



# Installation Guide

## VLT<sup>®</sup> EtherNet/IP MCA 121

VLT<sup>®</sup> HVAC Drive FC 102 • VLT<sup>®</sup> AQUA Drive FC 202

VLT<sup>®</sup> AutomationDrive FC 301/302





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# 1 Introduction

## 1.1 Purpose of the Manual

This installation guide provides information for the quick installation of a VLT® EtherNet/IP MCA 121 interface in a VLT® frequency converter.

The installation guide is intended for use by qualified personnel. Users are assumed to be familiar with:

- VLT® frequency converter.
- EtherNet/IP technology.
- PC or PLC that is used as a master in the system.

Read the instructions before installation and ensure that the instructions for safe installation are observed.

VLT® is a registered trademark.

## 1.2 Additional Resources

### Resources available for the frequency converters and optional equipment:

- The relevant frequency converter Operating Instructions provide the necessary information for getting the frequency converter up and running.
- The relevant frequency converter Design Guide provides detailed information about capabilities and functionality to design motor control systems.
- The relevant frequency converter Programming Guide provides greater detail on working with parameters and many application examples.
- The *VLT® EtherNet/IP MCA 121 Installation Guide* provides information about installing the EtherNet/IP and troubleshooting.
- The *VLT® EtherNet/IP MCA 121 Programming Guide* provides information about configuring the system, controlling the frequency converter, parameter access, programming, troubleshooting, as well as some typical application examples.

Supplementary publications and manuals are available from Danfoss. See [www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/VLT+Technical+Documentation.htm](http://www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/VLT+Technical+Documentation.htm) for listings.

## 1.3 Product Overview

### 1.3.1 Intended Use

This installation guide relates to EtherNet/IP interface.

Ordering number:

- 130B1119 (uncoated)
- 130B1219 (conformal coated)

The EtherNet/IP interface is designed to communicate with any system complying with the CIP EtherNet/IP standard. EtherNet/IP provides users with the network tools to deploy standard Ethernet technology for manufacturing applications while enabling Internet and enterprise connectivity.

VLT® EtherNet/IP MCA 121 is intended for use with:

- VLT® HVAC Drive FC 102
- VLT® AQUA Drive FC 202
- VLT® AutomationDrive FC 301
- VLT® AutomationDrive FC 302

### 1.3.2 Items Supplied

When the fieldbus option is not factory mounted, the following items are supplied:

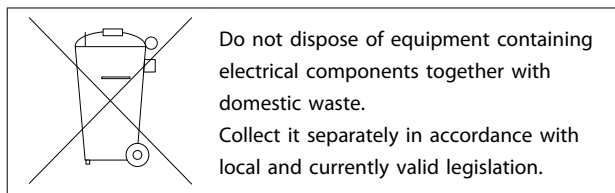
- Fieldbus option
- LCP cradle
- Front covers (in various sizes)
- Stickers
- Accessories bag
- Strain relief (only for A1 and A2 enclosures)
- Installation Guide

## 1.4 Approvals and Certifications



More approvals and certifications are available. For more information, contact a Danfoss local partner.

## 1.5 Disposal



## 1.6 Symbols, Abbreviations and Conventions

| Abbreviation | Definition                          |
|--------------|-------------------------------------|
| CIP™         | Common industrial protocol          |
| DHCP         | Dynamic host configuration protocol |
| EIP          | EtherNet/IP                         |
| EMC          | Electromagnetic compatibility       |
| IP           | Internet protocol                   |
| LCP          | Local control panel                 |
| LED          | Light emitting diode                |
| MAR          | Major recoverable fail              |
| MAU          | Major unrecoverable fail            |
| PC           | Personal computer                   |
| PLC          | Programmable logic controller       |
| TCP          | Transmission control protocol       |

Table 1.1 Symbols and Abbreviations

### Conventions

Numbered lists indicate procedures.

Bullet lists indicate other information and description of illustrations.

Italicised text indicates:

- Cross reference
- Link
- Parameter name

## 2

## 2 Safety

### 2.1 Safety Symbols

The following symbols are used in this document:

#### **⚠ WARNING**

Indicates a potentially hazardous situation that could result in death or serious injury.

#### **⚠ CAUTION**

Indicates a potentially hazardous situation that could result in minor or moderate injury. It can also be used to alert against unsafe practices.

#### **NOTICE**

Indicates important information, including situations that can result in damage to equipment or property.

### 2.2 Qualified Personnel

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

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

### 2.3 Safety Precautions

#### **⚠ WARNING**

##### **HIGH VOLTAGE**

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

- Installation, start-up, and maintenance must be performed by qualified personnel only.

#### **⚠ WARNING**

##### **UNINTENDED START**

When the frequency converter is connected to AC mains, DC power supply, or load sharing, the motor may start at any time. Unintended start during programming, service or repair work can result in death, serious injury, or property damage. The motor can start by means of an external switch, a serial bus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 software, or after a cleared fault condition.

To prevent unintended motor start:

- Disconnect the frequency converter from the mains.
- Press [Off/Reset] on the LCP before programming parameters.
- The frequency converter, motor, and any driven equipment must be fully wired and assembled when the frequency converter is connected to AC mains, DC power supply, or load sharing.

#### **⚠ WARNING**

##### **DISCHARGE TIME**

The frequency converter contains DC-link capacitors that can remain charged even when the frequency converter is not powered. 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 the AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.
- Disconnect or lock the PM motor.
- Wait for the capacitors to discharge fully before performing any service or repair work. The duration of waiting time is specified in the relevant frequency converter operating instructions, *Chapter 2 Safety*.

**⚠ WARNING****LEAKAGE CURRENT HAZARD**

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

- Ensure the correct grounding of the equipment by a certified electrical installer.

**⚠ 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 document.

**⚠ CAUTION****INTERNAL FAILURE HAZARD**

An internal failure in the frequency converter can result in serious injury, when the frequency converter is not properly closed.

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

## 3 Installation

### 3

### 3.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

### 3.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in the relevant frequency converter *Operating Instructions* and *Design Guide*. Refer to the fieldbus master manual from the PLC supplier for further installation guidelines.

### 3.3 Grounding

- Ensure that all stations connected to the fieldbus network are connected to the same ground potential. When there are long distances between the stations in a fieldbus network, connect the individual station to the same ground potential. Install equalising cables between the system components.
- Establish a grounding connection with low HF impedance, for example by mounting the frequency converter on a conductive back plate.
- Keep the ground wire connections as short as possible.
- Electrical contact between the cable screen and the frequency converter enclosure or ground is not allowed in Ethernet installations. The RJ45 connector of the Ethernet interface provides an electrical path for the electrical interference to ground.
- Use high-strand wire to reduce electrical interference.

### 3.4 Cable Routing

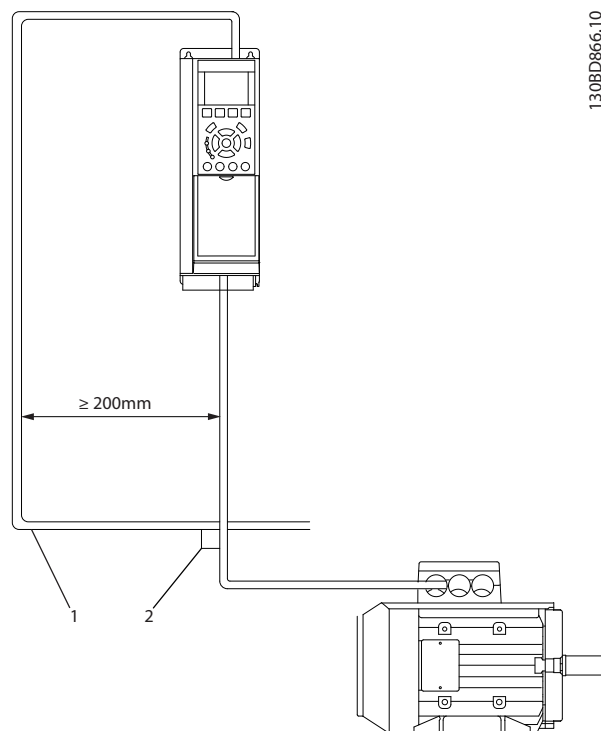
#### NOTICE

#### EMC INTERFERENCE

Use screened cables for motor and control wiring, and separate cables for fieldbus communication, motor wiring, and brake resistor. Failure to isolate fieldbus communication, motor, and brake resistor cables can result in unintended behaviour or reduced performance. Minimum 200 mm (7.9 in) clearance between power, motor, and control cables is required. For power sizes above 315 kW, it is recommended to increase the minimum distance of 500 mm (20 in).

#### NOTICE

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



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|   |                |
|---|----------------|
| 1 | Ethernet cable |
| 2 | 90° crossing   |

Illustration 3.1 Cable Routing

### 3.5 Topology

The EtherNet/IP MCA 121 module features a built-in Ethernet switch with 2 Ethernet RJ45/M12 connectors. The module enables the connection of several EtherNet/IP options in a line topology as an alternative to a traditional star topology.

The 2 ports are equal. If only 1 connector is used, either port can be used.

#### Star topology

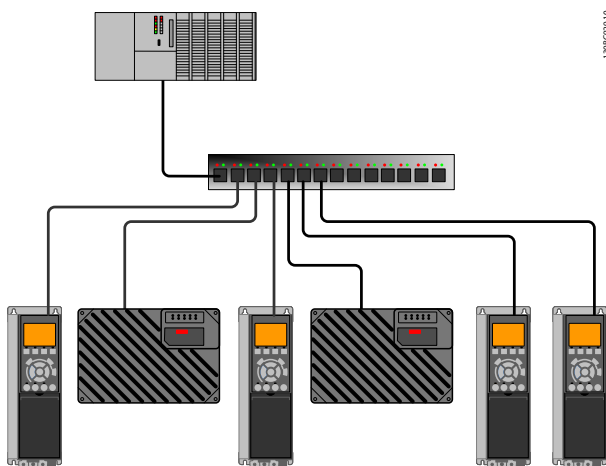


Illustration 3.2 Star Topology

#### Line topology

In many installations, line topology enables simpler cabling and the use of smaller or fewer Ethernet switches. The EtherNet/IP interface supports line topology with its 2 ports and built-in Ethernet switch.

When line topology is used, take precautions to avoid time out in the PLC when more than 8 frequency converters are installed in series. Each frequency 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 time out in the PLC. Set the update time as shown in *Table 3.1*. The numbers given are typical values and can vary from installation to installation.

| Numbers of frequency converters connected in series | Minimum update time [ms] |
|-----------------------------------------------------|--------------------------|
| <8                                                  | 2                        |
| 8-16                                                | 4                        |
| 16-32                                               | 8                        |
| >32                                                 | not recommended          |

Table 3.1 Minimum Update Time

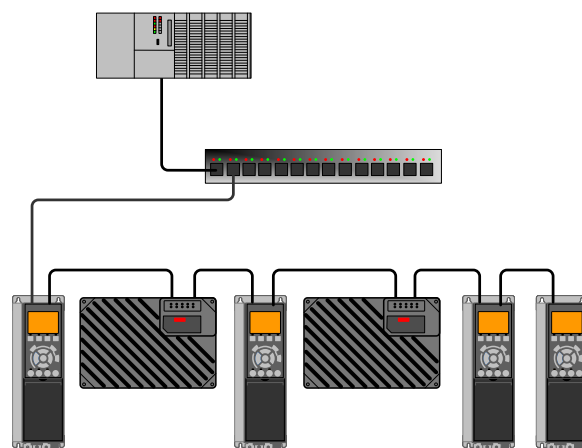


Illustration 3.3 Line Topology

#### NOTICE

In line topology, activate the built-in switch by powering all frequency converters, either by mains or a 24 V DC option card.

#### NOTICE

Installing frequency converters of different power sizes in line topology may result in unwanted power-off behaviour when using control word timeout (8-02 Control Word Source to 8-06 Reset Control Word Timeout). It is recommended to mount the frequency converters with the longest discharge time first in the line topology. In normal operation, the frequency converters with bigger power sizes have a longer discharge time.

#### Ring/redundant line topology

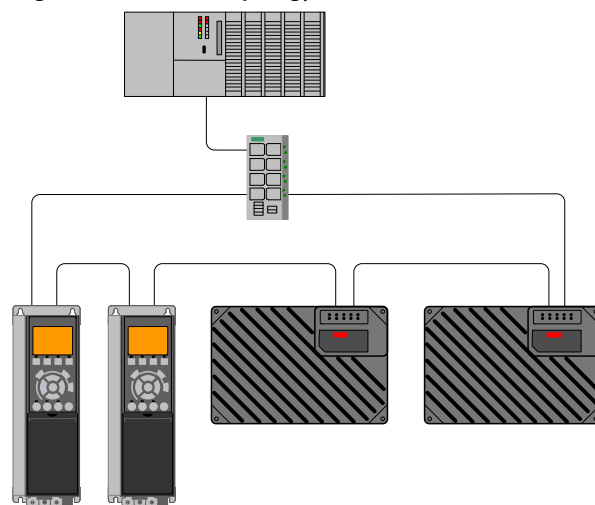


Illustration 3.4 Ring/Redundant Line Topology

Ring topology can increase the availability of an Ethernet network.

For ring topology:

- Install a special switch (redundancy manager) between the PLC and the frequency converters.
- Configure the redundancy manager switch to clearly define the ports that connect to the ring.

When the ring operates, the main redundancy manager sends test frames into the ring to detect. If the switch detects a fault in the ring, it reconfigures the ring into 2 lines instead. The transition time from 1 ring into 2 lines is up to 500 ms depending on the components installed in the ring. Set the timing of the PLC to ensure that the transition time does not lead to a time-out fault.

### NOTICE

For ring/redundant line topology, ensure the redundancy manager switch supports the detection of loss of line topology. The switch inside the EtherNet/IP interface does not support this detection.

### Recommended design rules

- Pay special attention to active network components when designing an Ethernet network.
- For line topology, a small delay is added with each additional switch in the line. For more information, see *Table 3.1*.
- Do not connect more than 32 frequency converters in series. Exceeding this limit can result in unstable or faulty communication.

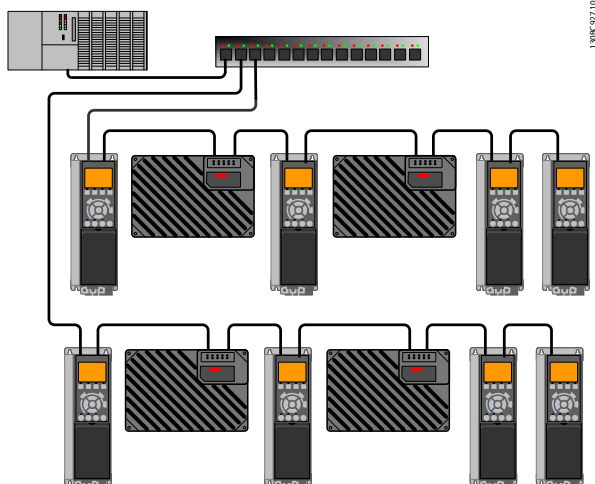
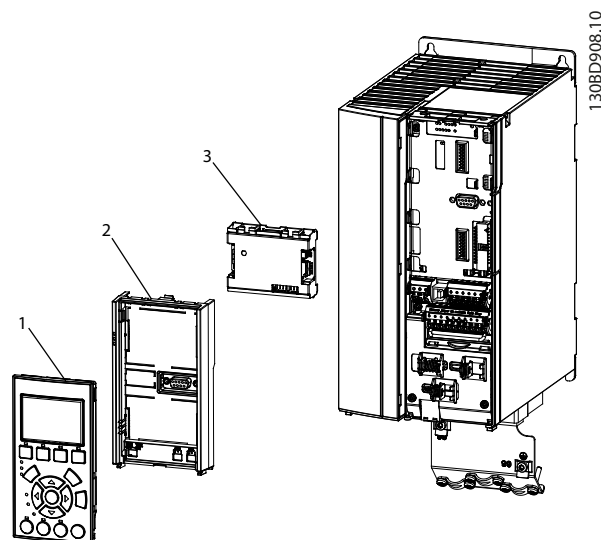


Illustration 3.5 Recommended Design Rules

## 3.6 Mounting

1. Check whether the fieldbus option is already mounted in the frequency converter. If already mounted, go to step 6.
2. Remove the LCP or blind cover from the frequency converter.
3. Use a screwdriver to remove the front cover and the LCP cradle.
4. Mount the fieldbus option. Mount the option with the Ethernet Port facing up for top cable entry (see *Illustration 3.7*), or with the Ethernet Port facing down for bottom cable entry (see *Illustration 3.8*).
5. Remove the knock-out plate from the new LCP cradle.
6. Mount the new LCP cradle.



|   |                 |
|---|-----------------|
| 1 | LCP             |
| 2 | LCP cradle      |
| 3 | Fieldbus option |

Illustration 3.6 Exploded View

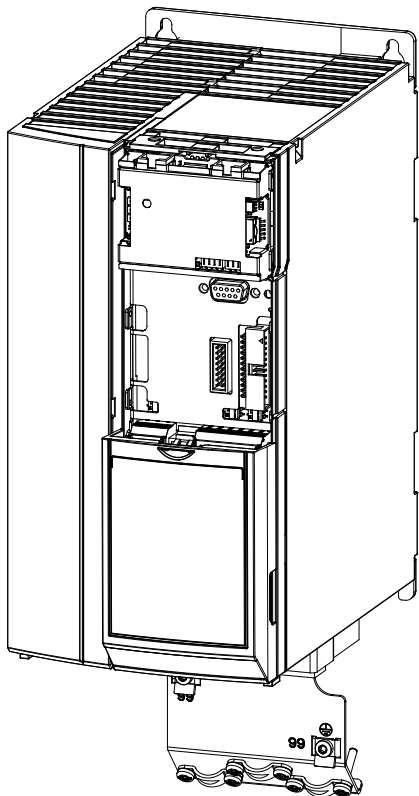


Illustration 3.7 Option Mounted with the Ethernet Port Facing Up (A1-A3 Enclosures)

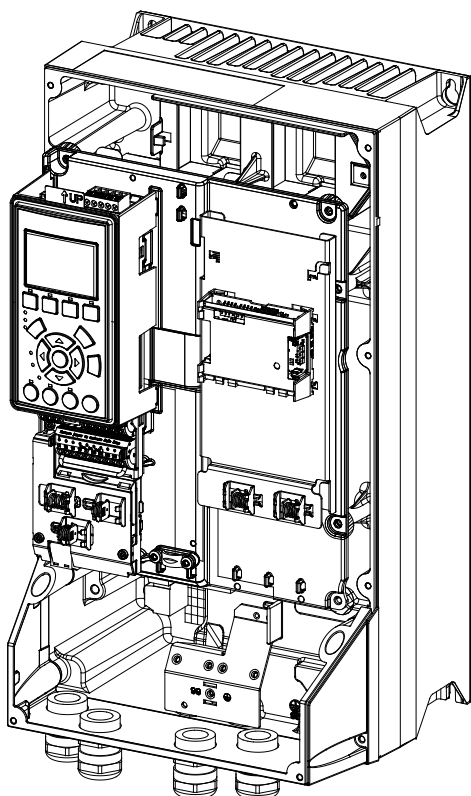
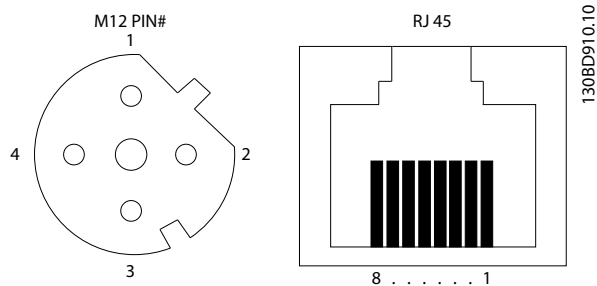


Illustration 3.8 Option Mounted with the Ethernet Port Facing Down (A4-A5, B, C, D, E, F Enclosures)



| Signal | M12 PIN # | RJ45 |
|--------|-----------|------|
| RX +   | 1         | 1    |
| TX +   | 2         | 3    |
| RX -   | 3         | 2    |
| TX -   | 4         | 4    |

Illustration 3.9 EtherNet/IP Connectors

## 3.7 Electrical Installation

### 3.7.1 Cabling Requirements

- Choose cables suitable for Ethernet data transmission. Normally CAT5e and CAT6 cables are recommended for industrial applications.
- Both types are available as unshielded twisted pair and shielded twisted pair. Screened cables are recommended for use in industrial environments and with frequency converters.
- A maximum cable length of 100 m is allowed between the switches.
- Use optical fibres for gapping longer distances and providing galvanic isolation.

### 3.7.2 Wiring Procedures

#### Wiring procedure for enclosure types A1-A3

1. Mount the pre-configured cable wires with the connectors on the fieldbus option. For A1 and A2 enclosures, mount the supplied strain relief on top of the frequency converter with 2 screws, as shown in *Illustration 3.10*. For cable specifications, refer to *chapter 3.7.1 Cabling Requirements*.
2. Position the cable between the spring loaded metal clamps to establish mechanical fixation and electrical contact between the cable and ground.

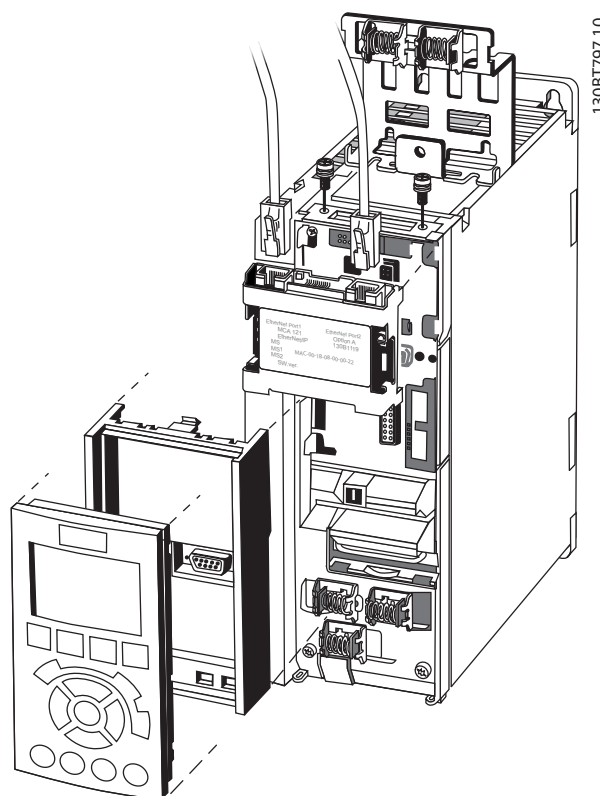
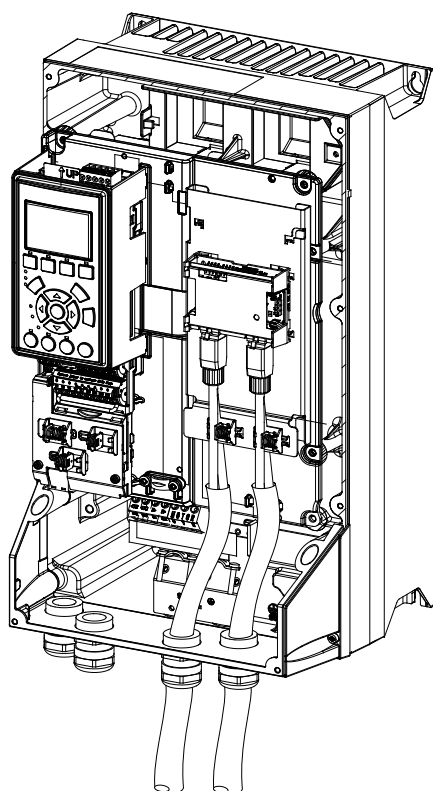


Illustration 3.10 Wiring for Enclosure Types A1-A3

#### Wiring procedure for enclosure types A4-A5, B1-B4, and C1-C4

1. Push the cable through the cable glands.
2. Mount the pre-configured cable wires with the connectors on the fieldbus option. For cable specifications, refer to *chapter 3.7.1 Cabling Requirements*.
3. Fix the cable to the metal base plate using the springs, see *Illustration 3.11*.
4. Tighten the cable glands securely.



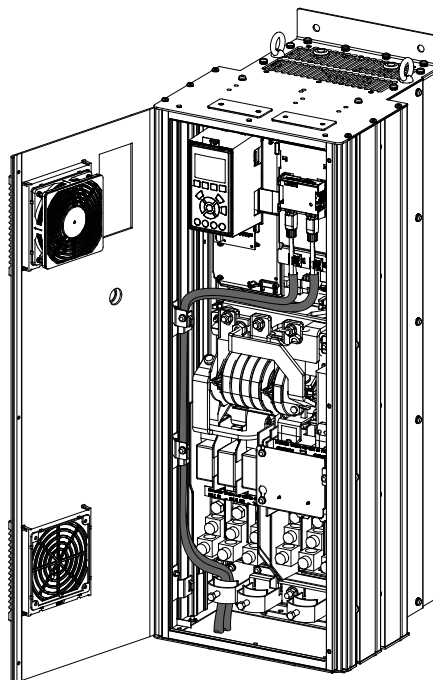
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Illustration 3.11 Wiring for Enclosure Types A4-A5, B1-B4, and C1-C4

### Wiring procedure for enclosure types D, E, and F

1. Mount the pre-configured cable wires with the connectors on the fieldbus option. For cable specifications, refer to *chapter 3.7.1 Cabling Requirements*.
2. Fix the cable to the metal base plate using the springs, see *Illustration 3.12*.
3. Tie down the cable and route it with other control wires inside the unit, see *Illustration 3.12*.

3



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Illustration 3.12 Wiring for Enclosure Types D, E, and F

### NOTICE

Do not strip the Ethernet cable. Do not ground it via the strain relief plate. Ground the screened Ethernet cables through the RJ45 connector on the EtherNet/IP interface.

### 3.8 Reassembling the Cover

1. Mount the new front cover and the LCP.
2. Attach the sticker with the correct product name to the front cover.

### 3.9 Applying Power

Follow the instructions in the frequency converter *Operating Instructions* to commission the frequency converter. The frequency converter automatically detects the EtherNet/IP interface. A new parameter group (Group 12) appears.

### 3.10 Checking Network Cabling

#### **NOTICE**

After installing the EtherNet/IP interface, be aware of the following parameter settings:

8-01 Control Site: [2] Control word only or [0] Digital and control word

8-02 Control Word Source: [3] Option A

## 4 Troubleshooting

### 4.1 Warnings and Alarms

#### NOTICE

Refer to the relevant frequency converter Operating Instructions for an overview of warning and alarm types, and for the full list of warnings and alarms.

Alarm word and warning word are shown in the display in Hex format. When there is more than 1 warning or alarm, the sum of all warnings or alarms is shown. Warning word and alarm word are displayed in 16-90 Alarm Word to 16-95 Ext. Status Word 2.

### 4.2 Troubleshooting

#### 4.2.1 LED Status

The EtherNet/IP interface has 3 bi-coloured LEDs that allow fast and detailed diagnosis. Each LED is linked to its unique part of the EtherNet/IP interface, see Table 4.1.

| LED label | Description                                                   |
|-----------|---------------------------------------------------------------|
| MS        | Module Status. Reflects the activity on the EtherNet/IP stack |
| NS1       | Network Status 1. Reflects the activity on Ethernet Port 1    |
| NS2       | Network Status 2. Reflects the activity on Ethernet Port 2    |

Table 4.1 LED Label

| State                     | LED                                                                                        |                    | Description                                           |
|---------------------------|--------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------------|
| Standby                   | Green:  | Flashing green     | The device needs commissioning.                       |
| Device operational        | Green:  | Solid green        | The device is operational.                            |
| Major recoverable fault   | Red:    | Flashing red       | The device has detected a recoverable fault (MAR).    |
| Major unrecoverable fault | Red:    | Solid red          | The device has detected an unrecoverable fault (MAU). |
| Self test                 | Red:    | Flashing red/green | The EIP option is in self-test mode.                  |
|                           | Green:  |                    |                                                       |

Table 4.2 MS: Module Status

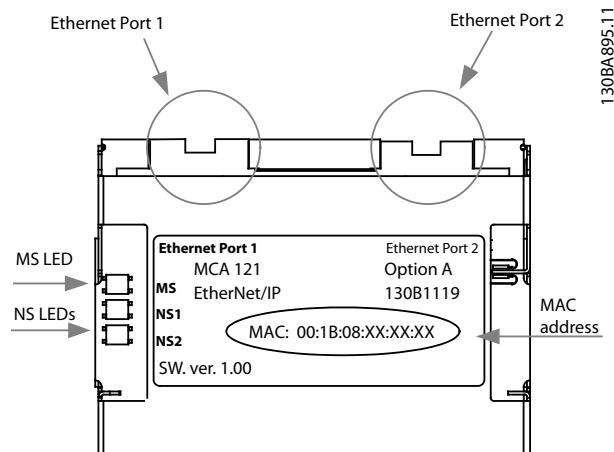


Illustration 4.1 Overview of EtherNet/IP Interface

| State               | LED                                                                                                                                                                                |                        | Description                                                   |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------------------------------------------|
| No connections      | Green:                                                                                            | Flashing green         | There are no established CIP connections to the device.       |
| Connected           | Green:                                                                                            | Solid green            | There is at least 1 established CIP connection to the device. |
| Connection time-out | Red:                                                                                              | Flashing red           | 1 or more CIP connections have timed-out.                     |
| Duplicate IP        | Red:                                                                                              | Solid red              | The IP-address assigned to the device is already in use.      |
| Self test           | Red: <br>Green:  | Flashing red/<br>green | The EIP option is in self-test mode.                          |

Table 4.3 NS1+NS2: Network Status (1 per Port)

## 4.2.2 No Communication with the Frequency Converter

### Check: Link status

The status of the Ethernet link cannot be directly identified using the LEDs, if CIP connection is not established.

Use *12-10 Link Status* to verify presence of the link.

Use *12-11 Link Duration* to verify that the link is steady present.

The parameter shows the duration of the present link, and is preset to 00:00:00:00 when the link is broken.

### Check: Cabling

In rare cases of cabling misconfiguration, the option may show the presence of a link but no communication is running. Exchange the cable if in doubt.

### Check: IP address

Verify that the option has a valid IP address (refer to *12-01 IP Address*). When the option has identified a duplicate IP Address, NS LEDs lights steady red. When the option is set up for BOOTP or DHCP, verify that a BOOTP or DHCP server is connected in *12-04 DHCP Server*. If no server is connected, the parameter shows: 000.000.000.000.

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