Operating Guide

iC7-Automation Modbus

Modbus TCP OS7MT

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Contents

5 Modbus Configuration

6 Troubleshooting

7 Modbus Features

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, Modbus technology, and the PC or PLC that is used as a master in the system.

Read the instructions before configuring Modbus, 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 and products.

⚠ 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).

	ISO warning symbol for general warnings
	ISO warning symbol for hot surfaces and burn hazard
	ISO warning symbol for high voltage and electric shock
	Symbol for indicating the required discharge time of the capacitors in the product.
	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

⚠ DANGER

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 regulations.
- 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
ACD	Address Conflict Detection
BOOL	Boolean
CTW	Control word
DCP	Discovery and configuration protocol
DHCP	Dynamic host configuration protocol
EMC	Electromagnetic compatibility

Table 1: Abbreviations - (continued)

Abbreviation	Definition
I/O	Input/Output
IP	Internet protocol
CP	Control panel
LED	Light-emitting diode
LLDP	Link layer discovery protocol
LSB	Least significant bit
MAV	Main actual value
MEI	Modbus encapsulated interface
MRV	Main reference value
MSB	Most significant bit
PC	Personal computer
PCD	Process channel data
PLC	Programmable logic controller
PNU	Parameter number
PPO	Process parameter object
REF	Reference
SNMP	Simple network management protocol
STW	Status word
VLAN	Virtual LAN

1.7 Trademarks

Ethernet® is a registered trademark of Xerox Corporation.

MODBUS® is a registered trademark of Schneider Electric USA, Inc.

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
AQ456329149698, version 0201	Updated to include the Active Front End application.
AQ456329149698, version 0101	Initial version.

2 Product Overview

2.1 Modbus 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 PROFINET RT can be selected in the configurator when ordering a drive or power converter, or alternatively, they can be activated later by a proof-of-purchase token.

Table 3: Modbus Model Codes

Model code	Description
+BAMT	Modbus TCP OS7MT

Modbus is a communication protocol developed by Modicon for sending information between electronic devices. In Modbus TCP, the device requesting the information is called the Modbus client, and the devices supplying information are called Modbus servers.

The client can also write information to the server. Modbus is typically used to transmit signals from instrumentation and control devices back to a main controller or data gathering system.

Modbus does not feature a dedicated data channel, and therefore Modbus requests are handled as acyclic.

Table 4: Modbus TCP Features

Feature	Technical data
Cyclic response	5 ms response time per variable (read/write non-persistent storage)
Supported Modbus objects	Coils (1 bit): Read-write
	Input register (16 bits): Read-only
	Holding register (16 bits): Read-write
Connection	LLDP/SNMP
	IPv4
	Addressing mode: DCP, STATIC, DHCP/BOOTP
Configuration	MyDrive® Insight

2.2 Communication Profiles and Objects

Communication profiles are selected in parameter ***Fieldbus Profile*** (parameter number ***1301***).

For Modbus, the fieldbus profile can also be selected via Holding Register location 1.

Table 5: Communication Profiles and Supported Applications

Profile	Application software		
	Industry	Motion	Active Front End
iC Speed Profile	X	X	–
iC Motion Profile	–	X	–
iC Active Front End	–	–	X
PROFIdrive	X	X	–

2.3 iC Speed

2.3.1 Overview

The iC Speed profile is used with the iC7 series motor applications. The iC Speed profile differs from the PROFIdrive 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

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	0: Causes the drive to immediately coast the motor. 1: No function.
4	No quick stop/Quick stop	0: Quick stops the drive and ramps down the motor speed to stop as defined with the quick stop ramp parameter. 1: No function.
5	No hold/Hold output frequency	0: Hold the present output frequency (in Hz). 1: No function.
6	Start/No start	0: Stops the drive and ramps down the motor speed as defined with the ramp-down parameter. 1: If the other starting conditions are fulfilled, this selection allows the drive to start the motor.
7	Reset	0: No function. 0 ⇒ 1: Reset faults.(1)
8	Jog/No jog	0: No function. 1: Sets the output frequency to the jog speed defined with the jog speed parameter.
9	Ramp select	0: Ramp 1 is active. 1: Ramp 2 is active.
10	Data valid	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. 1: Use process data (controlled by PLC). Use the previously processed data when the data valid bit was true (no control by PLC).
11	Reserved	Reserved for future use.

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

Bit number	Name	Description
12	User-defined	These bits are reserved for application-specific advanced control. Select the value ***CTW bit x***for any input parameter to use this signal for the activation of a selected function. For more information, refer to the *Parameter Descriptions* chapter in the application guide.
13	User-defined	
14	User-defined	
15	User-defined	

1) Edge-triggered from 0 to 1 to reset the fault.

2.3.3 Status Word

Table 7: iC Speed Profile Status Word Bits

Bit number	Name	Description
0	Control ready	0 = The device controls are not ready and do not react to process data. 1 = The device controls are ready and react to process data.
1	Frequency converter ready	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. 1 = The frequency converter is ready for operation.
2	Coast	0 = The frequency converter has an active coast signal and has released the motor. 1 = There are no active coast signals, and the motor can start when a start signal is given.
3	Fault	0 = There are no faults. 1 = A fault has occurred, and an acknowledge signal is required to re-establish operation.
4	Reserved	Reserved.
5	Reserved	Reserved.
6	Reserved	Reserved.
7	Warning	0 = There are no warnings. 1 = A warning is active.
8	Speed=reference	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. 1 = The current motor speed matches the current speed reference within a given tolerance. The tolerance is product-specific.
9	Bus control/Local operation	0 = The device does not react on commands from the fieldbus, for 1 of the following reasons: • CTW bit 10 = 0. • HMI is in local mode. • MyDrive® Insight has taken control. • Control places do not include fieldbus. 1 = The device is controlled and reacting to I/O and process data.

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

Bit number	Name	Description
10	Frequency limit	0 = The output frequency has exceeded the defined motor limits. 1 = The output frequency is within the defined motor limits. The speed limits are set with the parameters in parameter group ***5.8.3 Speed Limits and Monitors***.
11	Operation	0 = There are no active start requests, and the process does not run. The motor is coasted and is not started. 1 = The process is running, and the motor can be running or start at any time.
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

2.4.1 Overview

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. 1 001 = Preset Position Ref. 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
1	Preset position reference Bit 1	
2	Preset position reference Bit 2	
3	No Coast	0: Causes the drive to immediately coast the motor. 1: No function.
4	Start Synchronizing	0 = Ramp down to standstill. 1 = Follower locked to synchronizing master.
5	Enable Reference	0 = No Function. 1 = New position reference enabled.
6	Start	0 = Stop the frequency converter and ramp down the motor speed as defined with the ramp down parameter. 1 = If the other starting conditions are fulfilled, this selection allows the frequency converter to start the motor.
7	Reset	0: No function. 0 ⇒ 1: Acknowledge faults.[1]
8	Enable Superimposed	0 = No function. 1 = Execute superimposed movement.
9	Relative Positioning	0 = Absolute positioning. 1 = Relative positioning.
10	Data Valid	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. 1 = Use process data (control by PLC). Use the previously processed data when the data valid bit was true (no control by PLC).
11	Enable Home	0 = Abort homing function. 1 = Execute 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	

1) 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.

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	0 = The device controls are not ready and do not react to process data. 1 = The device controls are ready and react to process data.
1	Drive Ready	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. 1 = The device is ready for operation.
2	No coast (Enabled)	0 = The frequency converter has an active coast signal and has released the motor. 1 = There are no active coast signals, and the motor can start when a start signal is given.
3	Fault	0 = There are no faults. 1 = A fault has occurred, and an acknowledge signal is required to re-establish operation.
4	Home Done	0 = Homing is not completed. 1 = Homing is completed.
5	In Sync	0 = Follower is not in sync with master. 1 = Follower is in sync with master within the tolerance specified by parameter ***5.15.2.2 Synchronization Window***.
6	Reserved	Reserved.
7	Warning	0 = There are no warnings. 1 = A warning is active.
8	Position error within tolerance	0 = Position error is greater than the tolerance specified by parameter ***5.13.5.1 Position Error Window***. 1 = Position error is within the tolerance specified by parameter ***5.13.5.1 Position Error Window***.
9	Bus control	0 = The device does not react on commands from the fieldbus, for 1 of the following reasons: • CTW bit 10 = 0. • HMI is in local mode. • MyDrive® Insight has taken control. • Control places do not include fieldbus. 1 = The device is controlled and reacting to I/O and process data.
10	Frequency limit OK	0 = The output frequency has exceeded the defined motor limits. 1 = The output frequency is within the defined motor limits. The speed limits are set with the parameters: • ***5.8.3.1 Positive Speed Limit*** • ***5.8.3.2 Negative Speed Limit*** • ***5.8.3.3 Minimum Speed Limit***
11	In operation	0 = There are no active start requests, and the process does not run. The motor is coasted and is not started. 1 = The process is running, and the motor can be running or start at any time.

Table 10: Status Word - (continued)

Bit	Name	Description
12	Target position reached	0 = Target position is not reached. 1 = Target position is reached within the window defined by parameter ***5.14.2.18 On-target Window*** around the position reference.
13	Superimposed target reached	0 = Superimposed movement is not completed. 1 = Superimposed movement is 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	$-200\% \le I \le (200-2^{-14})\%$	$2^{-14} = 0.006\ 1\%$	2 Octet

Coding:

- Representation in twos complement, the most significant bit (MSB) is the bit after the sign bit (SN) of the 1st octet.
- SN = 0: positive numbers including 0.
- 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 iC Active Front End

2.5.1 Overview

The iC Active Front End profile is used in the iC7 series with the Active Front End application.

2.5.2 Control Word

Table 12: iC Active Front End Profile Control Word Bits

Bit number	Name	Description
0	Switch On Enabled	0: DC-link pre-charging, MCB closure, and running are prevented/interrupted. MCB is opened if closed. 1: DC-link pre-charging, MCB closure, and running are not prevented/interrupted. MCB is not opened if closed.
1	MCB Close Enabled	0: If pre-charging is completed, the MCB is not allowed to close. Running is also prevented or interrupted. MCB is opened if closed. 1: If pre-charging is completed, the MCB is allowed to close.
2	Quick Stop Inverse	0: Initiate quick stop. 1: Do not initiate quick stop.
3	Start	0: Stop the unit if it is running, or stop the pre-charging sequence if it is not completed. 1: Start running if already precharged. Otherwise initiate pre-charging and then start running. Use the parameter ***Fieldbus Start Mode*** (5114) to configure whether a new start command is required after the unit has been stopped, or whether the unit starts running immediately after all stopping conditions (quick stop, faults, and so on) are cleared.
4	Pre-charge	0: Stop the DC-link pre-charging, if ongoing. 1: Start/continue the DC-link pre-charging. Only used when the DC-link pre-charging is not controlled externally.
5	–	Reserved
6	–	Reserved
7	Fault Reset	0: Do not reset faults. 1: Reset active faults. A rising edge (a transition from false to true) on this bit issues a fault reset request.
8	–	Reserved
9	–	Reserved
10	Data Valid	0: Ignore the current incoming process data values, instead use the last processed value when ***Data Valid*** bit was true.1: Use the current incoming process data values.
11	Watchdog	Incoming fieldbus watchdog bit. used for monitoring the fieldbus connection.
12	User-defined	These bits are reserved for application-specific advanced control. Select the value ***CTW bit x*** for any input parameter to use this signal for the activation of a selected function. For more information, refer to the *Parameter Descriptions* chapter in the application guide.
13	User-defined	
14	User-defined	
15	User-defined	

2.5.3 Status Word

Table 13: iC Active Front End Profile Status Word Bits

Bit number	Name	Description
0	Ready to Switch On	0: The unit is not ready to run. 1: The unit is ready to run. This bit indicates that the unit is ready to start the startup sequence, that is, pre-charging and/or MCB closure, if controlled by the application. There are no active faults and the Switch on Enabled bit is active.
1	Converter Ready	0: The unit is not ready to run. 1: The unit is ready to run. When this bit is true, it indicates that the unit can be successfully started with the Start bit (bit 3) of the control word.
2	Running	0: The unit is not running (modulating). 1: The unit is running (modulating).
3	Fault	0: No faults active. 1: One or more faults active.
4	--	Reserved
5	Quick Stop Inverse	0: Quick stop is active. 1: Quick stop not active.
6	--	Reserved
7	Warning	0: No active warnings. 1: One or more warnings are active.
8	--	Reserved
9	Control by PLC	0: Fieldbus is not the active control place. 1: Fieldbus is the active control place.
10	--	Reserved
11	Run Enabled	0: Run enable from a dedicated input signal is missing. 1: Run enable from a dedicated input signal is present. This bit indicates the state of parameter ***Run Enable Input*** (103)
12	--	Reserved
13	--	Reserved
14	--	Reserved
15	Watchdog	Outgoing fieldbus watchdog bit, mirroring control word bit Watchdog (bit 11).

2.6 PROFIdrive – Standard Telegram 1

2.6.1 Overview

Standard telegram 1 is implemented according to PROFIdrive Application Class 1 profile as defined in the PROFIdrive standard and state machine diagram. It can be used with iC7 series motor applications.

2.6.2 Control Word

Table 14: Control Word Bits in PROFIdrive Standard Telegram 1

Bit number	Name	Description
0	On-Off	0: Off. 1: On.
1	Coast stop	0: Coast stop. 1: No coast stop.
2	Quick stop	0: Quick stop. 1: No quick stop.
3	Operation	0: Disable operation. 1: Enable operation.
4	Ramp generator	0: Reset ramp generator. The output of the RFG is set to 0. The drive decelerates along the current limit or along the voltage limit of the DC link. 1: Enable ramp generator (RFG).
5	Freeze	0: Freeze ramp generator. Freezes the present output frequency (in Hz). 1: Unfreeze ramp generator.
6	Enable setpoint	0: Disable setpoint. 1: Enable setpoint.
7	Fault acknowledge	0: No function. 0 ⇒ 1: Acknowledge faults.[1]
8	Jog 1	0: Jog 1 off. 1: Jog 1 on. Operation is enabled, drive is at standstill, and STW1 bit 4, 5, 6: 0. The drive runs up along the ramp to jogging setpoint 1.
9	Jog 2	0: Jog 2 off. 1: Jog 2 on. Operation is enabled, drive is at standstill, and STW1 bit 4, 5, 6: 0. The drive runs up along the ramp to jogging setpoint 2.
10	Control by PLC	0: Ignores the current process data. This is linked to a 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. 1: Uses process data (controlled by PLC).
11	–	Reserved
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	

1) Acknowledging is edge-triggered, when changing from logic 0 to logic 1.

2.6.3 Status Word

Table 15: Status Word Bits in PROFIdrive Standard Telegram 1

Bit number	Name	Description
0	Ready to switch on	0: Not ready to switch on. 1: Ready to switch on.
1	Ready to operate	0: Not ready to operate. 1: Ready to operate.
2	Operation enabled	0: Operation disabled. 1: Operation enabled.
3	Operation fault	0: No fault. 1: Fault present.
4	Coast stop	0: Coast stop activated (OFF2). 1: Coast stop not activated (No OFF2).
5	Quick stop	0: Quick stop activated (OFF3). 1: Quick stop not activated (No OFF3).
6	Switching on inhibited	0: Switching on not inhibited. 1: Switching on inhibited.
7	Warning	0: There are no warnings. 1: A warning has occurred.
8	Speed error within/out of tolerance range	0: The motor runs, but the present speed is more than 1% different from the reference. It could, for example, be the case while the speed ramps up/down during start/stop. 1: The present motor speed matches the present speed reference within 1% of motor nominal speed.
9	Fieldbus control active/inactive	0: The device does not react on commands from fieldbus.[1] 1: The device is controlled and reacting to I/O and process data.
10	Speed reached/Speed not reached	0: The actual speed is below the comparison value set with parameter ***Limit Supervision 1 Threshold*** (5253). 1: The actual speed is above the comparison value set with parameter ***Limit Supervision 1 Threshold*** (5253).
11	Reserved	Reserved
12	Reserved	Reserved
13	Reserved	Reserved
14	Reserved	Reserved
15	Reserved	Reserved

1) The reason why the device does not react to commands can be:

- *Fieldbus is not the active control place.*
- *Fieldbus signals are not configured to be part of the Advanced Control Place.*

2.6.4 PROFIdrive State Machine

In the PROFIdrive control profile, the control bits perform different functions:

- 0–3 perform the basic startup and power-down functions.
- 4–10 perform application-oriented control.

- 12–15 can be configured for different purposes.

See Figure 1 for the basic state transition diagram, where control bits 0–3 control the transitions and the corresponding status bit indicates the actual state. The black dots indicate the priority of the control signals. Fewer dots indicate lower priority, and more dots indicate higher priority.

The general state diagram is defined in the PROFIdrive standard.

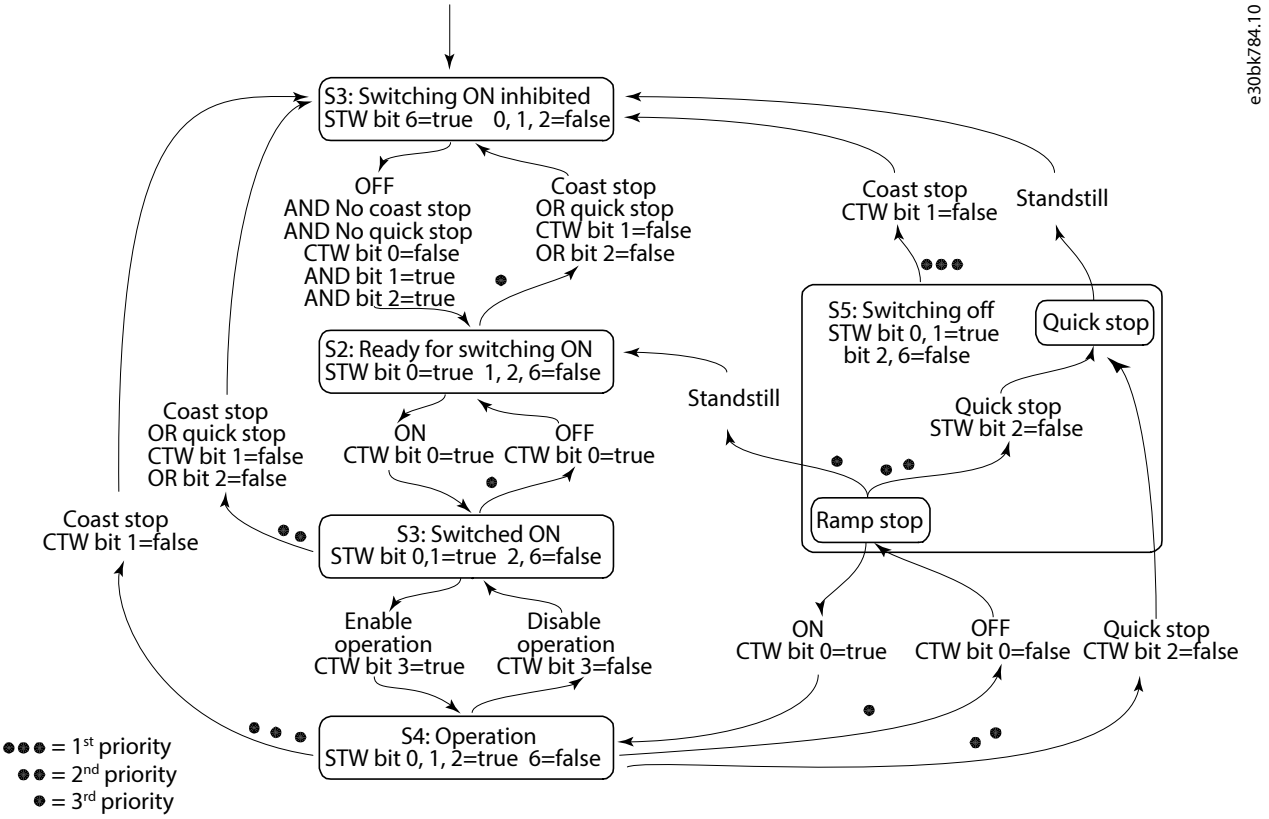


Figure 1: General State Diagram

2.7 Network Topologies

2.7.1 Overview

Communication interface X1/X2 is used for fieldbus connection.

The communication interface in the iC7 drives and power converters has 2 Ethernet ports (X1 and X2) and an embedded switch with 2 Ethernet RJ45 connectors. It has 1 MAC and IP address, and is considered a single device in the network. The communication interface supports 3 network topologies:

- Line topology
- Star topology
- Ring topology

2.7.2 Line Topology

In many applications, line topology enables simpler cabling and the use of fewer Ethernet switches. Observe network performance and the number of devices in a line topology. Too many devices in a line may exceed network update time limits.

NOTICE

When line topology is used, take precautions to avoid timeout in the PLC when more than 8 drives or power converters are installed in series. Each drive or power converter in the network adds a small delay to the communication due to the built-in Ethernet switch. When the update time is too short, the delay can lead to a timeout in the PLC.

- Set the update time as shown in the table. The numbers given are typical values and can vary from installation to installation.

Number of units connected in series	Minimum update time [ms]
<8	2
8–16	4
16–32	8
33–50	16
>50	Not recommended

NOTE: Using tools such as MyDrive® Insight may influence system performance in a line topology.

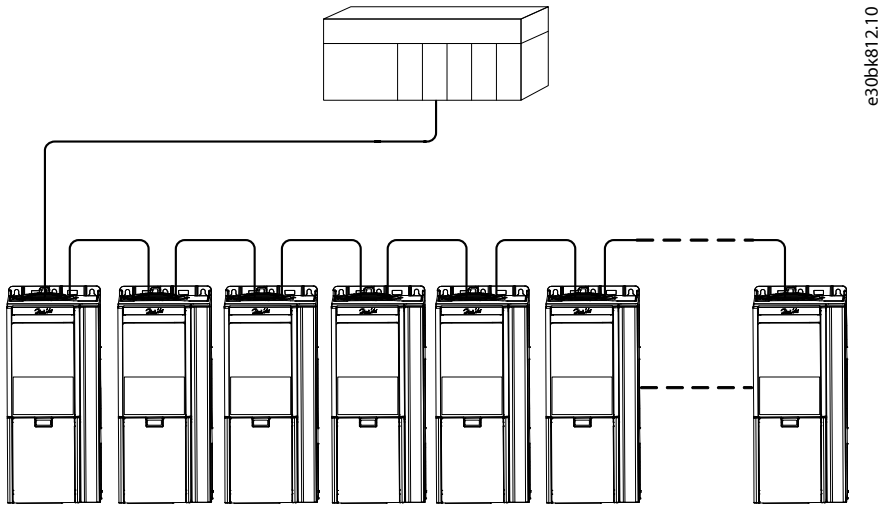


Figure 2: Example of Line Topology

NOTICE

Installing drives or power converters of different current ratings in line topology may result in unwanted fieldbus timeout messages in the event log.

- Mount the drives or power converters with the longest discharge time first in the line topology. In normal operation, the drives or power converters with bigger current ratings have a longer discharge time.

2.7.3 Star Topology

In a star network, all devices are connected to the same switch or switches. Star topology reduces the damage caused by a single cable failure. In a star topology, a single cable failure affects a single device instead of all devices in the network. In many applications, this topology enables simpler cabling depending on the location and distance of the device.

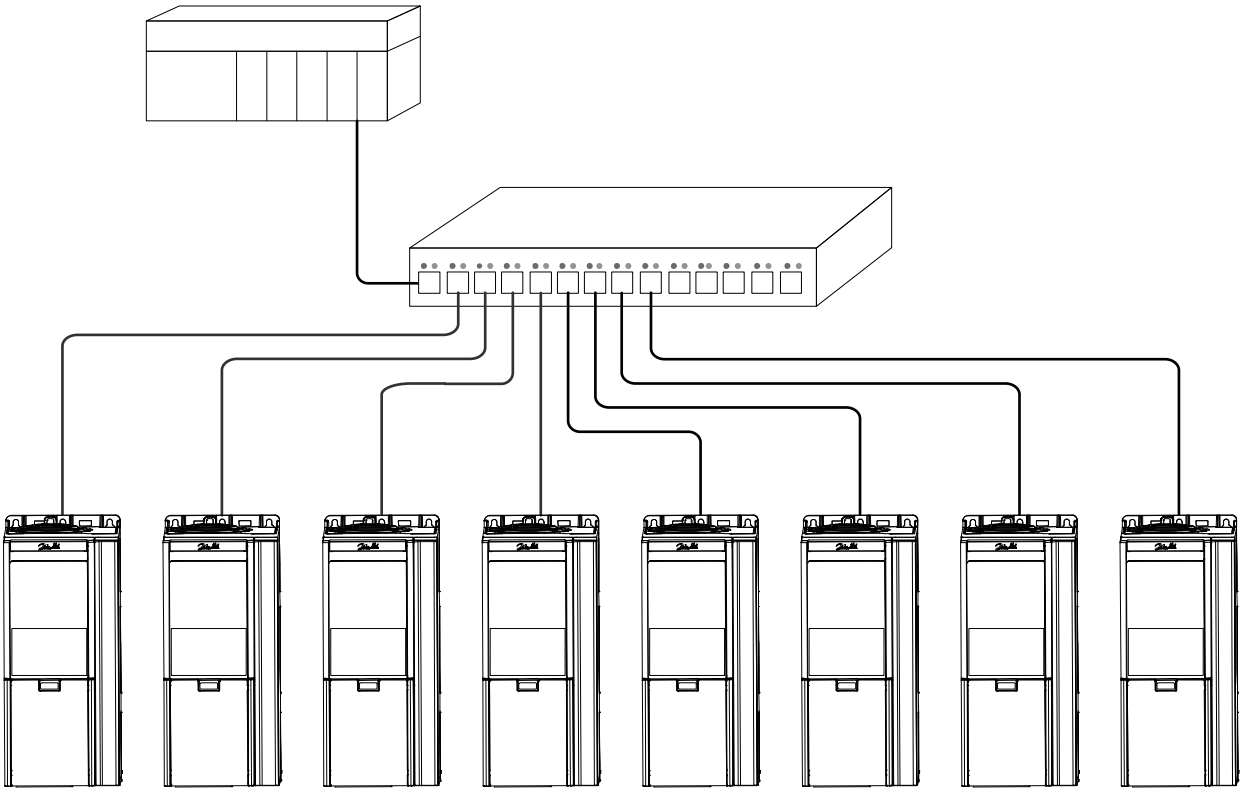


Figure 3: Example of Star Topology

2.7.4 Ring Topology

Ring topology enables the same simpler cabling and reduced cabling costs as line topology, but also reduces the damage caused by a single cable failure in a similar manner as star topology.

NOTICE

When ring topology is used, take precautions to avoid timeout in the PLC when more than 8 drives or power converters are installed in series. Each drive or power converter in the network adds a small delay to the communication due to the built-in Ethernet switch. When the update time is too short, the delay can lead to a timeout in the PLC.

- Set the update time as shown in the table. The numbers given are typical values and can vary from installation to installation.

Number of units connected in series	Minimum update time [ms]
<8	2
8–16	4
16–32	8
33–50	16
>50	Not recommended

The ring topology protocol depends on the protocol in use.

Modbus uses the parallel redundancy protocol (PRP). PRP is a layer 2 network protocol that enables a redundant topology in an Ethernet network. PRP provides uninterrupted switchovers in failure situations, and is independent of the application. For more information on configuring parallel redundancy protocol (PRP), see 5.7 Configuring Parallel Redundancy Protocol.

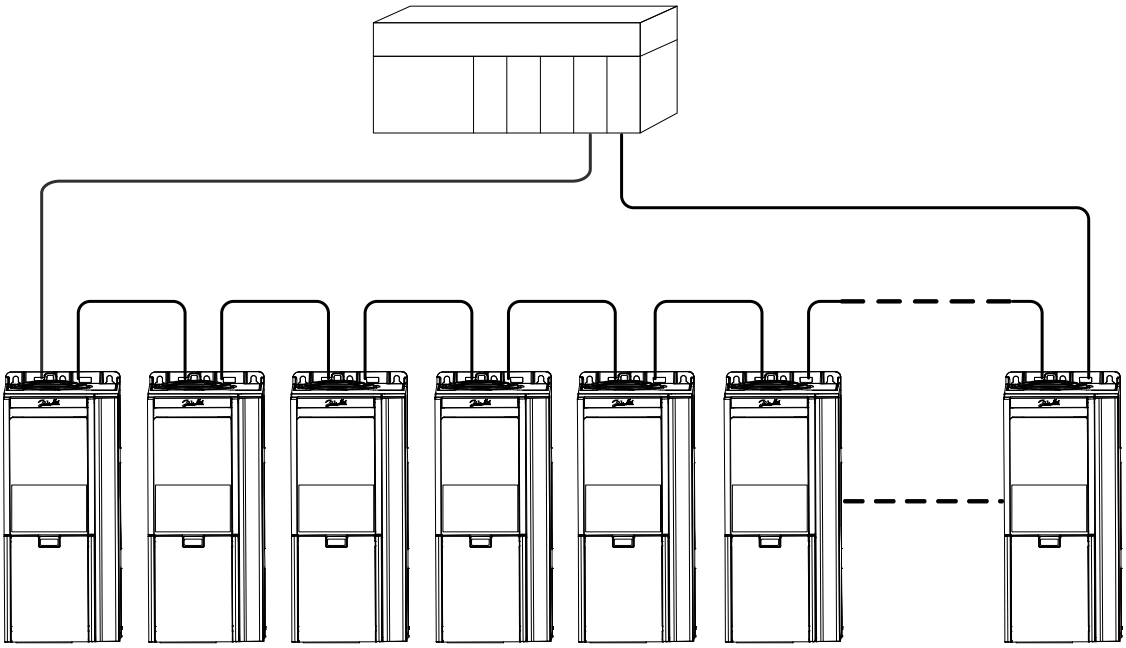


Figure 4: Example of Ring Topology

3 Modbus Data Mapping

3.1 Mapping Modbus Coils

A Modbus coil is a single-bit binary data item which can be both read and written. Coils can be mapped to specific bits in a parameter by using the customization feature in MyDrive® Insight.

Only bit-type parameters can be mapped to coils. The source type must be INT, UINT, USINT DINT, UDINT, WORD, or BOOL.

1. In MyDrive® Insight, go to *Customization* > *Live* > *MODBUS* > *Coils*.
   - To add a single coil, click the + *Add Item* icon.
   - To map multiple coils to a single parameter, click the – *Add Multiple Items* icon.

Table 16: Coil Mapping Settings

Column	Description
Location	Refers to the coil number. Coils are mapped from address 00000–0FFFF.
Reference type	• ***Terminal***: Mapping a terminal on an option to a coil. • ***Parameter***: Mapping a specific bit of a parameter to a coil. • ***Feature***: Functions such as store and restore.
Reference	The name of the mapped parameter, feature, or event.
Source type	Data type of mapped parameter
Index	Index pointer for array parameters
Bit number	Mapped bit number of the selected parameter. 0 refers to the 1st bit.
Permissions	Setting Read/Write permissions for each coil.
Watchdog	***Watchdog1***: Process data timeout watchdog. Timeout time is configured in parameter ***Process Data Timeout Delay (1340)***. The Watchdog timer is (re)triggered when writing to the mapped coil or register. ***Watchdog2***: Not used

3.2 Mapping Modbus Holding Registers

A Modbus holding register is a bit binary data item which can be both read and written. Registers can be mapped to a specific parameter by using the customization feature in MyDrive® Insight. The first 19 holding registers are pre-mapped or reserved and cannot be changed. From location 20 onwards, registers can be mapped freely.

NOTE: The parameter mapped to 1 register can only be remapped to another register.

NOTICE

A mismatch between the datatype and register type issues a warning of possible data loss.

Location	Reference type	Reference (parameter number)
1	Parameter	***Fieldbus Profile (1301)***
2	Parameter	***Fieldbus Control Word (1335)***
3	Parameter	***Fieldbus Main Reference (1339)***

Location	Reference type	Reference (parameter number)
4	Parameter	Reserved
5	Parameter	Reserved
6	Parameter	Reserved
7	Parameter	Reserved
8	Parameter	Reserved
9	Parameter	Reserved
10	Parameter	***Fieldbus Status Word (1307)***
11	Parameter	***Fieldbus Main Actual Value (1308)***
12	Parameter	Reserved
13	Parameter	Reserved
14	Parameter	Reserved
15	Parameter	Reserved
16	Parameter	Reserved
17	Parameter	Reserved
18	Parameter	Reserved
19	Parameter	Reserved
20	...	...
…	…	...

1. In MyDrive® Insight, go to *Customization* > *Live* > *MODBUS* > *Holding Registers*.
   - To add a single register, click the + *Add Item* icon.
   - To add multiple registers, click the – *Add Multiple Items* icon.

Table 17: Holding Register Settings

Column	Description
Location	Refers to the register number. Coils are mapped from address 00000–0FFFF.
Reference type	• ***Terminal***: Mapping a terminal on an option to a register. • ***Parameter***: Mapping a parameter to a register. • ***Constant***: Mapping a constant value to a register. • ***Feature***: Mapping a register to a feature, for example, Factory restore. • ***Event***: Mapping events to registers.
Reference	The name of the mapped parameter, feature, or event. Value for ***Constant*** type.
Source type	Data type of mapped parameter.
Index	Index pointer for array parameters.
Length	Number of bytes for string-type parameters.
Register type	Data type of the mapped parameter. By default, the Customizer selects a register type that matches the data type of the selected parameter.
Scaling	Scales the parameter value on the Modbus interface by dividing it by the scaling value entered.

Table 17: Holding Register Settings - (continued)

Column	Description
Unit	Unit of the mapped parameter
Permissions	Setting Read/Write permissions for each register.
Watchdog	***Watchdog1***: Process data timeout watchdog. Timeout time is configured in parameter ***Process Data Timeout Time (1340)***. The Watchdog timer is triggered when writing to the mapped coil or register. ***Watchdog2***: Not used

Mapping parameter of the REAL 32-bit datatype results in 2 consecutive register mappings.

Table 18: Example of a Holding Register Mapping

Location	Reference type	Reference (parameter number)	Source type	Register type
20	Parameter	Motor Current (9000)	REAL	Two Consecutive Floating point
22	Parameter	Heat Sink Temperature (2950)	REAL	Two Consecutive Floating point
...	...	...	...	...

Events from the device event log can be mapped into holding registers, starting from the most recent event. Each Event results in six consecutive register mappings.

Table 19: Example of an Event Register Mapping

Register	Description	Format
n	Timestamp	Seconds/milliseconds [SS.SSS][(1)]
n+1		Hours/Minutes [HHMM][(1)]
n+2		Month/Day [MMDD][(1)]
n+3		Year [YYYY][(1)]
n+4	Event Type	• MSB: 0 = Inactive event. • MSB: 1 = Active event. • LSB: 010 = Info. • LSB: 011 = Warning. • LSB: 100 = Fault.
n+5	Event Code	See the application guide for the application software in use.

1) Readable in hexadecimal format

3.3 Mapping Modbus Input Registers

A Modbus input register is a 16-bit read-only value.

Input registers can be mapped to specific parameters by using the customization feature in MyDrive® Insight.

1. In MyDrive® Insight, go to *Customization* > *Live* > *MODBUS* > *Coils*.
   - To add a single register, click the + *Add Item* icon.
   - To add multiple registers, click the – *Add Multiple Items* icon.

Table 20: Coil Mapping Settings

Column	Description
Location	Refers to the coil number. Coils are mapped from address 00000–0FFFF.
Reference type	• Parameter: Mapping a register to a parameter. • Constant: Mapping a register to a constant value. • Event: Mapping events to registers.
Reference	The name of the mapped parameter, feature, or event. Value for ***Constant*** type.
Source type	Data type of mapped parameter
Index	Index pointer for array parameters.
Length	Length as number of bytes for string-type parameters.
Register type	Data type of the mapped parameter. By default, the Customizer selects a register type that matches the data type of the selected parameter.
Scaling	Scales the parameter value on the Modbus interface by dividing it by the scaling value entered.
Unit	Unit of the mapped parameter.

3.4 Setting Permissions

Permissions can be set either in the *Permissions* column in the mapping view, or in the *Permissions* view in MyDrive® Insight.

1. In MyDrive® Insight, go to *Customization* > *Live* > *MODBUS* > *Permissions*.
2. Set the Read/Write permission for coils and registers:
   - By using the *Permissions* column in the mapping view.
   - By using the *Permissions* view in MyDrive® Insight.

> IMPORTANT: Individual settings for each coil or register overwrite the default selection ***ALL***. If the permission is not set for a specific coil, or register, the selection ***ALL*** is predominant.

3.5 Saving Modbus Configuration to a Device

After the Modbus mapping is finalized, the configuration can be saved as a new project or added to an existing MyDrive® Insight project.

1. To save a configuration, click the *Save* icon.
2. To deploy a configuration directly into a device, click the *Download* icon to create and save an export package (*.vpkg).
3. After exporting the configuration, update and power cycle the device with the exported software package.

Table 21: Example of an Export Package

Package name (Default: Fully Qualified Domain Name)	###
Package version (Default: 1.0.0)	###

4 Fieldbus Cable Connections

4.1 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.

4.2 Installation in Frequency Converters

4.2.1 Communication Interface X1/X2 in Frames FA02–FA12

The communication interface is on the top of the frequency converter as shown in Figure 5. 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.

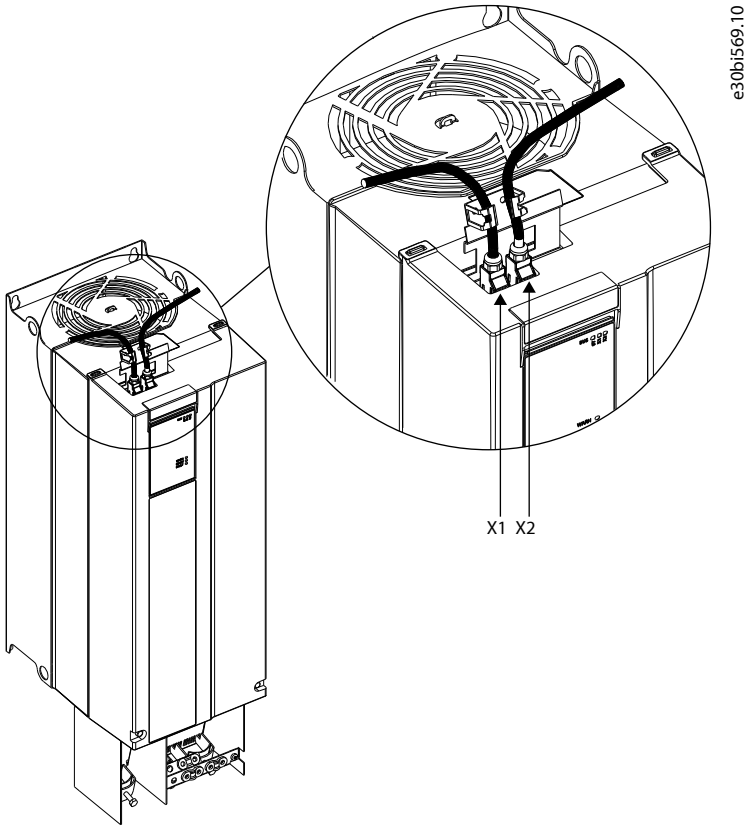


Figure 5: Location of the Communication Interface, X1/X2 in FA02-FA12 Frames (with the Optional EMC Plate)

4.2.2 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 6 and Figure 7.

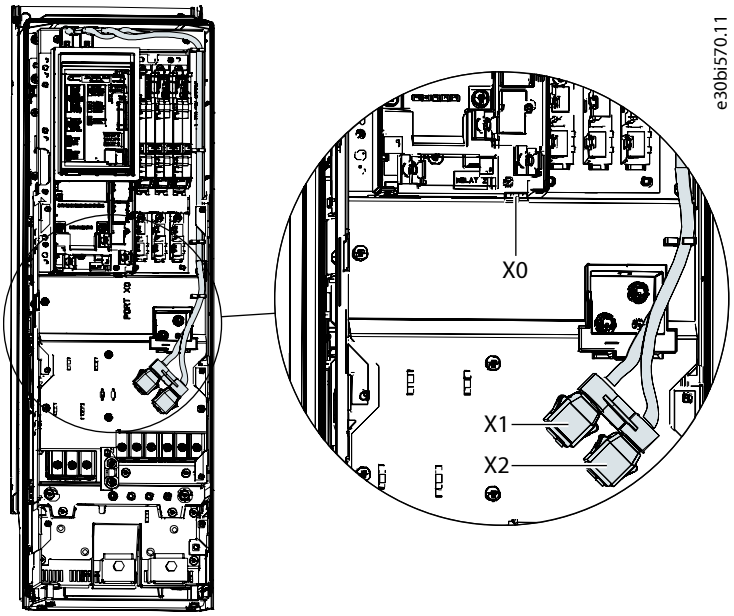


Figure 6: Communication Port X0, X1, and X2 Locations in FK06–FK08 Frames

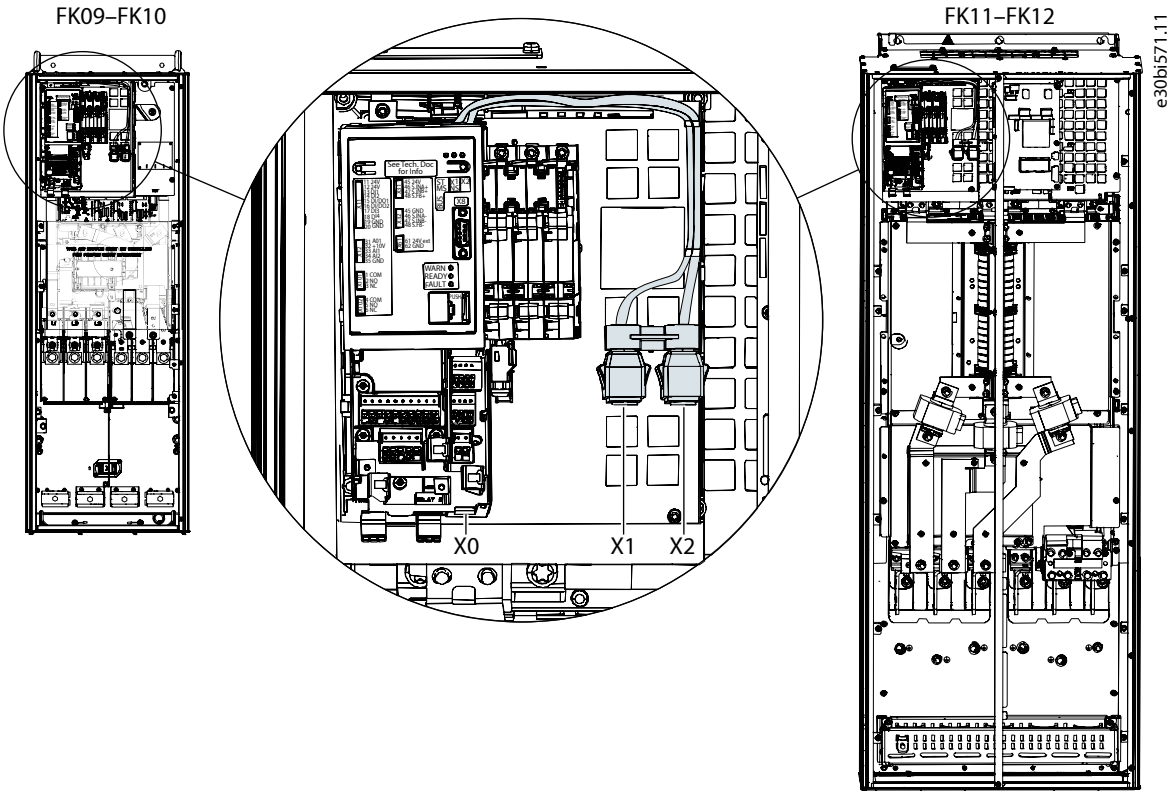


Figure 7: Communication Port X0, X1, and X2 Locations in FB09–FB12/FK09–FK12 Frames

4.3 Installation in System Modules

4.3.1 Communication Interface X1/X2 in System Modules

For systems that use system modules, the communication interface ports are located at the bottom facing side of the modular control unit as shown in Figure 8.

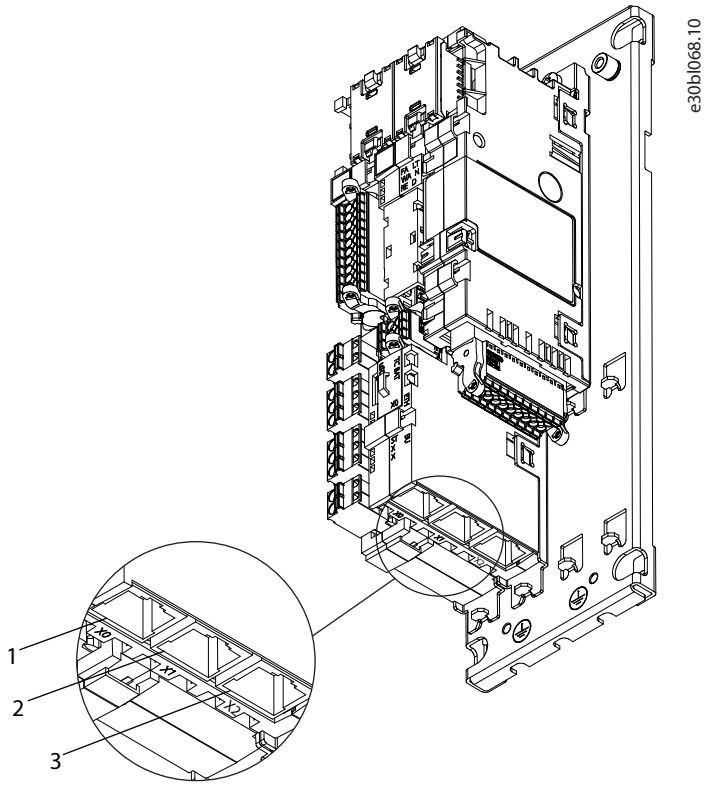


Figure 8: Communication Port X0, X1, and X2 Locations in the Modular Control Unit

1	Ethernet port (X0)	2	Ethernet port (X1)
3	Ethernet port (X2)		

4.4 EMC-compliant Installation

4.4.1 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.

4.4.2 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.

4.4.3 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 with a motor cable or a brake resistor cable, ensure that the cables intersect at an angle of 90°.

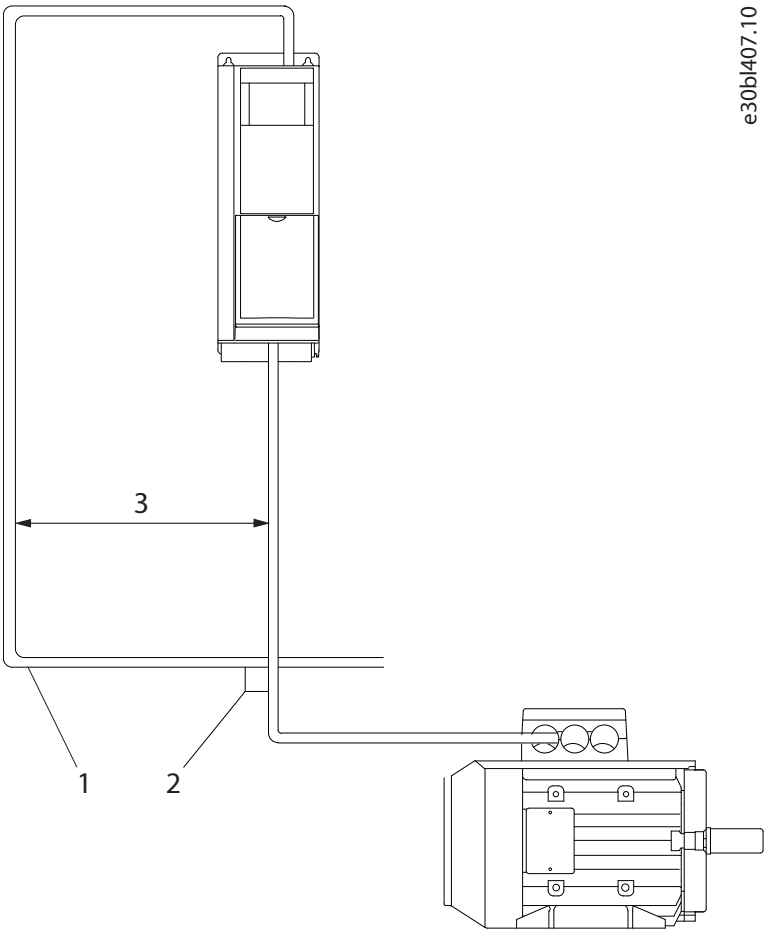


Figure 9: Cable Routing

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

5 Modbus Configuration

5.1 Selecting the Fieldbus Profile

For more information about the available profiles for the application in use, see Communication Profiles and Objects.

1. Navigate to ***Parameters*** > ***Control Places*** > ***Fieldbus Control*** > ***Fieldbus Profile***.
2. Select the fieldbus profile.

The selection affects the interpretation of the control word and status word. Selecting a profile may also automatically set specific values for certain parameters or affect control schemes. For details, refer to the application guide.

5.2 Configuring Fieldbus Protection Settings for the Industry Application

1. Navigate to ***Connectivity*** > ***Protocols*** > ***General Settings***.
2. Configure fieldbus protection settings.

Table 22: Fieldbus Protection Setting Parameters for the Industry Application

Parameter	Parameter number	Value	Description
Fieldbus Fault Response	1303	• Info (default) • Warning • Fault, ramp to coast • Fault See Table 23 for descriptions of the events.	Select the behavior when a fieldbus fault, for example loss of I/O connection occurs.
No Fieldbus Connection Response	1327	• Info (default) • Warning • Fault, ramp to coast • Fault See Table 23 for descriptions of the events.	Select the response in case there is no fieldbus connection.
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.

Table 22: Fieldbus Protection Setting Parameters for the Industry Application - (continued)

Parameter	Parameter number	Value	Description
Process Data Timeout Response	1341	• Info (default) • Warning • Warning - Change Control Place • Warning - Change Control Place - Persistent • Fault, Ramp to Coast • Fault, coast See Table 23 for descriptions of the events.	Select the response to a process data timeout.
Process Data Timeout Control Place	112	• Local control • Fieldbus control • I/O control • Advanced control	Select the alternative control place to be used in case of fieldbus timeout. This is only valid if there is a timeout warning or info.

Table 23: Event Descriptions for the Industry Application

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.
Warning - Change Control Place	The drive issues a warning, and the control place changes to the selected alternative while the timeout warning is active. The control place changes back to the original one when the fieldbus process data returns.
Warning - Change Control Place - Persistent	The drive issues a warning, and the control place changes to the selected alternative while the timeout warning is active. The control place requires a reset command to change back to the original one after the fieldbus process data returns.
Fault, ramp to coast	The drive issues a fault, ramps down, and coasts. Motor control is no longer possible.
Fault	The drive issues a fault and coasts the motor. Motor control is no longer possible.

5.3 Configuring Fieldbus Protection Settings for the Motion Application

1. Navigate to ***Connectivity*** > ***Protocols*** > ***General Settings***.
2. Configure fieldbus protection settings.

Table 24: Fieldbus Protection Setting Parameters for the Motion Application

Parameter	Parameter number	Value	Description
Fieldbus Fault Response	1303	• Info (default) • Warning • Fault, ramp to coast • Fault See Table 23 for descriptions of the events.	Select the behavior when a fieldbus fault, for example loss of I/O connection occurs.
No Fieldbus Connection Response	1327	• Info (default) • Warning • Fault, ramp to coast • Fault See Table 23 for descriptions of the events.	Select the response in case there is no fieldbus connection.
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.
Process Data Timeout Response	1341	• Info (default) • Warning • Warning - Change Control Place • Warning - Change Control Place - Persistent • Fault, Ramp to Coast • Fault, coast See Table 23 for descriptions of the events.	Select the response to a process data timeout.
Process Data Timeout Control Place	112	• Local control • Fieldbus control • I/O control • Advanced control	Select the alternative control place to be used in case of fieldbus timeout. This is only valid if there is a timeout warning or info.

Table 25: Event Descriptions for the Motion Application

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.
Warning - Change Control Place	The drive issues a warning, and the control place changes to the selected alternative while the timeout warning is active. The control place changes back to the original one when the fieldbus process data returns.
Warning - Change Control Place - Persistent	The drive issues a warning, and the control place changes to the selected alternative while the timeout warning is active. The control place requires a reset command to change back to the original one after the fieldbus process data returns.

Table 25: Event Descriptions for the Motion Application - (continued)

Value	Description
Fault, ramp to coast	The drive issues a fault, ramps down, and coasts. Motor control is no longer possible.
Fault	The drive issues a fault and coasts the motor. Motor control is no longer possible.

5.4 Configuring Fieldbus Protection Settings for the Active Front End Application

When using the iC7 series Active Front End application, the fieldbus profile is selected automatically.

1. Navigate to parameter group ***Parameters*** > ***Protections and Responses*** > ***Fieldbus Protections***.
2. Configure fieldbus protection settings.

Table 26: Fieldbus Protection Setting Parameters for the Active Front End Application

Parameter	Parameter number	Value	Description
Fieldbus Fault Response	1304	• No response • Info • Warning • Fault (default) • Fault, open MCB See Table 27 for descriptions of the events.	Select the behavior when a fieldbus fault, for example, loss of I/O connection occurs.
No Fieldbus Connection Response	1305	• No response (default) • Info • Warning • Fault • Fault, open MCB See Table 27 for descriptions of the events.	Select the response if there is no fieldbus connection.
Process Data Timeout Response	1306	• No response • Info (default) • Warning • Fault • Fault, open MCB See Table 27 for descriptions of the events.	Select the response to a process data timeout.
Process Data Timeout Delay	1340	0.05–18000 s (Default value: 1.00 s)	Set a delay for the triggering of the Process Data Timeout event. If process data has not been updated within this delay time the event is triggered.

Table 26: Fieldbus Protection Setting Parameters for the Active Front End Application - (continued)

Parameter	Parameter number	Value	Description
Fieldbus Watchdog Response	5244	• No response • Info • Warning (default) • Fault • Fault, open MCB See Table 27 for descriptions of the events.	Select the converter response for the fieldbus watchdog event.
Fieldbus Watchdog Delay	5245	0.0–3000.0 s (Default value: 5.00 s)	Set a delay for activating the fieldbus watchdog event.
Fieldbus Watchdog Start Delay	5246	0.0–3000.0 s (Default value: 30.00 s)	Set a startup delay time for activating the fieldbus watchdog event. The counter starts when the converter wakes up.

Table 27: Event Descriptions

Value	Description
No response	–
Info	The event is logged in the event log.
Warning	The drive or power converter issues a warning.
Fault	The drive or power converter issues a fault and stops modulation.
Fault, open MCB	The drive or power converter issues a fault, stops modulation, and opens the main circuit breaker.

5.5 Reference Handling

5.5.1 Industry and Motion Applications

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 28: 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.

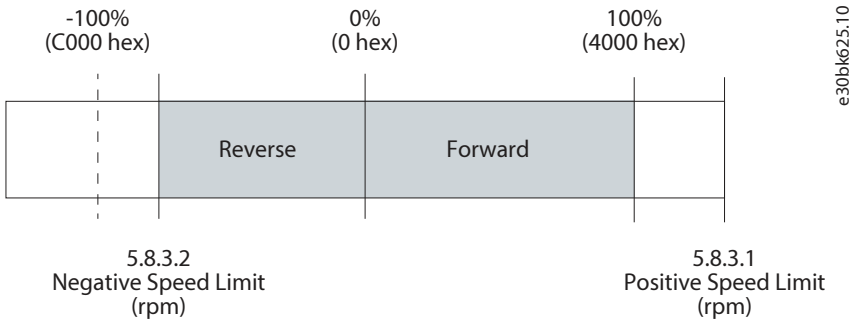


Figure 10: Example of Fieldbus Speed Reference in iC7-Automation

5.5.2 Active Front End Application

For the Active Front End application, the Main Reference [REF] and Main Actual Value [MAV] are tied to the DC-link voltage of the converter. Both of these signals are interfaced as 32-bit floating-point values. They are expressed in % of the ***Grid Nominal Voltage*** parameter (parameter number ***6537***).

5.6 Configuring the Ethernet Interface

The X1 and X2 interfaces are internally connected with an Ethernet switch and share the same physical MAC layer, and the same IP settings apply to both interfaces. IPv4 settings are configured in MyDrive® Insight or in the control panel.

1. Configure IPv4 settings.
   - In MyDrive® Insight, go to ***Setup and Service*** > ***Interface configuration*** > ***Interface X1/X2*** > ***IPv4 settings***.
   - In the control panel, navigate to parameter group ***Communication Interfaces***.

> **!** IMPORTANT: To ensure that outgoing IP packets are routed correctly, configure the IP addresses of the X1/X2 interfaces to a different subnet than the IP address of the X0 interface.

Table 29: IPv4 Settings

Function	Value	Description
Interface X1/X2 MAC address	00:1B:08: xx:xx:xx	The MAC address of interface X1/X2. The value is read-only.
IPv4 addressing method	Disable	Only link-local IP address in the 169.254.xxx.xxx range is active.
	Static IP	A static IP address is entered manually.
	Automatic	IP address is assigned via a DHCP or BOOTP server.
Requested IPv4 address	xxx.xxx.xxx.xxx	If ***Automatic*** is selected as the IPv4 addressing method and no DHCP/BOOTP server is present, the X1/X2 interface automatically configures an IP address and subnet mask in the 169.254.xxx.xxx range.
Requested IPv4 subnet mask	xxx.xxx.xxx.xxx	The requested IPv4 subnet mask for the interface.
Requested IPv4 gateway address	xxx.xxx.xxx.xxx	Requested IPv4 gateway address for the interface.

Table 29: IPv4 Settings - (continued)

Function	Value	Description
Enable ACD	Enable	Request to enable or disable Address Conflict Detection for the interface. The change does not take effect before a power cycle is performed. If no conflicts are detected, ACD activity shows 0. If an address conflict occurs, the ACD activity shows 1, and the IPv4 interface reverts to an automatically assigned IP address in the 169.254.xxx.xxx range.
	Disable (default)	
DNS server 1, 2	xxx.xxx.xxx.xxx	The user-requested Domain Name Server 1 for the interface (for manual IP addressing mode only).

Table 30: Ethernet Port Configuration (X1/X2)

Parameter name	Parameter number	Selections	Description
Link Configuration X1	7048	• Auto negotiation • 10 Mbps full duplex • 10 Mbps half duplex • 100 Mbps full duplex • 100 Mbps half duplex	Configures the Ethernet link parameter
Link Configuration X2	7049		

5.7 Configuring Parallel Redundancy Protocol

The parallel Redundancy Protocol (PRP) is based on the parallel transmission of information by sending duplicate frames to 2 independent network infrastructures known as LAN A and LAN B. Each PRP node has a connection to each of the networks called double attached nodes (DAN) in PRP terminology.

PRP is implemented in the end devices only. The Ethernet switches in the network have no specific PRP capabilities. Standard devices with a single network interface are referred to as single attached nodes (SAN) and can by default be connected directly to 1 of the 2 networks. Alternatively, a SAN can be connected via a redundancy box (RedBox) that connects 1 or more SANs to both LAN A and LAN B networks.

1. In MyDrive® Insight, go to ***Interface configuration*** > ***Ethernet Redundancy*** > ***PRP*** > ***Settings*** to configure PRP settings.

Function	Value	Description
PRP Interface	• Disabled (default) • Enabled X1/X2	Enables or disables PRP on the X1/X2 interface.
Enable VLAN	• Disabled (default) • Enabled	Enables or disables the transmissions of VLAN ID in the PRP supervision frames.
VLAN id	0–65535	VLAN ID used in PRP supervision frames when VLAN is enabled.

2. In MyDrive® Insight, go to ***Interface configuration*** > ***Ethernet Redundancy*** > ***PRP*** > ***Status*** to check PRP status.

Function	Description
Valid frames on LAN A	Valid frames received on LAN A with a valid sequence number.
Valid frames on LAN B	Valid frames received on LAN B with a valid sequence number.
Duplicate frames on LAN A	Valid frames received on LAN A dropped by duplicate detection.
Duplicate frames on LAN B	Valid frames received on LAN B dropped by duplicate detection.

Function	Description
Wrong LAN ID frames on LAN A	Valid frames received in LAN A with mismatching LAN ID.
Wrong LAN ID frames on LAN B	Valid frames received in LAN B with mismatching LAN ID.
Missing frames	The counter is incremented if there is a jump in the sequence number, indicative of frame drop in both LANs.
Out of sequence on LAN A	Valid and accepted frames received on LAN A with an unexpected sequence number.
Out of sequence on LAN B	Valid and accepted frames received on LAN B with an unexpected sequence number.
Out of sequence low on LAN A	Valid and accepted frames received on LAN A with a sequence number outside duplicate window.
Out of sequence low on LAN B	Valid and accepted frames received on LAN B with a sequence number outside duplicate window.
Warning count on LAN A	The counter is incremented if wrong frames or no PRP frames are received on LAN A.
Warning count on LAN B	The counter is incremented if wrong frames or no PRP frames are received on LAN B.

IMPORTANT: When configuring PRP, it is important to notice the assignment of the Ethernet ports:

- X1 = LAN A
- X2 = LAN B

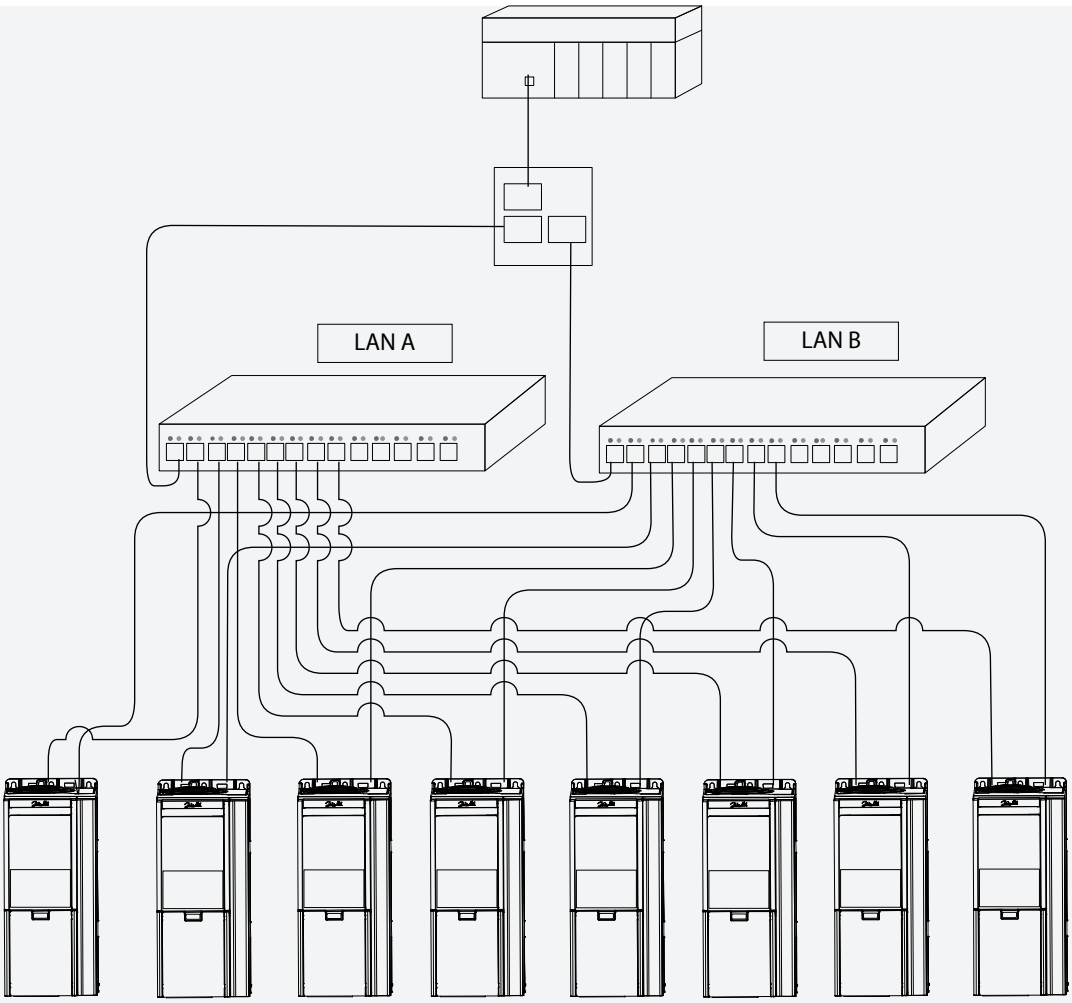


Figure 11: Example of Parallel Redundancy

5.8 Configuring Modbus Unit Identifier

In Modbus TCP, the device is addressed by its IP address, and the server ID is replaced by a single-byte unit identifier.

IMPORTANT: Value 255 (0xFF) must be used for the Modbus unit identifier (client ID).

When configuring the Modbus PLC client, a server ID, or a server address is used to address the serial Modbus RTU devices in the range of 1–247.

In Modbus TCP, an IP address and a single-byte unit identifier are used to address the device.

5.9 Configuring Modbus Data Settings

Use MyDrive® Insight or the control panel to select persistent storage and the byte and word order for Modbus communication.

1. Using MyDrive® Insight or the control panel, navigate to parameter group ***Modbus TCP*** > ***Configuration***.

Table 31: Parameters for Modbus Data Settings

Parameter name	Parameter number	Value	Description
Persistent Storage	7061	• Disable • Enable	Persistent Storage enables storing parameters written via Modbus in non-volatile memory. IMPORTANT: Enabling ***Persistent Storage*** causes a decrease in Modbus communication performance.
Byte Order	7062	• Little Endian • Big Endian (default)	Byte order of holding register.
Word Order	7063	• Little Endian (default) • Big Endian	Word order when mapping parameters (for example, 32-bit REAL) in multiple registers.

6 Troubleshooting

6.1 Configuring Port Mirroring Settings

Enable or disable the port mirroring function for network troubleshooting with a network analyzer tool.

1. In MyDrive® Insight, go to ***Setup and Service*** > ***Interface Configuration*** > ***Port Mirroring Settings***.

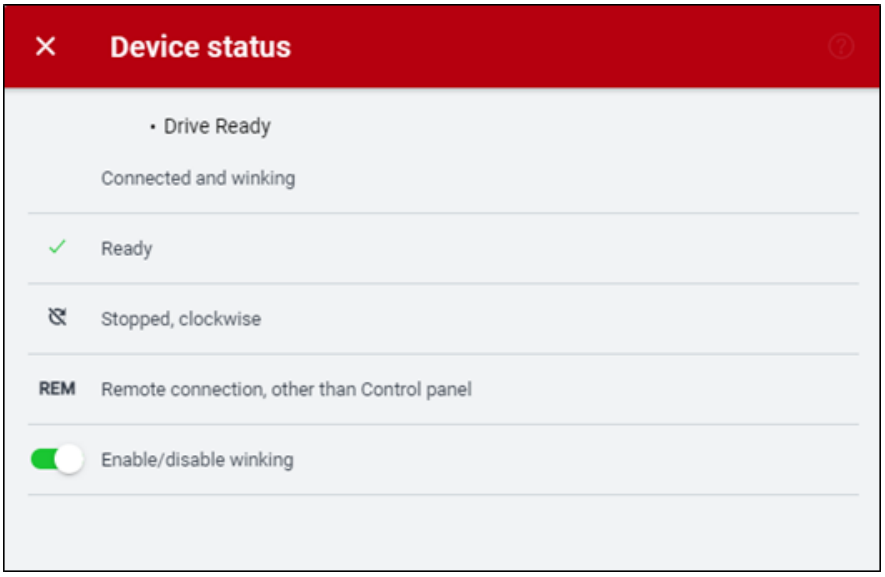
Table 32: Port Mirroring Settings

Function	Selections	Description
Source port	• X1 • X2	Frames are mirrored from this port.
Destination port	• X1 • X2	Frames are mirrored to this port.
Block RX from destination port	Enable/Disable	Device does not receive any frames from Destination Port when enabled.
Enable port mirroring	Enable/Disable	Enables the Port Mirroring feature.

6.2 Identifying a Unit

The winking function makes the fieldbus indicator LEDs flash yellow to make it easy to identify a unit. The function is enabled in MyDrive® Insight.

1. In MyDrive® Insight, click the device name in live mode.
2. Select *Device Status*.
3. To activate or deactivate the feature, click the toggle switch.



e30bk763.10

See 6.3 Fieldbus Indicator LEDs for more information on interpreting the LED signals and where the LEDs are located.

6.3 Fieldbus Indicator LEDs

The fieldbus indicator LEDs are in the top right corner of the control panel and the bottom part of the front-facing side of the modular control unit.

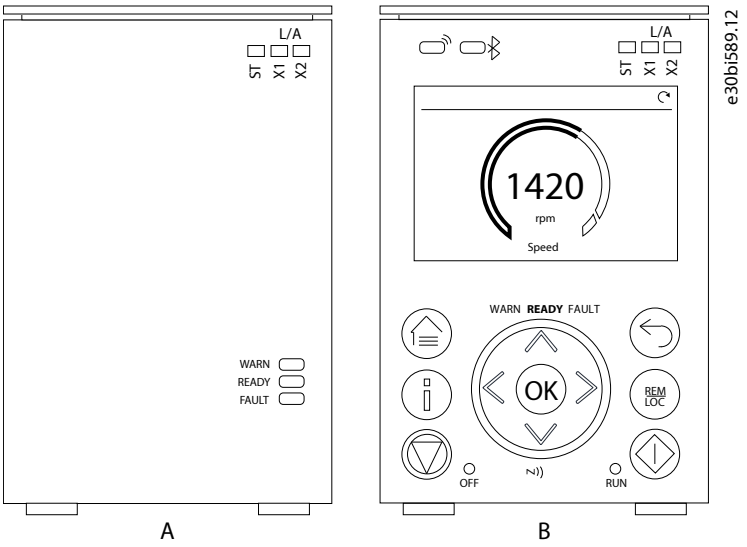


Figure 12: Fieldbus Indicator LEDs on Control Panel

A	Blind Panel	B	Control Panel 2.8

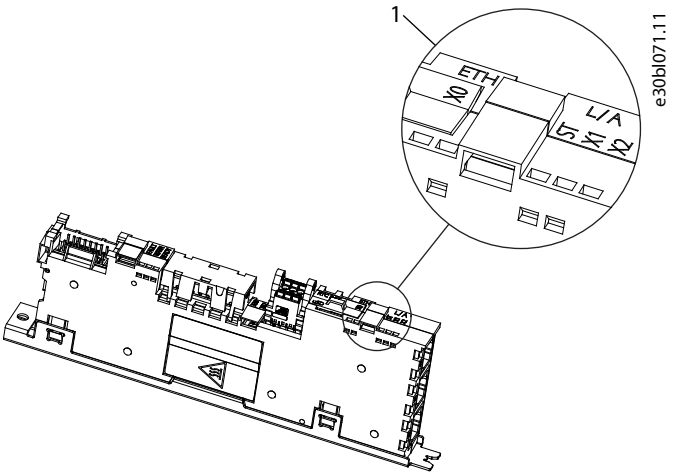


Figure 13: Fieldbus Indicator LEDs on Modular Control Board

1	Fieldbus indicator LEDs (ST, X1, and X2)

- The LED labeled ST shows the module status.
- The LED labeled X1 shows the network status on Ethernet port X1.
- The LED labeled X2 shows the network status on Ethernet port X2.

Table 33: Fieldbus Indicator LED Functions

LED label	Status	LED pattern	Description
ST	Standby	Flashing green	No active Modbus TCP connections.
	I/O connection ok	Solid green	Modbus TCP connection active.
	Lost Modbus connection	Flashing red	A Modbus TCP connection has failed, but 1 is still active (loss of I/O connection).
	Lost all Modbus connections	Steady red	Modbus TCP connections have failed (no I/O connection).

Table 33: Fieldbus Indicator LED Functions - (continued)

LED label	Status	LED pattern	Description
X1/X2	Link down	Off	–
	Link up	Solid green	Ethernet link is active.
	Cable fault	Solid yellow	The device has detected an Ethernet cable fault.
	Collision	Flashing yellow	Collision detected
	Duplicated IP address	Solid red	IP configuration error

7 Modbus Features

7.1 Data Objects

Table 34: Supported Object Types

Object type	Access	Size
Coil	Read/write	1 bit
Input register	Read only	16 bits
Holding register	Read/write	16 bits

7.2 Function Codes

The function code of a message frame contains 8 bits. Valid codes are in the range of 1–FF. Use function codes to send messages between client and server. When a message is sent from a client to a server device, the function code tells the server which action to perform. When the server responds to the client, it uses the function code to indicate either a normal (error-free) response, or that some error occurred (called an exception response). For a normal response, the server echoes the original function code. For an exception response, the server returns a code that is equivalent to the original function code with its most significant bit set to logic 1. Furthermore, the server places a unique code into the data field of the response message. It tells the client which error occurred, or the reason for the exception.

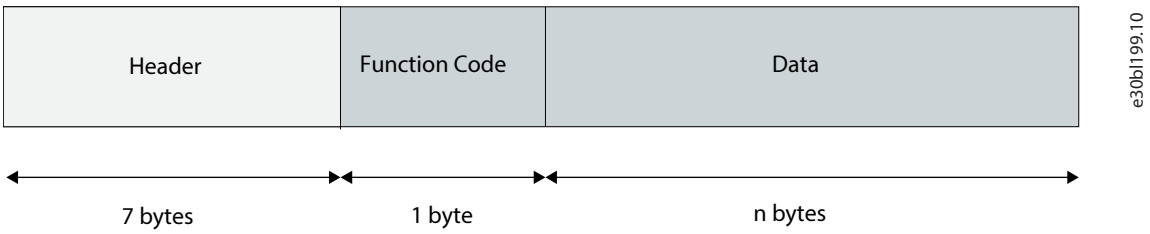


Figure 14: Modbus TCP Frame

Table 35: Supported Function Codes

Function code		Object type	Access type	Address range
Dec	Hex			
1	1	Read coils	Discrete (1 bit)	00001–09999
3	3	Read multiple holding registers	Register (16 bit)	40001–49999
4	4	Read input registers	Register (16 bit)	30001–39999
5	5	Write single coils	Discrete (1 bit)	00001–09999
6	6	Write single holding register	Register (16 bit)	40001–49999
15	F	Write multiple coils	Discrete (1 bit)	00001–09999
16	10	Write multiple holding registers	Register (16 bit)	40001–49999
23	17	Read/write multiple registers	Register (16 bit)	40001–49999
43	28	Read device ident	MEI	–

7.3 Data Field

The data field is constructed using sets of 2 hexadecimal digits in the range of 00–FF hexadecimal. These digits are made up of 1 TCP character. The data field of messages sent from a client to a server device contains extra information, which the server must use to act as defined by the function code. It can include items such as coil, or register addresses, the quantity of items to be handled, and the count of actual data bytes in the field.

7.4 Read Device Identity

The Read Device Identity function code is for reading the device manifest data via Modbus Encapsulated Interface transport.

Table 36: Request Structure

Function code	0x2B
MEI type	0x0E
MEI type specific data	Object ID See Table 37.

Table 37: Object IDs

Object ID	Object name/description	Type
0x00	VendorName	ASCII String
0x01	ProductCode	ASCII String
0x02	MajorMinorRevision	ASCII String
0x03	VendoreUrl	ASCII String
0x04	ProductName	ASCII String
0x05	ModelName	ASCII String
0x06	UserApplicationName	ASCII String

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