

ENGINEERING
TOMORROW



Operating Guide

iC7-Automation EtherCAT

EtherCAT OS7EC



drives.danfoss.com | **iC7**

Contents

1 Introduction and Safety

1.1 Purpose of the Operating Guide	5
1.2 Additional Resources	5
1.3 Safety Symbols	5
1.4 Qualified Personnel	6
1.5 Safety Precautions	6
1.6 Abbreviations	7
1.7 Trademarks	8
1.8 Version History	9

2 Product Overview

2.1 EtherCAT Features and Technical Data	10
2.2 Communication Profiles and Objects	10
2.3 iC Speed Profile	11
2.4 iC Motion Profile	13
2.5 CiA 402 – Velocity Mode	17

3 Fieldbus Cable Connections

3.1 Prerequisites for Installation	22
3.2 Communication Interface X1/X2 in Frequency Converters	22
3.3 EtherCAT Port Assignment	23
3.4 EMC-compliant Installation	24

4 Configuration

4.1 EtherCAT Subdevice Information File	26
4.2 Reference Handling	26
4.3 Connectivity Settings	27

5 Parameter Access

5.1 Overview	29
5.2 Accessing Parameters	29

6 Troubleshooting

6.1 Fieldbus Indicator LEDs

34

1 Introduction and Safety

1.1 Purpose of the Operating Guide

This operating guide provides information about configuring the system, controlling the drive or power converter, accessing parameters, programming, troubleshooting, and some typical application examples.

The operating guide is intended for use by qualified personnel, who are familiar with the iC7 drives and power converters, EtherCAT technology, and the PC or PLC that is used as a master in the system.

Read the instructions before configuring EtherCAT, and follow the procedures in this guide.

1.2 Additional Resources

Additional resources are available to help understand the features, and safely install and operate the iC7 series products:

- Safety guides, which provide important safety information related to installing iC7 series drives and power converters.
- Installation guides, which cover the mechanical and electrical installation of drives, power converters, or functional extension options.
- Design guides, which provide technical information to understand the capabilities of the iC7 series drives or power converters for integration into motor control and monitoring systems.
- Operating guides, which include instructions for control options, and other components for the drive.
- Application guides, which provide instructions on setting up the drive or power converter for a specific end use. Application guides for application software packages also provide an overview of the parameters and value ranges for operating the drives or power converters, configuration examples with recommended parameter settings, and troubleshooting steps.
- *Facts Worth Knowing about AC Drives*, available for download on www.danfoss.com.
- Other supplemental publications, drawings, and guides are available at www.danfoss.com.

Latest versions of Danfoss product guides are available for download at <https://www.danfoss.com/en/service-and-support/documentation/>.

1.3 Safety Symbols

The following symbols are used in Danfoss documentation.

DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

The guide also includes ISO warning symbols related to hot surfaces and burn hazard, high voltage and electrical shock, and referring to the instructions.

	ISO warning symbol for hot surfaces and burn hazard
	ISO warning symbol for high voltage and electrical shock
	ISO action symbol for referring to the instructions

1.4 Qualified Personnel

Correct and reliable transport, storage, installation, operation, and maintenance are required for the trouble-free and safe operation of the product. Only qualified personnel are allowed to install and operate this equipment.

Qualified personnel are defined as trained staff, who are authorized to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Also, the qualified personnel must be familiar with the instructions and safety measures described in this guide.

1.5 Safety Precautions

WARNING



HIGH VOLTAGE

Drives and power converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, startup, and maintenance by qualified personnel can result in death or serious injury.

- Only qualified personnel are allowed to perform installation, startup, and maintenance.

WARNING

UNINTENDED START

When the drive or power converter is connected to the AC mains or connected on the DC terminals, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage.

- Stop the drive or power converter before configuring parameters.
- Make sure that the drive or power converter cannot be started by an external switch, a fieldbus command, an input reference signal from the control panel, or after a cleared fault condition.
- Disconnect the drive or power converter from the mains whenever safety considerations make it necessary to avoid an unintended motor start.
- Check that the drive or power converter and any driven equipment are in operational readiness.

WARNING
DISCHARGE TIME

The drive or power converter contains DC-link capacitors, which can remain charged even when the drive or power converter is not powered. High voltage can be present even when the warning indicator lights are off. Failure to wait the specified time after power has been removed before performing service or repair work can result in death or serious injury.

- Stop the motor.
- Disconnect all power sources, including permanent magnet type motors.
- Wait for capacitors to discharge fully. The discharge time is specified on the drive or power converter product label.
- Measure the voltage level to verify full discharge.

WARNING
LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the drive or power converter properly can result in death or serious injury.

- Ensure that the minimum size of the ground conductor complies with the local safety regulations for high touch current equipment.

WARNING
EQUIPMENT HAZARD

Contact with rotating shafts and electrical equipment can result in death or serious injury.

- Ensure that only trained and qualified personnel perform installation, start-up, and maintenance.
- Ensure that electrical work conforms to national and local electrical codes.
- Follow the procedures in this guide.

CAUTION
INTERNAL FAILURE HAZARD

An internal failure in the drive or power converter can result in serious injury when the drive or power converter is not properly closed.

- Ensure that all safety covers are in place and securely fastened before applying power.

1.6 Abbreviations

Table 1: Abbreviations

Abbreviation	Definition
CE	European test and certification mark.
CiA	CAN in Automation
CiA 402	Device profile for drives and motion control.
CP	Control panel
CTW	Control word
DHCP	Dynamic host configuration protocol
EMC	Electromagnetic compatibility

Table 1: Abbreviations (continued)

Abbreviation	Definition
ESC	EtherCAT® Slave Controller
ESI	EtherCAT® slave information
ESM	EtherCAT® State Machine
ETG	EtherCAT® technology group
EtherCAT	Ethernet for Control Automation Technology
Firmware	Software in the unit. Firmware runs on the control board.
I/O	Input/Output
IP	Internet protocol
IPC	Industrial Personal Computer
LED	Light-emitting diode
LSB	Least significant bit
MAV	Main Actual Value
MRV	Main Reference Value
MSB	Most significant bit
PDO	Process Data Object (cyclic data access)
PELV	Protected extra low voltage. Low Voltage Directive regarding voltage levels and distances between lines.
PLC	Programmable logic controller. A programmable logic controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factor assembly lines.
REF	Reference
RFG	Ramp frequency generator
RJ45	Registered Jack 45. A variant of the 8P8C (Modular connector 8 Position 8 Contact) connector.
RPDO	Receive PDO
SDO	Service Data Object (acyclic data access)
STW	Status word
TPDO	Transmit PDO
vl	Velocity mode according to CiA 402

1.7 Trademarks

Beckhoff is a registered trademark of and licensed by Beckhoff Automation GmbH, Germany.

CANopen is a registered community trademark of CAN in Automation e.V.

CiA is a registered trademark of CAN in Automation e.V.



EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

1.8 Version History

This guide is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this guide is English.

Table 2: Version History

Version	Remarks
AQ481922104455, version 0101	First release. The information in this version applies to iC7-Automation frequency converters (1.3–1260 A).

2 Product Overview

2.1 EtherCAT Features and Technical Data

Fieldbus options for iC7 are integrated in the control board. Fieldbuses are enabled on communication interfaces X1 and X2 only. Modbus TCP is offered as standard, and other protocols such as EtherCAT can be selected in the configurator when ordering a drive, or alternatively, they can be activated later by a proof-of-purchase token.

Table 3: EtherCAT Model Codes

Model code	Description
+BAEC	EtherCAT OS7EC

EtherCAT is an open high-performance Ethernet-based fieldbus system.

Table 4: EtherCAT Features

Feature	Technical Data
Cyclic response	<ul style="list-style-type: none"> 1 ms or higher update cycle 1 RPDO and 1 TPDO assignment object, not configurable 1 RPDO and 1 TPDO mapping object, freely configurable
System integration	Supported ESI file versions: <ul style="list-style-type: none"> ESI version: current version For more information on the ESI files, see 4.1 EtherCAT Subdevice Information File .
CANopen over EtherCAT (CoE)	<ul style="list-style-type: none"> Complete access Diagnosis history
Modular Device Profile for application profiles	<ul style="list-style-type: none"> iC Speed Profile iC Motion Profile CiA 402 Velocity Profile
Addressing method	<ul style="list-style-type: none"> Explicit device identification Station alias (second slave address)

2.2 Communication Profiles and Objects

The iC7 series complies with EtherCAT and CiA DS402 profile standards, mandatory CiA and EtherCAT objects, Diagnostics and a range of vendor-specific profiles and objects for product-specific applications. Communication profiles are selected in parameter **10.3.1.2 Fieldbus Profile**.

Table 5: Communication Profiles and Supported Applications for iC7-Automation

Profile	Industry	Motion
CiA 402 profile	X	X
iC Speed Profile	X	X
iC Motion Profile	–	X

2.3 iC Speed Profile

2.3.1 Overview

The iC Speed profile is used with the iC7 series. The iC Speed profile differs from the CiA 402 profile because it does not have a State Machine. It is only controlled by the actual state 1/0 of the control bits, not the sequence in which they are manipulated.

2.3.2 Control Word (CTW)

Table 6: iC Speed Profile Control Word Bits

Bit number	Name	Description
0+1	Preset reference selector	00: Preset reference 1 01: Preset reference 2 10: Preset reference 3 11: Preset reference 4
2	Reserved	Reserved for future use. Any control words sent to the device should keep this bit at 0 to ensure compatibility with future extensions of the control word.
3	No coast/Coast	1: No function. 0: Causes the drive to immediately coast the motor.
4	No quick stop/Quick Stop	1: No function. 0: Quick stops the drive and ramps down the motor speed to stop as defined with the quick stop ramp parameter.
5	No hold/Hold output frequency	1: No function. 0: Hold the present output frequency (in Hz).
6	Start/No start	1: If the other starting conditions are fulfilled, this selection allows the drive to start the motor. 0: Stops the drive and ramps down the motor speed as defined with the ramp down parameter.
7	Reset	0 ⇒ 1: Acknowledge faults. Acknowledge is edge-triggered, when the logic is changed from 0 to 1. Faults can only be acknowledged if the triggering condition has been removed and any required acknowledgment has been done. 0: No function.
8	Jog/No jog	1: Sets the output frequency to the jog speed defined with the jog speed parameter. 0: No function.
9	Ramp select	1: Ramp 2 is active. 0: Ramp 1 is active.

Table 6: iC Speed Profile Control Word Bits (continued)

Bit number	Name	Description
10	Data valid	<p>1: Use process data (control by PLC).</p> <p>0: Ignore the current process data. This is linked to the submodule where the CTW is present. If signals are to be covered, the CTW/STW profile (for example, the iC Speed Profile) must be part of the signals list.</p> <p>Use the previously processed data when the data valid bit was true (no control by PLC).</p>
11	Reserved	Reserved for future use.
12	User defined	<p>These bits are reserved for application-specific advanced control. For more information, refer to the <i>Parameter Descriptions</i> chapter in the application guide.</p>
13	User defined	
14	User defined	
15	User defined	

2.3.3 Status Word (STW) in iC Speed Profile

Table 7: iC Speed Profile Status Word Bits

Bit number	Name	Description
0	Control ready	<p>1 = The device controls are ready and react to process data.</p> <p>0 = The device controls are not ready and do not react to process data.</p>
1	Frequency converter ready	<p>1 = The frequency converter is ready for operation.</p> <p>0 = The frequency converter is not ready for operation. This status does not involve faults and warnings as they are indicated in their respective bits elsewhere.</p>
2	Coast	<p>1 = There are no active coast signals, and the motor can start when a start signal is given.</p> <p>0 = The frequency converter has an active coast signal and has released the motor.</p>
3	Fault	<p>1 = A fault has occurred, and an acknowledge signal is required to re-establish operation.</p> <p>0 = There are no faults.</p>
4	Reserved	Reserved.
5	Reserved	Reserved.
6	Reserved	Reserved.
7	Warning	<p>1 = A warning is active.</p> <p>0 = There are no warnings.</p>

Table 7: iC Speed Profile Status Word Bits (continued)

Bit number	Name	Description
8	Speed=reference	1 = The current motor speed matches the current speed reference within a given tolerance. The tolerance is product specific. 0 = The motor runs, but the current speed is different from the current speed reference, for example while the speed ramps up or down during start or stop.
9	Bus control/Local operation	1 = The device is controlled and reacting to I/O and process data. 0 = The device does not react on commands from the fieldbus, for 1 of the following reasons: <ul style="list-style-type: none"> • CTW bit 10 = 0. • HMI is in local mode. • MyDrive® Insight has taken control. • Control places do not include fieldbus.
10	Frequency limit	1 = The output frequency is within the defined motor limits. 0 = The output frequency has exceeded the defined motor limits. The speed limits are set with the parameters: <ul style="list-style-type: none"> • <i>P 5.8.3.1 Positive Speed Limit</i> • <i>P 5.8.3.2 Negative Speed Limit</i> • <i>P 5.8.3.3 Minimum Speed Limit</i>
11	Operation	1 = The process is running, and the motor can be running or start at any time. 0 = There are no active start requests, and the process does not run. The motor is coasted and is not started.
12	Reserved	Reserved.
13	Reserved	Reserved.
14	User defined	These bits are reserved for application-specific advanced control. For more information, refer to the Parameter Descriptions chapter in the application guide.
15	User defined	

2.4 iC Motion Profile

2.4.1 Overview of iC Motion Profile

The iC Motion profile is used with the motion features of iC7-Automation and consists of:

- Motion-specific control word, speed reference, and position reference for controlling the drive.
- Motion-specific status word, actual speed, and actual position as status.

Table 8: Telegram Layout

	Word 1	Word 2	Word 3 and 4
Input to drive	Control word	Speed reference	Position reference
Output from drive	Status word	Actual speed	Actual position

Fieldbus reference is the default selection as the source for speed and position reference in the **5.5 Control Places** parameters but the references can be ignored if the *Control Places* settings are modified.

2.4.2 iC Motion Profile Control and Status Words

The iC Motion profile control and status words are based on the iC speed profile, with the addition of the most used signals for positioning and synchronizing. The Motion-specific signals require the selection of the appropriate operating mode, see parameter **5.4.2.16 Operation Mode**.

Table 9: Control Word

Bit	Name	Description
0	Preset position reference Bit 0	000 = Preset Position Ref. 1
1	Preset position reference Bit 1	001 = Preset Position Ref. 2
2	Preset position reference Bit 2	010 = Preset Position Ref. 3 011 = Preset Position Ref. 4 100 = Preset Position Ref. 5 101 = Preset Position Ref. 6 110 = Preset Position Ref. 7 111 = Preset Position Ref. 8
3	No Coast	1: No function. 0: Causes the drive to immediately coast the motor.
4	Start Synchronizing	1 = Follower locked to synchronizing master 0 = Ramp down to stand still
5	Enable Reference	1 = New position reference enabled 0 = No Function
6	Start	1 = If the other starting conditions are fulfilled, this selection allows the frequency converter to start the motor. 0 = Stop the frequency converter and ramps down the motor speed as defined with the ramp down parameter.
7	Reset	0 ⇒ 1: Acknowledge faults. Acknowledge is edge-triggered, when the logic is changed from 0 to 1. Faults can only be acknowledged is the triggering condition has been removed and any required acknowledgment has been done. 0: No function.
8	Enable Superimposed	1 = Execute superimposed movement 0 = No Function
9	Relative Positioning	1 = Relative positioning 0 = Absolute positioning
10	Data Valid	1 = Use process data (control by PLC). 0 = Ignore the current process data. This is linked to the submodule where the CTW is present. If signals are to be covered, the CTW/STW profile (the iC Speed Profile for example) must be part of the signals list. Use the previously processed data when the data valid bit was true (no control by PLC).

Table 9: Control Word (continued)

Bit	Name	Description
11	Enable Home	1 = Execute homing function 0 = Abort homing function
12	User defined	These bits are reserved for application-specific advanced control. For more information, refer to the Parameter Descriptions chapter in the application guide.
13	User defined	
14	User defined	
15	User defined	

The basic commands such as **Start** and **Coast** are configured via **5.5 Control Places**. By default the commands are mapped to the corresponding control word bits, but that can change if the **Control Places** settings are modified. The Motion-specific commands are not available for configuration in **Control Places**, but the logic when mapping these signals to digital inputs is "OR".

Table 10: Status Word

Bit	Name	Description
0	Control Ready	1 = The device controls are ready and react to process data. 0 = The device controls are not ready and do not react to process data.
1	Drive Ready	1 = The device is ready for operation. 0 = The device is not ready for operation. This status does not involve faults and warnings as they are indicated in their respective bits elsewhere.
2	No coast (Enabled)	1 = There are no active coast signals, and the motor can start when a start signal is given. 0 = The frequency converter has an active coast signal and has released the motor.
3	Fault	1 = A fault has occurred, and an acknowledge signal is required to re-establish operation. 0 = There are no faults.
4	Home Done	1 = Homing is completed. 0 = Homing is not completed.
5	In Sync	1 = Follower is in sync with master within the tolerance specified by parameter 5.15.2.2 Synchronization Window . 0 = Follower is not in sync with master.
6	Reserved	Reserved.
7	Warning	1 = A warning is active. 0 = There are no warnings.
8	Position error within tolerance	1 = Position error is within the tolerance specified by parameter 5.13.5.1 Position Error Window . 0 = Position error is greater than the tolerance specified by parameter 5.13.5.1 Position Error Window .

Table 10: Status Word (continued)

Bit	Name	Description
9	Bus control	1 = The device is controlled and reacting to I/O and process data. 0 = The device does not react on commands from the fieldbus, for 1 of the following reasons: <ul style="list-style-type: none"> • CTW bit 10 = 0. • HMI is in local mode. • MyDrive® Insight has taken control. • Control places do not include fieldbus.
10	Target position reached	1 = Target position is reached within the window defined by parameter 5.14.2.18 On-target Window around the position reference. 0 = Target position is not reached.
11	In operation	1 = The process is running, and the motor can be running or start at any time. 0 = There are no active start requests, and the process does not run. The motor is coasted and is not started.
12	Frequency limit OK	1 = The output frequency is within the defined motor limits. 0 = The output frequency has exceeded the defined motor limits. The speed limits are set with the parameters: <ul style="list-style-type: none"> • P 5.8.3.1 Positive Speed Limit • P 5.8.3.2 Negative Speed Limit • P 5.8.3.3 Minimum Speed Limit
13	Superimposed target reached	1 = Superimposed movement is completed. 0 = Superimposed movement is not completed.
14	User defined	These bits are reserved for application-specific advanced control. For more information, refer to the Parameter Descriptions chapter in the application guide.
15	User defined	

2.4.3 Speed Reference and Actual Speed

The speed values are represented by the N2 format, a 16 bit normalized value defined in the PROFIdrive profile. They are represented in percent of nominal motor speed.

PROFIdrive profile definition of N2

N2 is a linear normalized value. 0% corresponds to 0 (0x0), 100% corresponds to 2^{14} (0x4000).

Table 11: Range of N2 values

Coding	Data type	Range of values	Resolution	Length
113	N2	$-200\% \leq I \leq (200 \cdot 2^{-14})\%$	$2^{-14} = 0.0061\%$	2 Octet

Coding:

- Representation in twos complement, the most significant bit (MSB) is the bit after the sign bit (SN) of the first octet.
- SN = 0: positive numbers including zero.
- SN = 1: negative numbers.

2.4.4 Position Reference and Actual Position

Position values are expressed in 32 bit signed position units. The units are scaled by parameters **5.13.4.4 Position Unit Numerator** and **5.13.4.5 Position Unit Denominator**.

2.5 CiA 402 – Velocity Mode

2.5.1 Overview

Velocity mode is implemented according to the CiA 402 profile as defined in the CiA 402 standard and state machine diagram.

2.5.2 Control Word

Table 12: Control Word Bits in CiA 402 – Velocity Mode

Bit number	Name	Description
0	Switch On-Off	1 = On. 0 = Off.
1	Voltage Enable-Disable (coast)	1= No coast stop. 0 = Coast stop.
2	Quick stop	1= No quick stop. 0 = Quick stop.
3	Operation Enable-Disable	1 = Enable operation. 0 = Disable operation.
4	Ramp generator Enable-Disable	1 = Enable ramp generator (RFG). 0 = Reset ramp generator.
5	Ramp generator Lock-Unlock (freeze)	1 = Unfreeze ramp generator. 0= Freeze ramp generator. Freezes the present output frequency (in Hz).
6	Reference ramp Enable-Disable (setpoint)	1 = Enable setpoint. 0 = Disable setpoint.
7	Fault acknowledge (reset)	0 ⇒ 1 = Acknowledge faults. Acknowledging is edge triggered, when changing from logic 0 to logic 1. 0 = No function.
8	Halt (stop)	1 = Motor ramp stop. 0 = No function.
9	Reserved	Operation mode specific.
10	Manufacturer-specific (reserved)	Reserved for future use.
11	Manufacturer-specific (reserved)	Reserved for future use.
12	Manufacturer-specific (reserved)	Reserved for future use.
13	Manufacturer-specific (reserved)	Reserved for future use.
14	Manufacturer-specific (reserved)	Reserved for future use.
15	Manufacturer-specific (reserved)	Reserved for future use.

2.5.3 Status Word

Table 13: Status Word Bits in CiA 402 – Velocity Mode

Bit number	Name	Description
0	Ready to switch on	1= Ready to switch on. 0= Not ready to switch on.
1	Switched on (operational)	1 = Ready to operate. 0 = Not ready to operate.
2	Operation enabled	1= Operation enabled. 0 = Operation disabled.
3	Fault	1= Fault present. 0 = No fault.
4	Voltage Enabled-Disabled (coast)	1= Coast stop not activated. 0 = Coast stop activated.
5	Quick stop	1= Quick stop not activated. 0 = Quick stop activated.
6	Switching on Enabled-Disabled	1 = Switching on Enabled. 0 = Switching on Disabled.
7	Warning	1= A warning has occurred. 0 = There are no warnings.
8	Manufacturer-specific (reserved)	Reserved for future use.
9	Control Remote(bus)-Local	1 = The device is controlled and reacting to I/O and process data. 0 = The device does not react on commands from fieldbus, because of one of the following reasons: <ul style="list-style-type: none"> • HMI is in local mode. • MyDrive® Insight has taken control. • Control places do not include fieldbus.
10	Target reached (speed=reference)	1= The current motor speed matches the current speed reference within a given tolerance. The tolerance is product specific. 0 = The motor runs, but the current speed is different from the current speed reference, for example while the speed ramps up or down during start or stop.
11	Speed limit	1 = The output frequency has exceeded the defined motor limits. The speed limits are set with the parameters: <ul style="list-style-type: none"> • <i>P 5.8.3.1 Positive Speed Limit</i> • <i>P 5.8.3.2 Negative Speed Limit</i> • <i>P 5.8.3.3 Minimum Speed Limit</i> 0 = The output frequency is within the defined motor limits.
12	Reserved	Operation mode specific.
13	Reserved	Operation mode specific.

Table 13: Status Word Bits in CiA 402 – Velocity Mode (continued)

Bit number	Name	Description
14	Manufacturer-specific (reserved)	Reserved for future use.
15	Manufacturer-specific (reserved)	Reserved for future use.

2.5.4 CiA 402 State Machine


In the CiA 402 control profile, the control bits perform different functions:

- Transition 0–3 and 6-7 perform the basic startup and power-down functions.
- Transition 4–5 and 11-12 perform application-oriented control.
- Transition 13–15 perform fault and fault acknowledge functions.

The general state diagram is defined in the CiA 402 standard.

Data objects CiA 402 control word and CiA 402 status word can be used to control the CiA 402 state machine of the drive and to read the state of the CiA 402 state machine of the drive. See descriptions in [2.5.2 Control Word](#) and [2.5.3 Status Word](#). The possible CiA 402 state machine states and transitions are shown in [Figure 1](#). The state of the CiA 402 state machine of the drive can be changed by writing the corresponding bits 0–3 and 7 to the CiA 402 Control Word data object. The needed bit values for each command are shown in [Figure 1](#).

Table 14: CiA 402 Control Word Commands

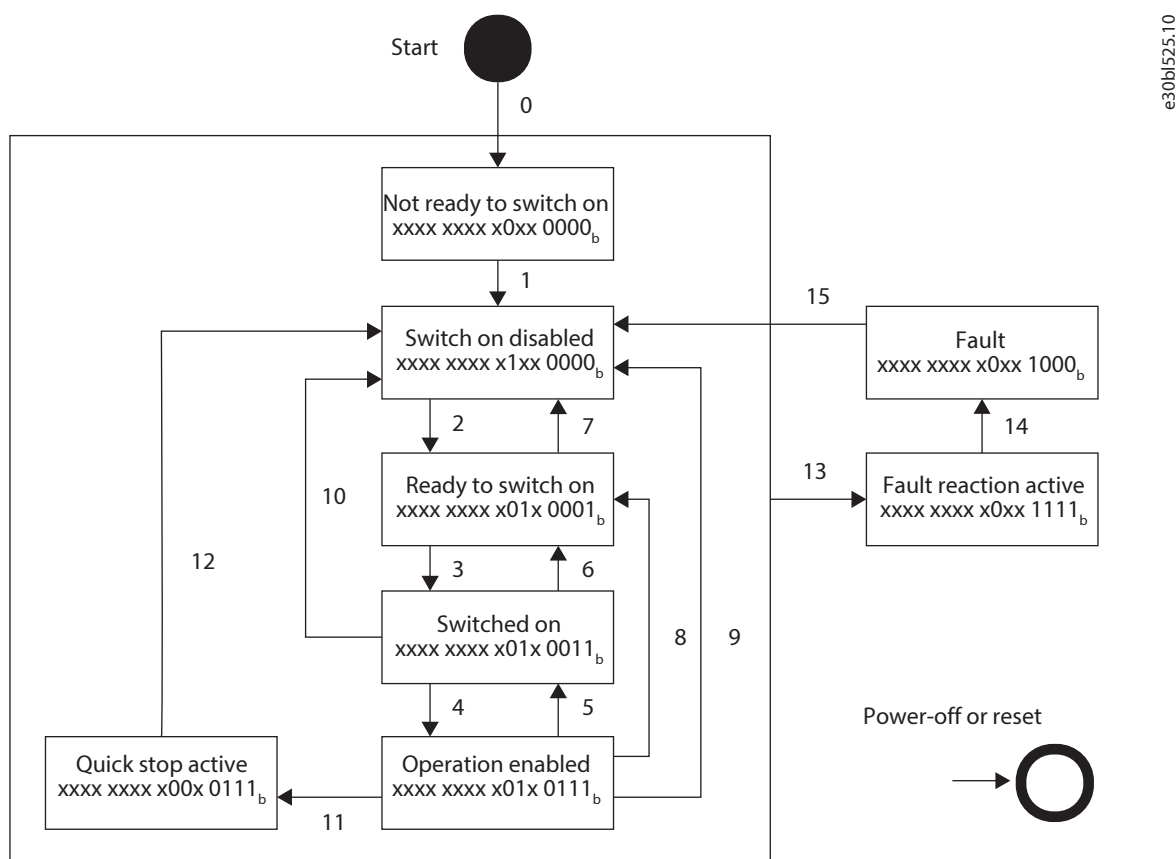
Command	Control word bits					Transitions
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0	
Shutdown	0	X	1	1	0	2.6.8
Switch on	0	0	1	1	1	3
Switch on + enable operation	0	1	1	1	1	3 + 4 ⁽¹⁾
Disable voltage	0	X	X	0	X	7, 9, 10, 12
Quick stop	0	X	0	1	X	7, 10, 11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4, 16
Fault reset		X	X	X	X	15

1) Automatic transition to Enable operation state after executing SWITCHED ON state functionality.

If CiA 402 mode is enabled, the state machine will always follow the state of the drive. However, the state machine is controllable via CiA 402 Control Word only if parameter **5.5.1.1 Active Control Place** is set to **Advanced Control** or **Fieldbus Control**. The table below explains the actions taken in different state transitions and which event triggers which state transition. If the used drive/application does not support different stop bits in Fixed Control Word, the stop method will always be according to set stop function.

Table 15: State Transition Events and Actions

Transition	Event(s)	Action(s)	Drive state
0	Automatic transition after power-on or reset	Self-initialization is performed	–
1	Automatic transition after drive status is ready.	None	Start Interlock
2, 6	Shutdown command	None	Drive Off
3	Shutdown command	None	Drive Ready
4	Enable operation command	Drive function is enabled	Running Disabled Reference 0.0 rpm
5	Disable operation command	Drive function ramp stop	Stopping
7	Disable voltage or quick stop command	None	Quick Stop/Drive Off
8	Shutdown command	Ramp stop	Stopping
9, 12	Disable voltage command	Coast stop	Start Interlock
10	Disable voltage command	None	Start Interlock
11	Quick stop command	Quick stop	Quick Stop
13	Fault signal	Go to fault state	Fault! Start Blocked
14	Automatic transition	None	–
15	Fault reset command	Reset fault currently active. The fault trigger must be solved before the fault can be reset.	–



e30h|525.10

Figure 1: CiA 402 General State Diagram

2.5.5 Configuring Quick Start

Prerequisite: The drive is connected to mains, is powered on, and reports *Start Interlock*.

1. Type in motor nameplate data and perform AMA.

Wait for AMA to be completed.

2. Write 0x0006 in the CTW.

➡ The drive reports *Motor Off*.

3. Write 0x0007 in the CTW.

➡ The drive reports *Drive Ready*.

4. Write 0x000F in the CTW.

➡ The drive reports *Running Disabled Reference 0.0 rpm*.

5. Write 0x007F in the CTW.

➡ The drive reports *Running at Standstill*.

➡ The reference can now be changed and the motor follows the requested reference.

3 Fieldbus Cable Connections

3.1 Prerequisites for Installation

Communication interfaces are integrated in the control board in iC7 drives and power converters.

The position of the connections differs based on the control board concept and frame, for example. For more information on the location of the connections, cabling, and shielding, refer to the product-specific design guide.

3.2 Communication Interface X1/X2 in Frequency Converters

3.2.1 Communication Interface X1/X2 in Frames FA02–FA12

The communication interface is on the top of the frequency converter as shown in [Figure 2](#). Industrial-grade RJ45 connectors are recommended for optimal connection. A combined shield/fixing plate, the Fieldbus EMC plate, is available as an accessory to strengthen the mechanical fixation of the cables. For information on ordering the EMC plate, refer to the product-specific design guide.

! **IMPORTANT:** Ethernet port X1 in the iC7-Automation frequency converter corresponds to EtherCAT Port 0 (IN), and Ethernet port X2 in the iC7-Automation frequency converter corresponds to EtherCAT Port 1 (OUT).

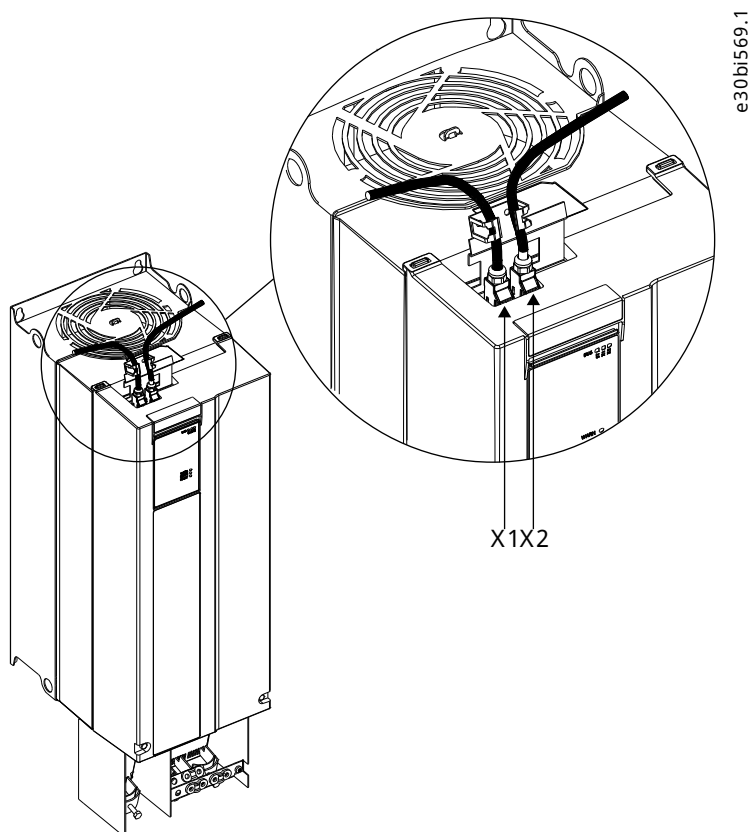


Figure 2: Location of the Communication Interface, X1/X2 in FA02-FA12 Frames (with the Optional EMC Plate)

3.2.2 Communication Interface X1/X2 in Frames FB09–FB12/FK06–FK12

The communication interface ports are located inside the frequency converter. The position of the ports and the recommended wiring path are shown in [Figure 3](#) and [Figure 4](#).

! **IMPORTANT:** Ethernet port X1 in the iC7-Automation frequency converter corresponds to EtherCAT Port 0 (IN), and Ethernet port X2 in the iC7-Automation frequency converter corresponds to EtherCAT Port 1 (OUT).

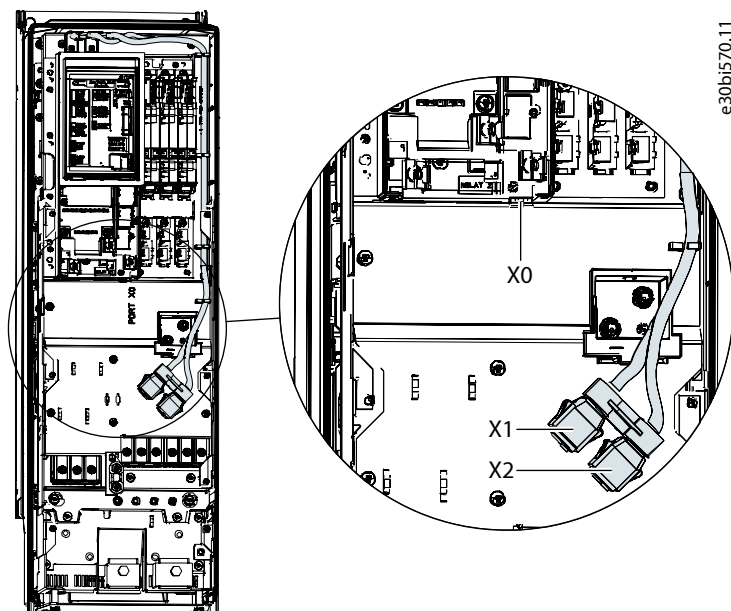


Figure 3: Communication Port X0, X1, and X2 Locations in FK06–FK08 Frames

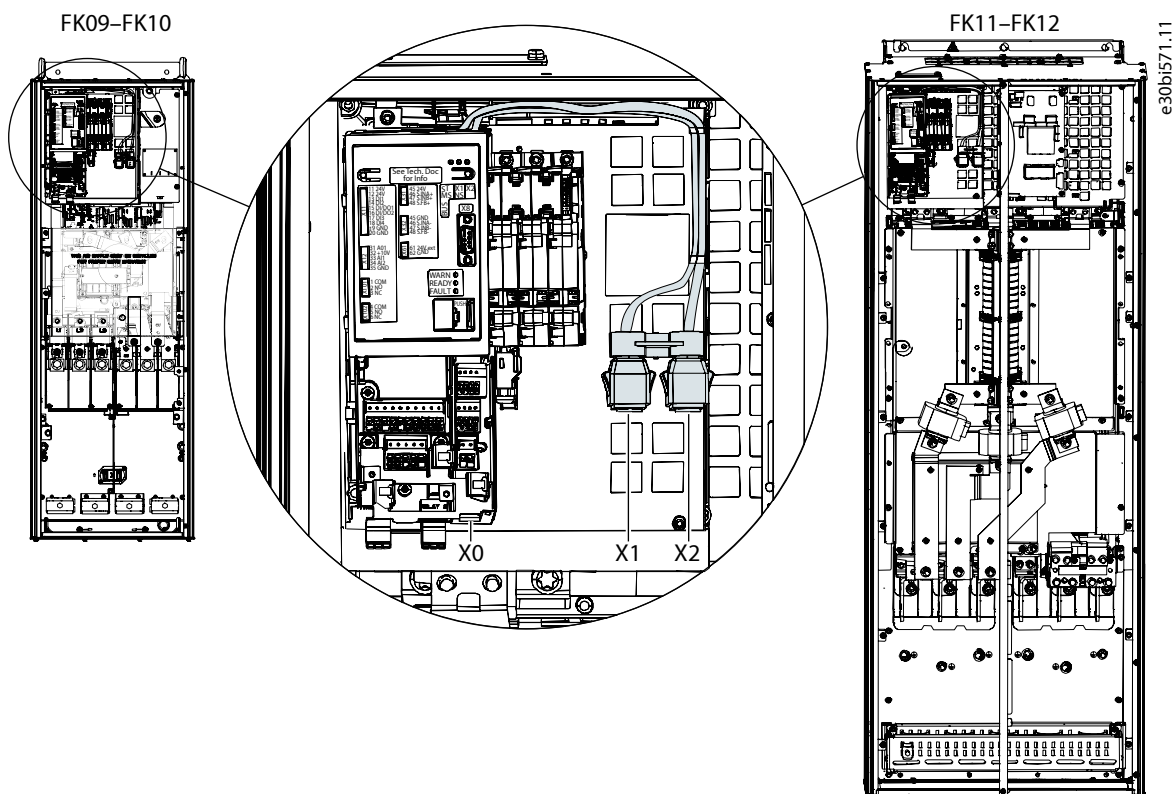


Figure 4: Communication Port X0, X1, and X2 Locations in FB09–FB12/FK09–FK12 Frames

3.3 EtherCAT Port Assignment

The EtherCAT port assignment for the iC7 products is shown in [Figure 5](#).



Figure 5: EtherCAT Port Assignment

3.4 EMC-compliant Installation

3.4.1 Overview

To obtain an EMC-compliant installation, follow the instructions provided in the product-specific design guide and the installation guide included in the shipment.

3.4.2 Grounding

- Ensure that all stations connected to the fieldbus network are connected to the same ground potential. When distances between the stations in a fieldbus network are long, connect the individual station to the same ground potential. Install equalizing cables between the system components.
- Establish a grounding connection with low HF impedance, for example, by mounting the unit on a conductive backplate.
- Keep the ground wire connections as short as possible.

3.4.3 Cable Routing

For more information on cabling, refer to the product-specific design guide and installation guide included in the shipment.

NOTICE

EMC INTERFERENCE

Failure to isolate fieldbus communication, motor, and brake resistor cables can result in unintended behavior or reduced performance.

- Use shielded cables for motor and control wiring, and separate cables for fieldbus communication, motor wiring, and brake resistor.
- A minimum of 200 mm (7.9 in) clearance between power, motor, and control cables is required. For power sizes above 315 kW (450 hp), increase the minimum distance to 500 mm (20 in).

NOTICE

CABLE ROUTING

- When the fieldbus cable intersects a motor cable or a brake resistor cable, ensure that the cables intersect at an angle of 90°.

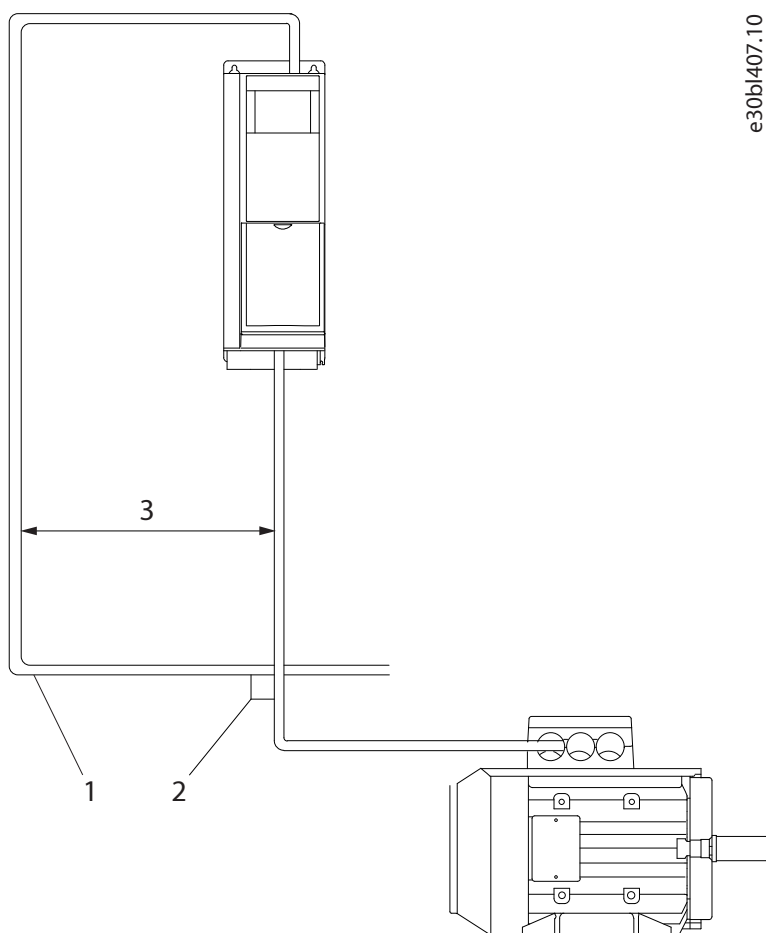


Figure 6: Cable Routing

1	Fieldbus cable	2	90° intersection
3	≥ 200 mm (7.9 in) (≥ 500 mm (20 in) for power sizes >315 kW (450 hp))		

4 Configuration

4.1 EtherCAT Subdevice Information File

To configure a EtherCAT master, the configuration tool needs an EtherCAT Subdevice Information (ESI) file for each type of device in the network. The ESI file is an XML file containing the necessary device description information for a given device.

Download the ESI files for the iC7 series from <https://www.danfoss.com/en/service-and-support/downloads/dds/fieldbus-configuration-files/>. Check that the ESI file version is compatible with the firmware and application version used in the product.

4.2 Reference Handling

The speed reference is scaled as a normalized relative value in percent (N2). The value is transmitted in hexadecimal:

- 0% = 0 hex
- 100% = 4000 hex
- -100% = C000 hex

Table 16: Reference Handling Parameters

Parameter	Parameter number	Unit	Range
Nominal Speed	402	[rpm]	0–100000
Positive Speed Limit	1729	[rpm]	0–35400
Negative Speed Limit	1728	[rpm]	-35400–0

For some applications, reversing is not wanted.

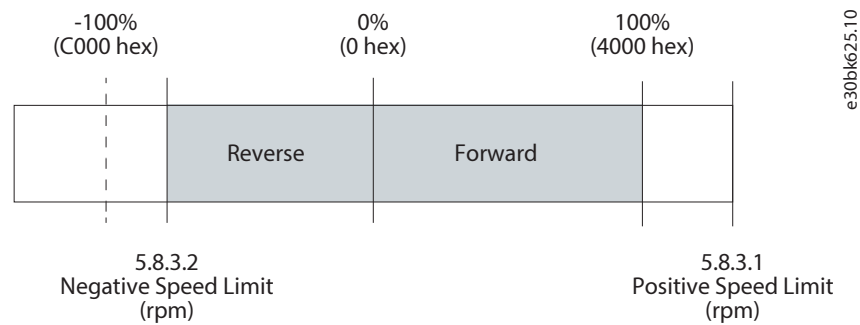


Figure 7: Example of Fieldbus Speed Reference in iC7-Automation

4.3 Connectivity Settings

Table 17: General Connectivity Settings for Industry and Motion

Menu index	Parameter	Parameter number	Value	Description
2.8.4.1	Fieldbus profile	1301	<ul style="list-style-type: none"> iC Speed Profile (default) iC Motion Profile⁽¹⁾ CiA 402 Velocity mode 	Select the fieldbus profile. The selection affects the interpretation of the control word and status word. ⁽²⁾
2.12.13.1	Fieldbus Fault Response	1303	<ul style="list-style-type: none"> Info (default) Warning Fault, Ramp to Coast Fault, coast See Table 18 for descriptions of the events.	Select the behavior when a fieldbus fault, for example loss of I/O connection occurs.
2.12.13.2	Process Data Timeout Response	1341	<ul style="list-style-type: none"> Info (default) Warning Fault, Ramp to Coast Fault, coast See Table 18 for descriptions of the events.	Select the response in case there is no fieldbus connection.
2.12.13.3	Process Data Timeout Time	1340	0.05–18000 s (Default value: 1.00 s)	Set the timeout time. If process data is not received within the time set, a process data timeout is triggered.
2.12.13.7	FB Monitoring Ctrl. Place Dependency	1338	<ul style="list-style-type: none"> Disabled Enabled 	Set the control place dependency for Fieldbus Fault, Process Data Timeout. When enabled, these functions are active only in the fieldbus control place. When disabled, these functions are active regardless of the control place.

1) Only available in Motion application.

2) When configuring EtherCAT, the correct profile is automatically selected.

Table 18: Event Descriptions for Industry and Motion

Value	Description
Info	The event is logged in the event log.
Warning	The drive issues a warning. The motor can still be controlled, but with limited performance.
Fault, ramp to coast	The drive issues a fault, ramps down, and coasts. Motor control is no longer possible.
Fault, coast	The drive issues a fault and coasts the motor. Motor control is no longer possible.

5 Parameter Access

5.1 Overview

iC7 series supports access to parameters via SDO. The data mechanism transmits requests and replies acyclically. The requests and replies are transmitted by the Acyclic Data Exchange mechanism.

For detailed instructions on how to access parameters via service data objects, refer to the documentation provided by the EtherCAT master controller manufacturer.

Parameters are accessible from the object dictionary 0x2000+parameter number.

5.2 Accessing Parameters

Prerequisite: MyDrive® Insight must be installed to access the parameters related to EtherCAT.

This example illustrates how the corresponding parameter number is allocated to each index number.

1. Connect the Ethernet cable from the PC to the Ethernet port X0 on the drive. To locate port X0, see [Fieldbus Cable Connections](#).
2. Add a link local IP address (169.254.x.x) to the network interface used on the PC connected to the drive.
3. Open MyDrive® Insight on the PC.
4. In MyDrive® Insight, click the discovered drive to which a connection should be established.

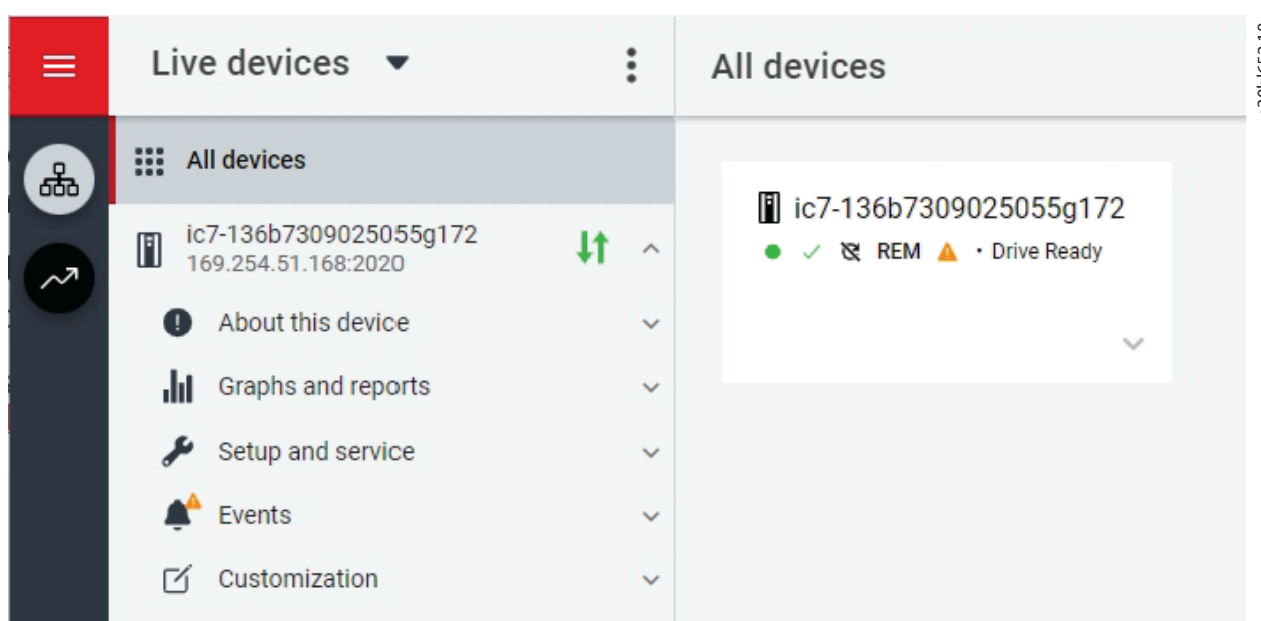
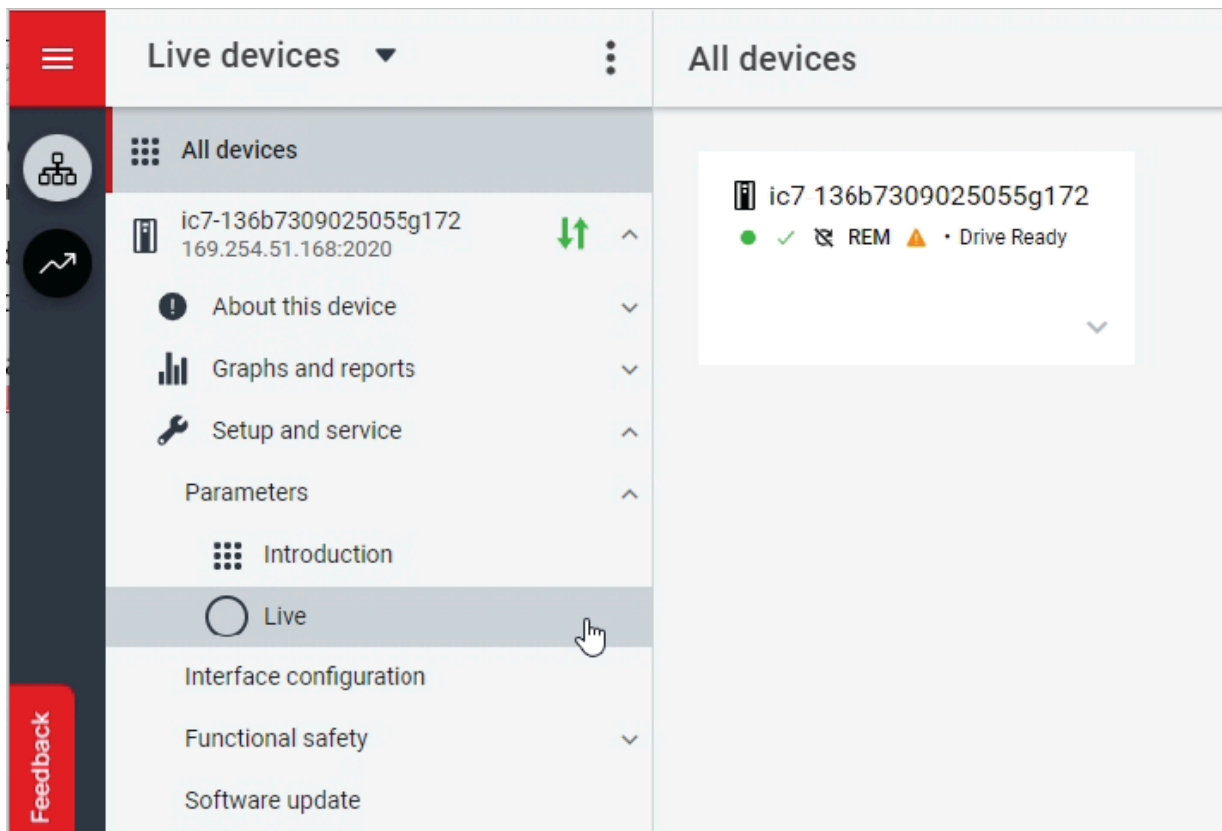


Figure 8: Connecting to a Drive with MyDrive® Insight

5. Select *Setup and service* > *Parameters* > *Live*.

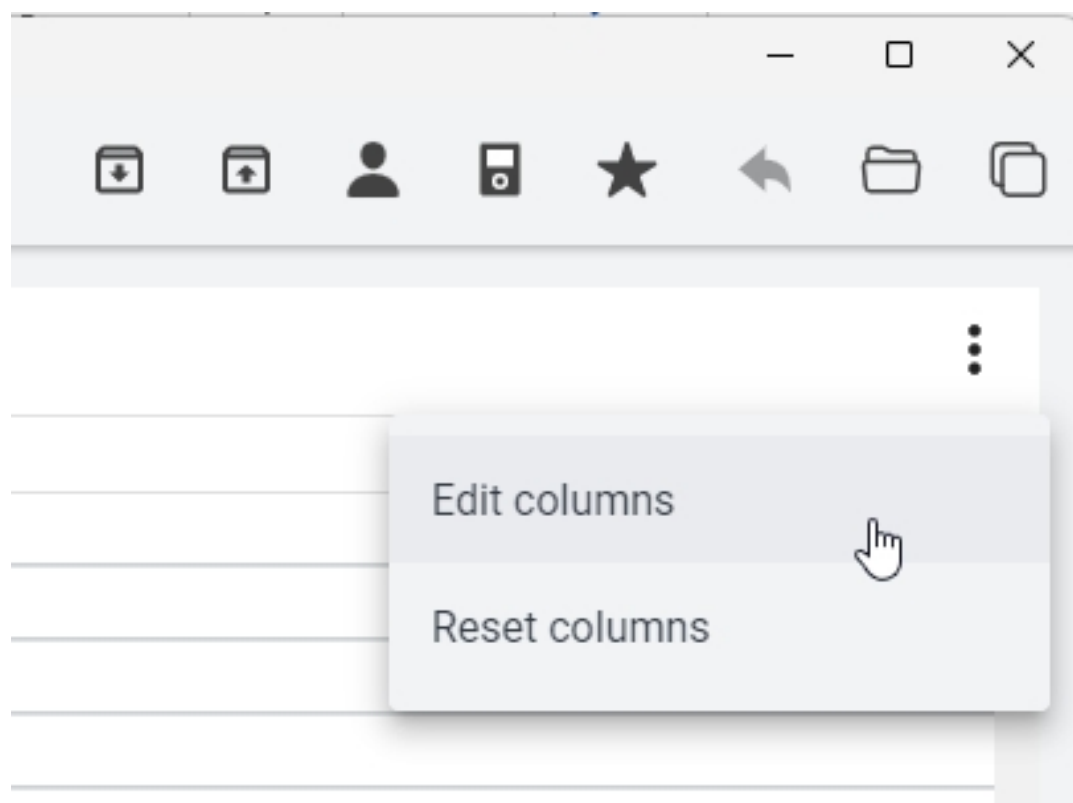


e30b653.10

Figure 9: Live Parameters in MyDrive® Insight

➡ A list of all available parameters in the drive is generated.

- In the upper right corner, select the 3 dots and *Edit columns*.



e30b654.10

Figure 10: Editing Columns in MyDrive® Insight

7. In the *Choose Column* dialog, select *Number*, and click *OK*.

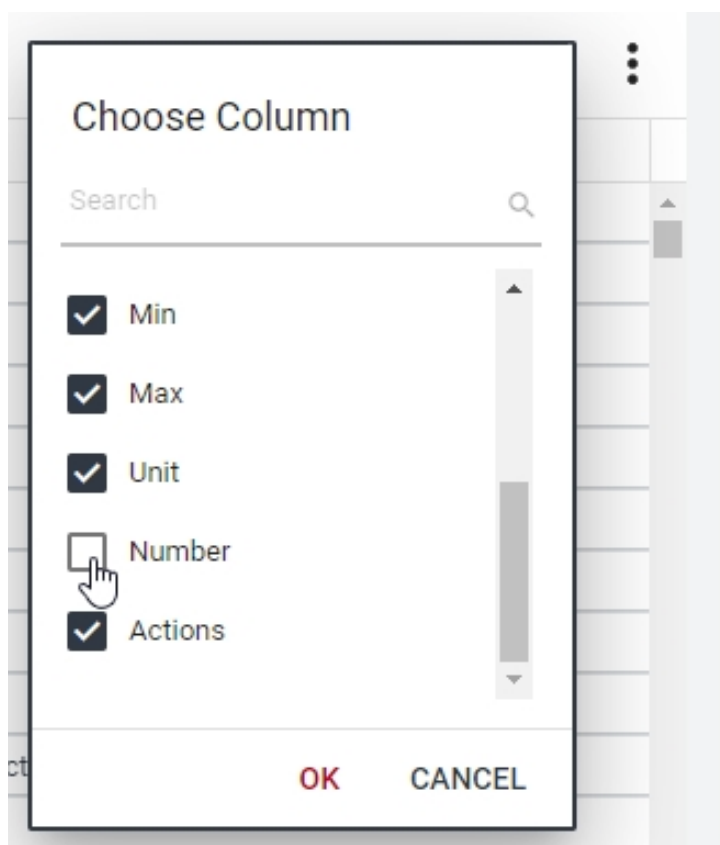


Figure 11: Adding Columns in MyDrive® Insight

➡ The *NUMBER* column is added to the parameter overview.

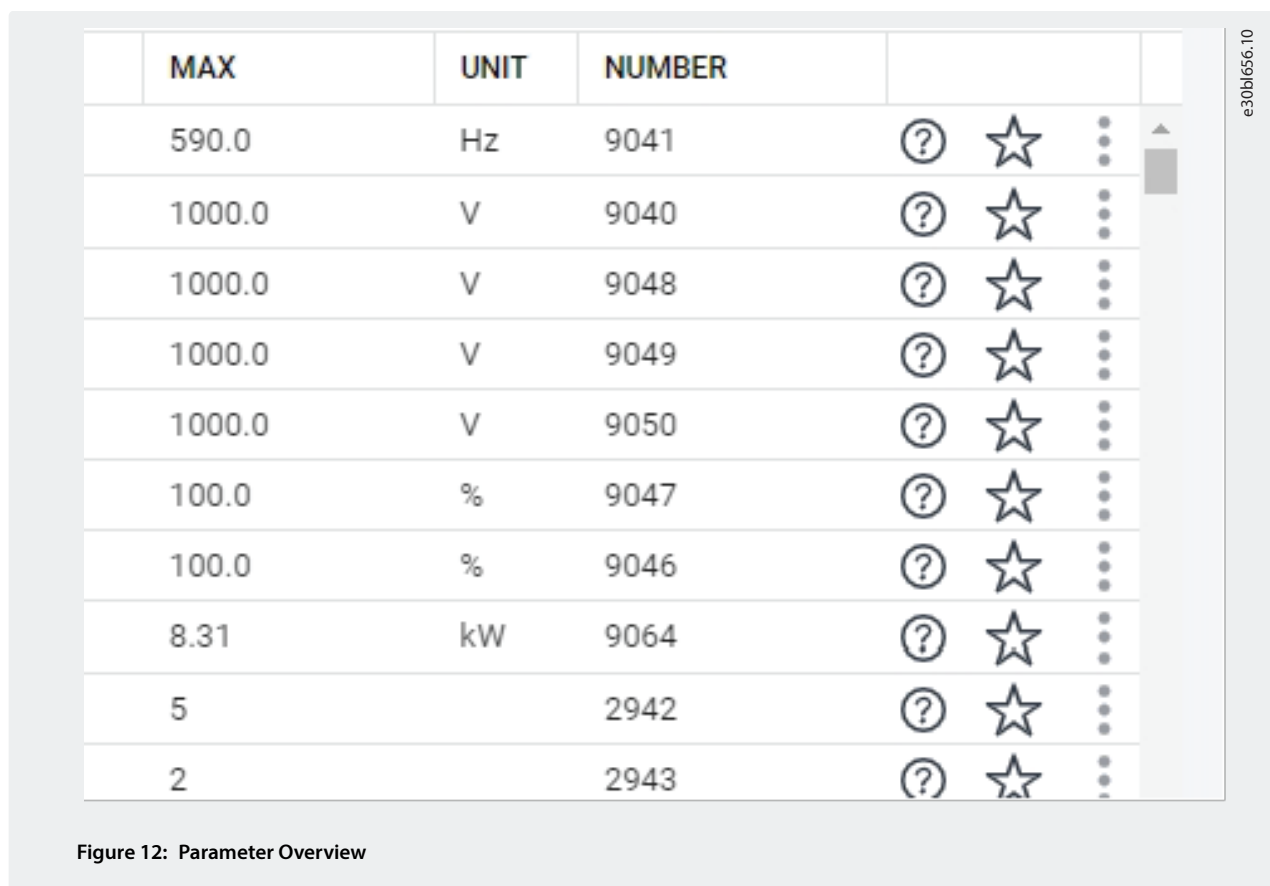


Figure 12: Parameter Overview

➔ The parameter overview includes the *NUMBER* column with the parameter numbers that are used to address parameters from EtherCAT.

For example, index **1.1.3 L1-L2 Line Voltage (RMS)** has the corresponding parameter number **9048**. To address this parameter, it must be converted to a hexadecimal number first. The decimal number 9048 corresponds to 0x2358 hexadecimal number. To address this number from EtherCAT, the value 0x2000 must be added. This means that the parameter addressing value for parameter **9048** from EtherCAT is $0x2000 + 0x2358 = 0x4358h$.

INDEX	NAME	VALUE	DEFAULT	MIN	MAX	UNIT	NUMBER
1.1.1	Grid Frequency	0.0		-590.0	590.0	Hz	9041
1.1.2	Line-To-Line Voltage (RMS)	410.0		0.0	1000.0	V	9040
1.1.3	L1-L2 Line Voltage (RMS)	410.0		0.0	1000.0	V	9048
1.1.4	L2-L3 Line Voltage (RMS)	410.0		0.0	1000.0	V	9049
1.1.5	L3-L1 Line Voltage (RMS)	410.0		0.0	1000.0	V	9050
1.1.6	Grid Voltage Imbalance	0.0		0.0	100.0	%	9047
1.1.7	Total Harmonic Distortion (THDv)	0.0		0.0	100.0	%	9046

Figure 13: Example of Parameters

6 Troubleshooting

6.1 Fieldbus Indicator LEDs

The fieldbus indicator LEDs are in the top right corner of the control panel.

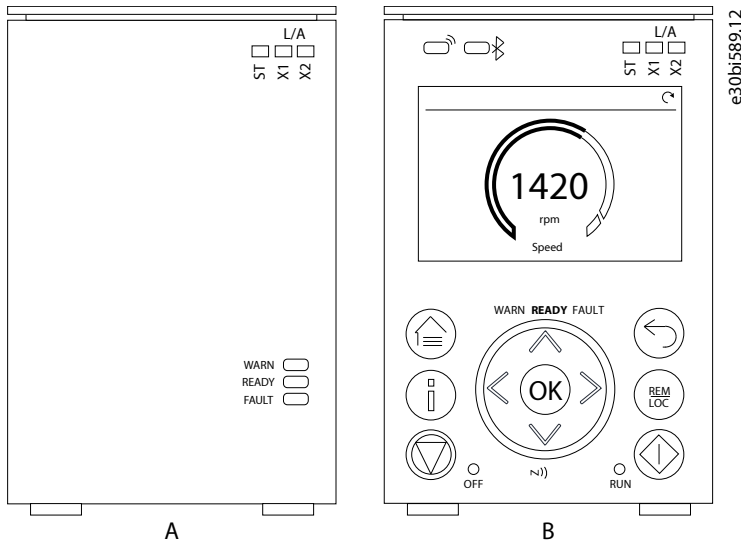


Figure 14: Fieldbus Indicator LEDs on Control Panel

ST	Drive status	X1	Network status on Ethernet port X1
X2	Network status on Ethernet port X2		

Table 19: Fieldbus Indicator LED Functions

LED label	Color	Status	LED pattern	Description
ST	Green	Initialization	Off	The device is in state INIT
		Pre-operational	Blinking	The device is in state PRE-OPERATIONAL
		Safe-operational	Single flash	The device is in state SAFE-OPERATIONAL
		Operational	On	The device is in OPERATIONAL
	Red/Green	Application watchdog timeout	Red double flash in between green	Process data watchdog timeout / EtherCAT watchdog timeout
		Local error	Red single flash in between green	EtherCAT state has been changed autonomously
Invalid configuration		Blinking red/green with 50% duty cycle.	General configuration error	

Table 19: Fieldbus Indicator LED Functions (continued)

LED label	Color	Status	LED pattern	Description
X0	Green	X0 link activity	Off	No link
			On	Link OK, no data
			Blinking	Link OK, data communication
	Orange	X0 link speed	Off	No link or 10 Mbps link
			On	100 Mbps link
X1	Green	-	-	Link/activity status of the IN port (X1)
		Link, but no activity	On	Ethernet link established
		Link and activity	Flickering	Ethernet link established and active
		-	Off	No Ethernet link
X2	Green	-	-	Link/activity status of the OUT port (X2)
		Link, but no activity	On	Ethernet link established
		Link and activity	Flickering	Ethernet link established and active
		-	Off	No Ethernet link

Danfoss A/S
Ulsnaes 1
DK-6300 Graasten
drives.danfoss.com

.....
Any information, including, but not limited to information on selection of product, its application or use, product design, weight, dimensions, capacity or any other technical data in product manuals, catalog descriptions, advertisements, etc. and whether made available in writing, orally, electronically, online or via download, shall be considered informative, and is only binding if and to the extent, explicit reference is made in a quotation or order confirmation. Danfoss cannot accept any responsibility for possible errors in catalogs, brochures, videos and other material. Danfoss reserves the right to alter its products without notice. This also applies to products ordered but not delivered provided that such alterations can be made without changes to form, fit or function of the product. All trademarks in this material are property of Danfoss A/S or Danfoss group companies. Danfoss and the Danfoss logo are trademarks of Danfoss A/S. All rights reserved.
.....

M00440

