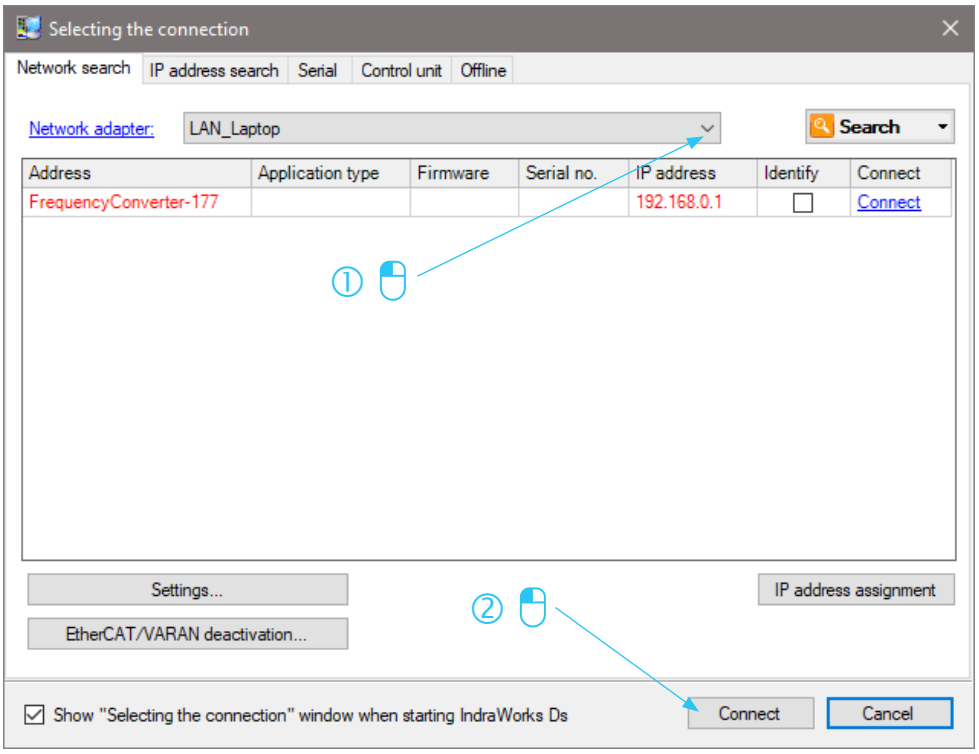


Fig. 4: Connection selection

If your network adapter is in a different IP address range (you can see this by the IP address highlighted in red), you will be asked whether the IP address should be adjusted.

– Click on "Extend IP address settings now".

After exiting IndraWorks Ds, this change will be undone if the checkbox "Restore old settings when exiting" in Fig. 5: Adjusting the IP configuration is set.

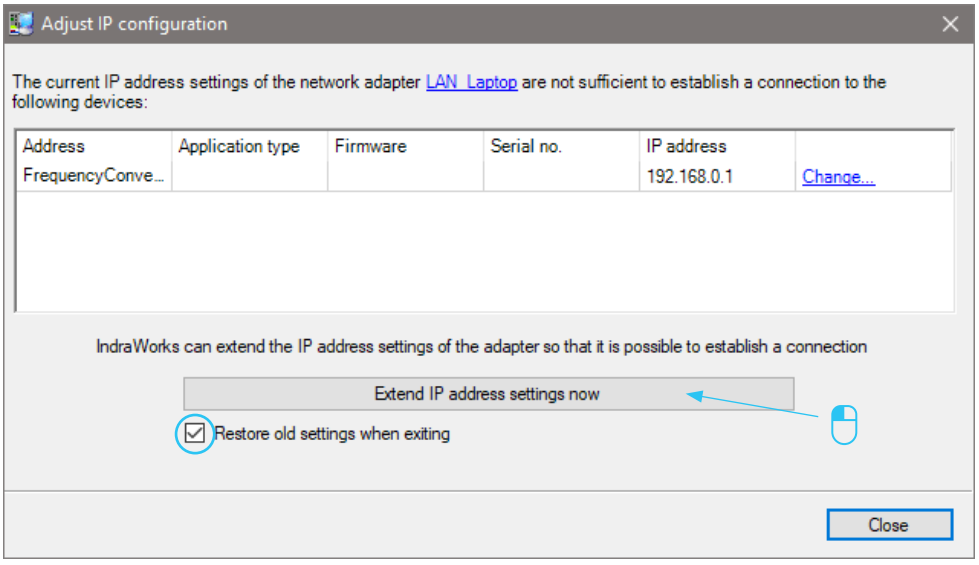


Fig. 5: Adjusting the IP configuration

A window is then opened, see Fig. 6: IP address added, with the customized IP address and then clicking "OK" will establish the connection to the innoCube.

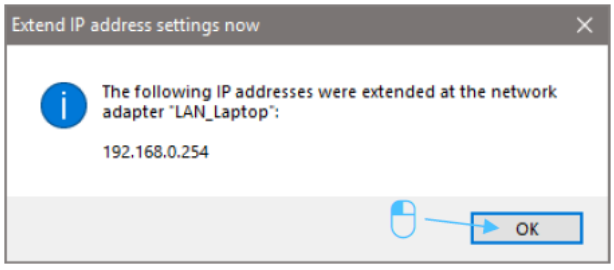


Fig. 6: IP address added

If the connection selection window does not appear, but the IndraWorks Ds start window does, click on the symbol

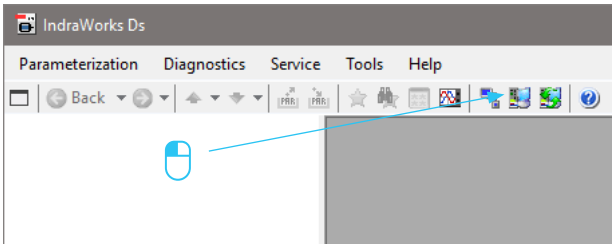


Fig. 7: Connection selection (alternatively)

3.6 Quick start steps

The quick commissioning steps for innoCube are as follows:

1. Connect the power supply according to the operating manual (RE 51045-B). For the power supply interface, see 7.6.2 of the operating manual. AC power and DC 24V power must be connected. Wiring for terminal control, analog command, analog feedback, and innoCube status feedback in the port 15x1 connector can be connected as needed;
2. Check the safe condition of electrical and hydraulic lines; ensure the cooling water system is operating normally (water-cooled version); ensure that relief valve and throttle valve are installed on the pressure line (equipment without pressure protection valve block);
3. Fill with hydraulic oil, see operating manual (RE 51045-B) for precautions;
4. Set the first run command source, E0.01: 0: Operating panel; 1: Multi-function digital input; 2: Communication; for parameter editing methods, see: 4.3 View/ edit parameters in the parameter editor.
5. Set the pressure command source. For specific setting methods, see: 5.3 Pressure command value. If using communication, see 7.1 Field bus communication.
6. Set the speed command source. For specific setting methods, see: 5.4 Flow command value. If using communication, see 7.1 Field bus communication.
7. If analog feedback signals such as pressure and flow are required, see: 5.2 Input and outputs for relevant settings of analog channels. If reading data via communication, see settings in 7.1;
8. After all the above settings are completed, the relief valve and throttle valve in the system need to be adjusted. For specific adjustment methods, see: 6.6 Adjustment of relief valve and throttle valve.

After all the above steps are completed, the innoCube can be controlled normally via commands.

4. IndraWorks DS functions

Also provide the three-phase AC power supply in addition to the 24V DC supply so that you have access to all parameters.

Bosch Rexroth recommends making a backup of the delivered parameter set (see chapter 4.1 Saving parameters) before making any changes. This way you can always restore the condition the innoCube was supplied in by loading this parameter set when this becomes necessary (see chapter 4.2 Loading parameters).
Please also note that the condition as supplied does not match the factory settings of the firmware extension ASF. If you have unintentionally reset the parameters to factory settings and do not have a backed-up parameter set, please contact the Bosch Rexroth customer service team. After specifying the type or material number of your innoCube, they can send you the corresponding parameter set as supplied.

4.1 Saving parameters

Proceed as follows to backup the parameters:

- In the IndraWorks Ds menu window, click "Parameterization", and then click "Save....". The following window is displayed:

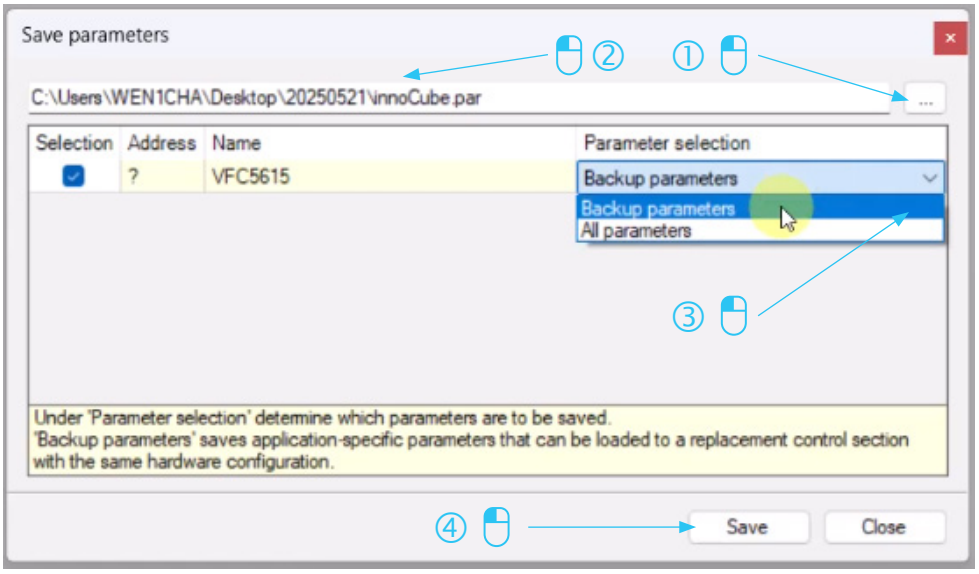


Fig. 8: Save parameters window

- Now, select a path and assign a name for the parameter file. You can save all parameters or backup parameters (see Fig. 8: Save parameters window).
  - A backup with the "Backup parameters" is sufficient for a recovery.
  - For a diagnosis (e.g. for service) it is helpful to save a backup with "All parameters". The last errors as well as current values, which are not necessary for the recovery, but contain additional information, are also stored. Then click on "Save". A file with the extension *.par is now saved.

Please do not use the function of IndraWorks Ds to restore the condition as supplied, as this will reset the frequency converter to factory settings. innoCube-specific parameters will be lost.

4.2 Loading parameters

- To restore the condition as supplied or another saved status, click on "Parameterization" in the IndraWorks Ds menu window and then on "Load...".
- Navigate in Windows Explorer to the parameter file you want to restore.
- Select it and click on "Open".
  A window will then open showing the path and name.
- Now, click on "Load" to load the parameter file.

(See Fig. 9: Load parameters window).

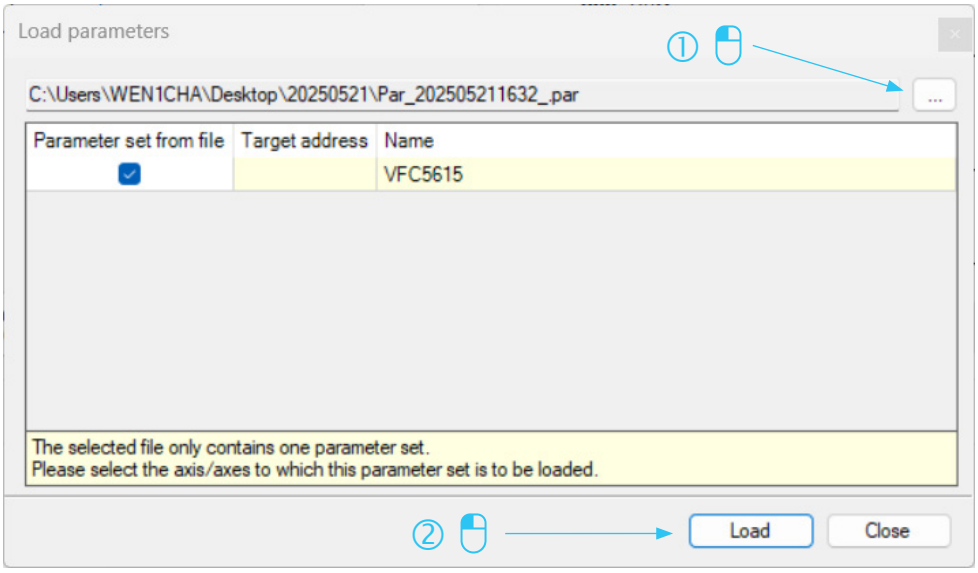


Fig. 9: Load parameters window

4.3 View/edit parameters in the parameter editor

The fastest way to view or edit parameters is to open the parameter editor.

- To do this, in the IndraWorks Ds menu window, click on "Parameterization", "Parameters" and then on "Parameter Editor".
  The parameter editor will then open in a new window.

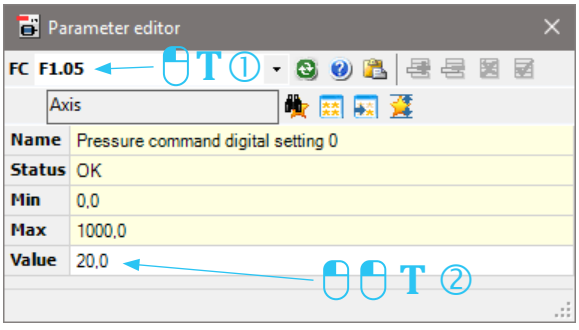


Fig. 10: Parameter Editor window

- Click in the empty white field (after FC).
- Enter a parameter name (e.g. "F1.05") and then press Enter. At "Value" you will see the current value of the desired parameter.
- By double clicking you can change the value (if this parameter is writable) and confirm with Enter.

Table 7: Parameter editor – other functions

Figure	Description
	Refresh parameter
	Parameter search
	Parameter in parameter group

Single bits cannot be set in the parameter editor. A decimal number must be entered.
Conversion from binary to decimal (n=bit position, x=decimal number):
$2^n = x$;

Example (for bit5):$2^5 = 32$;
When the parameter is not 0, a 32 (for bit5) must be added.

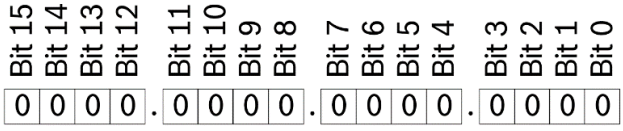


Fig. 11: Bit positions

4.4 Parameter search

If the parameter name is not known, there is the possibility of searching for parameters.

- To do this, in the IndraWorks Ds start window, click on "Parameterization", "Parameters" and then on "Parameter search".
  A new window for parameter search will then open (see Fig. 12: Parameter search window).

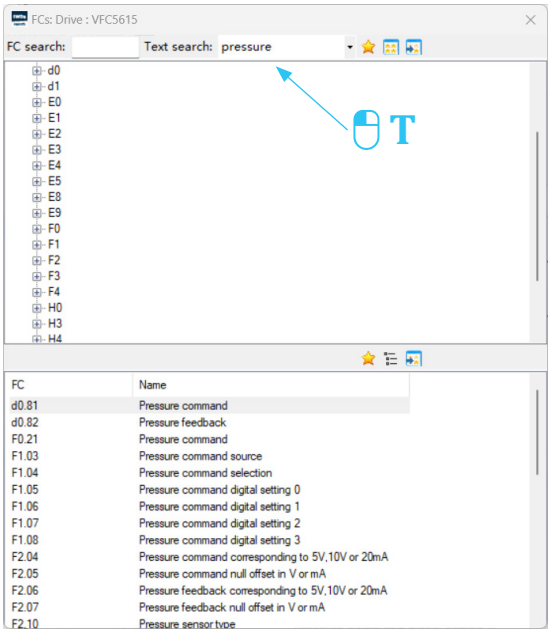


Fig. 12: Parameter search window

- By entering a text in the "Text search" field, relevant parameters are displayed in the lower part of the window during the input.
- Double-clicking on a parameter displays it in the parameter editor (alternatively click on the star).
- Likewise, individual (or several) parameters can be displayed in a parameter group (symbol on the right).

4.5 Parameter group

In some cases it is useful to display several parameters in a list.

▶ To do this, in the IndraWorks Ds menu window, click on "Parameterization", "Parameters" and then on "Parameter Group".
A new window for the parameter group will then open (see Fig. 13: Parameter group window).

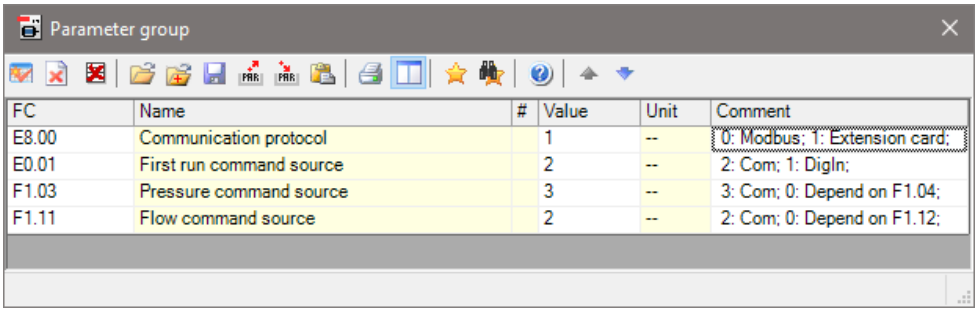


Fig. 13: Parameter group window

- Click on the leftmost symbol to create a new line. Now you can enter a parameter name in the column and confirm by pressing Enter. By pressing Enter again, a new row is automatically created in which further parameters can be entered.

– Alternatively, you can also add further parameters from the parameter editor or from the parameter search to the parameter group (see symbol Table 7: Parameter editor – other functions).
– In a parameter group, parameters can be provided with comments.
– By clicking the disk symbol the created parameter group can be saved (*.ipg) and reloaded the next time IndraWorks Ds is opened/started by clicking the folder symbol.

4.6 Firmware update VFC5615

An update of the firmware of the frequency converter can only be carried out via a USB connection.

The mains voltage (power connector 12X1) must be present during a firmware update and must not be switched off.

- Connect to the innoCube via USB cable (see chapter 3.4 Connection with innoCube (USB)).
- Click on "Service", "Firmware management..." in the IndraWorks Ds menu window to open the firmware update window. Here you can see the existing version in the device.

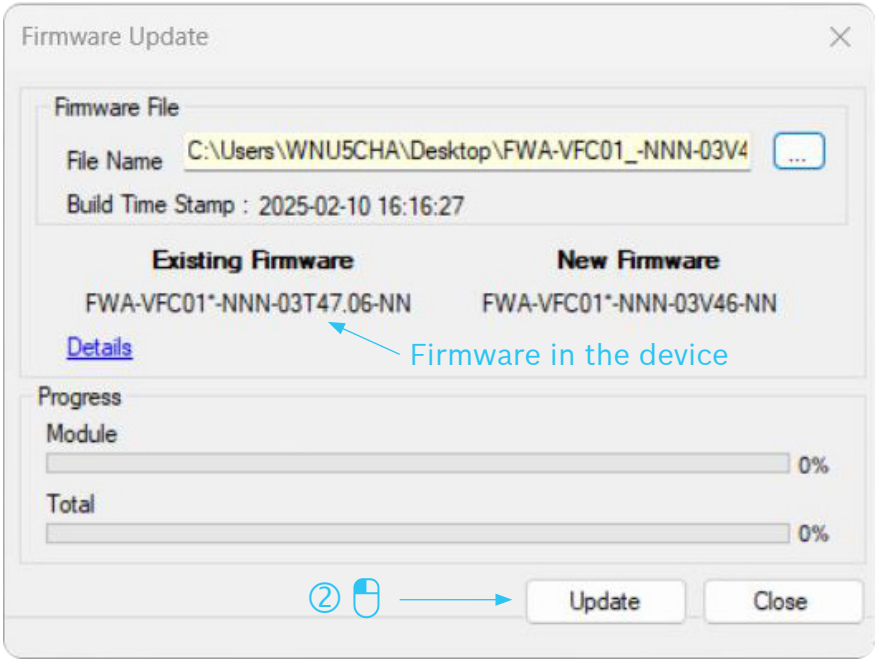


Fig. 14: Firmware update window

- Click on "..." to navigate to a firmware file (*.ibf) and download it to the device by clicking on "Update" (see Fig. 14: Firmware update window). A firmware downgrade would be performed in the same way.

4.7 Only Premium: Firmware update multi-Ethernet card (MEP)

An update of the firmware of the integrated multi-Ethernet card of the frequency converter can only be carried out via a connection using a network (LAN).

The mains voltage (power connector 12X1) must be present during a firmware update and must not be switched off.

- Connect to the innoCube using an Ethernet cable (see 3.5 Only Premium: Establishing a connection with innoCube (LAN)).
- In the IndraWorks Ds menu window, click on "Service", "Firmware management..." to open the window for a firmware update. Here you can see the existing version in the device.

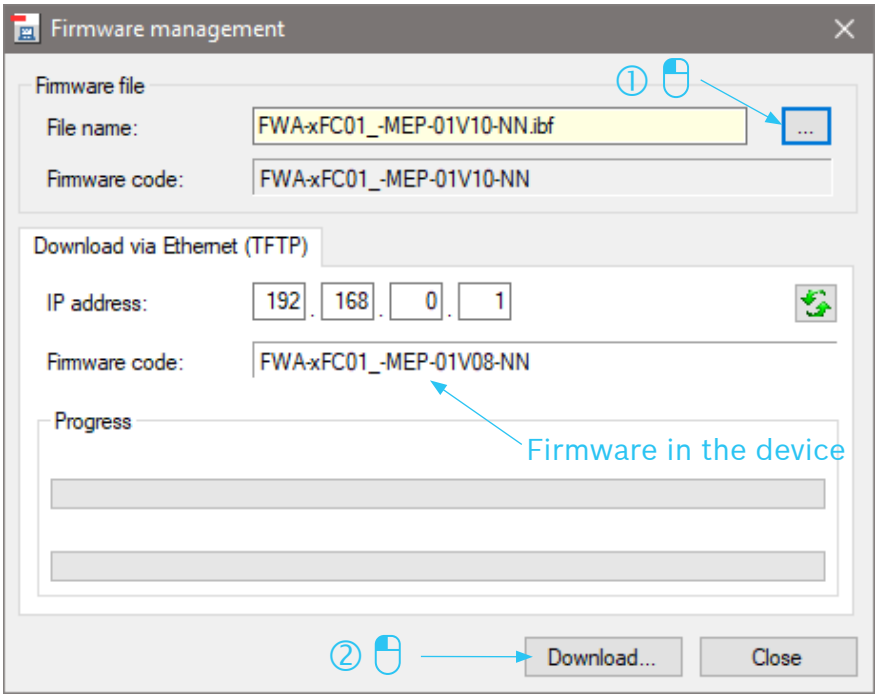


Fig. 15: Firmware update MEP window

- Click on "..." to navigate to a firmware file (*.ibf) and download it to the device by clicking on "Update" (see Fig. 15: Firmware update MEP window).

A firmware downgrade would be performed in the same way.

4.8 ASF update

An update of the ASF firmware can only be carried out via a USB connection.

The mains voltage (power connector 12X1) must be present during an ASF update and must not be switched off.

- Connect to the innoCube via USB cable (see chapter 3.4 Connection with innoCube (USB)).
- In the IndraWorks Ds menu window, click on "Service", "ASF update" to open the window for an ASF update. Here you can see the existing version in the device.

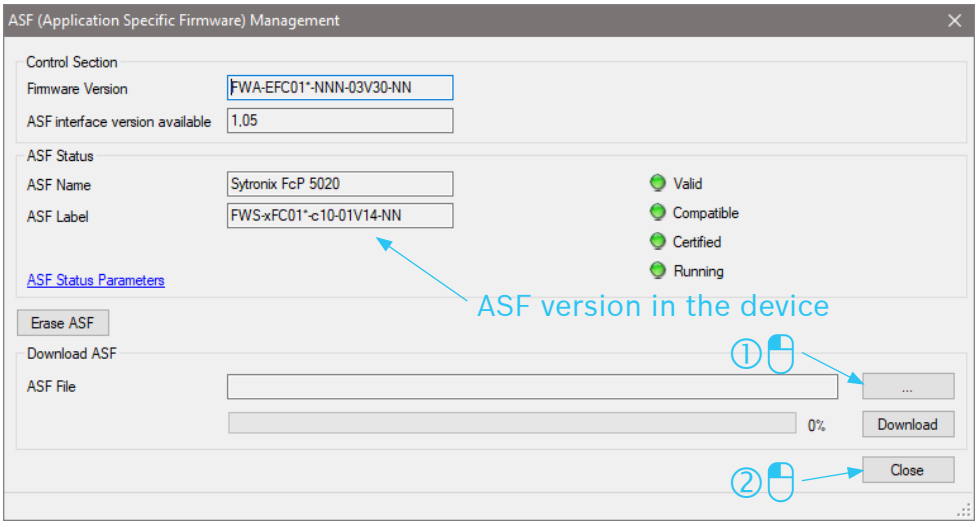


Fig. 16: ASF update window

- Click on "..." to navigate to an ASF file (*.ibf) and download it to the device by clicking on "Download".
- (See Fig. 16: ASF update window).

An ASF downgrade would be performed in the same way.
Then, the new ASF version must be licensed.

- Click on "..." to navigate to an ASF license file (*.par) and then click on "Certify" to certify the version (see Fig. 17: Licensing ASF window).

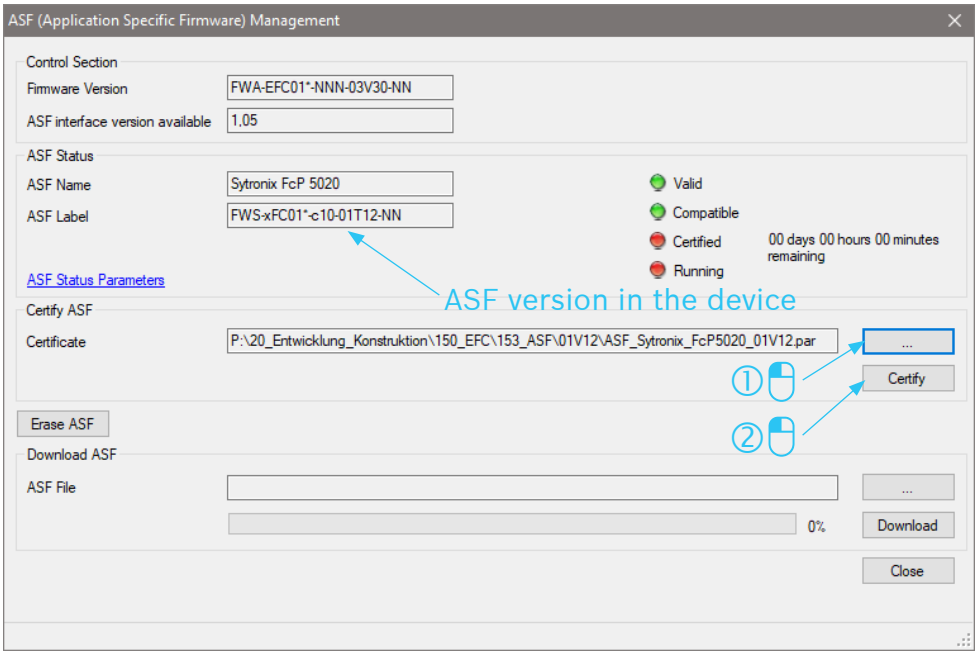


Fig. 17: Licensing ASF window

4.9 Oscilloscope function

The oscilloscope function allows you to perform measurements. Up to four signals can be recorded simultaneously.

- Connect to the innoCube via USB cable (see chapter 3.4 Connection with innoCube (USB)) and ensure that you are online.

From MEP firmware version 01V12 it is also possible to use the oscilloscope function via a LAN connection.

- In the IndraWorks Ds menu window, click "Diagnosis", "Oscilloscope". The following window is opened::

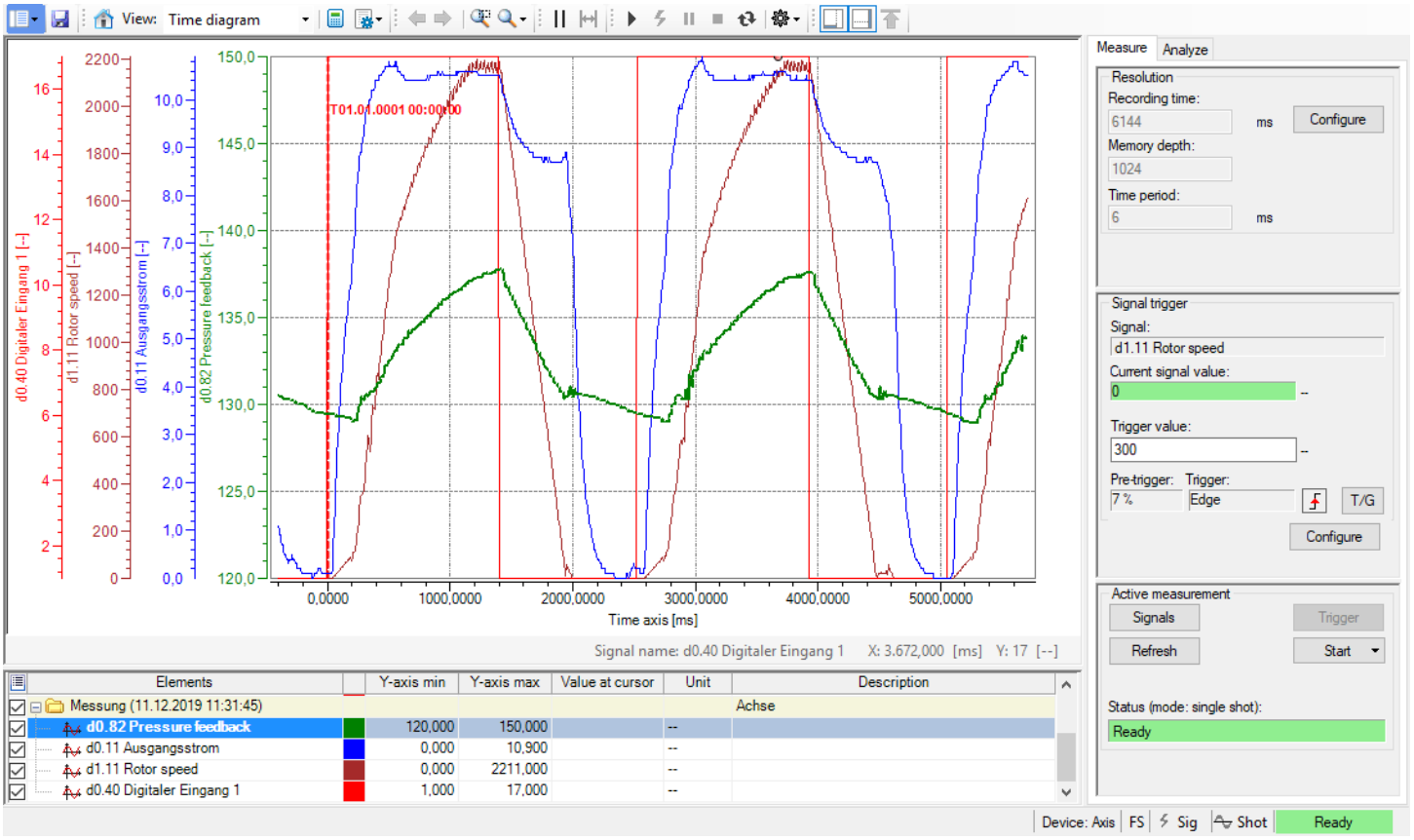


Fig. 18: Oscilloscope function window

Before you can start a measurement, you have to add the signals you want to record ① , set the trigger ② and, if necessary, the resolution ③ depending on the desired measurement duration.

- Click on "Start" to start the measurement ④ (see Fig. 18: Oscilloscope function window).
- By clicking on ⑤ you have the possibility to display all Y-axes or to select a range in which you can see the min/max/average/RMS values of each channel in a separate table.

For further information, please refer to the IndraWorks Ds oscilloscope's own help function.

Table 8: Overview of the most important signals (parameters)

Parameter	Description
d0.01	Current speed (smoothed value) – for better measurements use d1.11 Rotor speed
d0.11	Output current

Parameter	Description
d0.12	Output power
d0.20	Power module temperature
d0.40	Digital Input 1 (status of digital inputs X1...X5 ≙ bit0...bit4) [1]
d0.43	I/O card digital input status (status of digital inputs EX1...EX4 ≙ bit0...bit3) [1]
d0.48	I/O card EDO2 output (status of bit 0, "Ready, High level" status of 15X1 pin 12)
d0.80	ASF status word
d0.81	Pressure command value
d0.82	Actual pressure value
d0.83	Flow command value
d0.84	Actual, effective velocity command value – velocity command value (flow command value) generated internally from the pressure control
d0.88	ASF warning
d0.89	ASF error
d0.98	High resolution output current
d1.11	Rotor speed (not smoothed speed value)

[1] Single bits can be evaluated by a bit analysis (click on "Calculator")

4.9.1 Example configuration for measuring a pressure drop

- Add the following signals to the measurement by marking the signal and then clicking on ">" (see Fig. 19: Adding signals).
- Confirm the selection with "OK".
  - d0.82 Pressure feedback
  - d1.11 Rotor speed
  - d0.84 Effective speed command
  - d0.98 High resolution output current

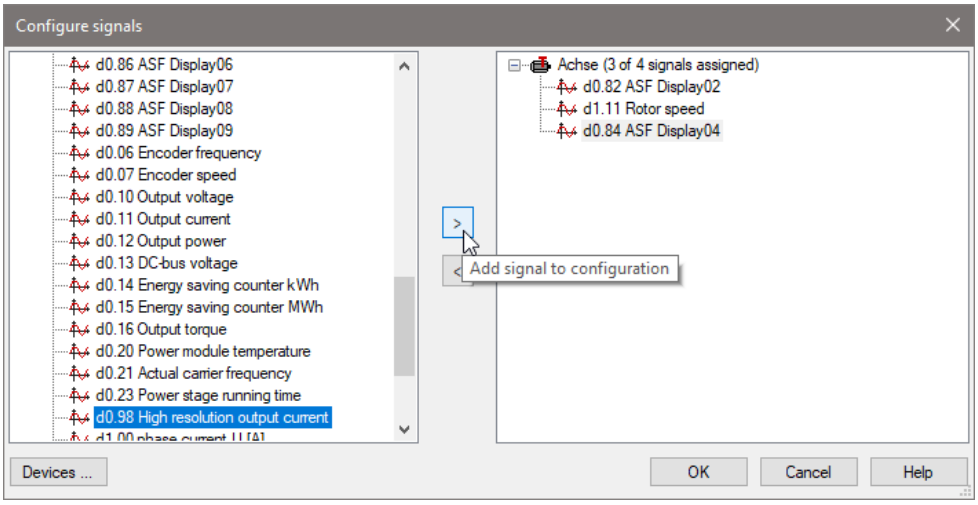


Fig. 19: Adding signals

② **Signal trigger:**

- Set the trigger method to "Signal trigger".
- The pre trigger (recording time in % before the trigger event) should be set low (≤ 10%).
- Select the actual pressure value as the trigger signal (d0.82 Pressure feedback).
- Set the "Falling edge" under "Edge".
- As "Trigger value" you should select a value which is below the command pressure and which is undershot (here command pressure:100 bar - trigger value: 95 bar).
- Confirm the selection with "OK".

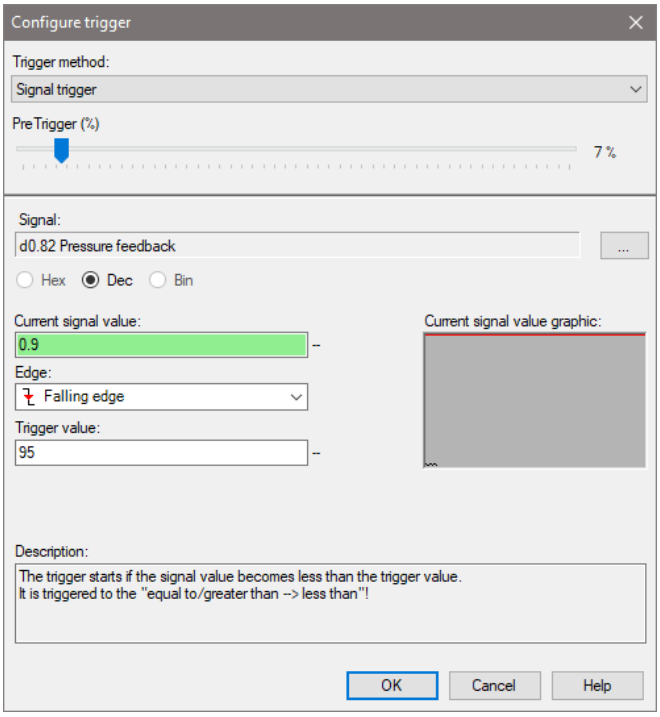


Fig. 20: Configure trigger

③ **Resolution Setting:**

- To execute a measurement of about 5 s set the time base to 5 ms.(Accumulator depth * time period = recording time)
- Confirm the selection with "OK".

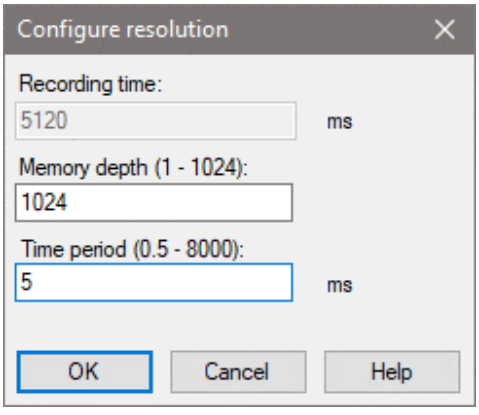


Fig. 21: Configure resolution[

④ **Start measurement:**

- By clicking on "Start" the trigger event is waited for before recording starts. This then happens in the background. After the measurement has finished, the signals are saved and then displayed in the diagram.

5. innoCube functions

5.1 General information about the FCP 5020 ASF

The FcP 5020 ASF is a software extension to the firmware of the VFC5615 converter family and implemented in the innoCube.
The FcP 5020 ASF provides the hydraulic functionality.
A Sytronix FcP 5020 system consists of a pressure controller that compares a pressure command value with the actual pressure value of an HM20 pressure sensor installed in the hydraulic system. Depending on the pressure command and actual pressure, the motor speed and thus the flow is readjusted. By overriding the pressure controller, a constant flow can be generated via the flow presetting, which is actually a flow limitation.

The screenshots in this chapter were created with IndraWorks Ds 15T23 and may differ from the current model. Since the dialog interface for the ASF software of VFC5615 has not yet been fully developed, functionality within the dialog interface will be explained via parameters in addition to screenshot descriptions.

The product provides the following features which are relevant for the innoCube:

- Pressure/flow setting
  - Easy setting of the command value (internal command values and 4 switchable parameters for the pressure command value)
  - Command value can be set via the operating panel for Fixed value
  - Command value can be set via analog
  - Command value setting via communication possible (only Premium)
- p/Q PID control
  - p/Q control with automatic switching between pressure and flow control modes
  - Flow control
  - Pressure control
  - Two switchable sets of controller parameters
- Extension functions
  - Hydraulic soft start and separate acceleration ramp
  - Sleep/wake function
  - Pressure drop/overshoot compensation
  - Pump power limitation
  - Master/slave control
- Protective function
  - Actual pressure monitoring
  - Limit value for pressure and flow command value
  - Oil change warning/error
  - Thermal pump monitoring
  - Sensor monitor
  - LED display of converter status

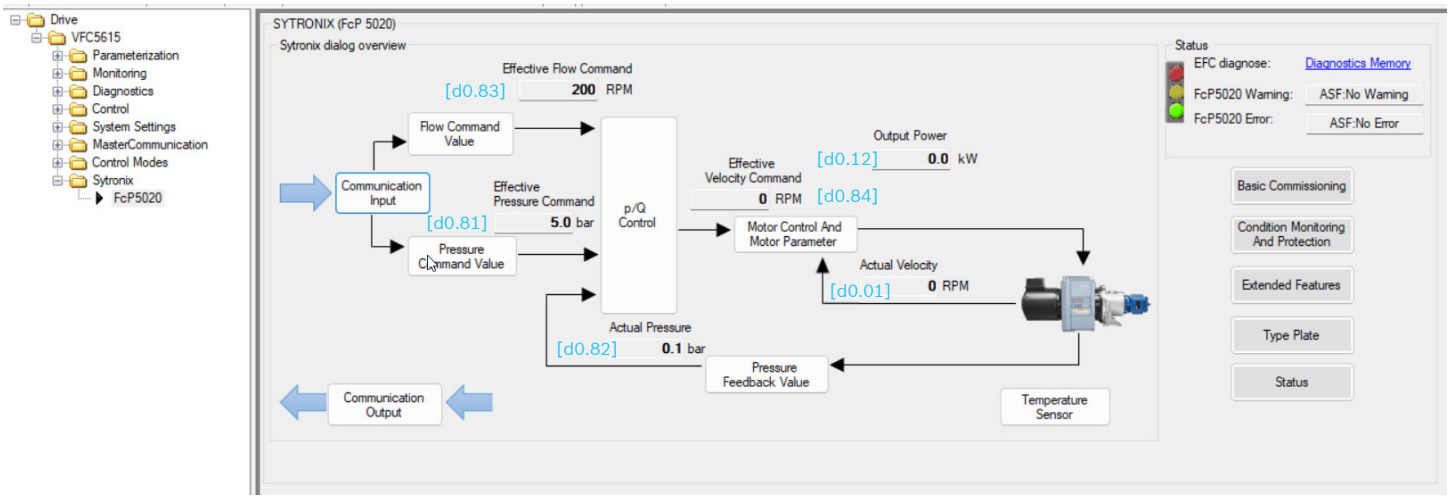


Fig. 22: Overview of the Sytronix FcP 5020 dialog

Table 9: Overview of the parameters of the FcP 5020 dialog

Parameter	Description
d0.01	Display actual speed (smoothed value) – for measurements better use d1.11 Rotor speed
d0.12	Display output power
d0.81	Display current pressure command value
d0.82	Display current actual pressure value
d0.83	Display current velocity command value (flow command value)
d0.84	Display current, effective velocity command value – velocity command value generated internally from the pressure control
d0.88	Display ASF warning – here in plain text
d0.89	Display ASF error – here in plain text

The Sytronix FcP 5020 dialog is only available from IndraWorks Ds version 15V23 and onwards. Currently, the dialog interface for the ASF software of VFC5615 has not been completed. All the above parameters can be viewed via parameters; see section 4.5 Parameter group for the method.

5.2 Input and outputs

Both the device firmware of the VFC and the technology function (ASF) can be assigned functions for digital inputs and outputs, as well as relay outputs. Here, assignments made by the ASF have priority over assignments made by the VFC5615 device firmware. The parameters are designated as follows:
Device firmware parameters: [Ex.xx] and [Hx.xx] parameters.
ASF parameters: [Fx.xx] parameters.

Table 10: List of parameters for setting relay outputs

Parameter	Designation	Setting range	Default
E2.15	Relay output 1 selection Assignment by firmware VFC5615	0...25[1)]	15
F2.40	Relay 1 output Assignment by ASF	0: No function assigned from 1: Converter warning 2: Two points/double pump control	0
H8.20	Extended EDO1 output selection Assignment by firmware VFC5615	0...25[1)]	25
H8.22	Extended EDO2 output selection Assignment by firmware VFC5615	0...25[1)]	15

[1)] See Table 11: Setting range [E2.15, H8.20, H8.22]. E2.15 , H8.20 and F2.40 are used to control the LED strip; please keep the default values and do not change them.

Table 11: Setting range [E2.15, H8.20, H8.22]

Setting	Description
0: Converter ready	After powering on, if no error occurs and there is no run command or output active indication, the frequency converter is ready for operation.
1: Converter running	The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).
10: Converter undervoltage	The output is active when the DC-bus voltage is lower than 230 V DC (model 1P 200 V AC)/430 V DC (model 3P 400 V AC). The output will be inactive when the DC-bus voltage resumes and becomes stable. In addition, this digital output will be activated by any soft start error.
13: Converter stop due to external error	The output is active as soon as an external error signal is active. The frequency converter stops and the error code "E-St" is displayed if one X1...X5 input is defined as either "Error signal normally open contact input" or "Error signal normally closed contact input".
14: Converter error	The output is active when an error occurs, inactive when the error is reset.
15: Converter OK	The output is inactive when the frequency converter is powered off or encounters an error/warning during running. The output is active when the frequency converter is powered on but not running, or the frequency converter is running without an error/warning.
25: Converter error or warning	The output is active when errors/warnings occur on the frequency converter. The output is inactive if there are no errors/warnings on the frequency converter.

Table 12: List of parameters for setting parameter inputs

Parameter	Designation	Setting range	Default
E1.00	X1 input (parameter input 1) Assignment by firmware VFC5615	0...36[1)]	35
E1.01	X2 input (parameter input 2) Assignment by firmware VFC5615	0...36[1)]	34
F2.16	X1 input (parameter input 3) Assignment by ASF	0...21[2)]	0
F2.17	X2 input (parameter input 2) Assignment by ASF	0...21[2)]	0
F2.18	X3 input (parameter input 3) Assignment by ASF	0...21[2)]	16
F2.19	X4 input (parameter input 2) Assignment by ASF	0...21[2)]	8
F2.20	X5 input (parameter input 2) Assignment by ASF	0...21[2)]	7
F2.21	EX1 input (parameter input 2) Assignment by ASF	0...21[2)]	5
F2.22	EX2 input (parameter input 2) Assignment by ASF	0...21[2)]	1

[1)] See Table 13: Setting range [E1.00 and E1.01]
[2)] See Table 14: Setting range [F2.16, F2.17, F2.18, F2.19, F2.20, F2.21, F2.22]. Do not change other parameters, except for F2.21 and F2.22 which can be set according to application requirements, as the corresponding input points and wiring are internally pre-configured.

Table 13: Setting range [E1.00 and E1.01]

Setting	Description
0: Inactive	-
31: Second run command source activation	Used to switch to the second run command source.
32: Error signal normally open contact input	Used to receive error signals from external sources (24 V: error signal active, 0 V: error signal inactive).
33: Error signal normally closed contact input	Used to receive error signals from external sources (0 V: error signal active, 24 V: error signal inactive).
34: Error reset	Used to reset errors.
35: Forward running (FWD)	Used to control the Run/Stop command.

Table 14: Setting range [F2.21, F2.22]

Setting	Description
0: No function assigned from ASF	-
1: Pressure command value selection bit0	See chapter 5.3.2 Pressure command value switchable (via parameter inputs).
2: Pressure command value selection bit1	See chapter 5.3.2 Pressure command value switchable (via parameter inputs).
3: p/Q parameter set selection	See chapter 5.5.7 p/Q parameter set switch-over (via parameter input).
4: Flow command value selection	See chapter 5.4.2 Flow command value switchable (via parameter input).
5: Master/slave operating mode selector switch	See chapter 7.3.5 Slave operation switch-over via parameter input.
20: Pressure drop compensation trigger	See chapter 5.8 Compensation for pressure drop/excessive pressure compensation.
21: Excessive pressure compensation trigger	See chapter 5.8 Compensation for pressure drop/excessive pressure compensation.

Table 15: List of parameters for setting analog outputs

Parameter	Designation	Setting range	Default
F2.31	AO1 output	0: No function assigned from ASF 1: Pressure command value **2: Actual pressure value** 3: Flow command value	2
E2.26	AO1 output	0: Output frequency (0.00...[E0.08] Hz) 1: Setting frequency (0.00...[E0.08] Hz) 2: Output current (0...2 times rated current) 4: Output voltage (0...1.2 times rated voltage) 5: Output power (0...1.2 times rated power) 6: AI1 analog input 7: AI2 analog input 8: EAI analog input 11: Motor temperature sensor power supply 99: Inactive	0
E2.25	AO1 output signal type	0: 0...10 V 1: 0...20 mA	0
F2.06	Actual pressure range	315bar	315
F2.32	EAO1 output	0: No function assigned from ASF 1: Pressure command value 2: Actual pressure value 3: Command speed **4: Actual speed**	4
H2.26	EAO1 output	0: Output frequency (0.00...[E0.08] Hz) 1: Setting frequency (0.00...[E0.08] Hz) 2: Output current (0...2 times rated current) 4: Output voltage (0...1.2 times rated voltage) 5: Output power (0...1.2 times rated power) 6: AI1 analog input 7: AI2 analog input 8: EAI analog input 11: Motor temperature sensor power supply 99: Inactive	0
F2.31	EAO1 output	0: No function assigned from ASF 1: Pressure command value **2: Actual pressure value** 3: Flow command value	2
H8.25	EAO1 output signal type	0: 0...10 V 1: 0...20 mA	0
F2.08	Speed feedback range	According to requirements	3000

5.3 Pressure command value

There are 4 different ways to provide the pressure command value.

5.3.1 Pressure command value fixed

Parameter F1.03 is set to 0, and the pressure command source is the fixed value F1.05. Enter the pressure command value in parameter [F1.05] (Pressure command digital setting 0). Alternatively, you can set the pressure command value in the Sytronix FcP 5020 interface:

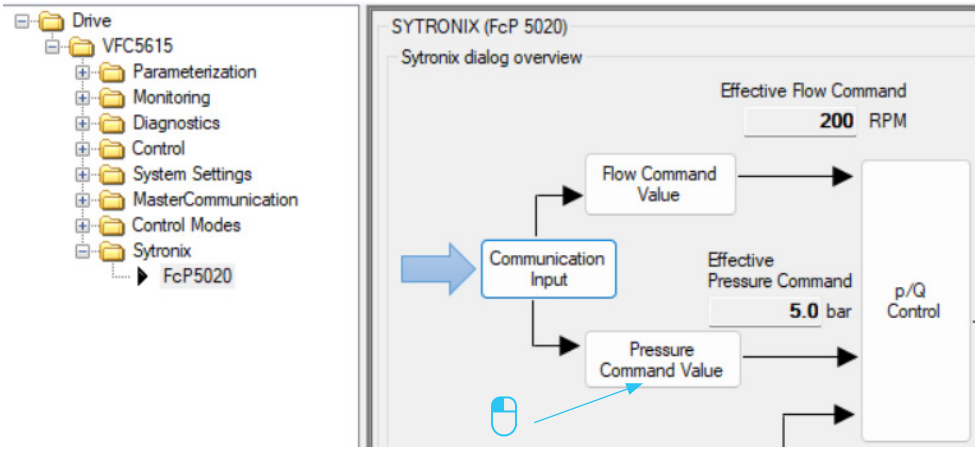


Fig. 23: Pressure command value fixed 1/2

1. Press "Pressure Command Value" (see Fig. 23: Pressure command value fixed 1/2).
   A new dialog opens.
2. Press "Click in this dialog to configure fixed value".
   A new window opens immediately.

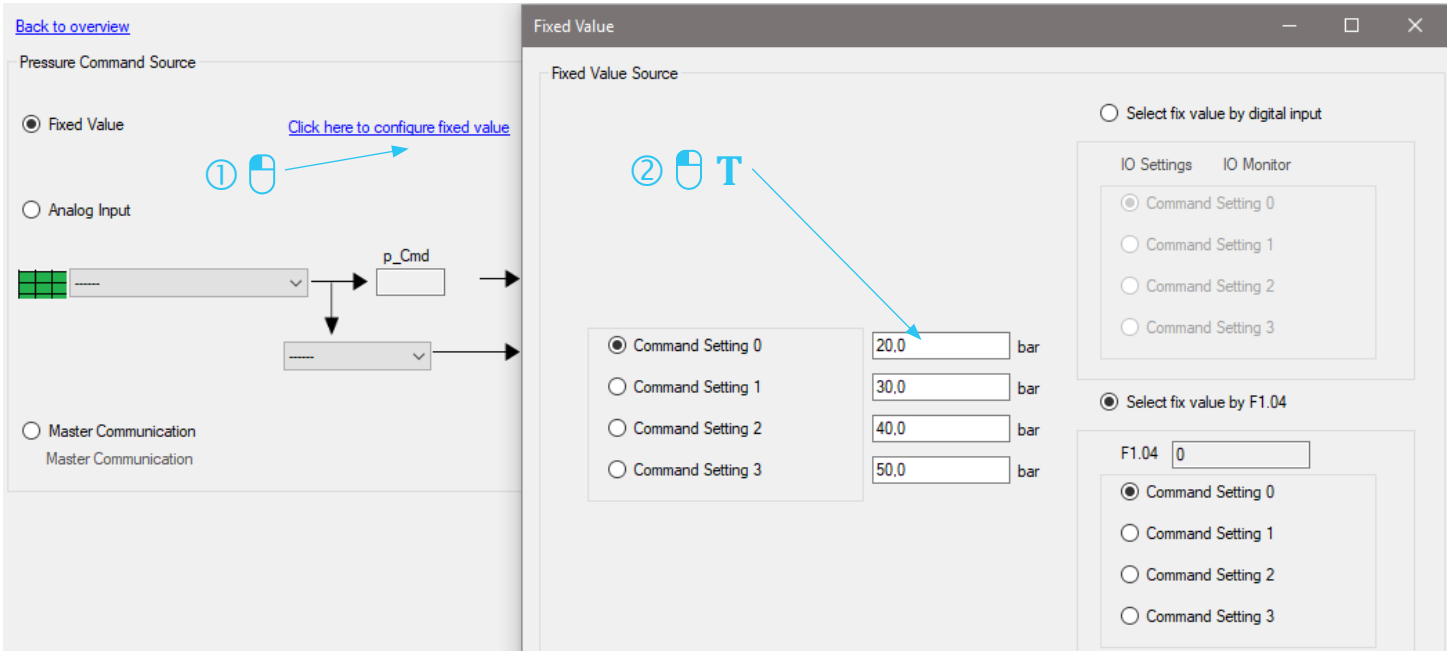


Fig. 24: Pressure command value fixed 2/2

3. Enter the desired pressure command in "Command Setting 0" (see Fig. 24: Pressure command value fixed 2/2).

5.3.2 Pressure command value switchable (via parameter inputs)

Up to 4 different pressure command values can be set. This is done via the digital inputs pin 5 and pin 6 (parameter input EX1 – input EX2) of the interface 15X1 (see chapter 5.2 Input and outputs (relay outputs, parameter inputs)).
On delivery, the pin 6 parameter input is set as the input for pressure command values (pressure command selection bit0), and the pin 5 parameter input is set as the input for master/slave. However, to enable the function, parameter [F1.03] must be set to 1. Which pressure command value is selected is indicated in parameter [F1.04] (0...3).
(See table below).

Table 16: Requirements for switchable pressure command value

Parameter	Designation	Setting range	Default
F2.22	EX2 input [1)]	Pressure command value selection bit0	1
F2.21	EX1 input [2)]	Pressure command value selection bit1	5[3)]
F1.03	Pressure command value source	Select via digital input	1

[1)] Interface 15X1 pin 6 (parameter input 1)
[2)] Interface 15X1 pin 6 (parameter EX2 input)
[3)] Interface 15X1 pin 5 (parameter EX1 input), If you want to use this pin as Pressure command value selection bit1, The value of F2.21 needs to be changed to 2

Table 17: Pressure command value parameters

Pressure command value selection bit0	15X1 pin 6 (EX2 input)	0	1	0	1
Pressure command value selection bit1	15X1 pin 5 (EX1 input)	0	0	1	1
F1.04		0	1	2	3
Pressure command value		F1.05	F1.06	F1.07	F1.08

Alternatively, you can set this in the Sytronix FcP 5020 dialog.

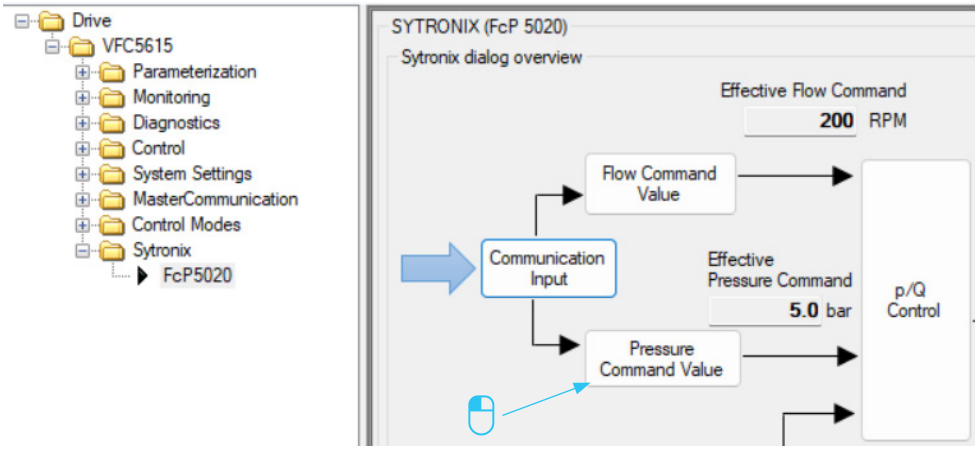


Fig. 25: Pressure command value switchable 1/2

1. Press "Pressure Command Value" (see Fig. 25: Pressure command value switchable 1/2).
   A new dialog opens.

2. Press "Click in this dialog to configure fixed value".
   A new window opens immediately.

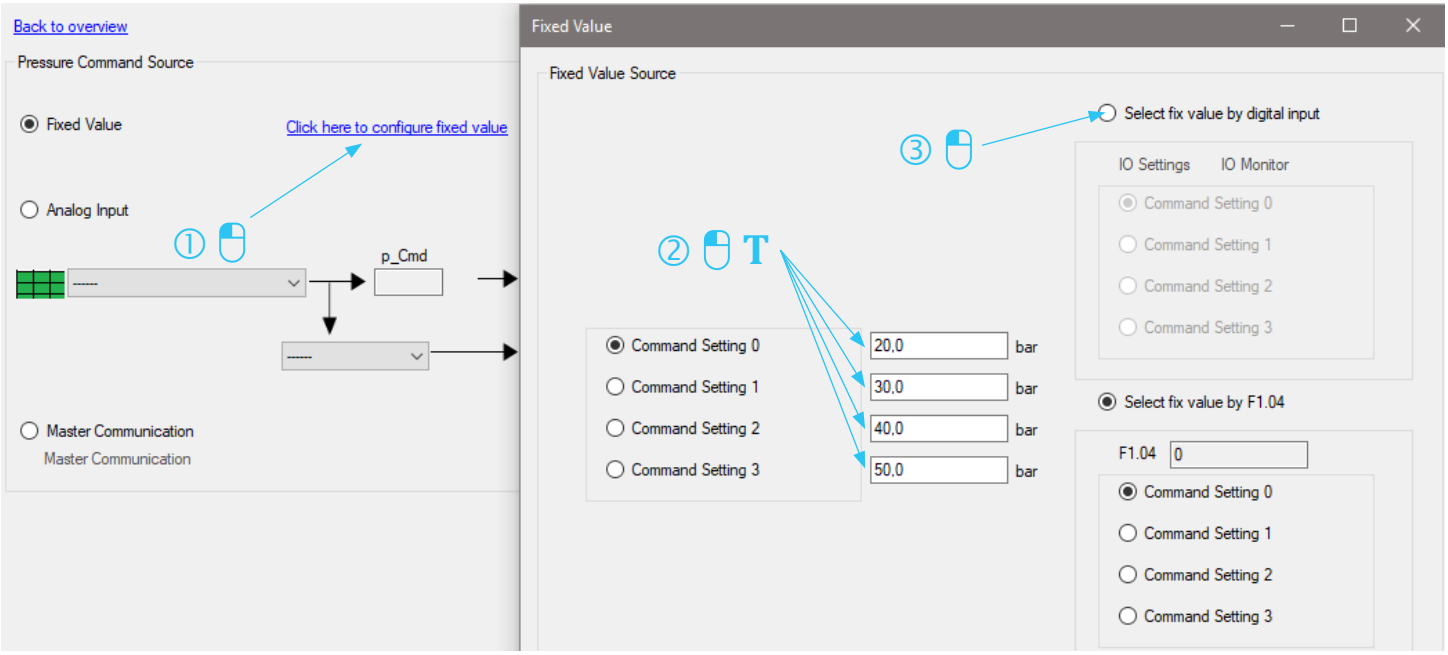


Fig. 26: Pressure command value switchable 2/2

3. Enter the desired pressure command values in "Command Setting 0...3".
4. Then click on the circuit at "Select fix value by digital input"
   (see Fig. 26: Pressure command value switchable 2/2).

5.3.3 Pressure command value via analog

Parameter F1.03 is set to 2 for analog input source. Alternatively, you can set the pressure command value in the Sytronix FcP 5020 interface:

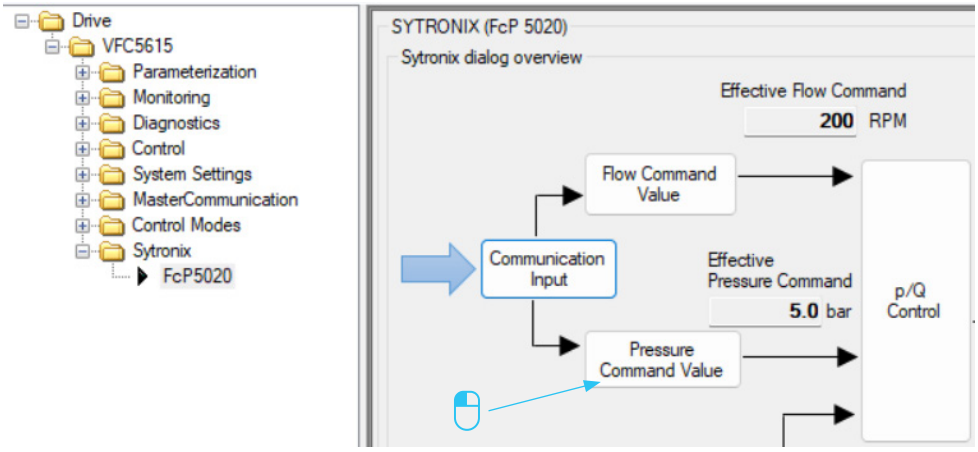


Fig. 27: Pressure command value via analog 1/2

1. Press "Pressure Command Value" (see Fig. 27: Pressure command value via analog 1/2).
   A new dialog opens.

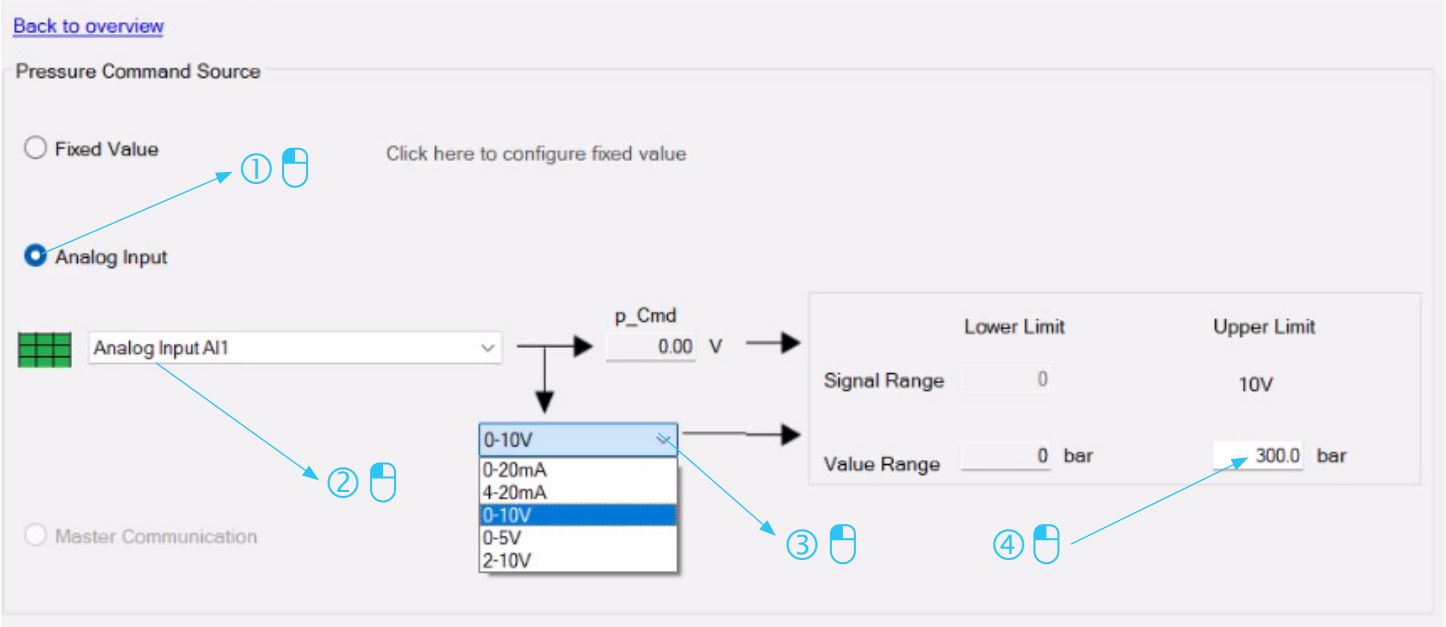


Fig. 28: Pressure command value via analog 2/2

2. Click to select analog input.
3. 3. Select analog channel input AI1;
4. 4. Select the analog signal type as required;
5. 5. Set the range of the analog input channel.

The above operations can also be completed directly by setting parameters. For the method of calling up the parameter group, see 4.5 Parameter group. The parameter settings are as follows:

Table 18: Pressure command value via analog

Parameter	Designation	Setting	Value
F1.03	Pressure command value source	Select via analog	2
F2.00	AI1	0: No function assigned from ASF 1: Pressure command value **2: Actual pressure value** 3: Flow command value	1
E1.35	AI1 signal input type	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V	Set as required
F2.04	Pressure command value range	300	300 (can be set as required)

5.3.4 Pressure command value via communication (only Premium)

The parameter [F0.21] Pressure command value can be written cyclically via fieldbus. For this, parameter [F1.03] must be set to 3 in the frequency converter

(already pre-set).

For further information, see chapter 7.1 Field bus communication.

5.4 Flow command value

As for the pressure command value, there are 4 different ways to set the flow command value. The flow command value is a speed limit and is specified in rpm (revolutions per minute).

5.4.1 Flow command value fixed

The flow command value is entered in parameter [F1.12] (Flow command digital setting 0) .
Alternatively, you can set the flow command value in the interface of the Sytronix FcP 5020 dialog:

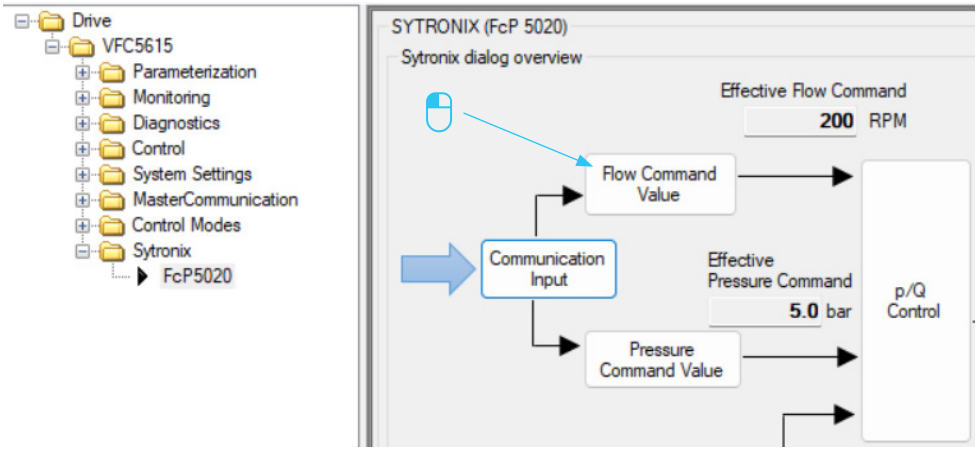


Fig. 29: Flow command value fixed 1/2

1. Press "Flow Command Value" (see Fig. 29: Flow command value fixed 1/2). A new dialog opens.
2. Enter the desired flow command value in the field below "Fixed value in parameter" (see Fig. 30: Flow command value fixed 2/2).

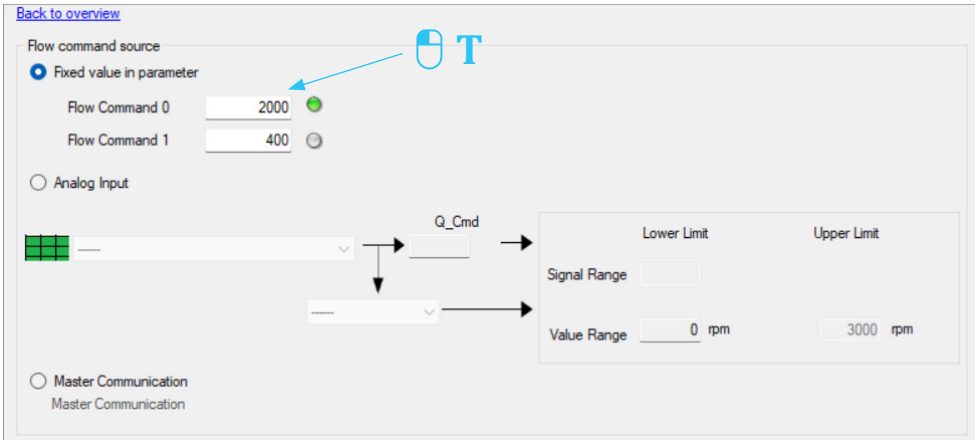


Fig. 30: Flow command value fixed 2/2

5.4.2 Flow command value switchable (via parameter input)

Up to 2 different flow command values can be set. This is done via the digital input pin5 or pin 6 (parameter input EX1 – input EX2) of the interface 15X1 (see chapter 5.2 Input and outputs (relay outputs, parameter inputs)). The following uses pin 6 as an example.
To enable the function, parameter [F1.11] must be set to 3. Which flow command value is selected is indicated in parameter [F1.14] (0...1).

Example configuration:

On delivery, this parameter input is set as the input for pressure command values (pressure command selection bit0). If 2 flow command values are to be assigned via digital inputs, Bosch Rexroth recommends setting them as follows (see table below).

Table 19: Requirements for switchable flow and pressure command value

Parameter	Designation	Setting	Value
F2.22	EX2 input [1)]	Flow command value selection	4
F1.11	Flow command value source	Select via digital input	3

[1)] Interface 15X1 pin 6 (parameter input 1)

Table 20: Flow command value parameters

Flow command value selection	15X1 pin 6 (EX2 input)	0	1
F1.14		0	1
Flow command value		F1.12	F1.13

Configuration for pressure command or flow command can also be made for parameter input F2.21 (pin 5); its factory default is the master/slave mode selector parameter.

5.4.3 Flow command value via analog (via parameter input)

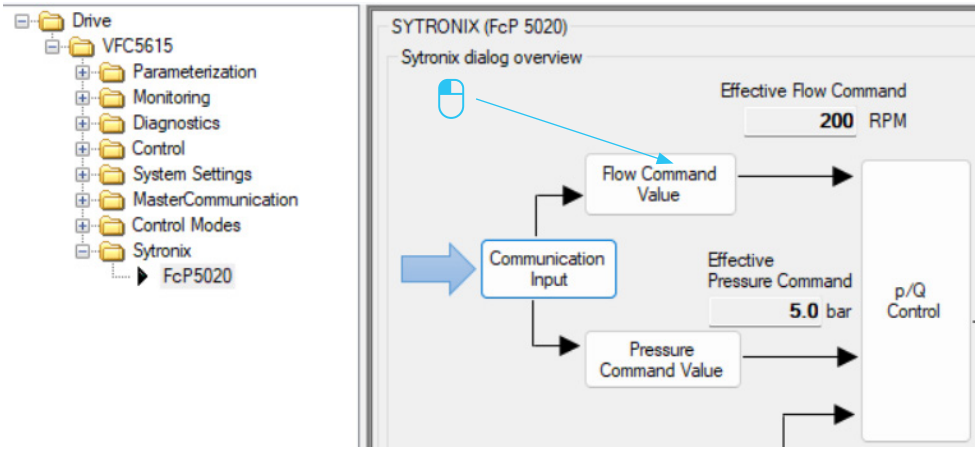


Fig. 31: Flow command value via analog 1/2

1. Press "Flow Command Value" (see Fig. 31: Flow command value via analog 1/2). A new dialog opens.

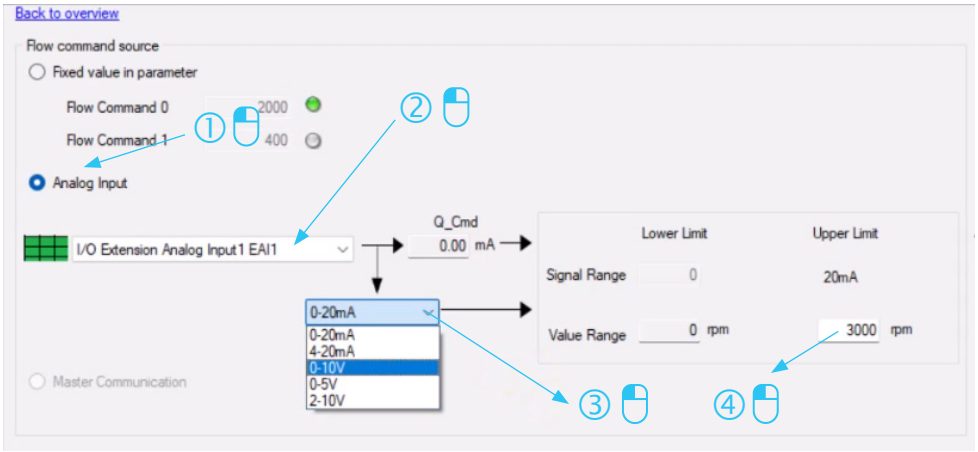


Fig. 32: Flow command value via analog 2/2

2. Click to select analog input.
3. Select analog channel input EAI1;
4. Select the analog signal type as required;
5. Set the range of the analog input channel.

Table 21: Flow command value via analog control

Parameter	Designation	Setting	Value
F1.11	Pressure command value source	Select via analog	1
F2.02	EAI1	0: No function assigned from ASF 1: Pressure command value 2: Actual pressure value **3: Flow command value**	3
H8.25	EAI1 signal input type	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V	Set as required
F2.08	Flow command value range	3000	3000 (can be set as required)

5.4.4 Only Premium: Flow command value via communication

The parameter [F0.22] Flow command value can be written cyclically via fieldbus. For this, parameter [F1.11] must be set to 2 in the frequency converter (already pre-set).

For further information, see chapter 7.1 Field bus communication.

5.5 p/Q PID control

FC			Name	#	Value	Unit	Comment
F3.12	Parameter set 0	P	Proportional gain [0]		8,00	--	
F3.13		I	Integral time 1 [0]		80	--	
F3.14			Integral time 2 [0]		0	--	
F3.15			Integral time TI switch threshold [0]		0,0	--	
F3.16		D	Differential gain [0]		0,000	--	
F3.17			Filter time for Kd [0]		35	--	
F3.18			Lower limitation for I+D [0]		0	--	
F3.19			System minimum speed [0]		200 [1]	--	
F3.32	Parameter set 1	P	Proportional gain [1]		8,00	--	
F3.33		I	Integral time 1 [1]		80	--	
F3.34			Integral time 2 [1]		0	--	
F3.35			Integral time TI switch threshold [1]		0,0	--	
F3.36		D	Differential gain [1]		0,000	--	
F3.37			Filter time for Kd [1]		35	--	
F3.38			Lower limitation for I+D [1]		0	--	
F3.39			System minimum speed [1]		200 [1]	--	

Fig. 33: PID control parameters

[1] May vary for different innoCube versions.

5.5.1 p/Q PID controller

The p/Q-PID controller consists of a pressure controller followed by a limiter. The limiter ensures that a certain speed is not exceeded (Flow command value) and that the speed does not fall below a minimum speed.
The pressure control performance is determined by the acceleration capability of the motor/pump combination.
The output of the p/Q PID controller is a speed command value, which is limited in acceleration by a ramp generator.

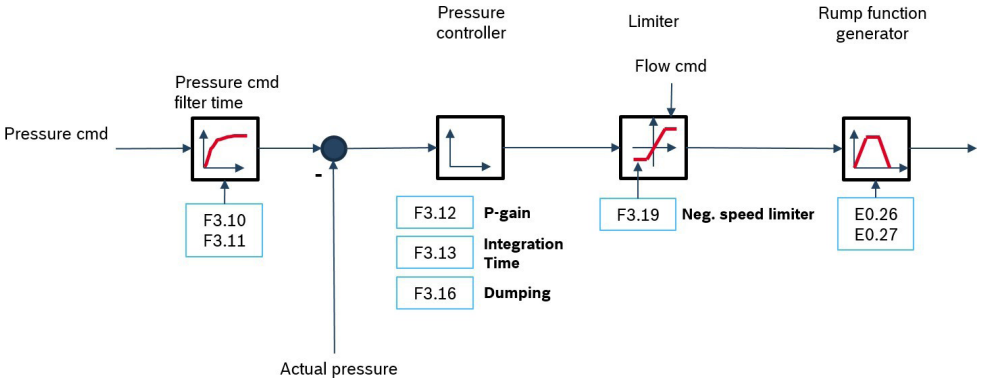


Fig. 34: p/Q-PID controller structure

5.5.2 Pressure command value filter time

Table 22: List of parameters for setting the pressure command value filter time

Parameter	Designation	Setting range	Default
F3.10	Filter time for pressure ascending [0]	0...999 ms	80
F3.11	Filter time for pressure descending [0]	0...999 ms	40

With changing pressure command values, the command value step can be damped via filter times. This avoids overshoots or possible undershoots if the command value step is negative.
The command value filter is designed as a PT1 element.

For systems with constant command pressure, these parameters have no effect.

5.5.3 Pressure controller

Table 23: List of parameters for setting the pressure controller

Parameter	Designation	Setting range	Default
F3.12	Gain factor [0]	0.00...500.00 rpm/bar	8.00
F3.13	Integral time 1 [0]	0...999 ms	80
F3.16	Differential gain [0]	0.000...10.000 (rpm/bar) *s	0.000

If there is a pressure drop in the system, the motor/pump combination must accelerate fast enough to compensate for the pressure drop. This can be achieved by increasing the gain or by decreasing the integral time.

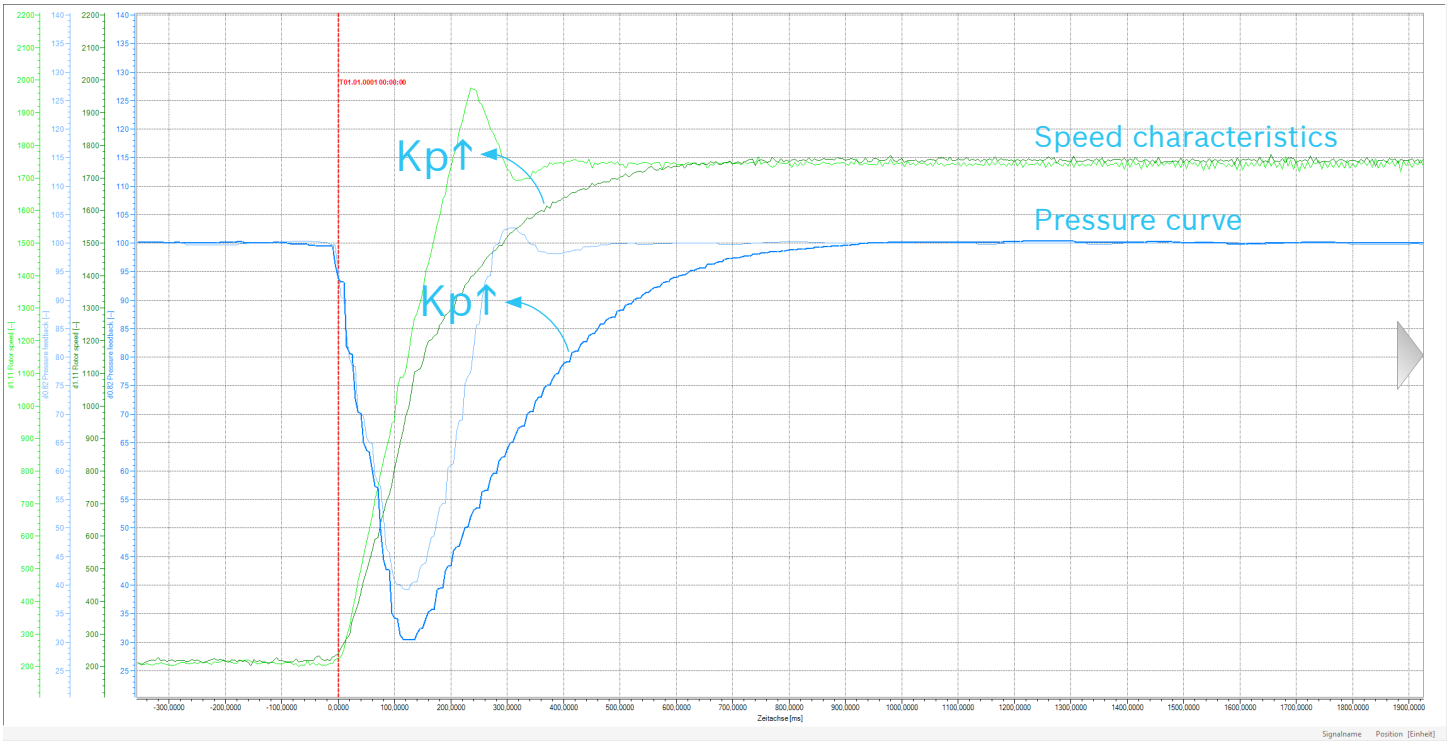


Fig. 35: Effect of change in gain factor (Kp)

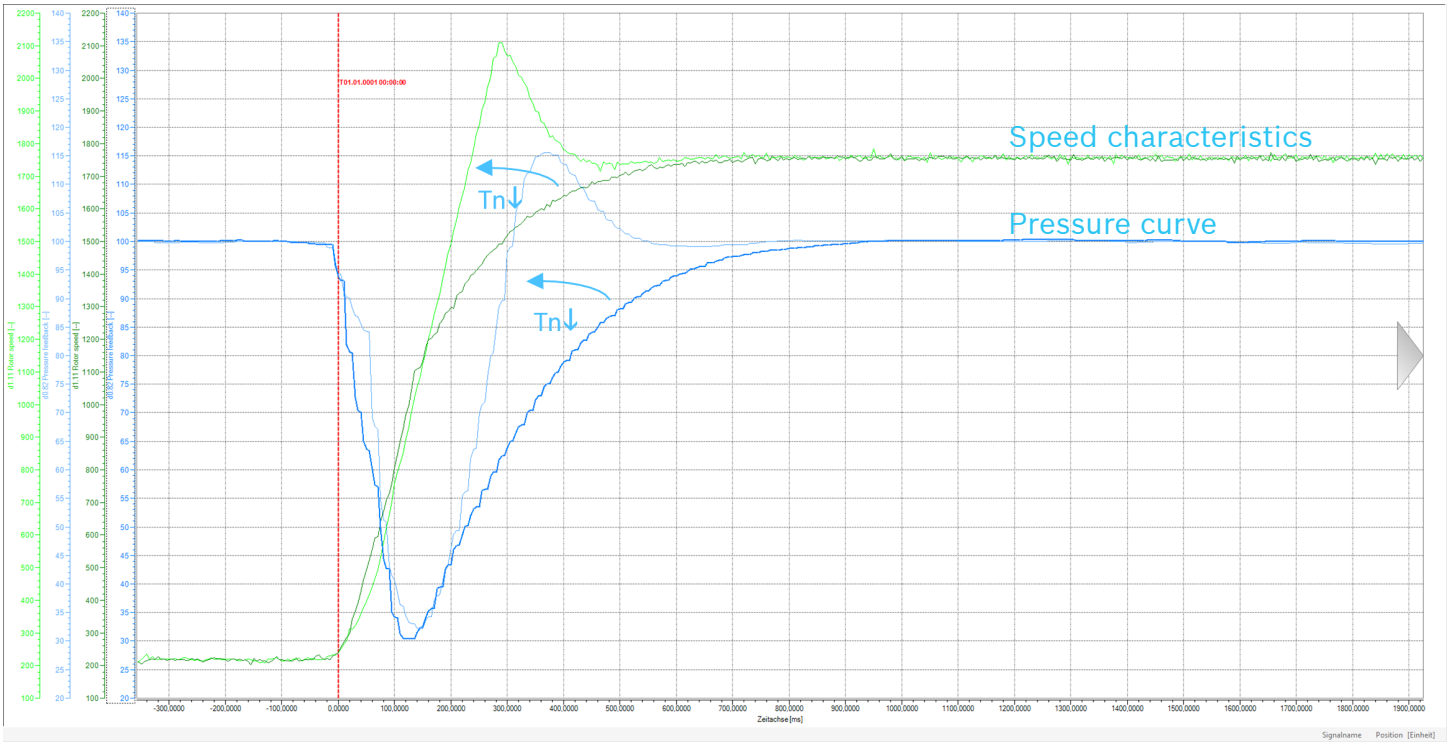


Fig. 36: Effect of change in integral time (Tn)

The differential gain is set to zero by default and is of hardly any significance in constant pressure systems with fixed pressure command values.
Similar to PT1 filtering in the command value, with changing pressure command values, it can counteract pressure overshoot during pressure build-up. In this case, it acts as damping, but at the cost of acceleration.

5.5.4 Switching I share

Table 24: List of parameters for setting the integral time

Parameter	Designation	Setting range	Default
F3.13	Integral time 1 [0]	0...999 ms	80
F3.14	Integral time 2 [0]	0...999 ms	40
F3.15	Integral time TI switch threshold [0]	-150.0...0.0 bar (with setting 0.0 the switching function is deactivated)	0.0

If a constant pressure system no longer requires a flow rate, a hydraulic valve is usually closed. Due to the still high speed of the pump, pressure overshooting will then occur. In this situation it is necessary for the pump to decelerate as quickly as possible. A steeper deceleration ramp is achieved by a shorter integral time.

In [F3.15] it is defined from which pressure overshoot on the second integral component is switched. Note that the value must be negative because: pressure command – actual pressure.

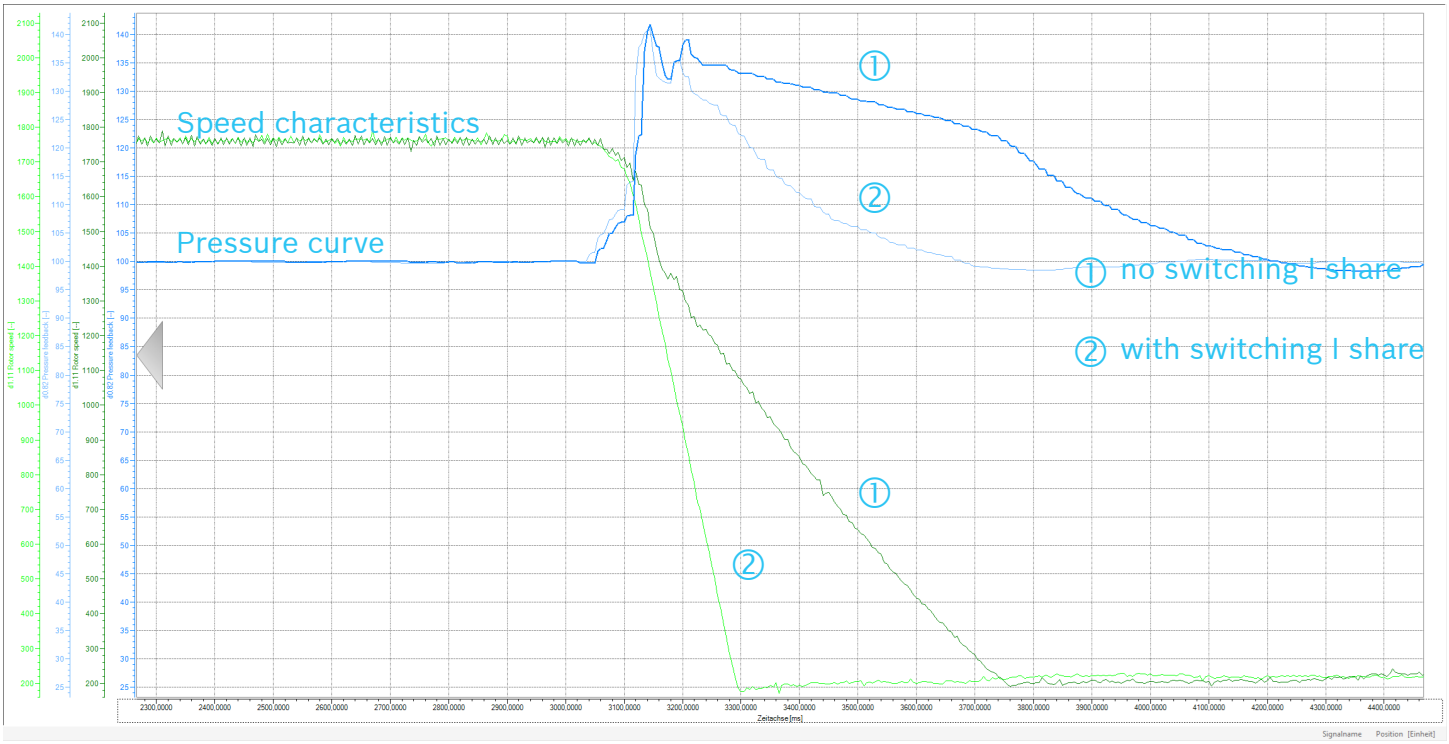


Fig. 37: Effect of switching I share

5.5.5 Acceleration limitation

Table 25: List of parameters for setting the limitation

Parameter	Designation	Setting range	Default
E0.26	Acceleration time	0.1...6000.0 s	0.3[1)]
E0.27	Delay time	0.1...6000.0 s	0.5

[1)] Depending on innoCube configuration

The maximum admissible accelerations resp. decelerations are preset in parameters [E0.26] and [E0.27].

In each case, the value refers to a speed of 4800 rpm. The value for acceleration [E0.26] must not be reduced, otherwise safe operation can no longer be assured.

For example, an acceleration limit of 0.3 seconds [E0.26] corresponds to an acceleration of:

$$a = \frac{2 * \pi * n}{t * 60} = \frac{2 * \pi * 2500\text{rpm}}{0.3\ \text{s} * 60} = 872\ \text{rad/s}^2$$

The drive is not permitted to accelerate faster.

Table 26: Variables of the formula for acceleration calculation

Parameter	Designation	Setting range
a	rad/s^2	Acceleration
n	rpm	Speed to which it is accelerated within the time t
t	s	Time of the acceleration limitation [E0.26]

The delay ramp [E0.27] value could be reduced to smaller. If an overvoltage error (OE-x error) occurs at an operating point during deceleration, increase the value again.

5.5.6 Assessment of the current acceleration or delay

When optimizing the system with the oscilloscope function of IndraWorks Ds, the speed ramp being driven must be evaluated in order to decide whether the pressure controller can be set even higher, or whether you are already driving at the acceleration limitation of 872 rad/s².

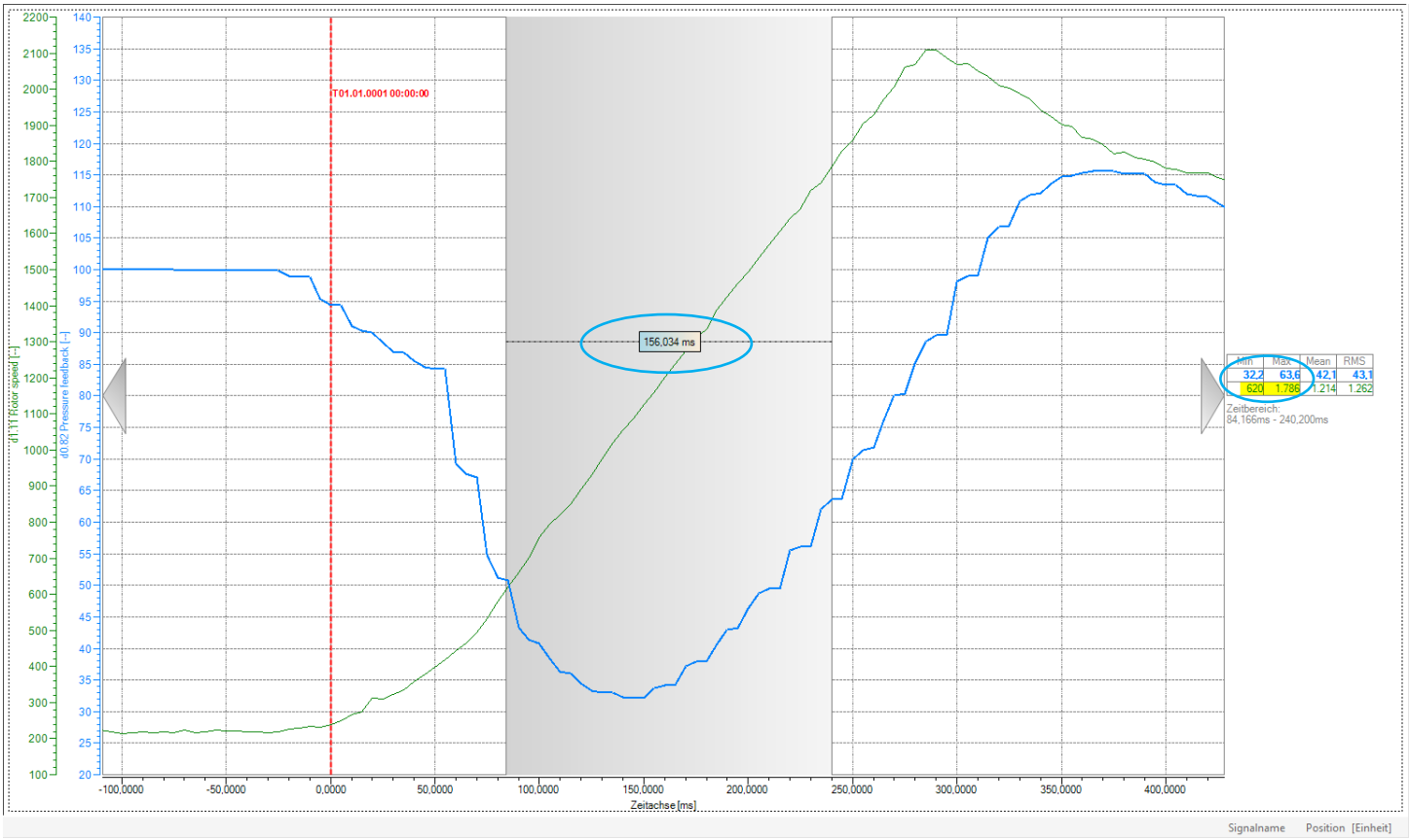


Fig. 38: Acceleration evaluation

As in the example measurement, identify a linear acceleration range of the actual speed value [d1.11] and determine Δn and Δt.

$$\Delta n = 1786\ \text{rpm} - 620\ \text{rpm} = 1166\ \text{rpm}$$

$$\Delta t = 0.156\ s$$

$$\Rightarrow a = \frac{2 * \pi * 1166\ \text{rpm}}{0.156\ s * 60} = 778\ \text{rad/s}^2$$

Since the acceleration value is lower than the maximum 872 rad/s², the drive parameters can be set even more dynamically via the pressure controller settings.

5.5.7 p/Q parameter set switch-over (via parameter input)

This function is used to switch over to other fixed set parameters for p/Q-PID control or another minimum speed may be set. As standard setting, p/Q parameter set [0] [F3.12...F3.19] is selected. It is also possible to switch to parameter set [1] [F3.32...F3.39] during operation. Parameter set [1] [F3.32...F3.39] has the same function as parameter set [0] [F3.12...F3.19].
This switch-over takes place via a digital input pin 5 (parameter input 1 – input EX1) or pin 6 (parameter input 2 – input EX2) of the interface 15X1 (see chapter 5.2 Input and outputs (relay outputs, parameter inputs)). To enable the function, parameter [F3.00] must be set to 1.
Which p/Q parameter set is selected is indicated in parameter [F3.01] (0...1).

Example configuration:

On delivery, both parameter inputs F2.21 are set as master/slave control functions, and F2.22 is set as the input for pressure command values (pressure command selection bit).
If p/Q parameter set switching is to be assigned via digital inputs, Bosch Rexroth recommends setting them as follows (see table below).

Table 27: Requirements for switchable p/Q parameter set and pressure command value

Parameter	Designation	Setting range	Default
F2.21	EX1 input [1)]	p/Q parameter set selection	3
F2.22	EX2 input [2)]	Pressure command value selection bit0	1
F1.03	Pressure command value source	Select via digital input	1
F3.00	p/Q parameter selection source	Digital input	1

[1)] Interface 15X1 pin 5 (parameter input 1)
[2)] Interface 15X1 pin 6 (parameter input 2)

Table 28: Parameter p/Q parameter set switching and pressure command value switchable

Pressure command value selection bit0	15X1 pin 6 (EX2 input)	0	1
p/Q parameter set selection	15X1 pin 5 (EX1 input)	0	1
F1.04		0	1
F3.01		0	1
Pressure command value		F1.05	F1.06

It is also possible to configure parameter input 1 differently, e.g. to trigger another function, or to use it to switch the flow command values and assign parameter input 2 differently.

5.5.8 Only Premium: p/Q parameter set switch-over via communication

This function is used to switch over to other fixed parameters for p/Q-PID control, or another minimum speed can be defined.
The parameter [F0.20] ASF control word can be written cyclically via field bus. The ASF control word must be switched permanently active via bit7 = 1. Now the p/Q parameter set can be switched via bit3. For this, parameter [F3.00] must be set to 2 in the frequency converter (see Table 29: Requirements for p/Q parameter set switchable via communication).

Table 29: Requirements for p/Q parameter set switchable via communication

Parameter	Designation	Setting range	Default
F3.00	p/Q parameter selection source	Communication	2
F0.20 bit7	ASF control word	0: Inactive 1: Active	1
F0.20 bit3	p/Q parameter set selection	0: Parameter set 0 1: Parameter set 1	

5.6 Hydraulic soft start and separate acceleration ramp

Table 30: List of parameters for setting the hydraulic soft start

Parameter	Designation	Setting range	Default
F4.20	p/Q command value soft start delay	0.0...1,000.0 s	0.0 ... 1.0[1)]
F4.21	Minimum pressure command value limit	0.0...[F4.22] bar	5.0
F4.23	Minimum flow command value limit	0...[F4.24] rpm	200
F4.25	Acceleration time hydraulic soft start	0.1...6,000.0 s	5.0

[1)] Depending on standard parameterization

The soft start function is used to reduce the p/Q command value and acceleration during start-up from standstill to minimize excessive acceleration or potential overcurrent during start-up. This function is not active on delivery ([F4.20] = 0). After enabling this function, the p/Q command values and the acceleration time are limited to [F4.21], [F4.23] and [F4.25] in the time period [F4.20].

Only if the p/Q command value soft start is active is the acceleration time of the hydraulic soft start function activated.

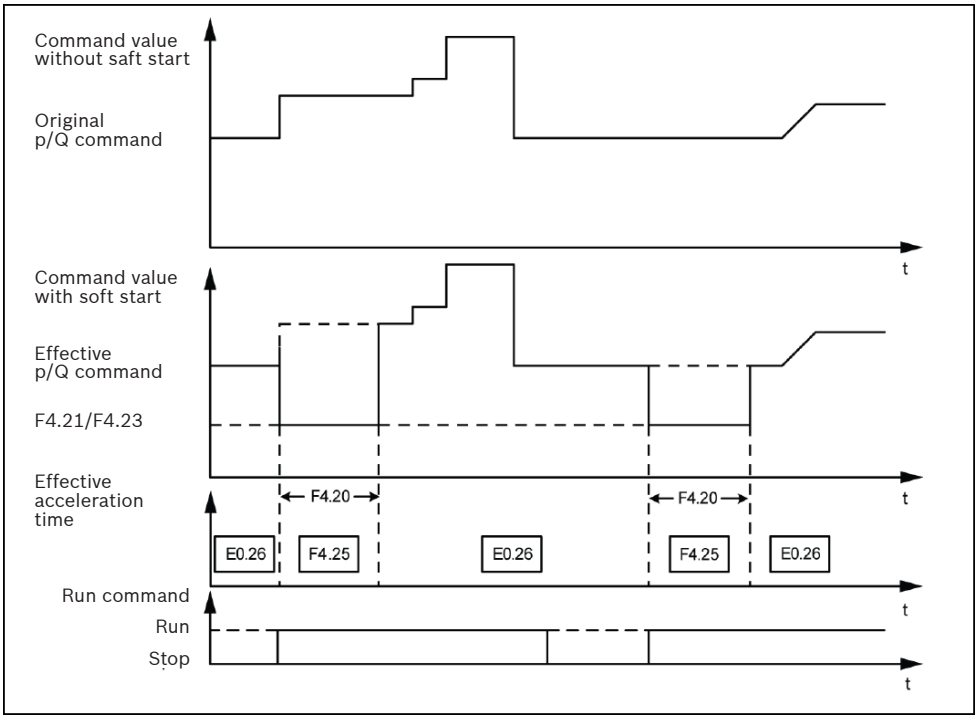


Fig. 39: Hydraulic soft start

5.7 Sleep/wake-up function

This function is used to achieve the maximum extent of energy-saving according to the type of loads in actual applications, for example hydraulic systems with small leakage or accumulators. This function runs in the PID control mode. As FcP 5020 ASF is active, it will be assigned to the p/Q PID controller in ASF; at the same time, the basic PID controller of the VFC will be deactivated.

The hydraulic soft start function is active at each wake-up from sleep mode. It should be deactivated by [F4.20] = 0.

Table 31: List of parameters for setting the sleep/wake-up function

Parameter	Designation	Setting range	Default
E5.15	Sleep level	0.00...[E0.09] Hz	0.00
E5.16	Sleep delay	0.0...3,600.0 s	60.0
E5.19	Wake up level	0.0...100.0 %	0.0
E5.20	Wake-up delay	0.2...60.0 s	0.5

Conversion of speed (n) into frequency (f): $f = \frac{n * 166.67}{2000}$

The frequency converter may go into the sleep mode when all the conditions below are met:

- [PID actual value] > Pressure command value (x [E5.19] "Wake up level") 1)
- [PID output] < [E5.15] "Sleep level"
- [Duration] t ≥ [E5.16] "Sleep delay"

[1)] Excluded from ASF version 01V16

- PID actual value means actual pressure value in FcP 5020. The wake-up level has unit of percentage. This percentage is referred to the pressure command value in bar.
- PID output means the speed output from the p/Q controller in FcP 5020, without speed ramp from E0.26/E0.27. This value has the same unit as the sleep level, i.e. Hz.

The following figure shows the sleep and wake-up process:

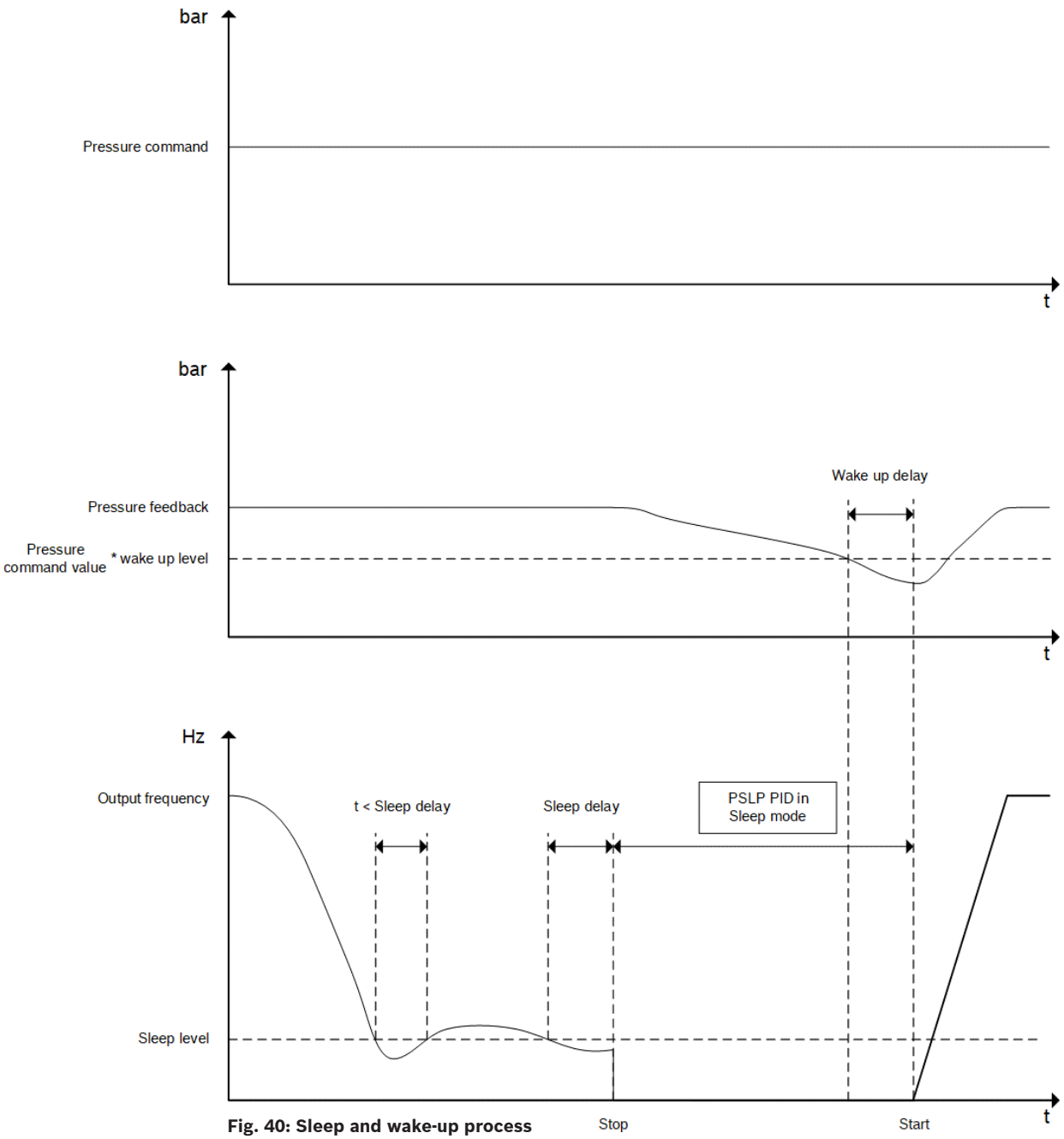


Fig. 40: Sleep and wake-up process

After [E5.16] "Sleep delay", the PID controller changes to the sleep mode. In sleep mode, the frequency converter stops output with "PSLP" displayed in the "Axis status". In the Premium version, bit1 of [H0.02] Extended status word indicates whether the innoCube is in sleep mode.
During sleep mode, the frequency converter monitors the PID actual value and wakes up when the following two conditions are met:

- [PID actual value] < Pressure command value x [E5.19] "Wake up level"
- [Duration] t ≥ [E5.20] "Wake up delay"

After having been reactivated, the frequency converter resumes the operational status that it had before changing to the sleep mode.

Alternatively, you can set the sleep/wake-up function in the Sytronix FcP 5020 dialog (see following figures).

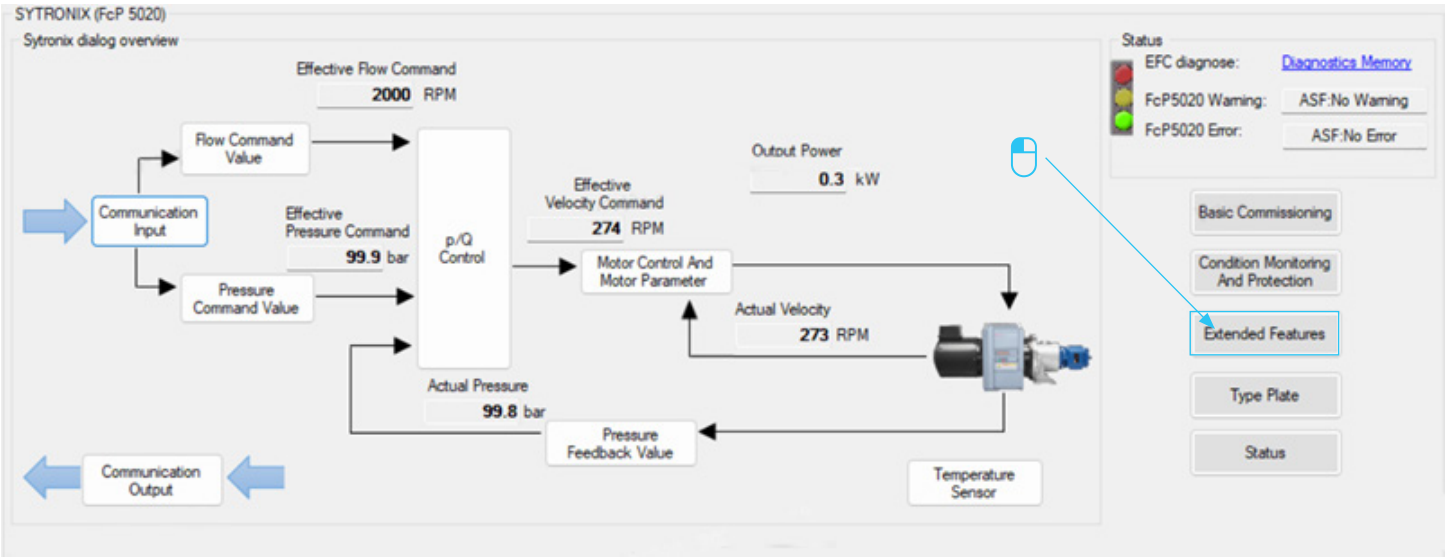


Fig. 41: Configuration of sleep/wake-up function 1/2

Fig. 42: Configuration of sleep/wake-up function 2/2

5.8 Pressure drop/excessive pressure compensation

Pressure drop/overshoot compensation function helps to reduce the incoming pressure drop or excessive pressure. The functions are triggered via digital inputs (parameter inputs), which are set by the customer PLC. This function must be started before the event to be compensated in order to be able to counteract in time.

- Set the control bit bit4 of [F4.03] to activate this function and configure the corresponding digital input (parameter input 1 or 2) to 20 for pressure drop compensation or 21 for excessive pressure compensation (see Table 32: Example configuration of the pressure drop/excessive pressure compensation).
  - If the digital input is set to 1, the pressure command value is modified (added or subtracted) by the value of [F4.45 or F4.46].
  - If the digital input is 0, the effective pressure command value is reset to the original value.

Table 32: Example configuration of the pressure drop/excessive pressure compensation

Parameter	Designation	Setting range	Value
F2.21	EX1 input [1)]	Pressure drop compensation trigger	20
F2.22	EX2 input [2)]	Excessive pressure compensation trigger	21
F4.45	Pressure boost for drop compensation	0.0...1,000.0 bar	Value for desired boost
F4.46	Reduction for excessive pressure compensation	-1.000,0...0,0 bar	Value for desired reduction

[1)] Interface 15X1 pin 5 (parameter input 1)
[2)] Interface 15X1 pin 6 (parameter input 2)

The switching time for the digital input depending on the application should be optimized.

Alternatively, the function can be activated via the Sytronix FcP 5020 dialog and the values for boost and reduction can be entered (see following figures).

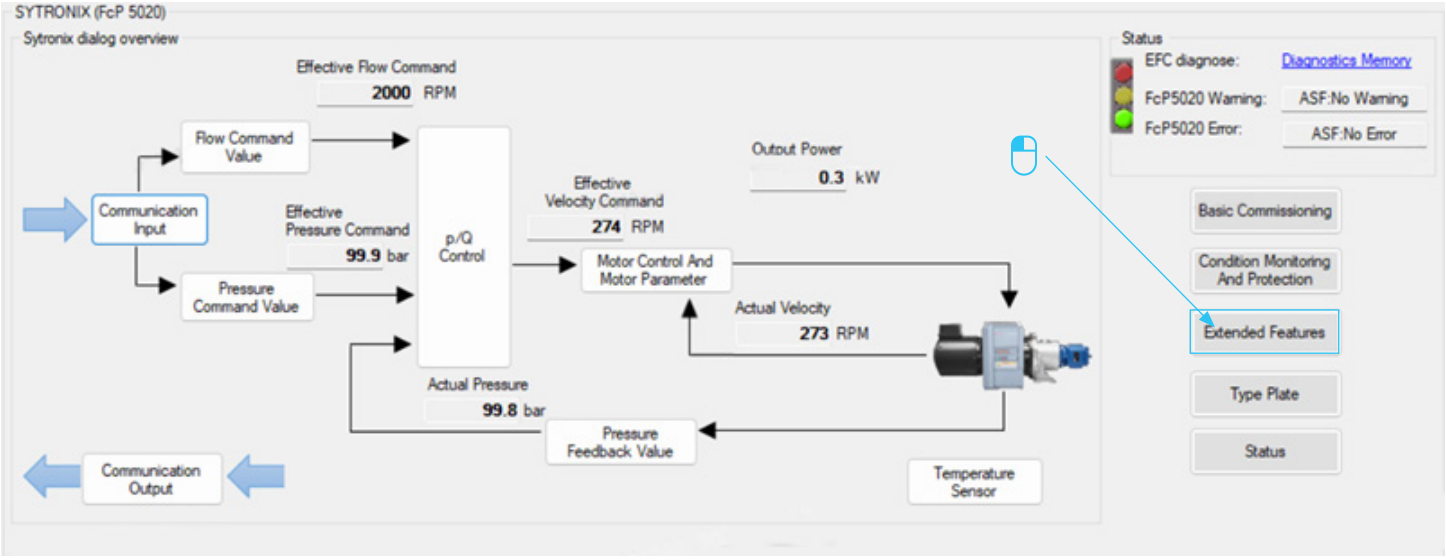


Fig. 43: Configuration of the pressure drop/excessive pressure compensation 1/2

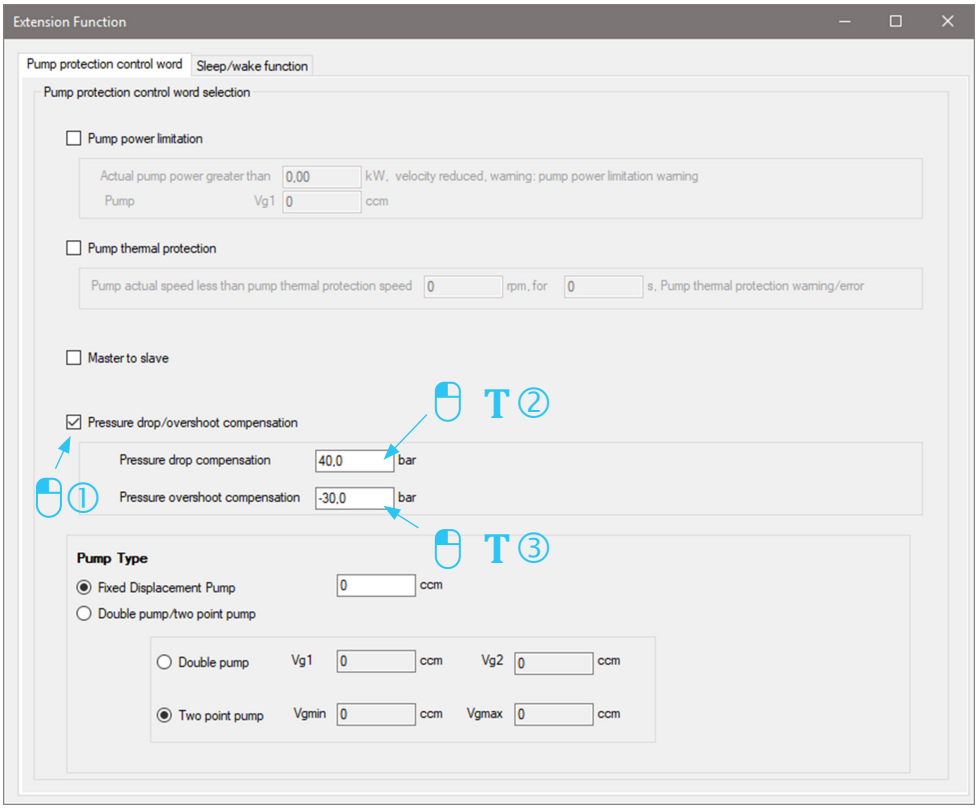


Fig. 44: Configuration of the pressure drop/excessive pressure compensation 2/2

5.9 Pump output limitation

Pump power limitation function can be activated via bit0 of [F4.03].
The real-time pump power can be calculated from the actual pressure value, the actual speed value and pump displacement volume. If the calculated pump power output exceeds the pump power limit value [F4.35] then the speed will be reduced to keep the pump power output within the limit value.

Table 33: List of parameters for pump power limitation

Parameter	Designation	Setting range	Default
F4.30	Pump Vg1 [1)]	0...1,000 ccm	Pump displacement
F4.35	Pump output [2)]	0.00...315.00 kW	Set to the value to be limited

[1)] innoCube is available with 6 different pump sizes (4/5.5/8/10.9/13/16 ccm). P11 and P13 sizes are only available at 2.2kW, 3kW, and 4kW. P16 size is only available at 4kW;

[2)] innoCube is available in 4 different power stages (1.5/2.2/3/4 kW).

Alternatively, the pump power limitation can also be configured via the Sytronix FcP 5020 dialog (see following figures).

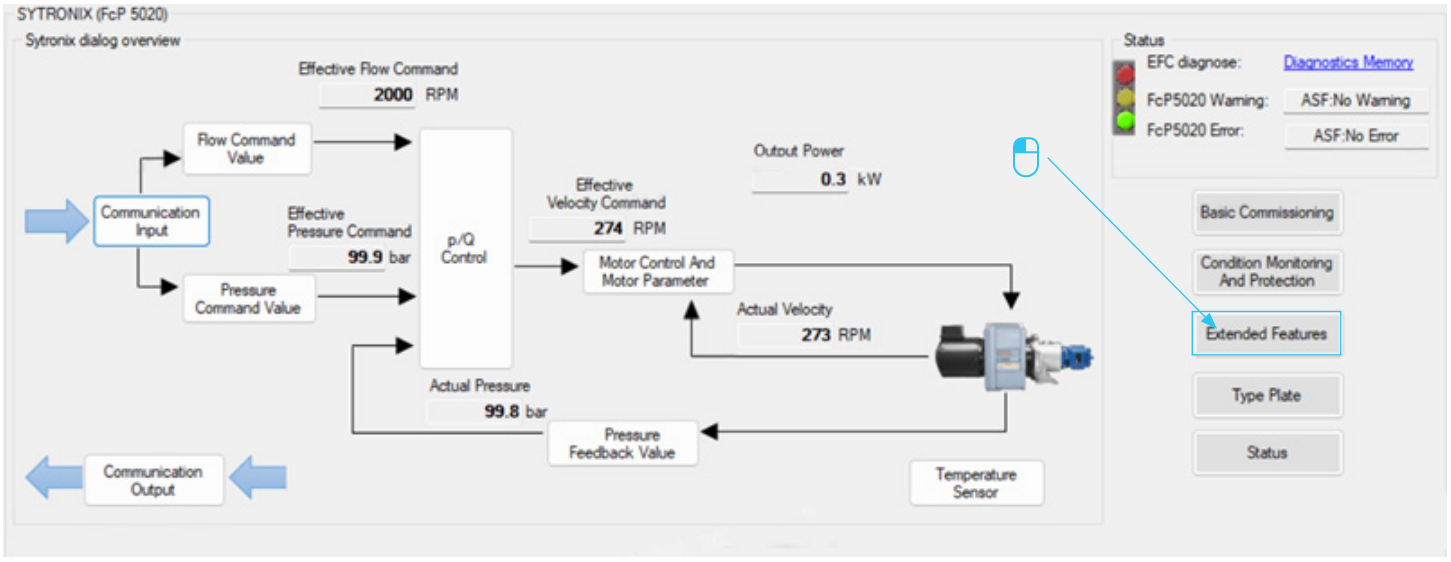


Fig. 45: Configuration of the pump power limitation 1/2

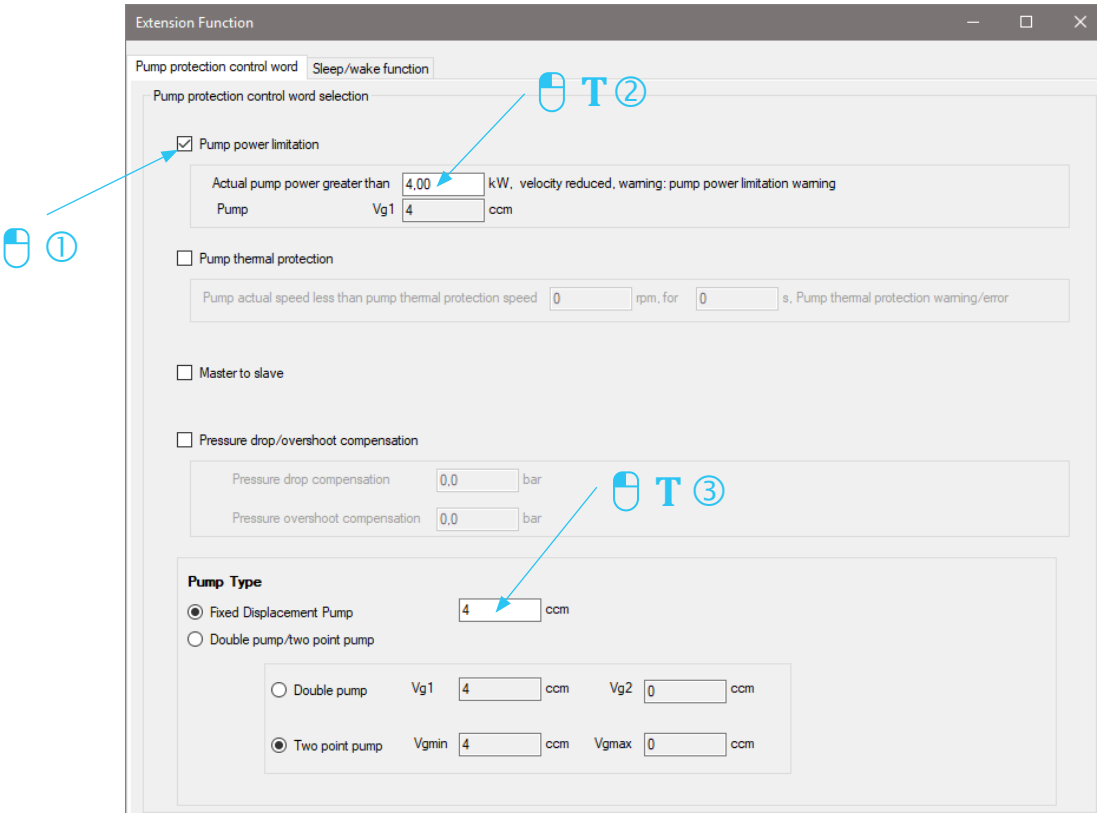


Fig. 46: Configuration of the pump power limitation 2/2

5.10 Operating panel

5.10.1 LED operating panel

The operating panel is mainly divided into two parts: the display area and the button control area. The display area shows parameter settings and frequency converter operating status; The button area allows users to view and change the inverter parameters.

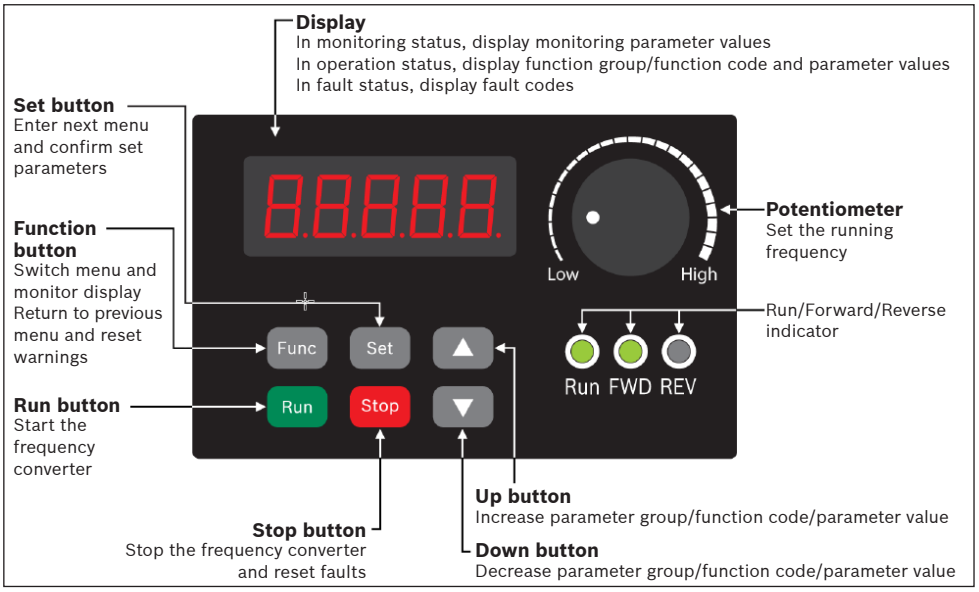


Fig. 47: LED operating panel

5.10.2 LED display

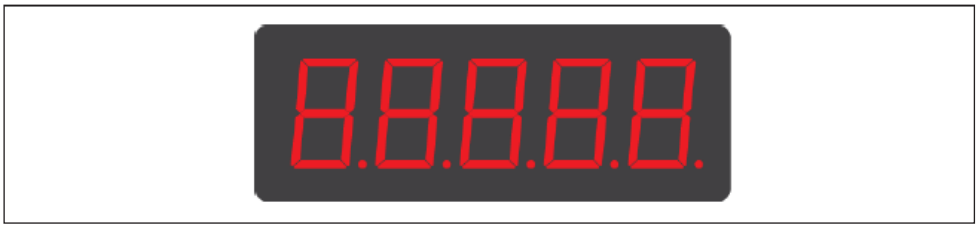


Fig. 48: LED display

5.10.3 LED indicators

Table 34: Indicators

Mode	Run	FWD	REV
Power off	LED Off	LED Off	LED Off
Standby	LED Off	LED Off	LED Off
Forward running	Green LED On	Green LED On	LED Off
Reverse running	Green LED On	LED Off	Green LED On
Ready to run/start DC braking/direction change dead time	Green LED flashing (long off, short on)	Green LED/LED Off	LED Off/Green LED
Deceleration stop phase/stop DC braking	Green LED flashing (long on, short off)	Green LED/LED Off	LED Off/Green LED
Warning during FWD running	Green LED On	Green LED On	LED Off
Warning during REV running	Green LED On	LED Off	Green LED On
Warning during stop	LED Off	Green LED/LED Off	LED Off/Green LED
Fault	LED Off	Green LED/LED Off	LED Off/Green LED

[1] If FWD and REV commands are valid simultaneously, the converter stops.

5.10.4 Operating instructions

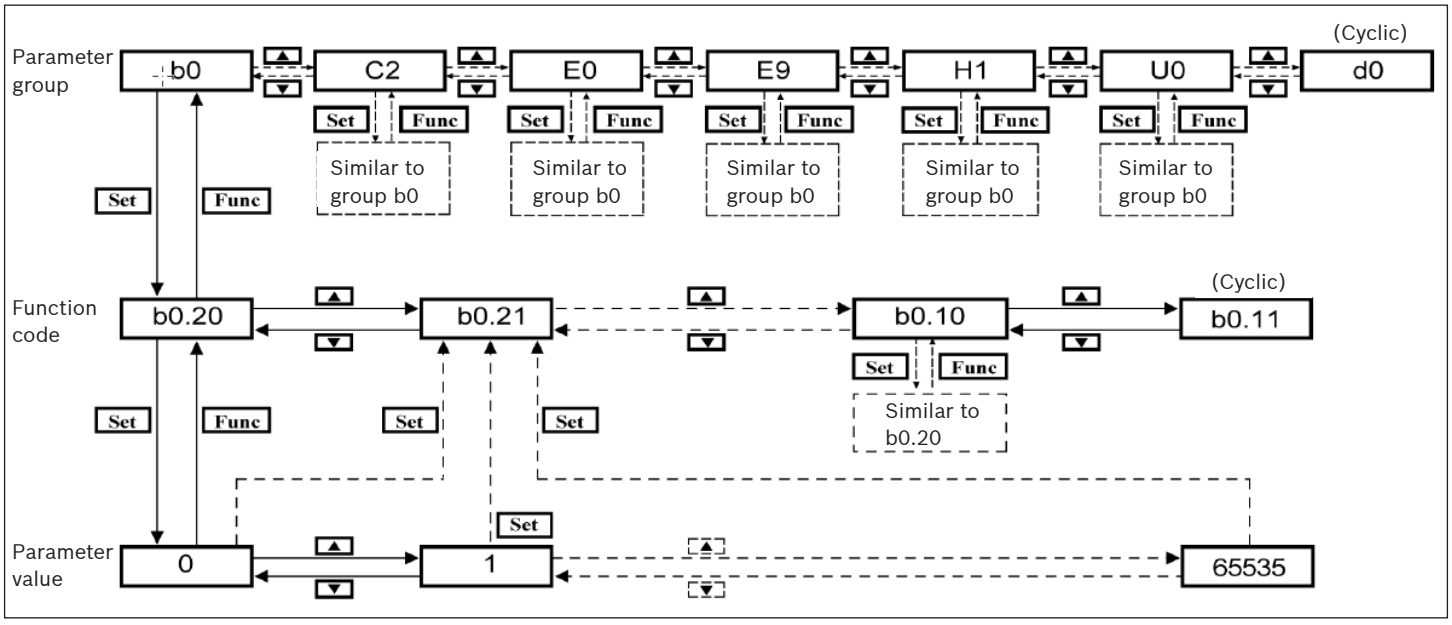


Fig. 49: Operating modes

If you need to change the value of E0.07, you can operate as in the following example. Other parameter values can be changed in the same way.

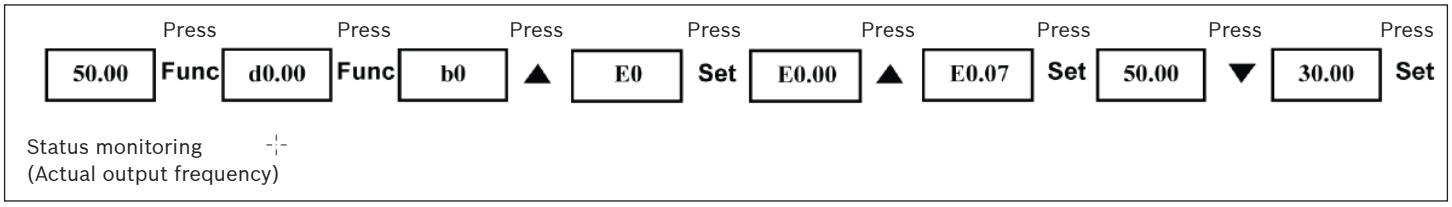


Fig. 50: Operation example

5.10.5 Fast parameter access using button combinations

VFC x615 allows fast access to parameter groups via the "<Func> + < ▲ >" or "<Func> + < ▼ >" combination. This function is only valid for the tens digit of the function code index number " □□ .x □ ".

- Press the "<Func> + < ▲ >" combination once: " □□ .x □ " becomes " □□ .x+1 □ ".
- Press the "<Func> + < ▼ >" combination once: " □□ .x □ " becomes " □□ .x-1 □ ".

Example: After setting with the <Func>, <Set>, < ▲ > and < ▼ > buttons, the converter currently displays "E0.07".
If you use the conventional method to change "E0.07" to "E0.17", you must press the < ▲ > button ten times. With the button combination function, you only need to press the "<Func> + < ▲ >" button combination once.

- PID actual value refers to the pressure feedback in FcP 5020. The wake-up level has unit of percentage. This percentage is referred to the pressure command value in bar.
- The fast parameter access function is only valid when [b0.00] = 0, 1, or 2, and is invalid for "-PF-" or "-EP-" group parameters.

- Press the <Func> button first, and do not release it before pressing the < ▲ > or < ▼ > button.
- After pressing the <Func> button, you need to press the < ▲ > or < ▼ > button within 2 s.
- If the parameter index numbers in a group are non-continuous, the adjacent parameter will be accessed. For example, if "E0.01" is currently displayed, pressing "<Func> + < ▲ >" should display "E0.11". However, if group E has no parameter E0.11 and the adjacent parameter is E0.15, "E0.15" will be accessed and displayed.

5.10.6 Modifying parameter values using shift function

VFC x615 also provides a function to modify parameter values via shifting. When the converter displays a parameter setting, press the "<Func> + < ▲ >" or "<Func> + < ▼ >" button combination once to activate this function. At this point, the digits of the parameter value start flashing.
Select the digit to be modified via the following button combinations:
● Press the "<Func> + < ▲ >" combination once: The flashing digit moves one place to the left.
● Press the "<Func> + < ▼ >" combination once: The flashing digit moves one place to the right.

Example: [E0.07] = 35.40. The converter currently displays "35.40".
To change "35.40" to "15.40", perform the following steps:
● Step 1: Press the "<Func> + < ▲ >" or "<Func> + < ▼ >" button combination once to activate the shift function. "35.40" is displayed, and the unit digit "5" flashes.
● Step 2: Press the "<Func> + < ▲ >" button combination again to move the flashing digit one place to the left. Now "35.40" is displayed, and the tens digit "3" flashes.
● Step 3: Press the < ▼ > button twice to change the tens digit from "3" to "1". Now "15.40" is displayed, and the tens digit "1" flashes.
● Step 4: Press the <Set> button to save the modified parameter value "15.40". The display will return to the previous menu and show the next adjacent parameter "E0.08".

- The shift function is only valid for parameters with values, not for parameters with options.
- Press the <Func> button first, and do not release it before pressing the < ▲ > or < ▼ > button.
- After pressing the <Func> button, you need to press the < ▲ > or < ▼ > button within 2 s.

- If no other button is pressed within 2s after pressing the <Func> button, the uncompleted setting via button combination will be canceled.

5.11 Cooling fan thermostat adjustment

5.11.1 Operating and display panel

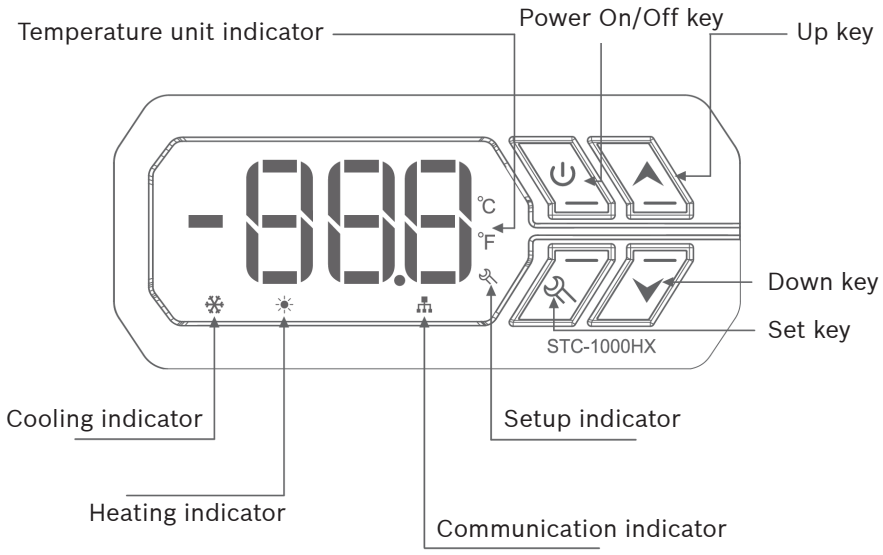


Fig. 51: Thermostat operating and display panel

Table 35: Thermostat key descriptions

⏻	Press and hold for 3 seconds: Turn control function on or off; Quick press: Return step by step
▲	Quick press: Display temperature setpoint; return to normal temperature display after 2 seconds
▼	Quick press: Display temperature difference setpoint; return to normal temperature display after 2 seconds
🔧	Press and hold for 3 seconds: Enter parameter adjustment mode

5.11.2 Quick start guide

1. Key unlocking

During normal operation, in the absence of button input for 10 seconds, the controller enters lock mode and the button lock indicator illuminates. When the button lock is activated, pressing and holding any button for a duration exceeding 3 seconds will deactivate the button lock indicator and unlock the buttons.

2. Viewing parameters

While the controller is operating normally, press and immediately release the " ▲ " key once to display the temperature setpoint; press and immediately release the " ▼ " key once to display the temperature difference setpoint. Return to normal temperature display after 2 seconds.

3. Parameter setting method

While the controller is operating normally, press and hold the key 🔧 for more than 3 seconds to enter the parameter modification mode. The indicator light 🔧 will turn on, and the digital tube will display the code for the first menu item, "F1". Press the " ▲ " or " ▼ " key to scroll up or down through the menu items and display their codes. Press the 🔧 key to display the parameter setpoint of the current menu. Then, press the " ▲ " or " ▼ " key to adjust up or down and display the parameter setpoint of the current menu. Once the setting is complete, press 🔧 to return to the parameter code. Press and release the key ⏻ to save the parameter modification and return to the normal temperature display state. If there is no key operation within 10 seconds, the current parameter modification will not be saved and the system will return to the normal display state. If an error occurs while saving parameters, "Er" will be displayed, and it will return to the normal display state after 3 seconds.

4. Operation instructions

When the controller is operating normally, the digital tube displays the current measured temperature and performs automatic identification and conversion between cooling and heating modes. When the measured temperature ≥ temperature setpoint + temperature difference setpoint and the delay time is reached, cooling starts and the indicator light turns on; when the measured temperature ≤ temperature setpoint, cooling stops and the indicator light turns off; When the measured temperature ≤ temperature setpoint – temperature difference setpoint, heating starts and the ☀ indicator light turns on; when the measured temperature ≥ temperature setpoint, heating stops and the ☀ indicator light turns off.

5. Power On/Off operation

When the controller is operating normally, press and hold the power key for more than 3 seconds to turn off the controller; when the controller is off, press and hold the power key for more than 3 seconds to turn on the controller.

Table 36: Menu description

Menu identifier	Menu function	Setting range	Factory setting	Remarks
F1	Temperature setpoint	-49~109℃ /-56~228 ℉	30℃	
F2	Temperature difference setpoint	1~10℃ /33~50 ℉	0℃	
F3	Delay time	0 - 10 minutes	0	
F4	Temperature calibration	-10~10℃ /-10~10 ℉	0℃	

Menu identifier	Menu function	Setting range	Factory setting	Remarks
F5	Temperature display unit	0: ℃	0	
F6	Communication address	1~127	1	Supported by some models

5.11.3 System faults and causes

Sensor fault alarm: When a short circuit or open circuit fault occurs in the temperature probe circuit, the controller activates the probe fault alarm mode, shuts down all execution states, and the buzzer sounds while the digital tube displays "EE". Press any key to silence the buzzer. Once the fault is cleared, the system returns to normal operation mode.

Safety rules

DANGER:

1. Strictly distinguish between sensor leads, power lines, and output relay interfaces. Incorrect connections are prohibited, and relays must not be overloaded;
2. All wiring changes must be performed with the power supply disconnected.

WARNING:

This controller is prohibited from use in water or excessively humid environments, and prohibited from use in environments with high temperatures, strong electromagnetic interference, or strong corrosivity.

NOTICE:

1. The power supply voltage should match the voltage marked on the controller, and the stability of the power supply voltage must be ensured;
2. To avoid possible interference, it is recommended to maintain an appropriate distance between the sensor leads and the power lines.

6. Protective functions

6.1 Actual pressure monitoring

This monitoring is deactivated in the condition as supplied.

Table 37: List of parameters for overpressure detection

Parameter	Designation	Setting range	Default
F4.00	Protection function configuration word	0...15 Bit 0: Pressure sensor failure (PSF) Bit 1: Actual pressure monitoring Bit 2: p/Q max. command value limit; Bit 3: Oil change detection	4
F4.15	Maximum system pressure (warning)	0.0...[F4.16] bar	500.0
F4.16	Maximum pump pressure (error)	[F4.15]...4,000.0 bar	1000.0
F4.17	Maximum system pressure warning time delay	0.0. 6000.0 s	0.0
F4.18	Maximum pump pressure error time delay	0.0. 6000.0 s	0.0

The detection of actual pressure values can be activated via bit 1 of parameter [F4.00].

The actual pressure monitoring function is continuously active, regardless of whether the frequency converter is in operation or in standby mode.

[F4.15]: When the actual pressure value goes beyond [F4.15] bar for [F4.17] s, the warning ([d0.88] = 1) will be triggered for the pressure feedback surpassing the maximum admissible system pressure.
[F4.16]: When the actual pressure value goes beyond [F4.16] bar for [F4.18] s, the error ([d0.89] = 1) will be triggered for the pressure feedback value surpassing the pump limit pressure, and then the drive stops.

Alternatively, actual pressure monitoring can also be configured via the Sytronix FcP 5020 dialog (see following figures).

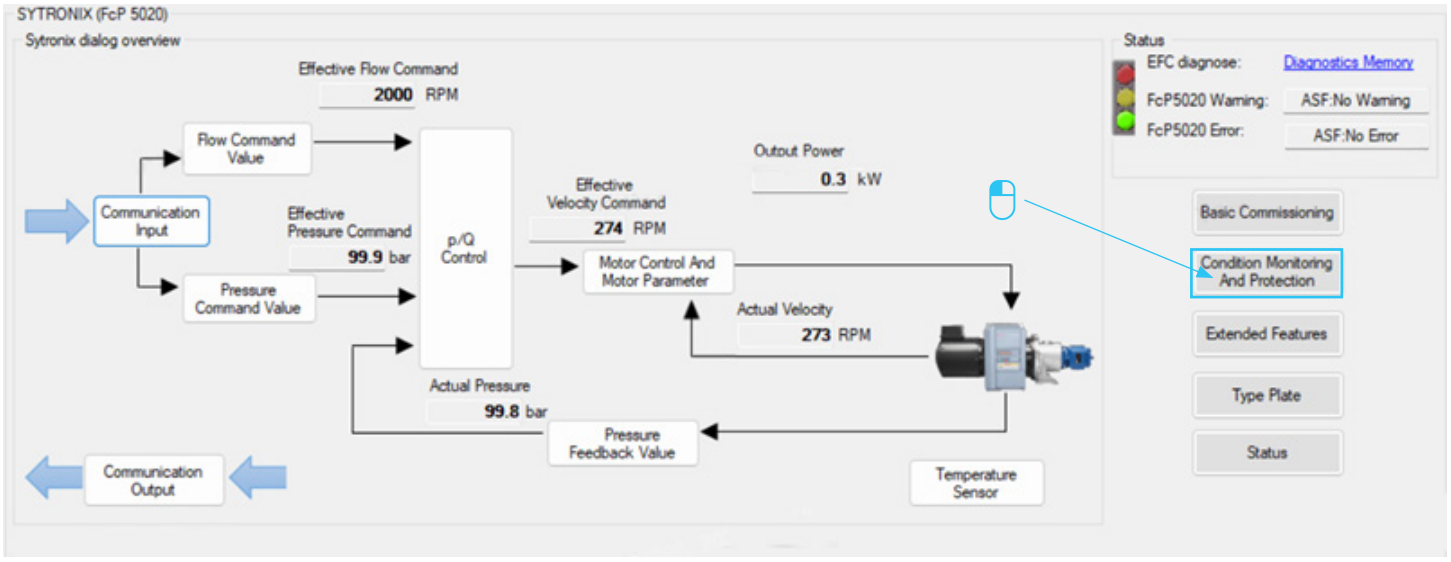


Fig. 52: Actual pressure monitoring 1/2

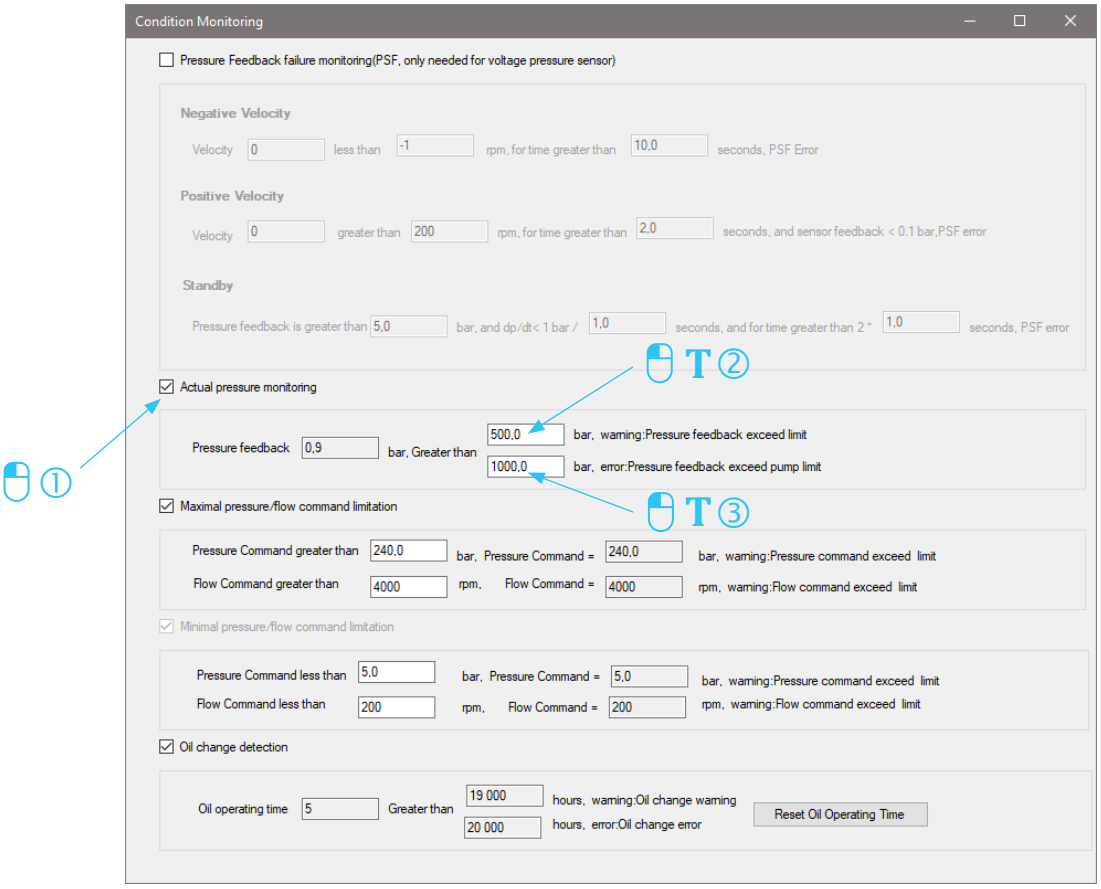


Fig. 53: Configuration of actual pressure monitoring 2/2

6.2 Limit value for pressure and flow command value

This monitoring is activated in the condition as supplied.

Table 38: List of parameters for the limit value for the pressure and flow command value

Parameter	Designation	Setting range	Default
F3.19	Minimum flow command value limit	0...[F4.24] rpm	200
F4.00	Protection function configuration word	0...15 Bit 0: Pressure sensor failure (PSF) Bit 1: Actual pressure monitoring Bit 2: p/Q max. command value limit; Bit 3: Oil change detection	4
F4.21	Minimum pressure command value limit	0.0...[F4.22] bar	5.0
F4.22	Upper limit for pressure command value	[F4.21]...1,000.0 bar	250.0
F4.23	Minimum flow command value limit	0...[F4.24] rpm	200
F4.24	Upper limit for flow command value	[F4.23]...5,000 rpm	2500

The minimum pressure and flow command value limitation ([F4.21 and F4.23]) works all the time, independently to any control bit. That means if the setting pressure or flow command value is lower than [F4.21 or F4.23], it will be limited to [F4.21 or F4.23] without any error/warning message.
The maximum pressure and flow command value limitation should not be deactivated. This function will check whether the pressure or flow command value given by the customer exceeds the limit value set in [F4.22 and F4.24]. If a given command exceeds its limit value, the effective command value will be limited to the maximum limit, and a warning signal will be raised.

Alternatively, the limits of pressure and flow command values can also be set via the Sytronix FcP 5020 dialog (see following figures).

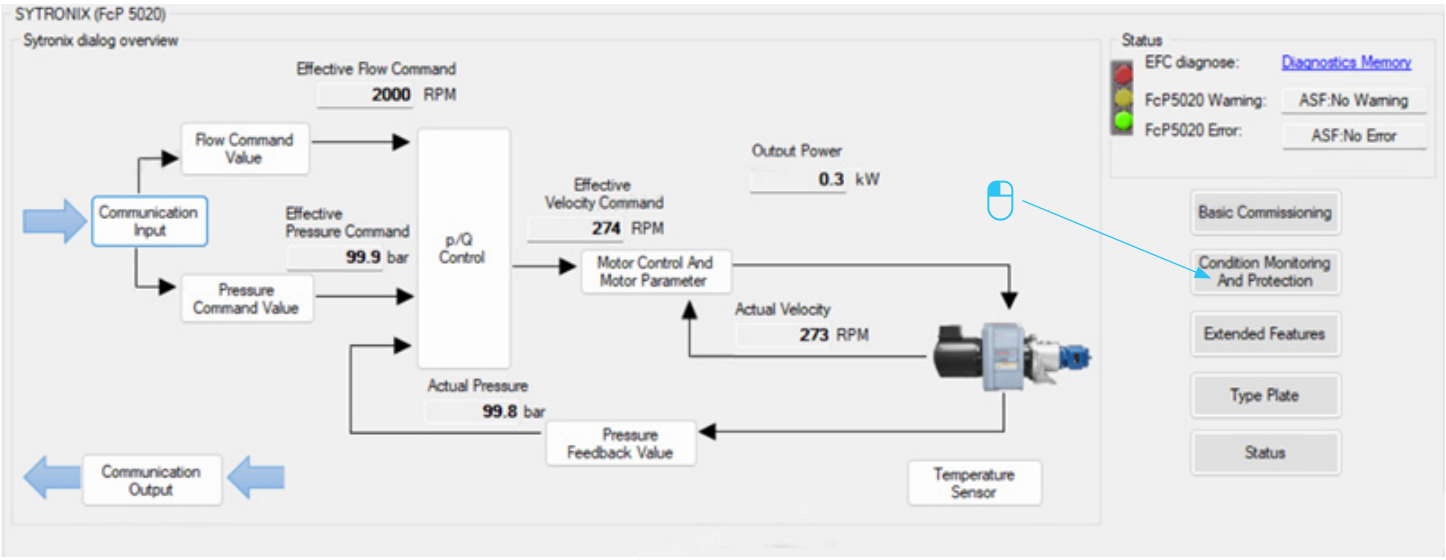


Fig. 54: Configuration of the limit values for pressure and flow command value 1/2

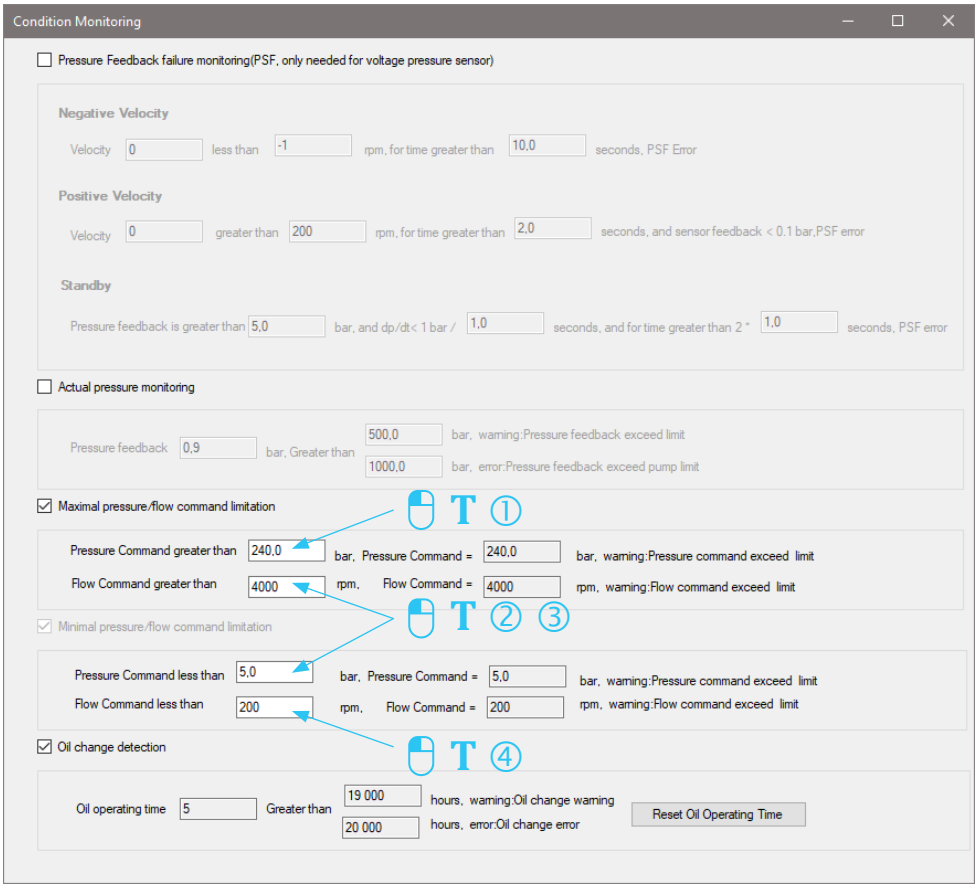


Fig. 55: Configuration of the limit values for pressure and flow command value 2/2

6.3 Oil change warning/error

This monitoring is deactivated in the condition as supplied and can be activated via bit 3 of [F4.00].

Table 39: List of parameters for the oil change warning/error function

Parameter	Designation	Setting range	Default
F4.00	Protection function configuration word	0...15 Bit 0: Pressure sensor failure (PSF) Bit 1: Actual pressure monitoring Bit 2: p/Q max. command value limit; Bit 3: Oil change detection	4
F4.51	Hours for oil change warning	0...60,000 hours	19,000
F4.52	Hours for oil change error	0...60,000 hours	20,000
F4.53	Oil in operation time	0...60,000 hours	0
F4.54	Reset oil in operation time	0...1	0

Oil in operation time will be counted and saved in [F4.53] when the frequency converter starts running. If this time exceeds the warning or error level in [F4.51] or [F4.52], a warning or error signal will be generated. Parameter [F4.54] = 1 is used to reset the oil in operation timer [F4.53].

The timer is only active during drive in operation (drive enabled).

Alternatively, the oil in operation time can also be reset via the Sytronix FcP 5020 dialog (see following figures).

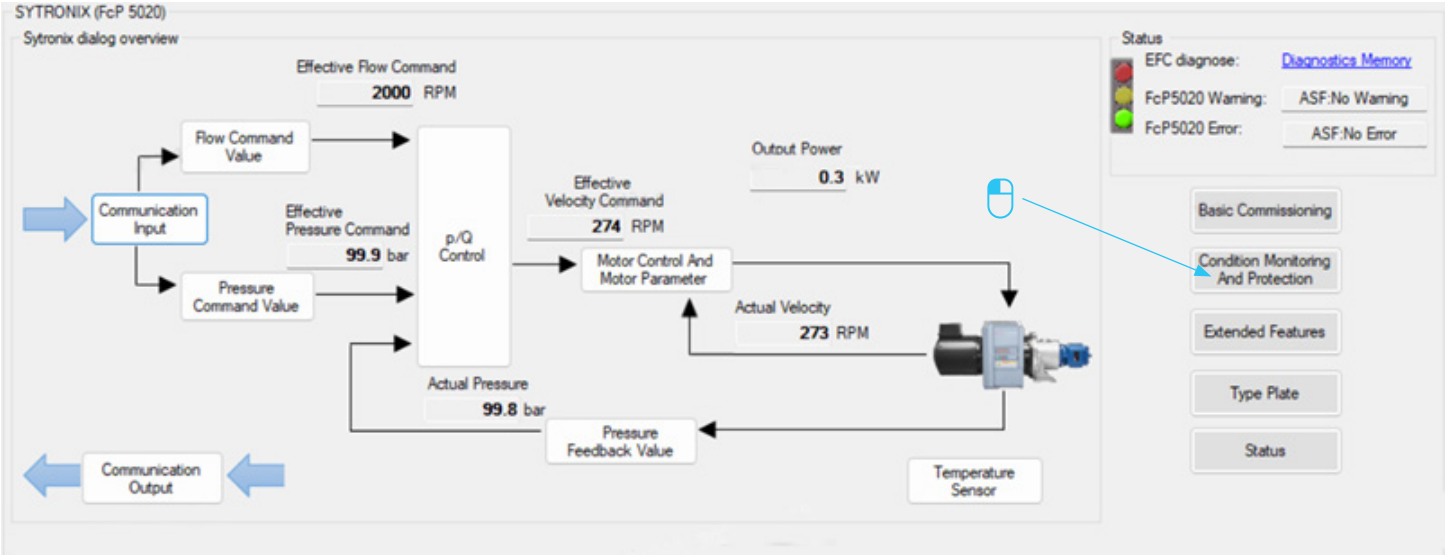


Fig. 56: Reset oil in operation time 1/2

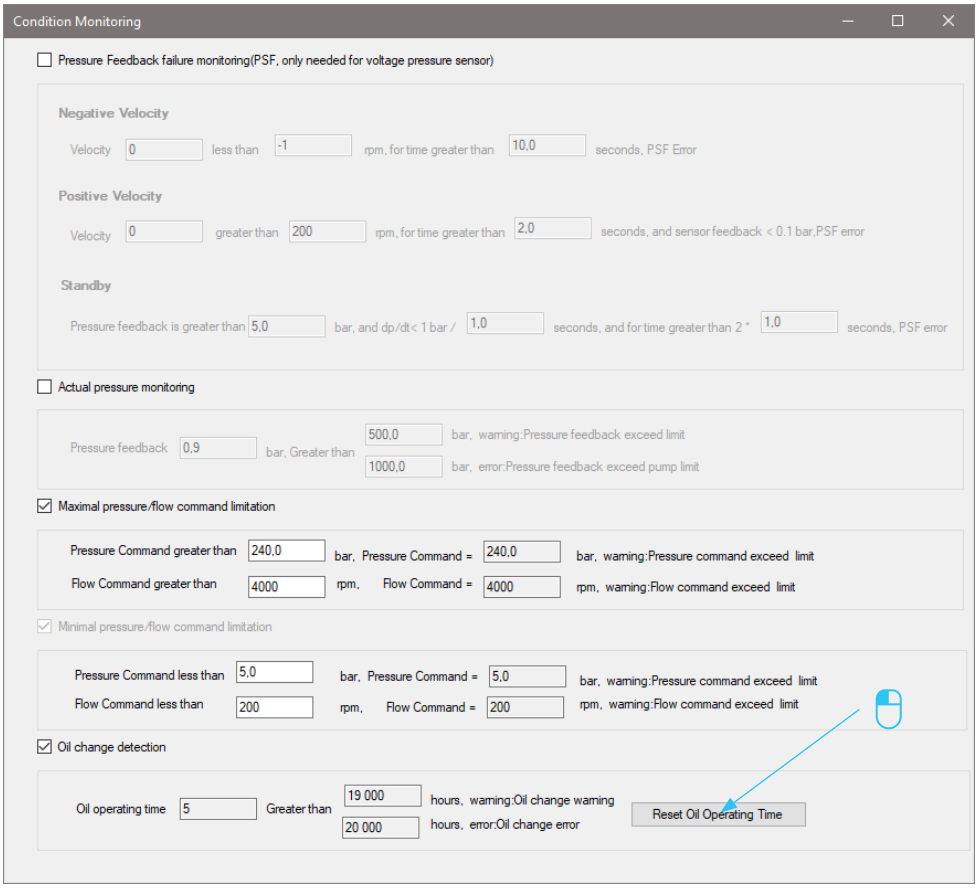


Fig. 57: Reset oil in operation time 2/2

6.4 Thermal pump monitoring

This monitoring is deactivated in the condition as supplied. To protect the pump, the minimum speed ([F3.19/F3.39] minimum speed of the system) is set appropriately. The thermal pump monitoring can be activated via bit 1 in [F4.03]. It is only active when the drive is in operation.

Table 40: List of parameters for thermal pump monitoring

Parameter	Designation	Setting range	Default
F4.36	Pump thermal monitoring speed	0...5,000 rpm	500
F4.37	Pump thermal monitoring time constant	0...6,000 s	0

The pump may overheat at a low speed since the oil volume required for the pump cooling may not be adequate. The pump thermal monitoring function will detect if pump speed is lower than the speed limitation [F4.36] and triggers a warning (for [F4.37] = 0) or error message according to the time [F4.37] (if [F4.37] > 0). For details, refer to the following table and figure.

Table 41: Protection condition of the thermal pump monitoring

Protection condition	F4.36 (protection speed) = 0 rpm	F4.36 (protection speed) > 0 rpm
F4.37 (protection time constant) = 0 s	Inactive	WARNING
F4.37 (protection time constant) > 0 s	Inactive	Error

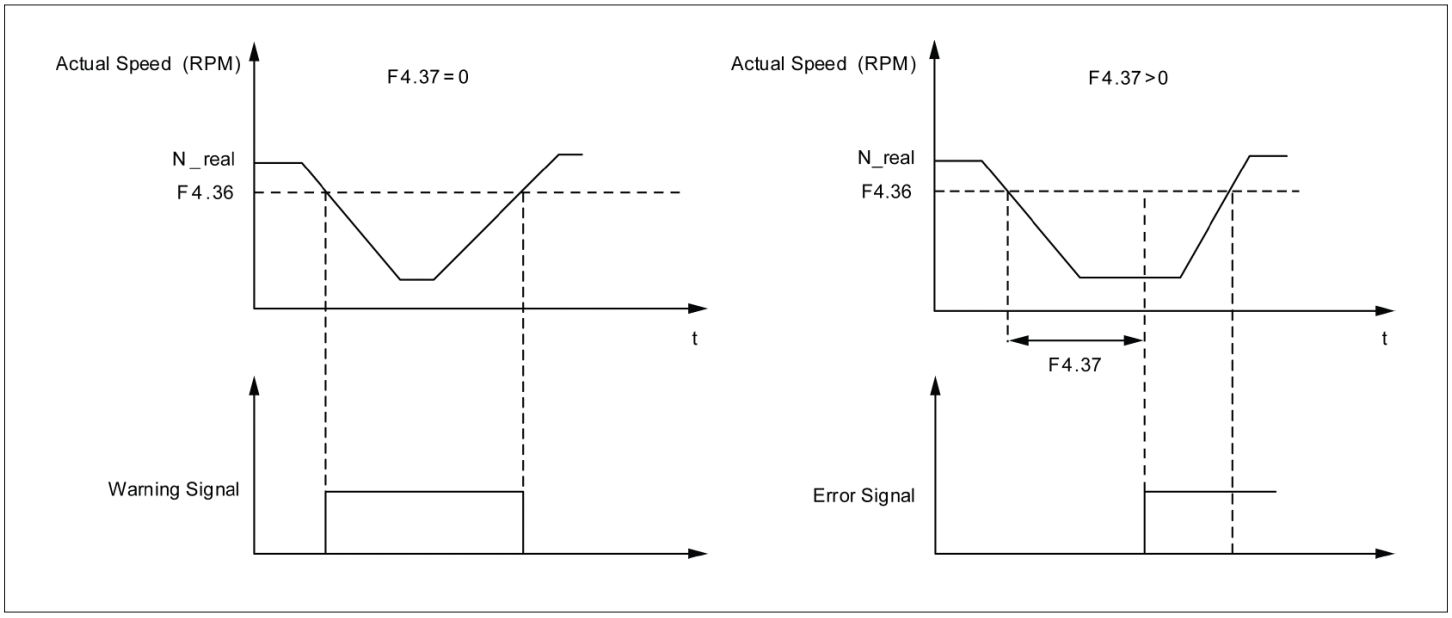


Fig. 58: Thermal pump monitoring

6.5 Sensor monitoring

The innoCubes have wired sensors for monitoring the hydraulic system. These are already parameterized accordingly in the condition as supplied (see following table).

Table 42: List of parameters for sensor monitoring

Parameter	Designation	Setting range	Value
F2.18	X3 input	Oil level/temperature error inverted[1)]	16
F2.19	EX4 input	Oil filter warning inverted	8
F2.20	EX5 input	Oil temperature warning	7

[1)] These signals are automatically delayed, i.e. a "true" signal that is present for longer than [F4.50] seconds is confirmed.

"16: Oil level/temperature error inverted" is the inverted evaluation oil level and temperature error signal. Both oil level and temperature errors are evaluated via a digital input. Since an oil warning comes before an error, the warning information will help the converter to determine if it is an "oil level error", "oil temperature error", or even "oil level or temperature error" if both or no warning is present.

Some signals are inverted for wire break detection; i.e. "true" for no warning/error, "false" for a warning/error. All warning and error information are presented by parameters [d0.88] and [d0.89].

For further information on this, please see chapter 10 Diagnostics/ troubleshooting.

Under "Monitoring", "I/O Monitor" you can check the status of the sensor signals. The following figure shows the signals for the corresponding input/output in the condition as supplied. innoCube ready for operation, filled with oil, error-free and without warnings. All sensors deliver the corresponding signal.

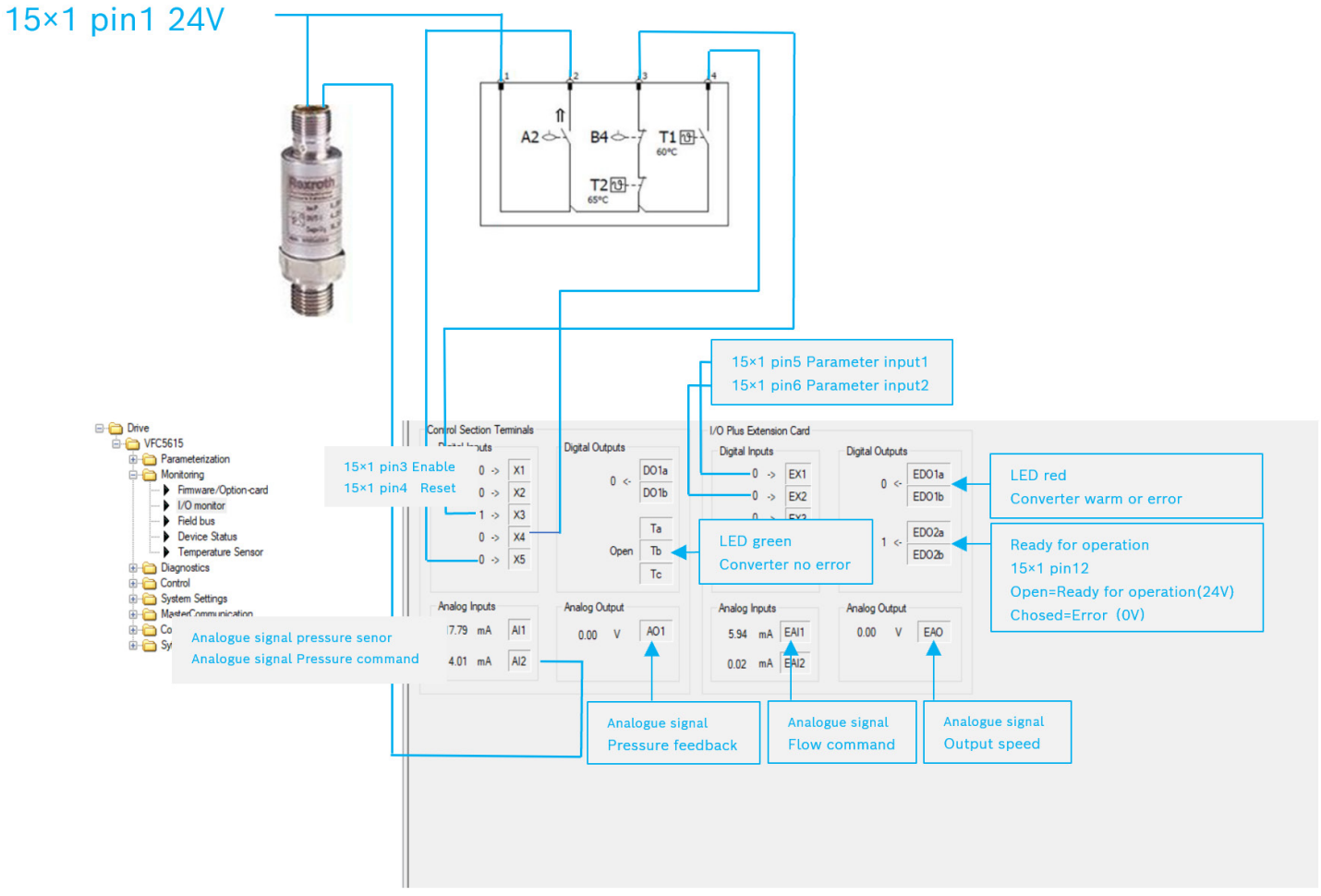


Fig. 59: I/O monitor – assignment of the corresponding signals

6.6 Adjustment of relief valve and throttle valve

The relief valve and throttle valve are adjusted according to the following steps:

1. Before starting the innoCube, please close the throttle valve MNR R901109366 completely and open the relief valve MNR R900423725 completely; (For the positions of the relief and throttle valves, see 10.6 Spare and wear parts in the operating manual RE 51045-B)
2. Set the pressure command to the maximum operating pressure of the system + 30 bar; set the speed command to 300 RPM;
3. Connect the external power supply of 380 VAC and 24 V DC to the innoCube (the air-cooled version also requires 220 VAC), and start running the innoCube;
4. Using an M7 hex wrench, adjust the socket head screw of the relief valve clockwise to allow the actual pressure at the innoCube outlet to rise slowly; the actual pressure of the system must be monitored in real time (parameter D0.82; if using IndraWorks DS, see Fig. 22: Overview of the Sytronix FcP 5020 dialog; feedback can also be sent to the host computer via analog or communication for viewing). When the actual pressure reaches the setpoint, stop adjusting the relief valve and tighten the lock nut;
5. After the relief valve adjustment is complete, adjust the throttle valve counterclockwise to release it completely. Set the pressure command to the minimum operating pressure of the system and the speed command to 500 RPM;
6. Adjust the throttle valve clockwise and observe the actual motor speed of the innoCube (parameter D0.01; if using IndraWorks DS, see Fig. 22: Overview of the Sytronix FcP 5020 dialog; feedback can also be sent to the host computer via analog or communication for viewing). When the speed reaches the minimum motor speed requirement shown in Fig. 60, the throttle valve adjustment is complete. Likewise, the lock nut of the throttle valve must be tightened;
7. After the adjustments of the relief valve and throttle valve are completed, set the pressure command and speed command according to the system requirements for operation.

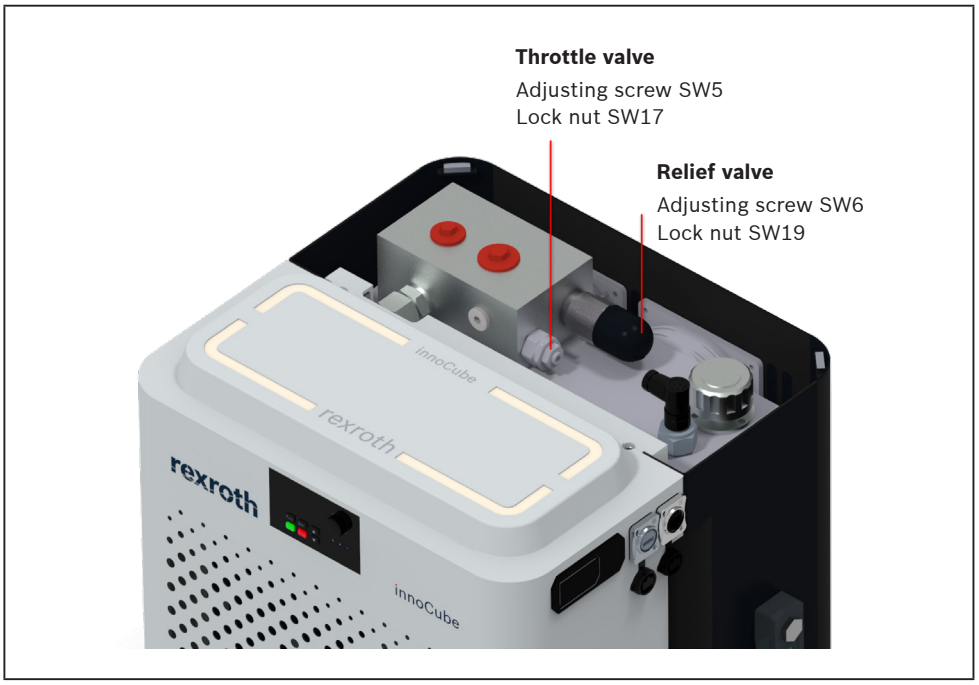


Fig. 60: Description of relief valve and throttle valve positions

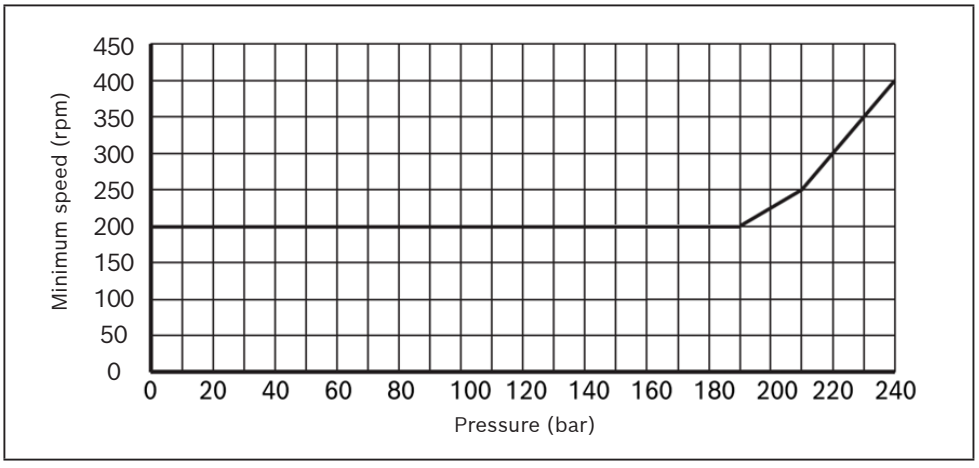


Fig. 61: Correspondence between minimum motor speed and system holding pressure

If the innoCube is equipped with a PSB valve block, its factory settings are: throttle valve closed and relief valve protection pressure set to 30 bar. The customer needs to adjust the protection pressure and the throttle valve according to actual operation. (The reason the throttle valve requires adjustment is that the minimum operating speed of the innoCube is 200 RPM; if the throttle valve is not adjusted, the system pressure during holding conditions will be very high, which is detrimental to the safe and stable operation of the system.) If the actual motor speed is greater than 200 RPM when the system is operating in holding mode, the throttle valves should be fully closed and no adjustment is required.

7. Premium

All functional explained so far also apply to the innoCube Premium model. This chapter describes functions and fieldbus communications that are only applicable to this model. Device description files for different communication protocols can be downloaded from the "Downloads" area at

Software Download | Bosch Rexroth china

(Operating Instructions for Frequency Converter Communication Module Multi-Ethernet Card).

7.1 Field bus communication

The innoCube is configured so that all command values are set via communication. Enable, stop, and reset are set via bits in the control word, and status messages are signaled via bits in the status words (see chapter 7.4 Parameters involved).

Table 43: Communication parameters in the condition as supplied

Parameter	Designation	Setting range	Default
H3.03	MEP: IP Address	xxx.xxx.xxx.xxx	192.168.0.1
H3.04	MEP: Subnet Mask	xxx.xxx.xxx.xxx	255.255.255.0
H3.05	MEP: Gateway Address	xxx.xxx.xxx.xxx	0.0.0.0
H3.06	MEP: IP Options	0: DHCP deactivated 1: DHCP activated	0
H3.20	MEP: Station Name (PROFINET)	-...0x50014x	axis01
H3.23	MEP: Device Address	-...0x50014x	1
E0.01	First run command source	0: Operating panel input 1: Multi-function digital input 2: Communication input	2
E8.00	Communication protocol card	0: Modbus 1: Extension card	1
F1.03	Pressure command source	0: Depending on F1.04 1: Depending on digital input 2: Analog input 3: Communication input	3
F1.11	Flow command source	0: Fixed value F1.12 1: Analog input 2: Communication input	2

7.1.1 Protocol

The desired protocol variant must be selected and activated by a restart. Profinet is already pre-set and activated. If error 48 (idA-): Internal communication error is displayed, acknowledge it.

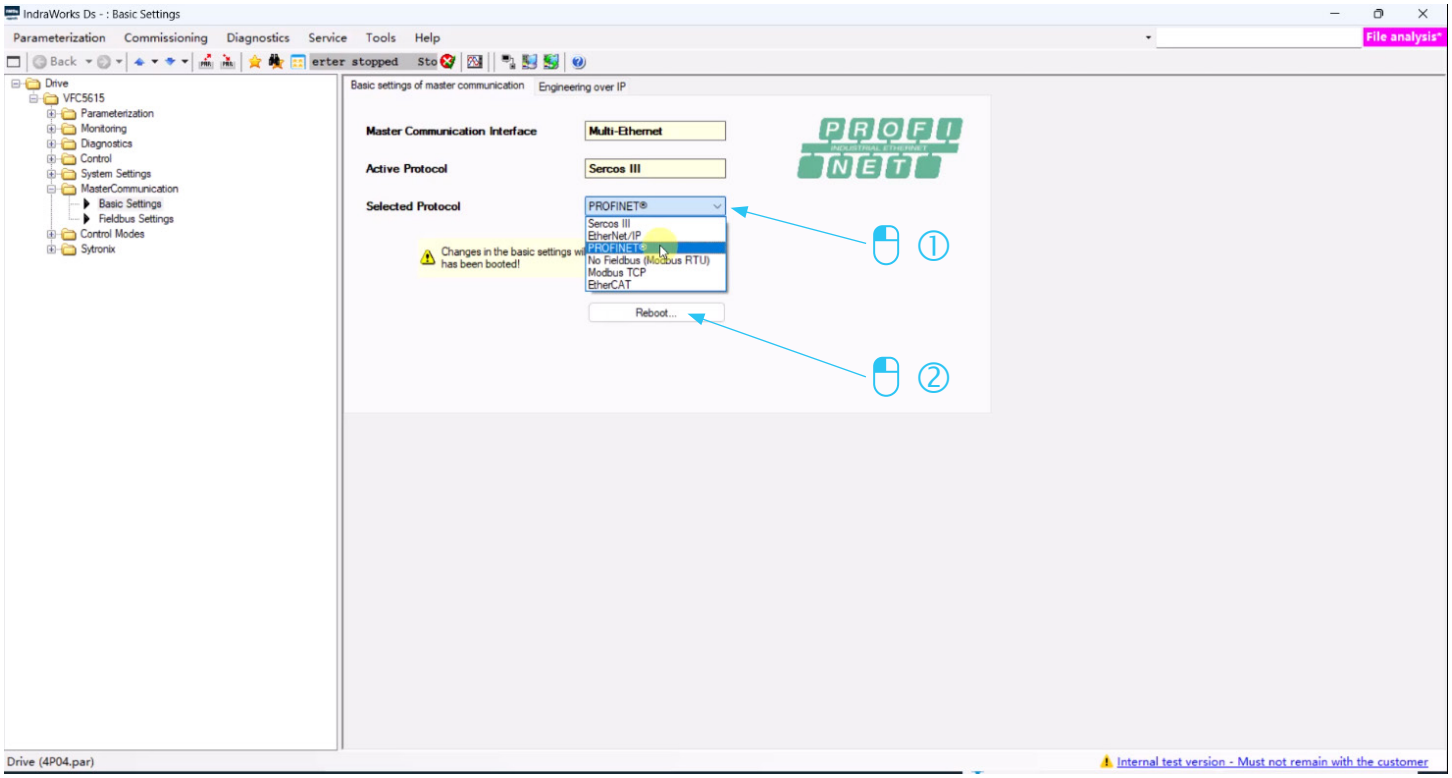
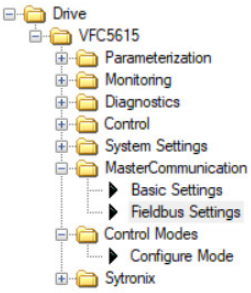


Fig. 62: Protocol

7.1.2 Process data

In the condition as supplied, the process data input and output in the frequency converter are configured as follows (8 input words, 4 output words). A more detailed description of the parameters can be found in chapter 7.4 Parameters involved. These can be changed either in the parameter editor ([H3.30, H3.31]) or in a dialog (see following figures).



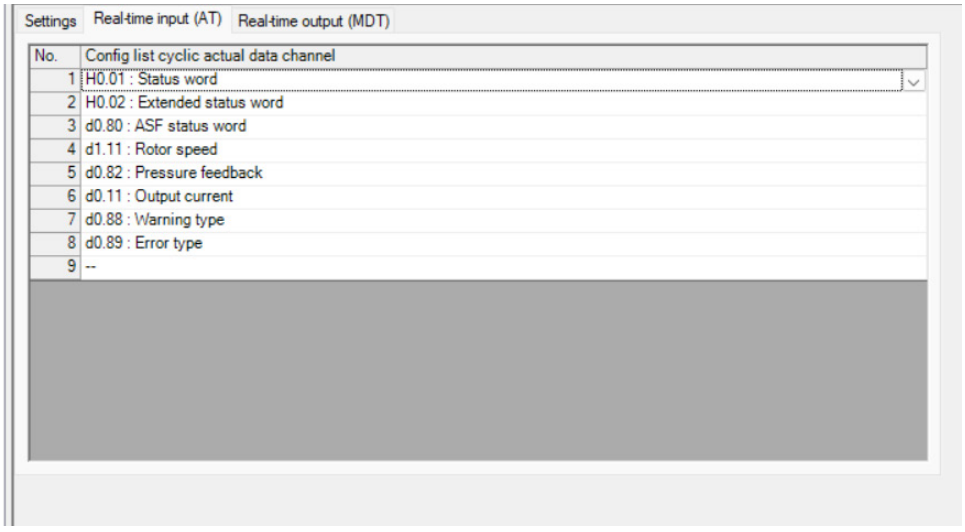
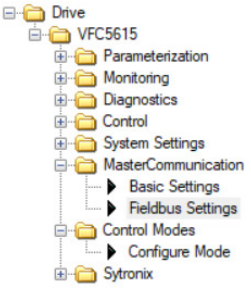


Fig. 63: Setting of input process data (innoCube output data)



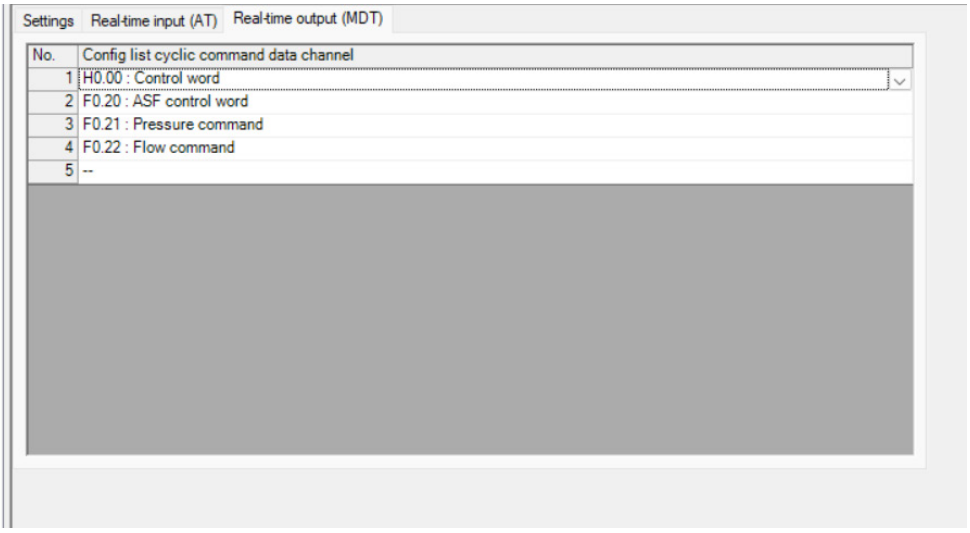


Fig. 64: Setting of output process data (innoCube input data)

The process data list that is configured in the frequency converter can only be defined for the protocols Profinet, EtherNet/IP, and Modbus TCP.

7.1.3 Topology

The innoCube integrates only one RJ45 communication interface, which is suitable for typical star topologies. If a line topology is used, the innoCube must be placed at the last station. The innoCube does not support ring topologies.

7.1.4 Profinet

- ▶ Add the downloaded device description file to your hardware catalog by installing the GSDML file in the GSD file management.
  GSD download address:
  Software Download | Bosch Rexroth china
- ▶ Then double-click on the device "xFC0x 01V01 GSDML V2.1" to add it.

- Process data
  Change the modules to "Input 08 Words" and "Output 04 Words" – this corresponds to the condition as supplied of the process data. If the process data were changed, the modules must be adjusted accordingly. Process data are read and written in sequence. The sequence and length must match in the frequency converter and the control system (see chapter 7.1.2 Process data).

If a different address range is used in the existing Profinet network, or if these addresses are already assigned, they must be adapted accordingly. The same applies to the device name. Usually, the IP address assignment and the device naming are done from the controller
(afterwards, the innoCube should be repowered).

Bosch Rexroth recommends that the communication settings in the drive be carried out first and only then the communication from the controller be established. As soon as Profinet is in operation mode, the frequency converter does not allow any more parameter changes.

With Siemens control systems, the low and high bytes may have to be swapped.

7.1.5 Ethernet/IP

- Protocol
  Change the protocol to EtherNet/IP as described in chapter 7.1.1 Protocol.

- Generic device
  The MEP extension card is implemented as a "Generic Device" when it is configured in the EtherNet/IP network. The EtherNet/IP object directory implemented contains the following objects:
  – Identity Object (16#01)
  – Message Router Object (16#02)
  – Ethernet Link Object (16#F6)
  – TCP/IP Object (16#F5)
  – Port Object (16#F4)
  – Connection Manager Object (16#06)
  – Assembly Object (16#04)
  The cyclic communication is implemented via "EtherNet/IP-I/O messaging" (Class 1). Up to 15 objects can be configured in both data directions.

- Topology
  The star and line topologies are both supported.

- Process data
  For information on process data, see chapter 7.1.2 Process data.

- Error codes
  If a manufacturer-specific error occurs during parameter access, the supplementary error code provides pointers to the cause of the error. Excerpts of the main error codes are listed in the following table:

Table 44: Error codes

Error number	Meaning
16#03	Invalid parameter value • Value is less than the minimum value • Value is greater than the maximum value • Value is not correct • Invalid indirect addressing • Command execution not possible (invalid or wrong parameters)
16#0E	Parameter cannot be changed
16#0F	Parameter is password-protected
16#10	Parameter is write-protected • Parameter currently write-protected • Parameter is write-protected, as configured cyclically in the MDT • Parameter write-protected on account of other settings (parameters,operating mode, ...) • Command execution is not possible (e.g. command cannot be enabled in this phase)

Error number	Meaning
16#13	Parameter transmitted for too short time period
16#15	Parameter transmitted for too long time period
16#1F	• Command is already active • Command interruption is not possible

If write access is provided to two-byte type parameters, any values exceeding 65,535 (16xFFFF) will be reduced automatically to a two-byte value. If the reduced two-byte value is in the valid range, it will be accepted without transmitting the limit value indication.
For further information, see chapter 6 of the "Frequency converter, multi-Ethernet card" operating instructions in section 1.2 Required and amending documentation.

7.1.6 Modbus/TCP

- Protocol
  Change the protocol to Modbus/TCP as described in chapter 7.1.1 Protocol.

- Protocol configuration
  If necessary, adjust the IP address, subnet mask, and gateway address (see Table 43: Communication parameters in the condition as supplied).
  A Modbus/TCP client can connect to the default TCP port 502. Additionally, you can specify another port by writing a port number to parameter [H3.51]. However, only one client connection is accepted by the multi-Ethernet card.

- System configuration
  For information on process data, see chapter 7.1.2 Process data. The multi-Ethernet card supports the following Modbus/TCP transactions:

Table 45: Modbus/TCP transactions

Modbus function code	Transaction name	Max. Value of N
3	Read N register words	16
6	Write one register word	-
16	Write N register words	16
23	Read/write N register words	16/16
43 (sub-function code 14)	Read Device Identification	

Besides accessing parameters by their function code virtual address, there are some special register addresses that can be used, e.g. for reading/writing the complete process data image. The following table gives an overview.

Table 46: Overview of special register addresses

Register address	Contents
16#7F00	Control word [H0.00]
16#7FA0	Status word [H0.01]
16#7FE0	Input Process Data Image as specified by [H3.30]
16#7FF0	Output Process Data Image as specified by [H3.31]

1. When a Modbus/TCP client has established a new connection to the multi-Ethernet card, the output process data status initially is set to invalid at the multi-Ethernet card. The output data status changes to valid as soon as all parameters were written at least once to the output process data list. The output data status then remains valid until the TCP connection is closed or terminated.
2. Special Register Addresses mentioned above can only be used without any offset. Example: It is not allowed to use address 16#7FF2 for accessing the second output process data item.

- Exception codes
  In Modbus/TCP, error cases will cause the multi-Ethernet card to return exception codes in the Modbus response telegram. The exception codes are listed in the following table:

表格 47: 异常代码

Exception codes	Designation	Meaning/possible causes
1	Illegal function	Unknown function code; the transaction contained a Modbus function code not supported by the multi-Ethernet card.
2	Illegal data address	• Access to unknown address • Error occurred during function code 43 transaction
3	Illegal data value	• Invalid read/write length value in Modbus transaction • Malformed request telegram • Invalid object ID in function code 43 transaction
4	Server device failure	Read/write access failed

7.1.7 Sercos III

- Protocol
  Change the protocol to Sercos III as described in chapter 7.1.1 Protocol.

- Device address
  The unique device address in the Sercos III network must be set using parameter [H3.23]. However, the Sercos address can also be assigned in the project from the automatically calculated topology index. The resulting address reflects in parameter [H3.24].

- Process data
  The process data configuration is transmitted from the Sercos III master during bus startup.

- Topology
  Line topology is supported, and the innoCube is placed as the last slave in the line topology.

S-0-0135 (device status) and P-0-1098.0.1 (status word [H0.01]) must always be added in sequence to the input list.
S-0-0134 (drive control) and P-0-1098.0.0 (control word [H0.00]) must also be added to the output list in sequence (see Fig. 65: Process data configuration Sercos III-Master, here: IndraControl XM).

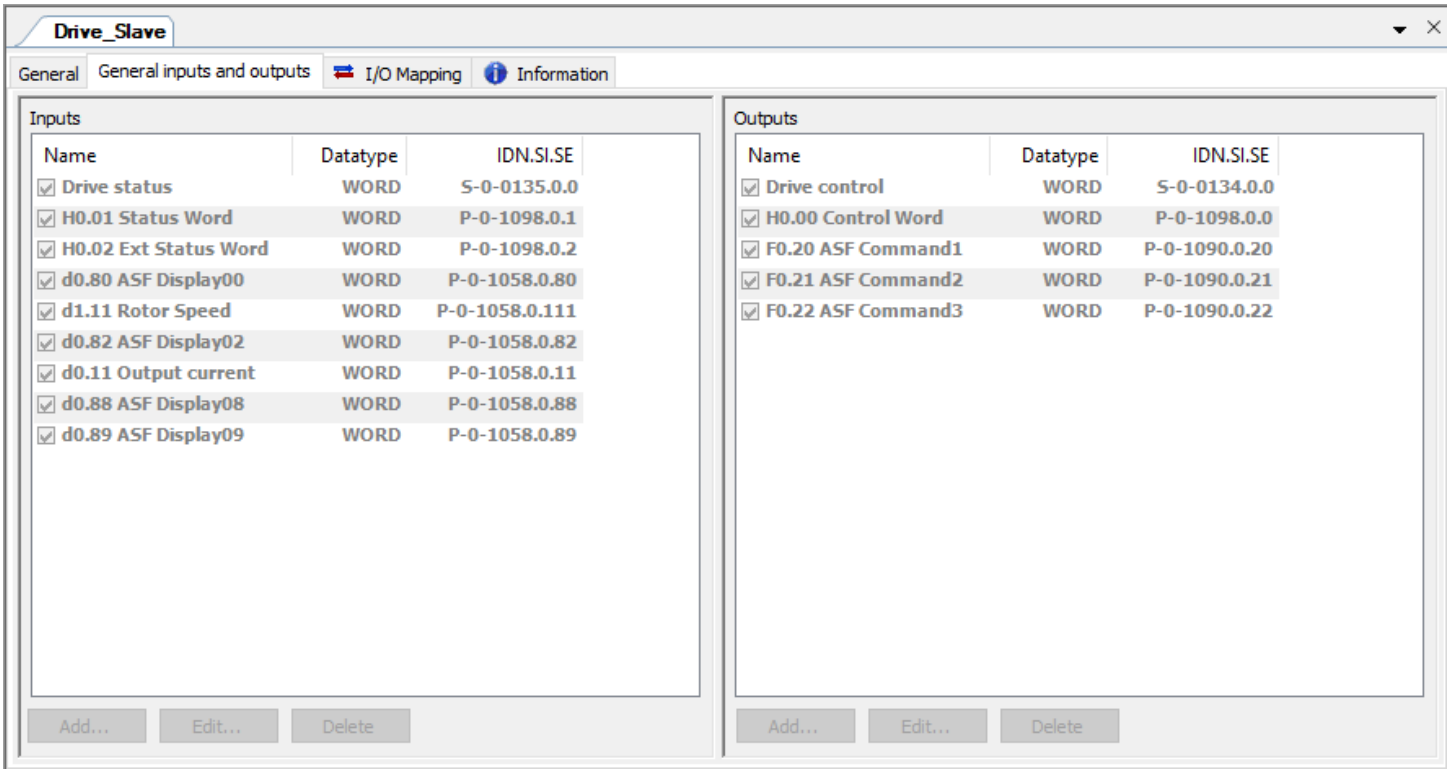


Fig. 65: Process data configuration Sercos III-Master, here: IndraControl XM

With Sercos III, the drive enable (16#E000) and stop (16#A000) are set via drive control word S-0-0134.

The parameters must be specified in Sercos parameter format (IDN addresses) (see Table 47: Parameter address Sercos III).

Table 48: Parameter address Sercos III

Code range	IDN range
b0.00...b0.99	P-0-1050.0.0 --- P-0-1050.0.99
d0.00...d0.99	P-0-1058.0.0 --- P-0-1058.0.99
C0.00...C0.99	P-0-1066.0.0 --- P-0-1066.0.99
C1.00...C1.99	P-0-1066.0.100 --- P-0-1066.0.199
C2.00...C2.99	P-0-1067.0.0 --- P-0-1067.0.99
C3.00...C3.99	P-0-1067.0.100 --- P-0-1067.0.199
E0.00...E0.99	P-0-1074.0.0 --- P-0-1074.0.99
E1.00...E1.99	P-0-1074.0.100 --- P-0-1074.0.199
E2.00...E2.99	P-0-1075.0.0 --- P-0-1075.0.99
E3.00...E3.99	P-0-1075.0.100 --- P-0-1075.0.199
E4.00...E4.99	P-0-1076.0.0 --- P-0-1076.0.99
E5.00...E5.99	P-0-1076.0.100 --- P-0-1076.0.199
E8.00...E8.99	P-0-1078.0.0 --- P-0-1078.0.99
E9.00...E9.99	P-0-1078.0.100 --- P-0-1078.0.199
U0.00...U0.99	P-0-1082.0.0 --- P-0-1082.0.99
U1.00...U1.99	P-0-1082.0.100 --- P-0-1082.0.199
F0.00...F0.99	P-0-1090.0.0 --- P-0-1090.0.99
F1.00...F1.99	P-0-1090.0.100 --- P-0-1090.0.199
F2.00...F2.99	P-0-1091.0.0 --- P-0-1091.0.99
F3.00...F3.99	P-0-1091.0.100 --- P-0-1091.0.199
F4.00...F4.99	P-0-1092.0.0 --- P-0-1092.0.99
F5.00...F5.99	P-0-1092.0.100 --- P-0-1092.0.199
H0.00...H0.99	P-0-1098.0.0 --- P-0-1098.0.99
H1.00...H1.99	P-0-1098.0.100 --- P-0-1098.0.199
H2.00...H2.99	P-0-1099.0.0 --- P-0-1099.0.99
H3.00...H3.99	P-0-1099.0.100 --- P-0-1099.0.199
H4.00...H4.99	P-0-1100.0.0 --- P-0-1100.0.99
H8.00...H8.99	P-0-1102.0.0 --- P-0-1102.0.99
H9.00...H9.99	P-0-1102.0.100 --- P-0-1102.0.199

7.1.8 EtherCAT

In order to fully support an EtherCAT slave running CoE (CAN over EtherCAT), an EtherCAT master needs both EtherCAT slave information (ESI - *.xml) and an electronic data sheet (EDS - *.eds). ESI provides a description of the slave device for EtherCAT PLC controls as well as information about the configuration of the EtherCAT communication. The EDS describes the CAN objects of the device that can be accessed. Copy both files into the TwinCAT application folders.

- Protocol
  Change the protocol to EtherCAT as described in chapter 7.1.1 Protocol.

No further settings need to be made on the frequency converter for EtherCAT communication. Lengths of the input and output words are set by the EtherCAT master.

- Topology
  Line topology is supported, and the innoCube is placed as the last slave in the line topology.

- Operating mode/cyclic communication
  When configuring the slave in your control project, use the "Rexroth mode" operating mode, because only this supports free configuration of the PDOs. It is necessary to expand cyclic communication via PDOs.
  PDO5 cannot be changed. PDO22 is empty and can be extended with additional parameters (see Fig. 65: Process data configuration EtherCAT master, here: IndraControl XM).
  The process data can be configured by writing CAN object indexes to the following lists:

  – Producer data list [16#1A15]
  – Consumer data list [16#1615]

Frequency command values are ignored here. The innoCube does not react to frequency command values, instead it receives a flow command value as command value (see chapter 5.4 Flow command value).

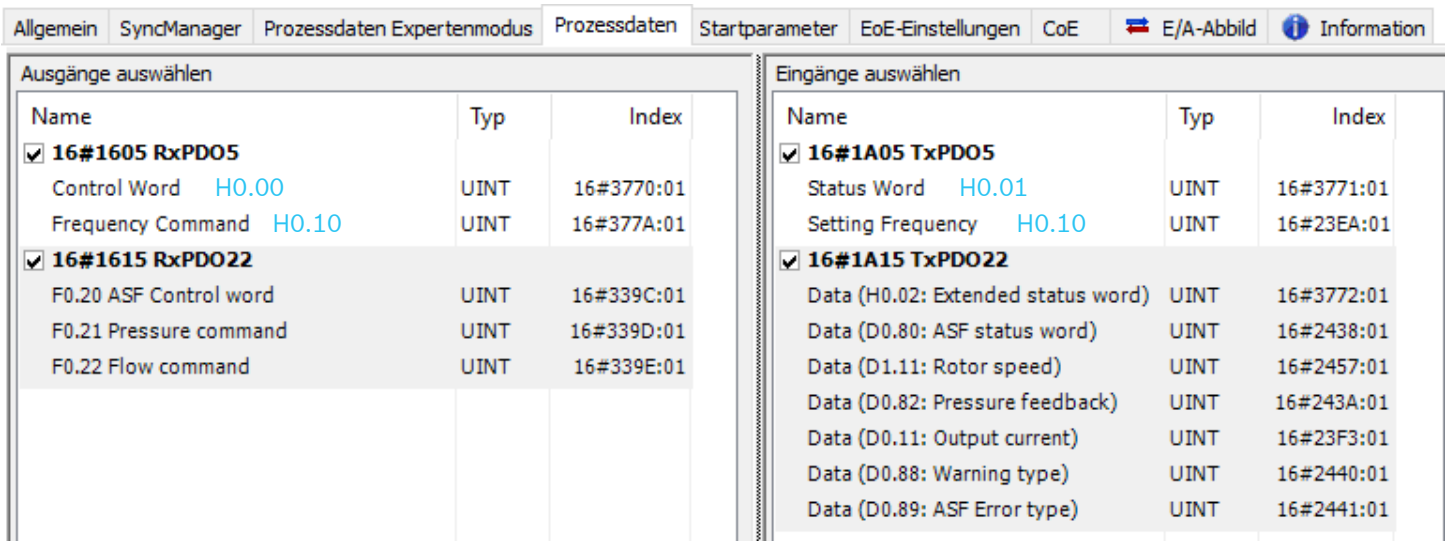


Fig. 66: Process data configuration EtherCAT master, here: IndraControl XM

- Acyclic communication
  With support of CAN over Ethernet (CoE), all function code parameters of the VFC series frequency converter can be read, and if admissible can be written, directly by SDO. The table below shows the CAN indexes corresponding to the function code parameters.

Table 49: CAN indexes corresponding to the function code parameters

Code range	CAN index range
b0.00...b9.99	16#2000...16#23E7
d0.00...d9.99	16#23E8...16#27CF
C0.00...C9.99	16#27D0...16#2BB7
E0.00...E9.99	16#27B8...16#2F9F
U0.00...U9.99	16#2FA0...16#3387
F0.00 ...F9.99	16#3388...16#376F
H0.00...H9.99	16#3770...16#3B57

7.2 Running Premium without control communication

If it is desired/necessary to operate the innoCube without a higher-level control (control communication), a Premium innoCube can be configured to behave like an innoCube without control communication. Change the following parameters as shown in Fig. 67: Running Premium innoCube without control communication.

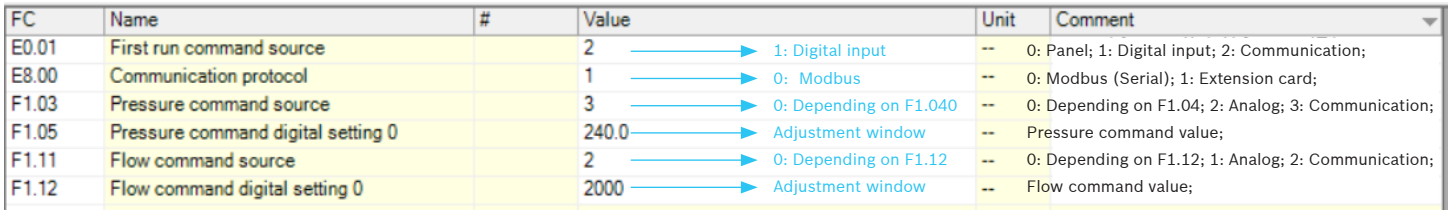


Fig. 67: Running Premium innoCube without control communication

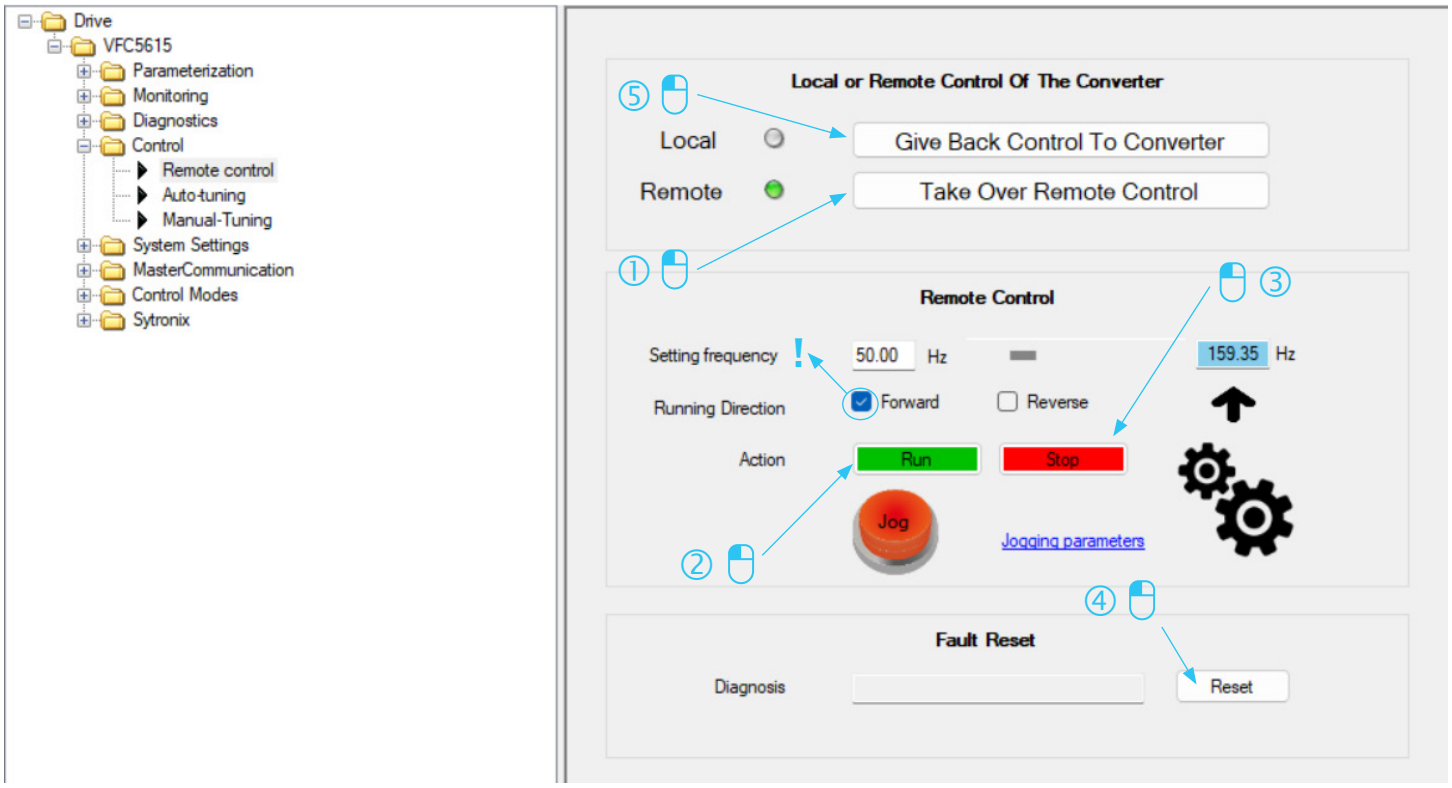


Fig. 68: Remote control

If the enable signal cannot be set digitally via the enable input, it is possible to set the enable from the IndraWorks Ds remote control.

- To do this, click on "Control", "Remote Control" and then on "Take Over Remote Control" ① .
- The window expands.
- Enable by pressing "Run" ② .
- Stop the drive by pressing "Stop" ③ .
- Acknowledge errors via the Reset key ④ .

NOTICE: Wrong direction of rotation!
Rotating the pump in the wrong direction may damage the innoCube.

- If you are enabling via remote control, make sure that the direction of rotation is set to "Forward".
  The true direction of rotation is reverse. The default direction is forward – therefore, by internal inversion, the pump rotates reverse.

Frequency command values are ignored here.
If the connection to the innoCube is lost while it is running via remote control, the converter will exit with an error (Error 54 (PcE-): Remote control communication error).

- Then click on "Give Back Control To Converter" ⑤ again to give back control to the converter.

7.3 Master/slave operation

Requirements:

- Insert two innoCubes with the same pump size, as they work with the same speed command value.

Fig. 69: Two innoCubes in master/slave operation

Master/slave operation with two innoCubes can be implemented only with control communication (control), because no direct communication is possible between the innoCubes. This means that two innoCubes of the Premium version are absolutely necessary, as well as a higher-level control to transmit the command value from the innoCube master to the innoCube slave.
The innoCube master assumes the pressure control. The speed command value generated for this purpose is passed on by the higher-level control to the innoCube slave for flow control (see Fig. 69: Functional overview). This doubles the flow with unchanged pressure. Two innoCubes of the same power class should be used.
If two innoCubes with the same pump but different power class are used, the characteristic curve of the innoCube with lower power class should be used with double the flow.
If using two Basic innoCubes for master/slave operation, pin 5 of the 15X1 digital input must be used to enable the master/slave function, and the actual speed of the master station (pin 11 of 15X1) must be sent to the slave station via analog (pin 10 of 15X1). When using analog signals for master-slave control, only the actual speed of the master station can be transmitted to the slave station as the speed command; the effective speed command of the master station cannot be transmitted as the speed command.

It should be noted that the minimum volumetric flow (minimum speed) doubles (minimum speed of master + minimum speed of slave).

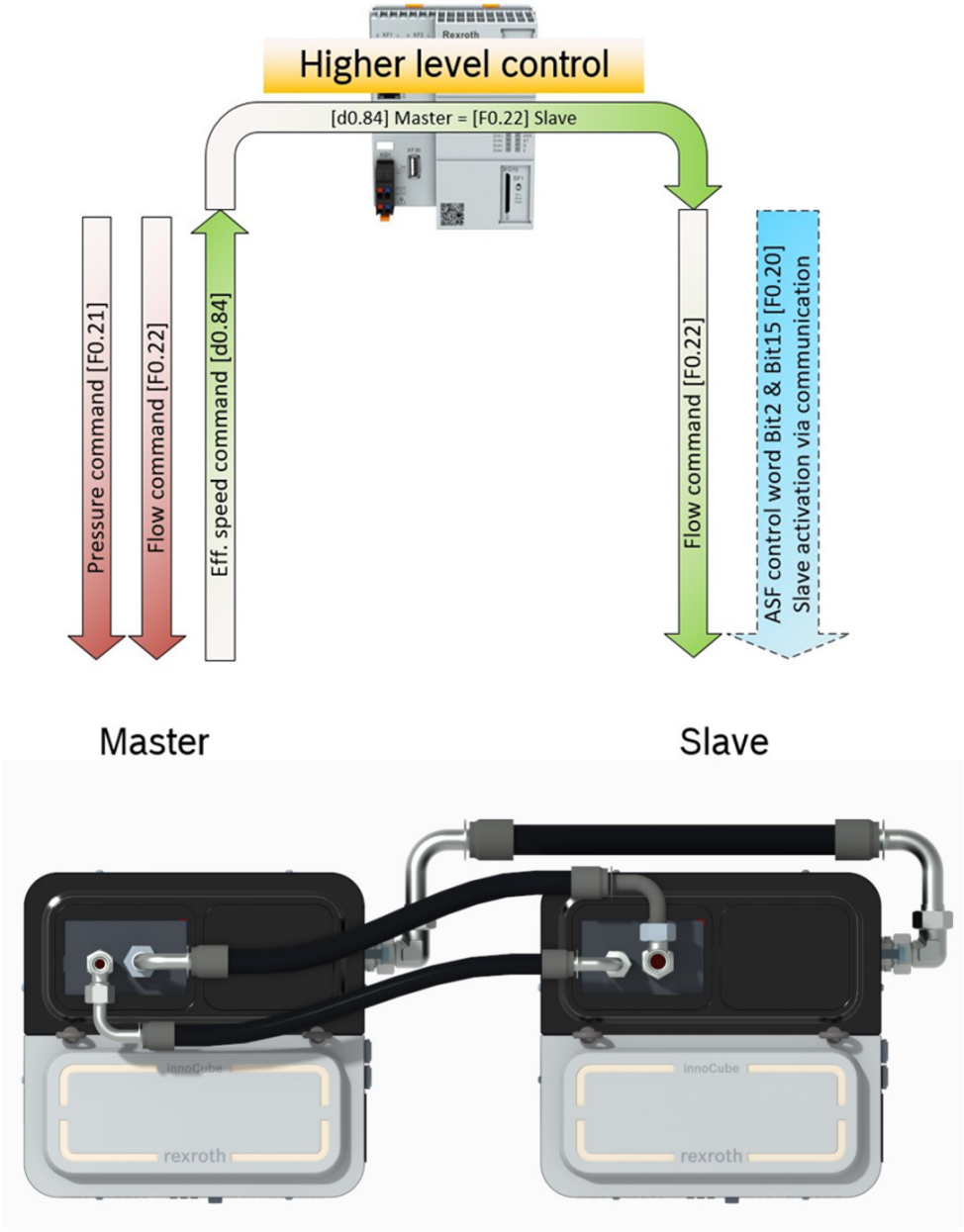


Fig. 70: Functional overview

The innoCube is set as the master by default at the factory. To use it as a slave, it must be configured as a slave. This can be done directly in the frequency converter (see section 7.3.4 Permanently activating slave operation in the converter), or it must be configured in the frequency converter so that the higher-level control can perform this task (see section 7.3.6 Enabling slave operation switch-over via the control system in the frequency converter).

7.3.1 Requirements

For master/slave operation, you need two innoCubes with option A1. They have an additional oil tank connector/return port T: G1

Fig. 71: Functional overview

For information on the hydraulic and water supply ports in master/slave operation, refer to the overview drawing and hydraulic circuit diagram in the operating instructions RE 51045-B and data sheet RE 51045; see section 1.2 Required and amending documentation.

7.3.2 Parameterization

To configure the innoCube, Bosch Rexroth recommends that you connect using the USB service interface. This prevents confusion between the master and the slave. The following procedure refers to parameterization via the USB service interface. Parameterization via LAN is also possible, but it is too cumbersome here. Fieldbus parameters can only be changed when there is "no communication with the higher-level controller" (i.e., with the Ethernet cable unplugged).
Likewise, even if the IP address, device address, or device name is assigned by the controller according to the protocol, they should be adjusted for the innoCube slave to avoid confusion between the master and slave innoCubes. For an example setting, see the table below.

Table 50: Example setting of communication parameters

Parameter	innoCube-Master	innoCube-Slave
H3.03 MEP: IP Address	192.168.0.1	192.168.0.2
H3.20 MEP: Station Name (PROFINET)	axis01	axis02
H3.23 MEP: Device Address	1	2

7.3.3 Process data

The innoCube master must additionally transmit the parameter "d0.84 Effective speed command" in the process data input word so that the higher-level control can pass it on as the command value for the innoCube slave.

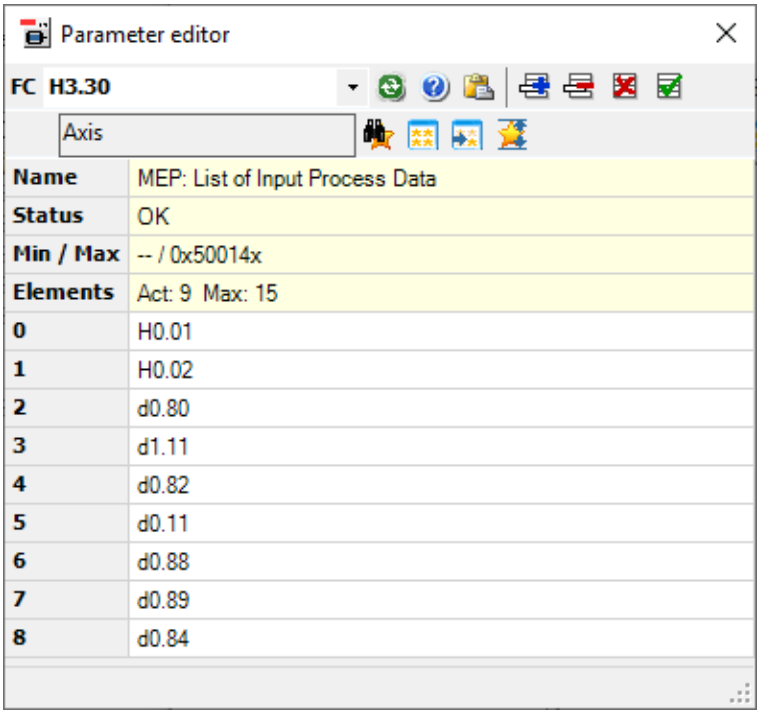


Fig. 72: Process data input for innoCube master, e.g., for Profinet

7.3.4 Permanently activating slave operation in the converter

To permanently activate slave operation in the frequency converter, bit 2 in parameter [F4.03] must be set.

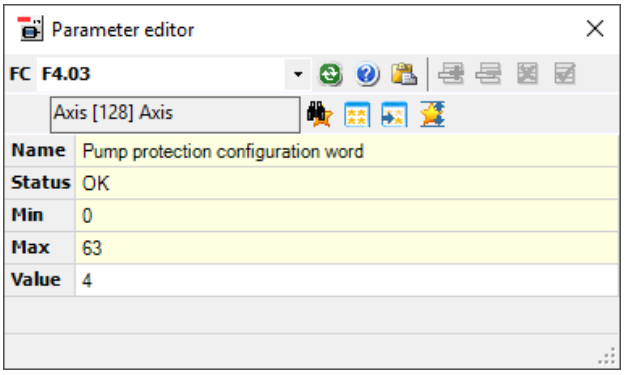


Fig. 73: [F4.03] Pump guard control word

Alternatively, you can activate slave operation in the Sytronix FcP 5020 interface. Click on "Extended Features" and activate the "Master to slave" checkbox (see Fig. 74: Extended Features and Fig. 75: Pump guard control word).

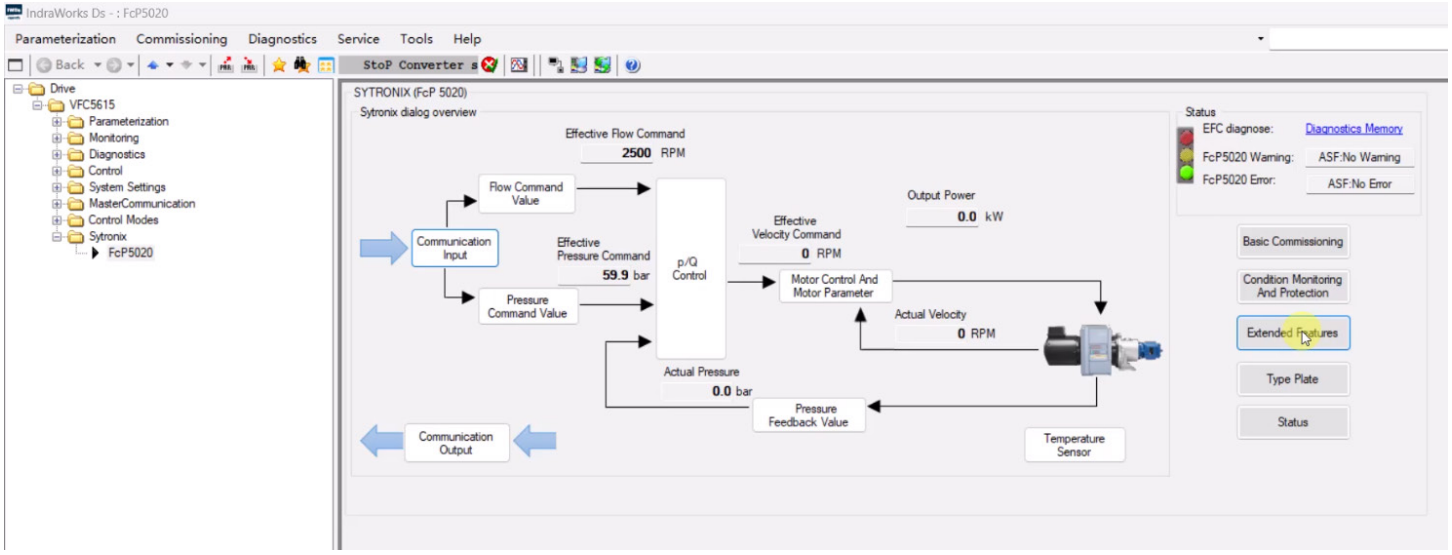


Fig. 74: Extended Features

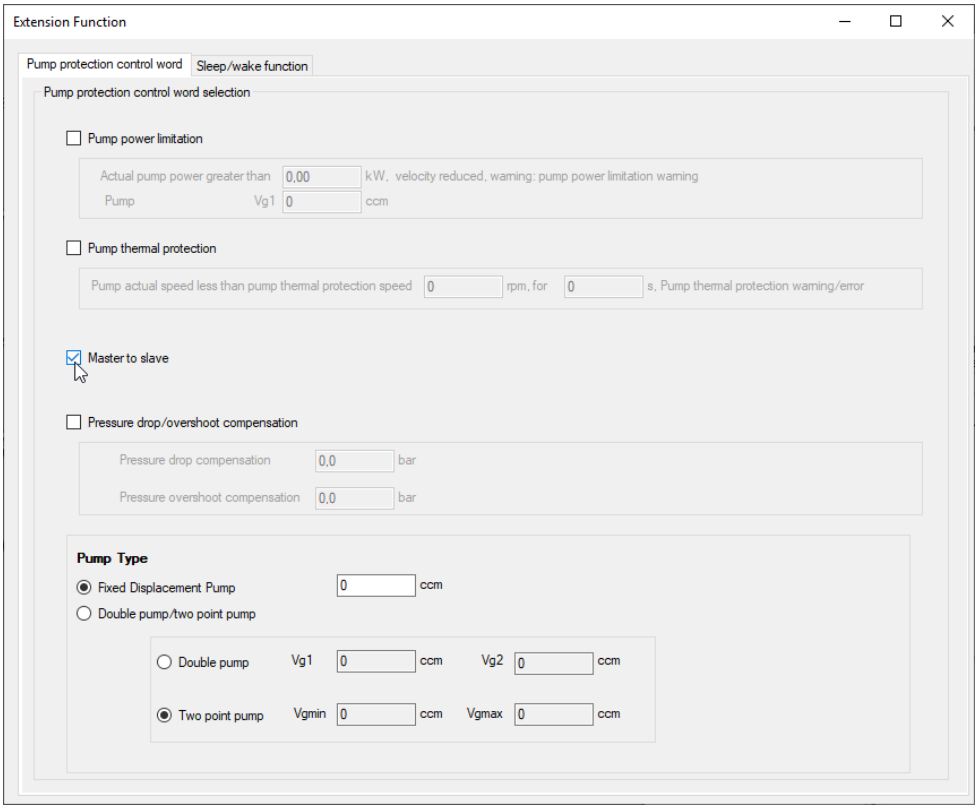


Fig. 75: Pump guard control word

7.3.5 Slave operation switch-over via parameter input

If the switch-over between master and slave mode is to be made via a parameter input (i.e., via a digital input), the value 1 must be written to parameter [F4.39] in the frequency converter (see Fig. 76: [F4.39] Master/slave switch source). A digital input (parameter input) must be assigned the corresponding master/slave selection function. To do this, set either parameter [F2.21] (15×1 pin 5, input EX1, defaulted to 5) or parameter [F2.22] (15×1 pin 6, input EX2) to 5 (Master/slave operating mode selector switch). Once configured, if this pin receives a 24V high level, the innoCube will enter slave mode.。

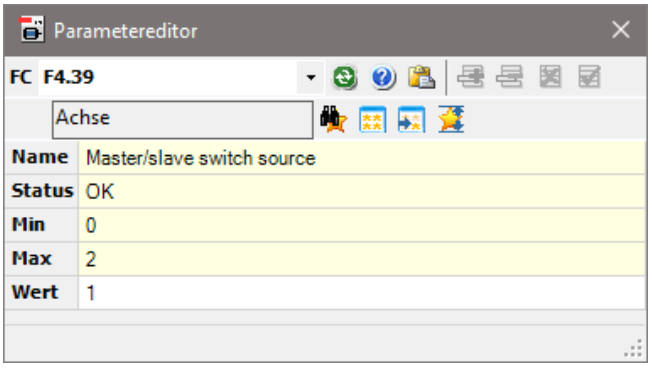


Fig. 76: [F4.39] Master/slave switch source

7.3.6 Enabling slave operation switch-over via the control system in the frequency converter

If the switch-over between master and slave mode is to be made via communication (i.e., via the higher-level control), the value 2 must be written to parameter [F4.39] in the frequency converter (see Fig. 77: [F4.39] Master/slave switch source). This allows slave operation to be activated from the control system.

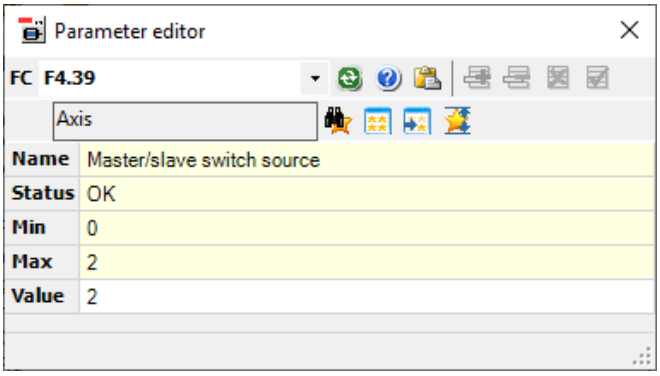


Fig. 77: [F4.39] Master/slave switch source

7.3.7 Enabling slave operation via the control system

To activate the slave functionality of the innoCube slave, bit 2 and bit 15 must be set in the process data output parameter "F0.20 ASF control word." (See Table 56: Definition of [F0.20] ASF control word).

This only has an effect if section "7.3.6 Enabling slave operation switch-over via the control system in the frequency converter" has been implemented, and not section "7.3.4 Permanently activating slave operation in the converter" or section "7.3.5 Slave operation switch-over via parameter input."

7.3.8 Slave active status

Whether the innoCube slave is operating in slave mode can be seen in IndraWorks Ds in the Sytronix FcP 5020 interface under "Status" (see Fig. 78: FcP5020 status and Fig. 79: Slave operation status), or is indicated by bit 2 in parameter [d0.80] ASF status word.

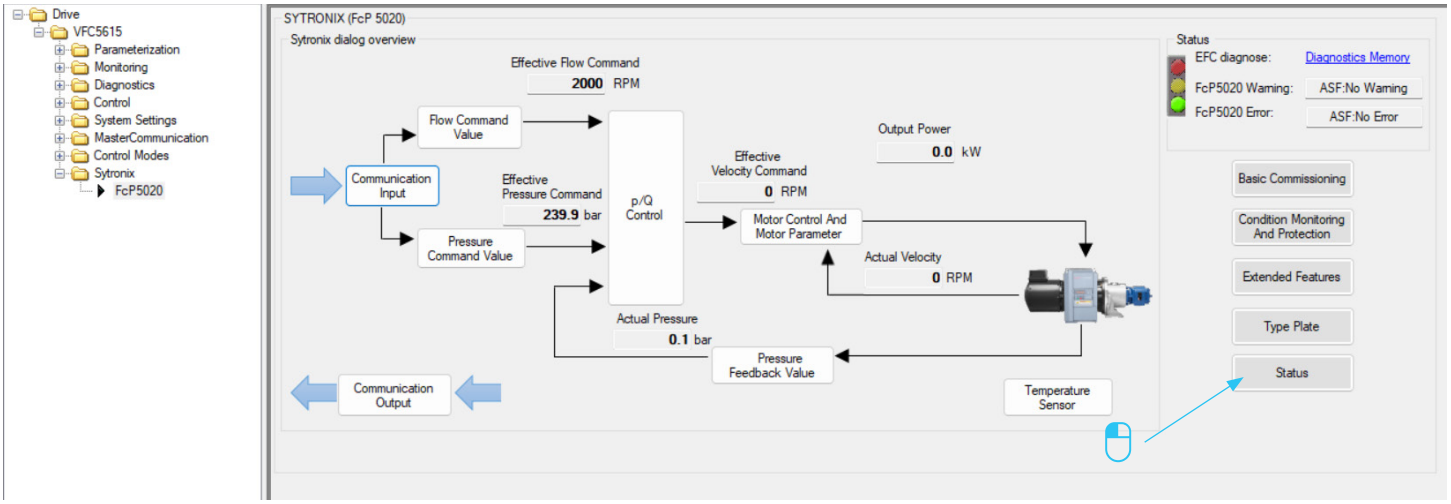


Fig. 78: FcP5020 status

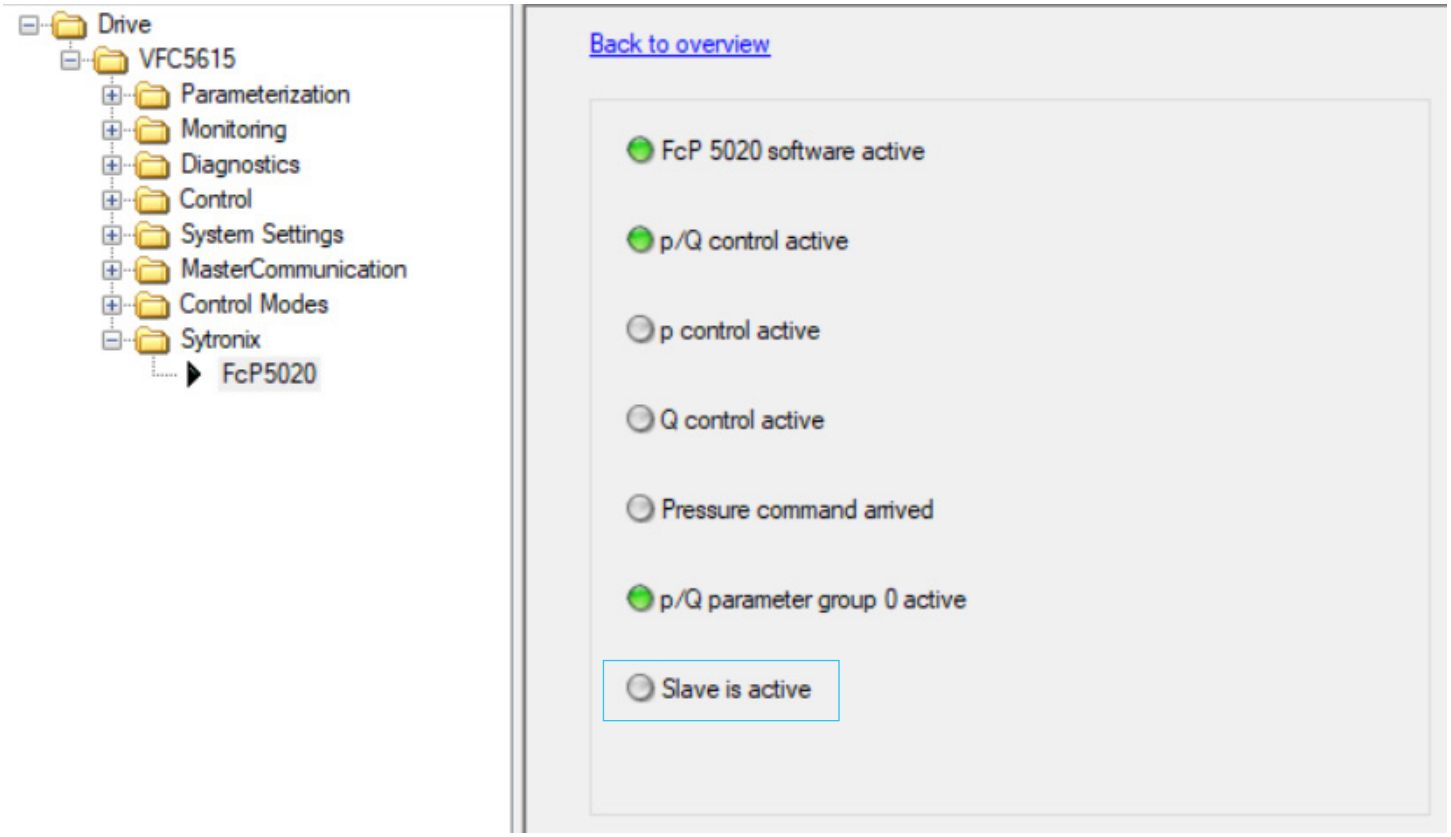


Fig. 79: Slave operation status

7.3.9 Command value for innoCube slave

The process data input parameter "d0.84 Effective speed command" is read from the innoCube master via the controller and passed directly to the innoCube slave as the command value for the flow control of the innoCube slave (process data output parameter "F0.22 Flow command").

7.3.10 Information for operation

The innoCube master and slave must be started and stopped separately (this should be done simultaneously, e.g., by using the control words for both innoCubes).

- Ensure via the controller that both innoCubes are stopped in case of an error, as this is not done automatically.

7.4 Parameters involved

7.4.1 Process data input parameters

The process data input parameters (innoCube output parameters) are described in detail below.

Table 51: Overview of involved parameters of process data input (innoCube output)

Code	Designation	Description	S3(IDN.SI.SE)	EC Index	MB Register	Protocol
	Drive status	Drive status word	S-0-0135.0.0			S3
H0.01	Status word	Status word	P-0-1098.0.1	16#3771:01	16#7FA0	S3/PN/EI/EC/MB
H0.02	Extended status word	Extended status word	P-0-1098.0.2	16#3772:01	16#6002	S3/PN/EI/EC/MB
H0.03	STO safety status word	STO status word	P-0-1098.0.3	16#3773:01	16#6003	S3/PN/EI/EC/MB
d0.80	ASF status word	ASF status word	P-0-1058.0.80	16#2438:01	16#1050	S3/PN/EI/EC/MB
d1.11	Rotor speed	Actual speed	P-0-1058.0.111	16#2457:01	16#110B	S3/PN/EI/EC/MB
d0.82	Actual pressure value	Actual pressure value	P-0-1058.0.82	16#243A:01	16#1052	S3/PN/EI/EC/MB
d0.11	Output current	Output current	P-0-1058.0.11	16#23F3:01	16#100B	S3/PN/EI/EC/MB
d0.88	Warning type	Warning (Code)	P-0-1058.0.88	16#2440:01	16#1058	S3/PN/EI/EC/MB
d0.89	Error type	Error (Code)	P-0-1058.0.89	16#2441:01	16#1059	S3/PN/EI/EC/MB
d0.84[1)]	Effective speed command	Effective speed command value	P-0-1058.0.84	16#243C:01	16#1054	S3/PN/EI/EC/MB

[1)] Necessary for master/slave operation for the master innoCube

Table 52: Definition of [S-0-0135] status word Sercos III

Bit	Description	Setting range
13	Error	0: No error 1: Error
15...14	Drive status	00: Drive not ready 01: Drive ready for main power on 10: Drive ready and mains voltage applied 11: Drive enabled

Table 53: Definition of [H0.01] status word

Bit	Description	Setting range
0	Direction of rotation	0: Forward 1: Reverse [1)]
1	Running/Stopped	0: Stop 1: Running
3	Acceleration	0: Not in acceleration 1: Acceleration
4	Delay	0: Not in delay 1: Delay
5	Overvoltage limitation	0: Normal 1: Overvoltage limitation
6	Over-current limitation	0: Normal 1: Over-current limitation
7	Error	0: No error 1: Error
8...15	Error codes	

[1)] The innoCube rotates reverse to build up pressure. There is no need to specify the direction of rotation.

- Bit 8...15 Error code
  A detailed error code description can be found in section 10.5 Error codes. The specified error code is the error which occurs when the frequency converter is in error mode (i.e., bit 7 = 1). The last entry remains even if the error has been acknowledged (bit 7 = 0).

Table 54: Definition of [H0.02] advanced status word

Bit	Description	Setting range
0	Voltage supply	0: Mains voltage available 1: 24 V mode
1	Sleep mode	0: Normal 1: Sleep mode
2	Converter OK	0: Converter not OK 1: Converter OK
14	General warning	0: No warning 1: Warning

Table 55: Definition of [d0.80] ASF status word

Bit	Description	Setting range
2	Master/slave status	0: Master 1: Slave
3	p/Q parameter group	0: Parameter set 0 1: Parameter set 1
11	Pressure drop/ excessive pressure compensation	0: No compensation 1: Compensation
12	Pressure command value reached	0: Pressure deviation bigger than tolerance range 1: Pressure deviation within tolerance range
13	ASF status	0: Active 1: Inactive
14	ASF warning	0: No warning 1: Warning
15	ASF error	0: No error 1: Error

[d1.11] Rotor speed
- Velocity actual value in rpm (revolutions per minute)
- Decimal places: 0

[d0.82] Output current
- Output current in A (Amperes)
- Decimal places: 1

[d0.88] Warning type
- ASF warning type (interpret as decimal number – not bitwise!)
- Decimal places: 0

Table 56: Definition of [d0.88] warning type

Value (decimal)	Description
0	No warning
1	Actual pressure value exceeds limit value
2	Pressure command value exceeds limit value
3	Flow command value exceeds limit value
5	Oil level warning
6	Oil temperature warning
7	Oil change warning
8	(Reserved)
9	Pump thermal monitoring warning
10	Pump power limitation warning

[d0.89] Error type
- ASF error type (interpret as decimal number – not bitwise!)
- Decimal places: 0

Table 57: Definition of [d0.89] error type

Value (decimal)	Description
0	No error
1	Actual pressure value exceeds pump limit value
2	Pressure sensor error
3	Parameter setting error
5	Oil level error
6	Oil temperature error
7	Oil change error
8	Oil level or temperature error
9	Pump thermal monitoring error

[d0.84] Effective speed command
- Internally generated velocity command value in rpm (revolutions per minute) for pressure control
- Decimal places: 0

7.4.2 Process data output parameters

The process data output parameters (innoCube input parameters) are described in detail below.

Table 58: Overview of involved parameters of process data output (innoCube input)

Code	Designation	Description	S3(IDN.SI.SE)	EC Index	MB Register	Protocol
	Drive Control	Drive control word	S-0-0134.0.0			S3
H0.00	Control word	Control word	P-0-1098.0.0	16#3770:01	16#6000	S3/PN/EI/EC/MB
F0.20	ASF control word	ASF control word	P-0-1090.0.20	16#339C:01	16#5014	S3/PN/EI/EC/MB
F0.21	Pressure command	Pressure command value	P-0-1090.0.21	16#339D:01	16#5015	S3/PN/EI/EC/MB
F0.22	Flow command	Flow command value	P-0-1090.0.22	16#339E:01	16#5016	S3/PN/EI/EC/MB

Table 59: Definition of [S-0-0134] control word Sercos III

Bit	Description	Setting range
13	Drive halt/restart	0: Drive halt 1: Drive restart
14	Enable drive	0: Disable drive 1: Enable drive
15	Drive OFF/ON	0: Drive OFF 1: Drive ON

Table 60: Definition of [H0.00] control word

Bit	Description	Setting range
0	Run command	0: Inactive 1: Run command active
3	Stop command	0: Inactive 1: Stop
4	E-stop	0: Inactive 1: E-stop active
5	Fault reset	0: Inactive 1: Fault reset active
7	Control word enable [1)]	0: Inactive 1: Control word active

[1)] The control word must be permanently active for the innoCube to accept commands.

NOTICE: Wrong direction of rotation of the pump!
Rotating the pump in the wrong direction may damage the innoCube.

▶ Make sure that bit 2 of control word [H0.00] remains at 0 (= forward).
The true direction of rotation is reverse. The default direction is forward – therefore, by internal inversion, the pump rotates reverse.

The control bits (bit 0...6) in the control word are all edge sensitive. Bosch Rexroth recommends resetting the value to 0#0080 (80 hexadecimal) when the program starts initially, and sending the run control word 0#0081 (81 hexadecimal) during operation. When using a Siemens PLC, the high and low bytes of the control word must be swapped.
The control bits are only effective when the control word is switched to active (Bit 7 = 1).

- Bit 4 E-stop active
  Freewheel stop will be triggered in conjunction with display error 'E-St' when bit 4 = 1.

Table 61: Definition of [F0.20] ASF control word

Bit	Description	Setting range
2	Master/slave selection	0: Master 1: Slave
3	p/Q parameter set selection	0: Parameter set 0 1: Parameter set 1
15	ASF control word enable	0: Inactive 1: Active

The control bits are only effective when the control word is switched to active (bit 15 = 1). When using a Siemens PLC, the high and low bytes of the control word must be swapped.

[F0.21] Pressure command
- Pressure command value in bar (55.5 bar ≙ 555)
- Decimal places: 1

[F0.22] Flow command
- Velocity command value (limit) in rpm (revolutions per minute)
- Decimal places: 0

8. Optimization options

8.1 Pressure drop/Acceleration

If the pressure drops too much during pressure control, e.g., due to a large cylinder/load moving, there are several ways to minimize this as described below.

8.1.1 Optimization through PID controller setting

First try to counteract the pressure drop by increasing the proportional gain [F3.12] (typical values 8...25). This makes the pressure control loop respond faster (see chapter 5.5 p/Q PID control).

8.1.2 Optimization by pressure drop compensation

Another possibility is to use pressure drop compensation. In this case, the current pressure command value is increased by [F4.45]. This function can be started by a digital signal at a parameter input and should be carried out a certain amount of time before the pressure drops (see chapter 5.8 Pressure drop/excessive pressure compensation). Experience has shown that the pressure drop is minimized when the compensation pressure is switched on 50...100 ms before the drop occurs. The optimum time must be determined empirically. For this purpose, use the oscilloscope function of the frequency converter (see chapter 4.9 Oscilloscope function).

With the Premium version, the pressure command value can simply be increased via communication a certain amount of time in advance to achieve the same effect.

8.1.3 Optimization through parameter set switch-over

In practice, the method of parameter set switch-over with a defined velocity command value (increased minimum speed) has been successfully applied. Here,

the parameter set switch-over is activated either by a digital signal at a parameter input (see chapter 5.5.7 p/Q parameter set switch-over via parameter input), or in the case of the Premium version, also via the ASF control word (see chapter 5.5.8 Only Premium: p/Q parameter set switch-over via communication). A certain time before the pressure drops, the system switches to the second parameter set, which has a higher minimum speed (system minimum speed) in order to accelerate to a defined speed. Experience has shown that the pressure drop is minimized when the compensation pressure is switched on 50...100 ms before the drop occurs. The optimum time must be determined empirically. For this purpose, use the oscilloscope function of the frequency converter (see chapter 4.9 Oscilloscope function).
This method, however, only works if the second parameter set is not yet used for other purposes, e.g., use of parameter sets with different controller settings.

9. Typical errors during commissioning

NOTICE

Adjustment of motor parameters or settings not described in this documentation!
Damage to property!
- Note that the innoCube is already delivered fully parameterized and functional, so there is no need to select the motor, change, optimize, or adjust the motor parameters (such as the direction of rotation of the pump), or adjust the sensor technology.

9.1 Minimum speed not observed

NOTICE

Overheating the pump by reducing the minimum speed!
Damage to property!
- Make sure that the minimum speed of the innoCube is not undershot, as this is absolutely necessary for cooling the pump.

The built-in pump of the innoCube requires a certain speed (minimum speed) to ensure its cooling. Even when the innoCube has reached its pressure, or the hydraulic system has little or no leakage, the speed does not drop to zero but always runs at the minimum speed. These situations can cause the innoCube to generate more pressure than the pressure command value.

9.2 Auto tuning performed

Motor parameters adjusted by auto-tuning. The motor parameters are already optimized and the innoCube is delivered parameterized accordingly. By adjusting the motor parameters, it is possible that the innoCube will no longer function properly.

- Never perform an auto-tuning.
- If an auto-tuning was performed, Bosch Rexroth recommends loading a suitable parameter set (see chapter 4.1 Saving parameters and chapter 4.2 Loading parameters).

9.3 Reset to factory settings

Resetting the parameters to factory settings does not reset the frequency converter parameters to the condition as supplied, because the factory defaults of the firmware extension ASF do not correspond to the condition as supplied. As a result, the innoCube will no longer work properly.

Bosch Rexroth recommends making a backup of the delivered parameter set (see chapter 4.1 Saving parameters) before making any changes. This way you can always restore the condition the innoCube was supplied in by loading this parameter set when this becomes necessary (see chapter 4.2 Loading parameters).

If you have unintentionally reset the parameters to factory settings and do not have a backed-up parameter set, please contact the Bosch Rexroth customer service team. After specifying the type or material number of your innoCube, they can send you the corresponding parameter set as supplied.

10. Diagnostics/troubleshooting

10.1 General procedure

- Proceed calmly and carefully during troubleshooting.
- Avoid switching on and off unnecessarily, as the error memory may be filled needlessly and with incorrect information.
- For initial diagnostics, observe the operating panel and status LED of the innoCube; red LED indicates a fault.

The operating panel will display fault information. Try to find a remedy by following the suggested solutions in the warning and error codes (see 10.3 Warning codes and 10.4 Error codes).

Alternatively, perform the following steps:

1. Connect to the innoCube (see 3.4 Connection with innoCube (USB)).
2. Check the diagnostic messages (see Fig. 80: Diagnosis).
   – Axis status (converter status) ①
   – FcP 5020 (ASF) status ②
3. Try to find a remedy by following the suggested solutions in the warning and error codes (see 10.3 Warning codes and 10.4 Error codes).

You can check whether the sensors provide the corresponding signal by looking at the display of the I/O monitor (see Fig. 59: I/O monitor – assignment of the corresponding signals).

4. Acknowledge the error (Reset).

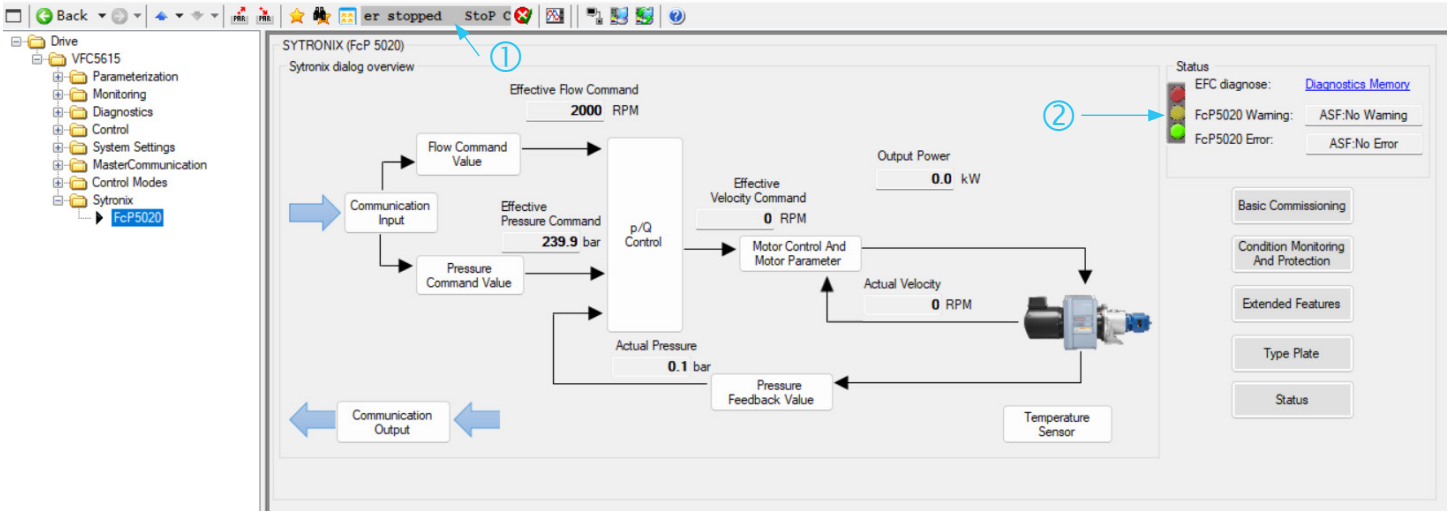


Fig. 80: Diagnosis

FcP 5020 warnings and errors are displayed by the frequency converter as APF1 (application warning) and APE1 (application error), as these messages come from the ASF. These messages are also stored in the error memory.
To interpret these messages, you have to check parameters [d0.88] (warning code) and [d0.89] (error code) or the messages in the Sytronix FcP 5020 dialog while the message is still pending.

10.2 Status codes

Table 62: Status codes

Code	Designation
P.oFF	Displayed only at shut-off drop in stop state (only 24V supplied)
PSLP	PID in sleep mode
-PF-	Modified parameters that differ from the standard value
-EP-	Parameters with invalid settings
S.Err	Parameter change blocked
PrSE	Parameter setting contradiction

10.3 Warning codes

Table 63: Warning codes

Code	Designation
C-dr	Communication disconnection
FLE	Fan maintenance period expired
noCP	No modified parameter
PLE	Pump leakage
Aib-	Analog input wire break detection
OCi	Communication data exceeds value range
Fdi	Fieldbus process data invalid
APF1	Warning that can be triggered by the application - ASF warning (see [d0.88])
UH-A	Under-temperature converter
SLi-	Velocity limitation

Code APF1: Application warning (ASF customer warning 1)

Function code	Error information (value)	Cause	Solution
	0: No warning		
	1: Actual pressure value exceeds limit value	• Excessive pressure setting • Pressure sensor error	• Set pressure to a lower value • Check that the wiring is properly connected for actual pressure value transmission.
	2: Pressure command value exceeds limit value	Pressure command value set too high by user [F4.22]	Set pressure to a lower value
	3: Flow command value exceeds limit value	Flow command value set too high by user [F4.24]	Set flow to a lower value
[d0.88]	5: Oil level warning	Oil level too low	Refill oil.
	6: Oil temperature warning	Max. oil temperature reached	Reduce hydraulic losses or improve oil cooling.
	7: Oil change warning	Operation time exceeds oil life time	Change oil and reset oil in operation timer [F4.54].
	8: (Reserved)		-
	9: Pump thermal monitoring warning	Pump speed is lower than required for pump cooling [F4.36]	Increase system minimum speed.
	10: Pump power limitation warning	Required pump power exceeds power limitation set in [F4.35]	Adjust power limitation or system load.

10.3.1 Multi-Ethernet card warning code

Function code	Error information (value)	Cause	Solution
Fdi	Fieldbus process data invalid	• Cyclic communication had been established, but was stopped because of an error • Cyclic communication is running, but fieldbus master has set data status invalid	• Check the fieldbus master status. If the controller is in stop mode, the Fdi warning will also appear • Check the Ethernet cables and switches. • On the PLC side, set the application status and/or process data status to valid.

10.4 Error codes

Error 1 (OC-1): Over-current at constant speed

Possible cause	Solution
Sudden load change in operating mode	Reduce occurrence and scale of sudden change
Low mains voltage	Check the power supply.
Excessive inertia or load	• Check motor and frequency converter power. • Check the load.
Excessive torque compensation	Reduce the torque compensation setting [C2.22] until the current decreases.
Excessive overexcitation braking factor	Reduce [E0.55].

Error 2 (OC-2): Over-current during acceleration

可能原因	解决方案
Excessively short acceleration time	Increase the acceleration time [E0.26].
Excessive start-up frequency	Decrease the start frequency [E0.36].
Excessive load rotation inertia or impact	• Increase the acceleration time [E0.26]. • Reduce sudden load cycles.
Running command active while motor is coasting	Restart after stopping the motor or start with speed recording [E0.35].
Wrong settings of V/f curve-related parameters	Adjust settings of V/f curve-related parameters.
Excessive torque compensation	Reduce the torque compensation setting [C2.22] until the current decreases.
Excessive overexcitation braking factor	Reduce [E0.55].
Wrong motor parameter settings	Correct the motor parameter settings.

Error 3 (OC-3): Over-current during delay

Possible cause	Solution
Excessively short delay time	Increase the delay time [E0.27].
Excessive overexcitation braking factor	Reduce [E0.55].
Wrong motor parameter settings	Correct the motor parameter settings.

Error 4 (OE-1): Overvoltage at constant speed

Possible cause	Solution
Surge voltage from mains connection	Check the power supply.
Motor-to-earth short-circuit causes DC-bus capacitors overcharged	Check the motor connection.
EMC interference	Check the wiring of the control circuit, main circuit and grounding.

Error 5 (OE-2): Overvoltage during acceleration

Possible cause	Solution
Surge voltage from mains connection	Check the power supply.
Motor-to-earth short-circuit causes DC-bus capacitors overcharged	Check the motor connection.
Direct start during motor running	Restart after stopping the motor or start with speed recording [E0.35].
Excessively short acceleration time	Increase acceleration time [E0.26] or use the S characteristic curve [E0.25, E0.28, E0.29].

Error 6 (OE-3): Overvoltage during delay

Possible cause	Solution
Surge voltage from mains connection	Check the power supply.
Motor-to-earth short-circuit causes DC-bus capacitors overcharged	Check the motor connection.
Excessively short delay time	• Increase the delay time [E0.27]. • During delay, release the protection against overvoltage [C0.25].

Error 7 (OE-4): Overvoltage during stop

Possible cause	Solution
Excessive inertia on the load	• Increase the delay time [E0.27]. • Use suitable braking components.
Surge voltage from mains connection	Check the power supply

Error 8 (UE-1): Undervoltage during operation

Possible cause	Solution
Power failure during operation	Check the power supply.
Deterioration of main flow capacitor	Contact customer service.

Error 9 (SC): Surge current or short-circuit

Possible cause	Solution
External phase-phase short-circuit of motor	Check the motor wiring.
Earth surge	Remove the ground connection and check the motor.
Internal error of power module	Contact customer service.
Surge current	• Increase the acceleration time [E0.26]; overexcitation. • Reduce the braking factor [E0.55].

Error 10 (IPH.L): Input phase loss

Possible cause	Solution
Abnormal, omitted or broken connections of frequency converter power supply	• Check the power connections. • Replace missing or broken ports.
Broken fuse	Check the fuse.
Imbalance in the three phases of input power supply	Check if the imbalance situation exceeds the converter overload capacity.
Deterioration of main flow capacitor	Contact customer service.

Error 11 (OPH.L): Output phase loss

Possible cause	Solution
Abnormal, omitted or broken connections of frequency converter outputs	• Check the ports at the frequency converter outputs. • Remove missing or broken ports.
Imbalance in the three phases of outputs	Check the motor.

Error 12 (ESS): Soft start error

Possible cause	Solution
Soft start resistance value has been changed due to overtemperature	Contact customer service.
Power failure	Check the power supply.
Input phase loss occurs during start-up (three-phase)	Correct the input phase loss.
Deterioration of main flow capacitor	Contact customer service.

Error 20 (OL-1): Converter overload

Possible cause	Solution
Long time overload	• Reduce the overload time. • Reduce the load.
Wrong settings of V/f curve-related parameters	Adjust settings of V/f curve-related parameters.
Overload happens at lower speed	• Reduce the load at low speed. • Use a higher performance frequency converter.
Excessive load, excessively short acceleration/delay time or cycle	• Adjust the load, acceleration/delay time or cycle. • Use a higher performance frequency converter.
Low mains voltage	Check the power supply.
Excessive torque compensation	Reduce the torque compensation setting [C2.22] until the current decreases.
Excessive overexcitation braking factor	Reduce [E0.55].

Error 21 (OH): Converter overtemperature

Possible cause	Solution
Frequency converter temperature [d0.20] is higher than max. admissible temperature 70° C	• Reduce ambient temperature, improve ventilation and heat dissipation; remove dust and deposits from ventilation ducts; check the fan and power connector (if installed). • If necessary, reduce the load.
Error in temperature detection circuit	Contact customer service.

Error 25 (CoL): Command value lost

Possible cause	Solution
Command value lost	Contact customer service.

Error 30 (OL-2): Motor overload

Possible cause	Solution
Motor blocked	Prevent the motor from blocking.
Normal motor runs for a long time with large load at low speed	• Reduce the load. • Adjust the load to a higher value in standstill [C1.76]. • Set the correct temperature model motor protection time constant [C1.74].
Low mains voltage	Check the power supply.
Wrong settings of V/f curve-related parameters	Adjust settings of V/f curve-related parameters.
Excessive sudden load change	Check the load.
Excessive overexcitation braking factor	Reduce [E0.55].
Wrong motor protection parameter settings	Adjust the settings of [C1.74, C1.75 and C1.76] according to the actual motor situations.

Error 31 (Ot): Motor overtemperature

Possible cause	Solution
Excessive load or bad cooling	• Check the load. • Create better cooling conditions.
Wrong motor protection parameter settings	Set the motor protection parameters according to the actual protection circuits [C1.74].

Error 35 (SPE-): Speed control loop error

Possible cause	Solution
The speed loop difference is outside [C3.26] over a time of [C3.25]	Contact customer service.

Error 38 (AibE): Analog input wire break detection

Possible cause	Solution
24 V supply was switched on after the power supply	Note the activation sequence.
Analog input wire is disconnected	Check the wiring of AI1, AI2 and EAI.

Error 39 (EPS-): DC_IN power supply error

Possible cause	Solution
DC_IN power supply voltage is out of the range 20...28 V	Check the supply voltage on terminal DC_IN and make sure that the voltage is in the range 20...28 V.

Error 42 (E-St): Terminal error signal

Possible cause	Solution
External error caused by input signals via external terminals	Check the state of the external terminals.
Wrong wiring/setting of multi-function external terminals	Ensure the right external signals have been connected correctly to the right multi-function external terminals which are assigned to external error input ([E1.00]...[E1.04] = 32, 33).
Converter stop caused by active emergency stop command via Modbus communication	Check the stop command via the Modbus communication (0X0088: Stop according to parameter setting; 0X0090: emergency stop active).If the converter receives 0X0090, E-St will be displayed.

Error 43 (FFE-): Firmware version compatibility issue

Possible cause	Solution
Extension card may be installed to the frequency converter with older/newer firmware	Contact customer service.
Control board may be installed in another device	Contact customer service.
Operating panel may be placed to the frequency converter with older/newer firmware	Contact customer service.

Error 44 (rS-): Modbus communication error

Possible cause	Solution
Device connection problem	Check the device communication port.
Communication target error	Check the status of the communication target.

Error 45 (E.Par): Invalid parameter settings

Possible cause	Solution
Parameter settings are invalid after firmware update or extension card removal or parameter backup	• Check the "-EP-" parameter group and change the parameter values which appeared under "-EP-". • Charging the saved parameters.

Error 46 (U.Par): Unknown parameter restore error

Possible cause	Solution
If one or more parameters in the backup were not found in the device, they will be skipped during parameter retrieval.	Check the differences between the different firmware versions.

Error 48 (idA-): Internal communication error

Possible cause	Solution
Internal error caused by communication between control boards	• Restart the frequency converter. • Contact customer service.

Error 49 (idP-): Internal parameter error

Possible cause	Solution
Internal error caused by parameter handling	Contact customer service.

Error 50 (idE-): Internal converter error

Possible cause	Solution
Internal error occurs	Contact customer service.

Error 51 (OCd-): Internal extension card error

Possible cause	Solution
Extension card was successfully detected by the device at startup, but the communication failed afterwards	Contact customer service.

Error 52 (OCc): Extension card PDOs configuration error

Possible cause	Solution
Internal communication error between communication card and converter control board	• Update the firmware version. • Contact customer service.

Error 53 (Fdi-): No valid process data

Possible cause	Solution
No valid process data is received from remote communication server, the remote communication server may be turned off	Check the remote communication server.

Error 54 (PcE-): Remote control communication error

Possible cause	Solution
Error if communication to IndraWorks is lost during remote control	• Check the status of the communication between the frequency converter and IndraWorks. • Contact customer service.

Error 60 (ASF-): Application firmware error

Possible cause	Solution
Error message if the application firmware was not loaded correctly or trial use is over	Contact customer service.

Error 61 (APE1): Application error (ASF customer error 1)

Function code	Error information (value)	Cause	Solution
d0.89	0: No error 1: Actual pressure value exceeds pump limit value	- Actual pressure exceeded [F4.16] (maximum pump pressure)	- • Set pressure to a lower value • Check that the wiring is properly connected for actual pressure value transmission. • Increase [F4.16].
	2: Pressure sensor error	• The negative motor speed exceeds [F4.06] with duration time exceeding [F4.07] • Slow decrease of actual pressure value after switching off	• Check if the pressure sensor can work properly. Increase the value of [F4.06, F4.07, F4.08 and F4.09]. • Check if the pressure sensor can work properly. Increase the value of [F4.10 and F4.11].
	3: Parameter setting error	Identical parameter settings	Check if parameter settings are in conflict.
	5: Oil level error	Oil level too low	Refill oil.
	6: Oil temperature error	Max. oil temperature reached	Reduce hydraulic losses or improve oil cooling.
	7: Oil change error	Operation time exceeds oil life time	Change oil and reset oil in operation timer [F4.54]
	8: Oil level or temperature error	No warning signal for oil level and temperature available, or both are active	• Check warning signal/sensor. • Same solution as oil level/temperature error
	9: Pump thermal monitoring error	Pump speed is lower than required for pump cooling [F4.36]	Increase system minimum speed.

10.4.1 Multi-Ethernet card error codes

Error codes	Description	Cause	Solution
Fin-	Initialization failed	• Error while parameterizing MEP. MEP could not start up completely •MEP could not start up completely • [H3.03] IP Address and [H3.05] Gateway Address do not match.	• Check the [H3.62] list of invalid parameters and write valid values onto invalid parameters. • Write a consistent set of [H3.03] IP address, [H3.04] subnet mask and [H3.05] gateway address. Set [H3.05] to 0.0.0.0 if no gateway is required.
FnC-	Network setup error	• Parametrized IP address already present in network • No DHCP response from DHCP server • Incorrect fieldbus parametrization at MEP	• Change the [H3.03] IP address to a valid IP address on the subnet. • Check if the DHCP server is up and running. • Check that the installed GSD file is the right one.
FPC- (Error 134)	Process data configuration mismatch	Parametrized process data configuration between MEP and fieldbus master are differing in length. Check [H3.28/H3.29 and H3.32/H3.33] to allow a comparison	Correct the process data configuration either at the MEP ([H3.30/H3.31]) or at the master. Before correcting the process data configuration at MEP side, the active connection between master and MEP should be disabled. After the fix, set up the connection to reset this error.
Fdi-	Fieldbus process data invalid	Telegrams are lost or an error occurs when frequency converter is running	• Check host status and cable connections. • Check switch status, if applicable. • Check cable shielding and routing in case of EMC problems. • Reduce Ethernet traffic; if bus load is too high, establish a separate network for fieldbus communication.
Ocd-	MEP extension card error	• Two fieldbus extension cards installed simultaneously • Internal communication was disturbed.	• Keep only one fieldbus extension card in the slots. • Check the installation of the MEP card and attempt to reset the error.
FCd-	Internal communication watchdog error	Internal communication timed out.	Reset the error; if the problem persists, [H3.38] timeout input data can be increased.
FnF-	Subsystem corrupted	Firmware file corrupted	Update the MEP firmware. If the problem persists, replace the MEP hardware.
FCE-	Internal error	Fatal error or exception	Boot the frequency converter again. If the problem persists, replace the MEP hardware.

11. Alphabetical index

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