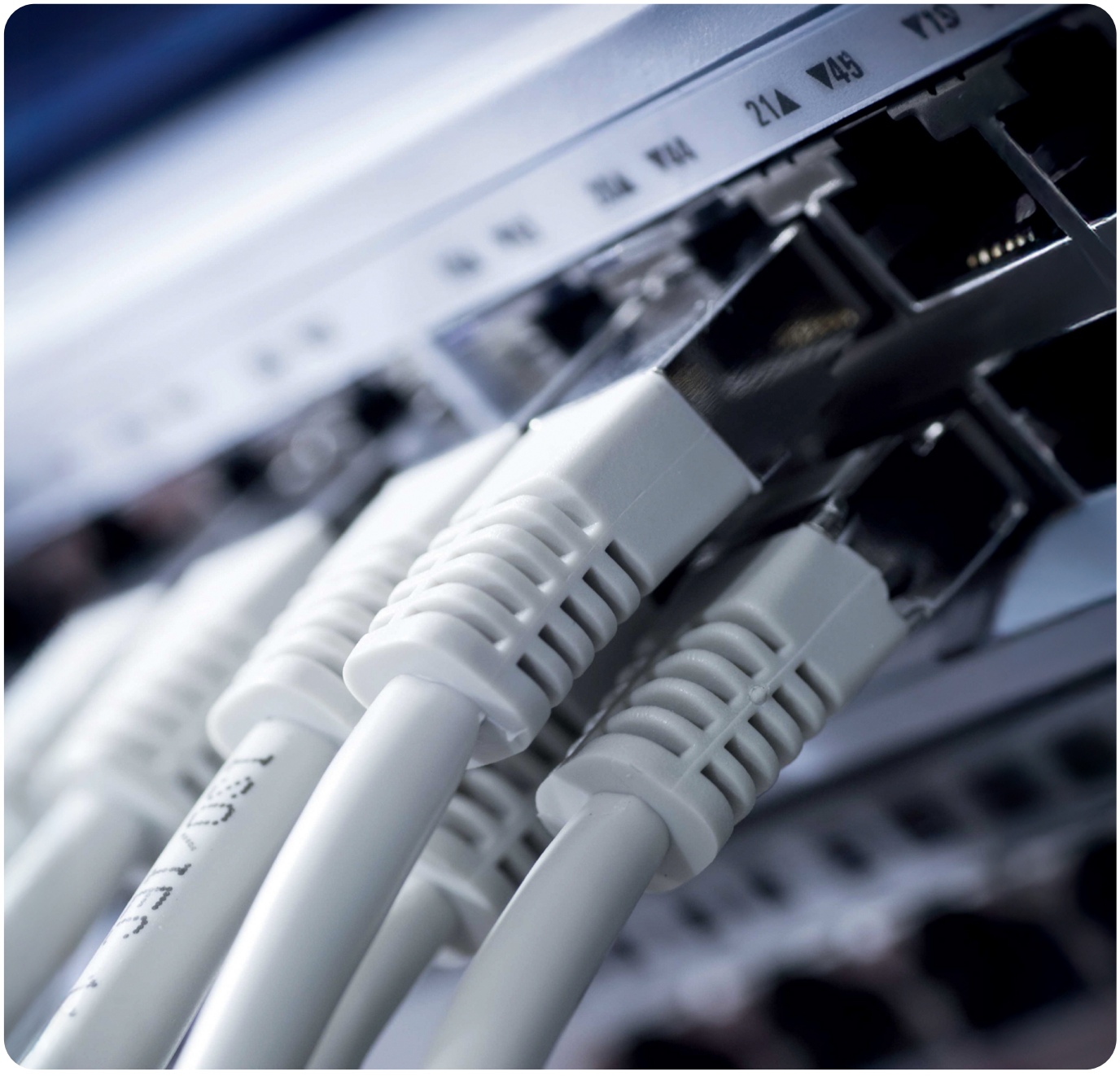
Installation Guide

VLT® Modbus TCP MCA 122

VLT® HVAC Drive FC 102, VLT® Refrigeration Drive FC 103, VLT® AQUA Drive FC 202, VLT® AutomationDrive FC 301/FC 302



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1 Introduction

1.1 Purpose of the Installation Guide

This installation guide provides information for the quick installation of a VLT® Modbus TCP MCA 122 in a VLT® drive.

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

- VLT® drives.
- Modbus TCP technology.
- The 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.

1.2 Trademarks

VLT® is a registered trademark for Danfoss A/S.

Ethernet® is a registered trademark of Xerox Corporation.

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

1.3 Additional Resources

Resources available for the drives and for optional equipment:

- The drive-specific operating guide of the relevant drive provides the necessary information for getting the drive ready for operation.
- The drive-specific design guide of the relevant drive provides detailed information about capabilities and functionality to design motor control systems.
- The drive-specific programming guide of the relevant drive provides greater details on working with parameters.
- The *VLT® Ethernet Fieldbuses MCA 12X Installation Guide* provides information about installing and troubleshooting the Modbus TCP interface.
- The *VLT® Modbus TCP Programming Guide* provides information about configuring the system, programming, and troubleshooting.
- The *VLT® Motion Control Tool MCT 10 Operating Guide* provides information for installation and use of the software on a PC.

Supplementary publications and guides are available from Danfoss. See www.danfoss.com for listings.

1.4 Document and Software Versions

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

The original language of this guide is English.

Table 1: Document and Software Versions

Edition	Remarks	Software version
AN542940142245, version 0201	New section on grounding Ethernet shield to chassis added.	7.00

1.5 Product Overview

1.5.1 Intended Use

This installation guide relates to the Modbus TCP interface.

Code number:

- 130B1196 (uncoated)

- 130B1296 (conformal coated)

The VLT® Modbus TCP MCA 122 interface is designed to communicate with any system complying with the Modbus Messaging on TCP/IP Implementation Guide V1.0b and Modbus Application Protocol Specification V1.1b standard. The MCA 122 option is tested to conform to the Modbus standards and is certified towards conformance test level version 3.

VLT® Modbus TCP MCA 122 is intended for use with:

- VLT® HVAC Drive FC 102.
- VLT® Refrigeration Drive FC 103.
- VLT® AQUA Drive FC 202.
- VLT® AutomationDrive FC 301/FC 302.

1.5.2 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
- Accessory bags
- Strain relief (only for A1 and A2 enclosures)
- Installation guide.

1.6 Approvals and Certifications

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

1.7 Disposal

Do not dispose of equipment containing electrical components together with domestic waste.
Collect it separately in accordance with local and currently valid legislation.

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2 Safety

2.1 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

2.2 Qualified Personnel

To allow trouble-free and safe operation of the unit, only qualified personnel with proven skills are allowed to transport, store, assemble, install, program, commission, maintain, and decommission this equipment.

Persons with proven skills:

- Are qualified electrical engineers, or persons who have received training from qualified electrical engineers and are suitably experienced to operate devices, systems, plants, and machinery in accordance with pertinent laws and regulations.
- Are familiar with the basic regulations concerning health and safety/accident prevention.
- Have read and understood the safety guidelines given in all manuals provided with the unit, especially the instructions given in the operating guide.
- Have a good knowledge of the generic and specialist standards applicable to the specific application.
- Are cleared by the asset owner to have access to the work zone according to the security level in the zone.

2.3 Safety Precautions

⚠ WARNING

LACK OF SAFETY AWARENESS

This guide provides important information on preventing injury and damage to the equipment or the system. Ignoring this information can lead to death, serious injury, or severe damage to the equipment.

- Make sure to fully understand the dangers and safety measures present in the application.
- Before performing any electrical work on the drive, lock out and tag out all power sources to the drive.

⚠ WARNING



HAZARDOUS VOLTAGE

Drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

- Only qualified personnel must perform installation, start-up, and maintenance.

⚠ WARNING

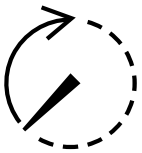
UNINTENDED START

When the drive is connected to AC mains, DC supply, or load sharing, the motor may start at any time. The motor may start by activation of an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using VLT® Motion Control Tool MCT 10, or after a cleared fault condition. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage.

- Disconnect the drive from the mains.
- Press [*Off/Reset*] on the LCP before programming parameters.
- Ensure that the drive is fully wired and assembled when it is connected to AC mains, DC supply, or load sharing.

⚠ WARNING





DISCHARGE TIME

The drive contains DC-link capacitors that can remain charged even when the drive 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 AC mains, permanent magnet type motors, and remote DC-link supplies including battery backups, UPS, and DC-link connections to other drives.
- Wait for the capacitors to discharge fully before performing any service or repair work. The discharge time is specified on the drive product label.
- Before performing any service or repair work, use a measuring device to make sure that capacitors are fully discharged.

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⚠ WARNING



ELECTRICAL SHOCK HAZARD - HIGH LEAKAGE CURRENT

Leakage currents exceed 3.5 mA. Failure to connect the system properly to protective earth may result in death or serious injury.

- Ensure reinforced protective earthing conductor according to IEC 60364-5-54 cl. 543.7 or according to local safety regulations for high touch current equipment. The reinforced protective earthing of the converter can be done with:
- PE conductor with a cross-section of at least 10 mm^2 Cu or 16 mm^2 Al.
- PE conductor completely enclosed within an enclosure or otherwise protected throughout its length against mechanical damage.

⚠ WARNING



INTERNAL FAILURE HAZARD

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

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

3 Installation

3.1 Safety Instructions

See 2.3 Safety Precautions for general safety instructions.

3.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in the product-relevant operating guide and design guide. Refer to the fieldbus master manual from the PLC supplier for further installation guidelines.

3.3 Grounding Procedure

3.3.1 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 drive on a conductive mounting plate.
- Keep the ground wire connections as short as possible.
- To establish electrical contact between the cable shield and the drive enclosure, use metal grommets or the clamps provided on the equipment.
- Use high-strand wire to reduce burst transient.
- Use shielded Ethernet cables for Ethernet interface to ensure proper shield termination and effective EMC performance.

3.3.2 EtherNet Shield-to-Chassis Ground Connection

- The Ethernet option design of the drive provides a defined grounding and shielding path between the shield of the connected shielded Ethernet cable and the drive chassis.
- This connection provides a low-impedance path for high-frequency (HF) interference currents and supports the EMC performance of the fieldbus interface.
- The shield of the Ethernet cable is electrically bonded to the metallic housing of the RJ45 connector. From the RJ45 metallic housing, the shield connection is routed through the RC filter provided on the drive Ethernet board.
- The metallic frame of the Ethernet board is in contact with the drive chassis, which is connected to the drive main Protective Earth (PE) connection.
- The RC network on the drive Ethernet board provides a frequency-dependent path for high-frequency electromagnetic interference between the Ethernet cable shield and the drive chassis. This helps manage interference currents and may reduce noise coupling to other devices

3.4 Cable Routing

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

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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

SYSTEM MALFUNCTION

Correct handling of the shield of the motor cable is vital for the overall performance of the system. Not following the rules and recommendations may lead to loss of control and system malfunction.

- Only let qualified personnel install the option, and ensure that they adhere to rules and recommendations.

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°.

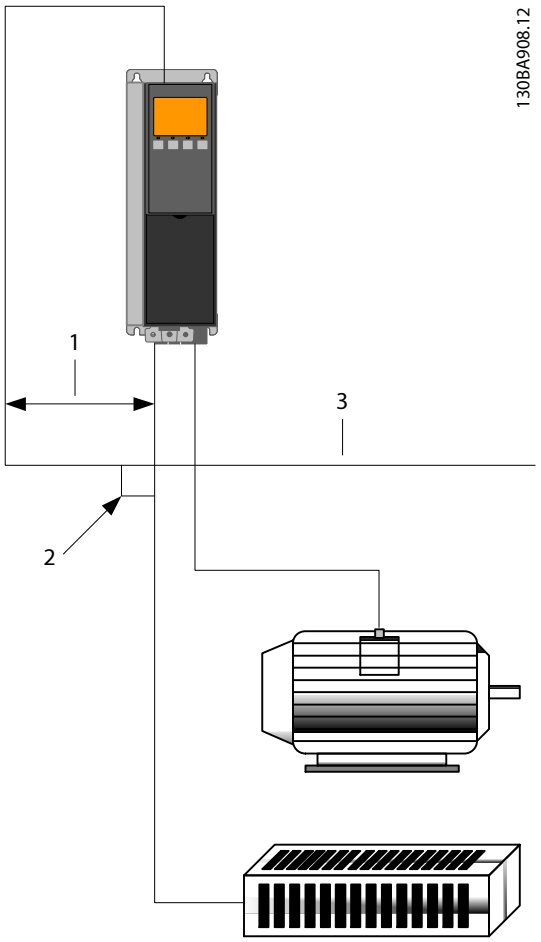


Figure 1: Cable Routing

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

3.5 Topology

3.5.1 Overview of Topology

The VLT® Modbus TCP MCA 122 module features a built-in Ethernet switch with 2 Ethernet RJ45 connectors. The fieldbus module enables the connection of several Modbus TCP 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.

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3.5.2 Star Topology

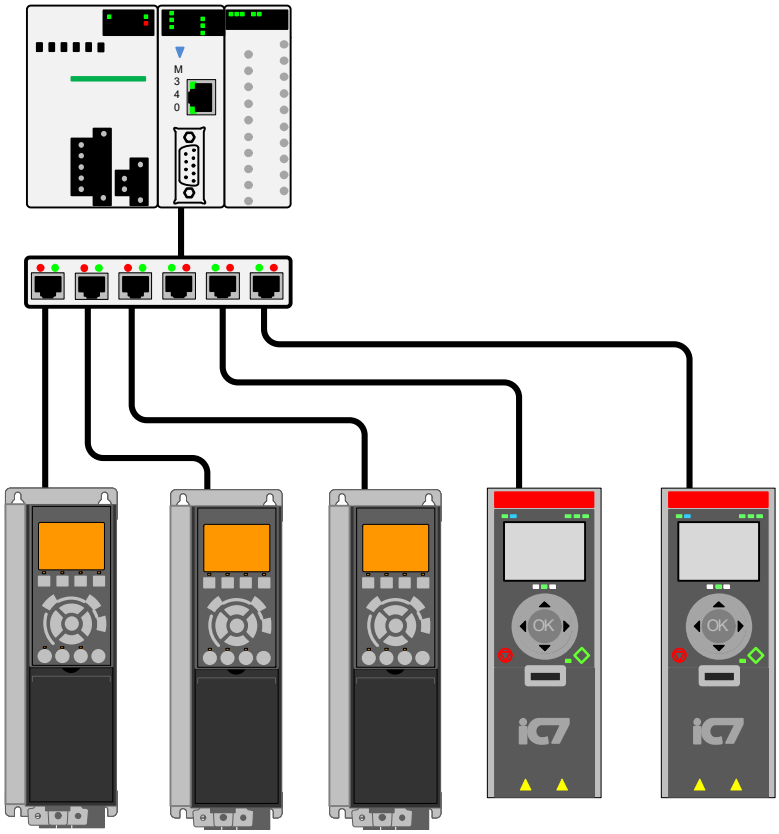


Figure 2: Star Topology

3.5.3 Line Topology

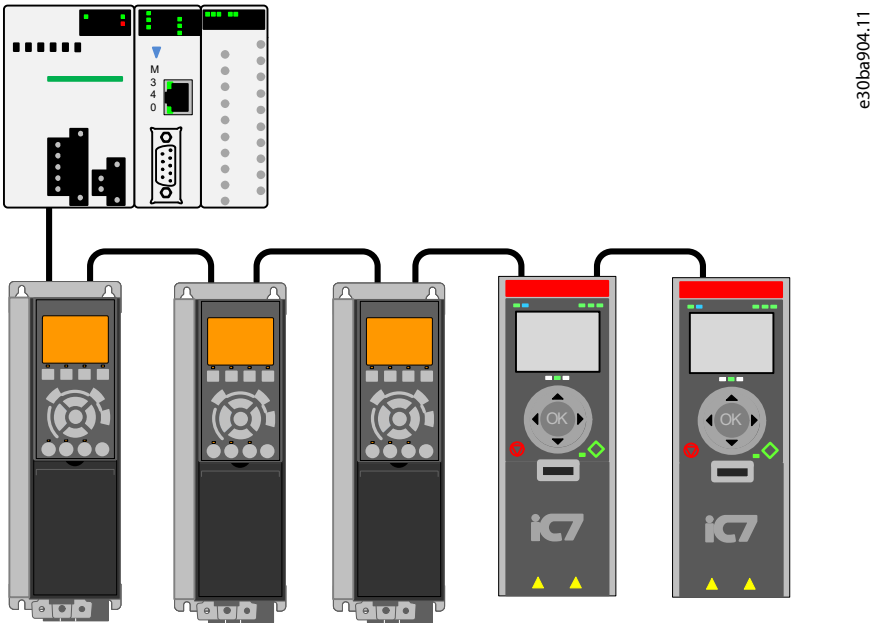


Figure 3: Line Topology

In a line topology, all drives must be powered, either by mains or by their 24 V DC option cards for the built-in switch to work.

Mounting of different power sizes in a line topology may result in unwanted power-off behavior. Smaller drives discharge faster than bigger drives. This can result in loss of link in the line topology, which may lead to control word timeout. To avoid this timeout, mount the drive with the longest discharge time first in the topology.

3.5.4 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 drives.
- Configure the redundancy manager switch to define clearly the ports that connect to the ring.

When the ring is closed, the redundancy manager tests the ring for defects. If the redundancy manager detects a fault in the ring, it reconfigures the ring into 2 lines instead. The transition time from ring topology into 2 lines can vary from 200 ms up to several seconds depending on the components installed in the ring. Set the timing of the PLC controller to ensure that the transition time does not lead to a timeout fault.

IMPORTANT: For ring/redundant topology, ensure that the redundancy manager switch supports the detection of loss of line topology. The switch inside the Modbus TCP interface does not support this detection, as the redundancy manager has to perform this task.

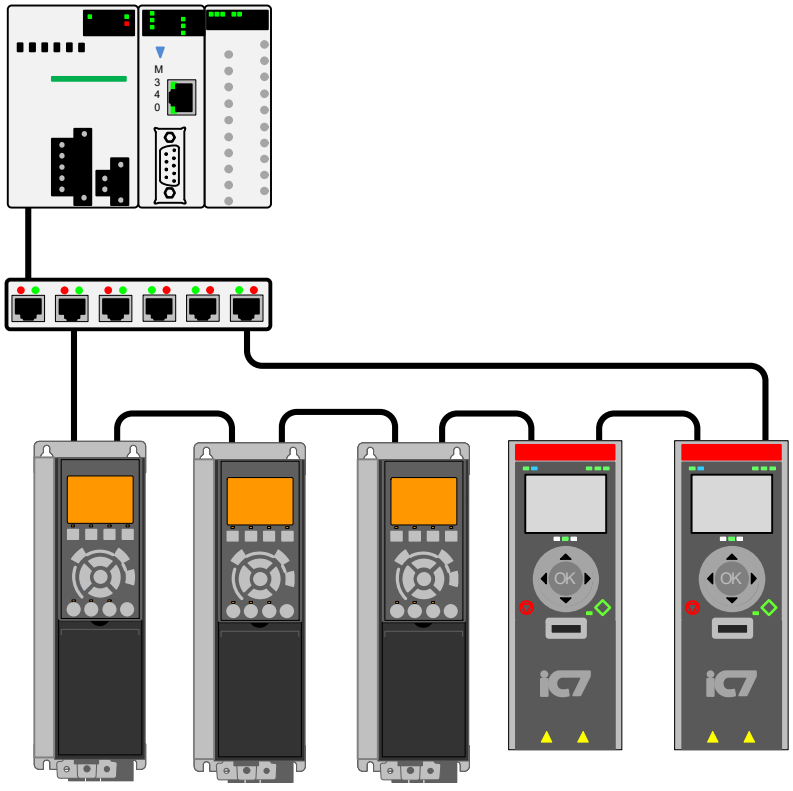


Figure 4: Ring/Redundant Line Topology

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.
- Do not connect more than 32 drives in a series. Exceeding this limit can result in unstable or faulty communication.

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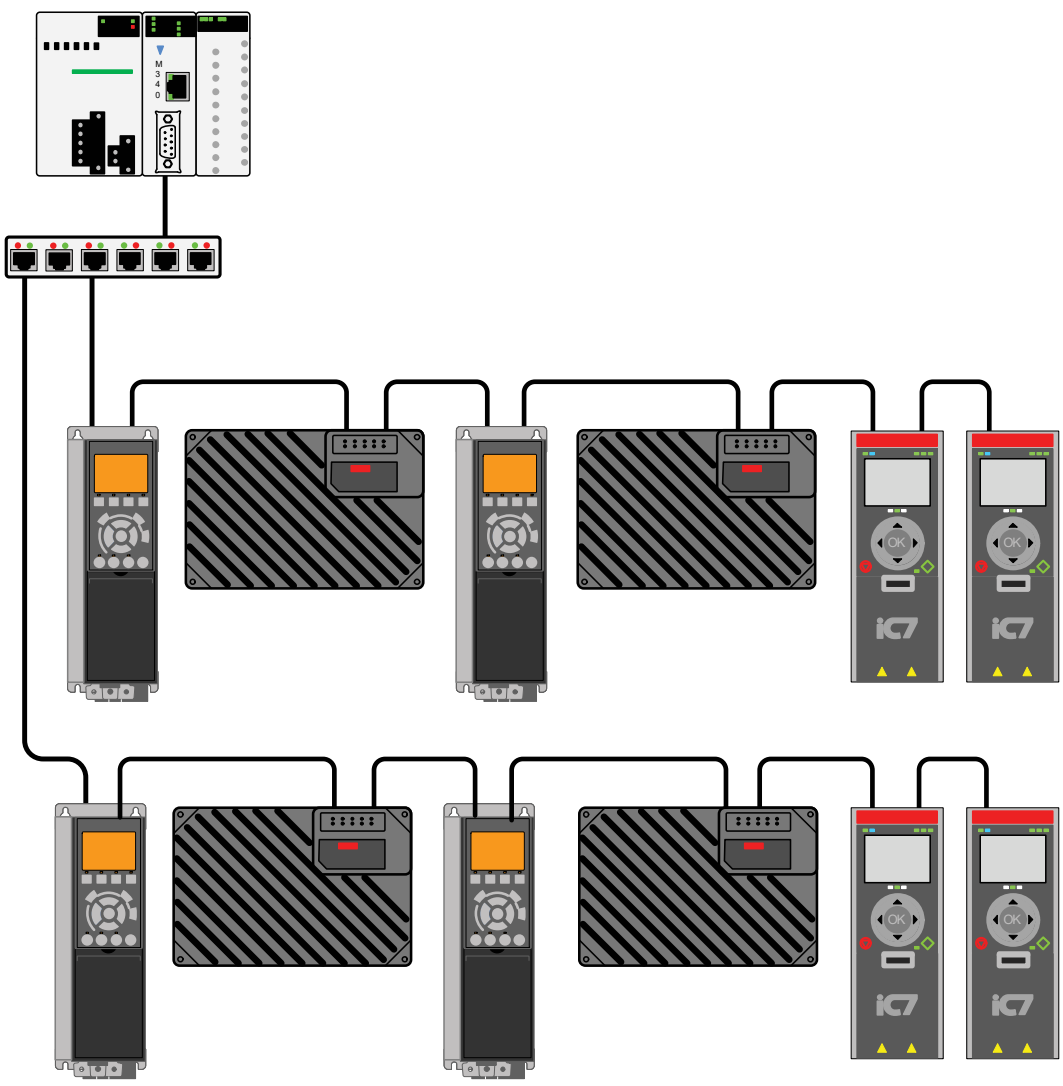


Figure 5: Recommended Design Rules

3.6 Mounting the Fieldbus Option

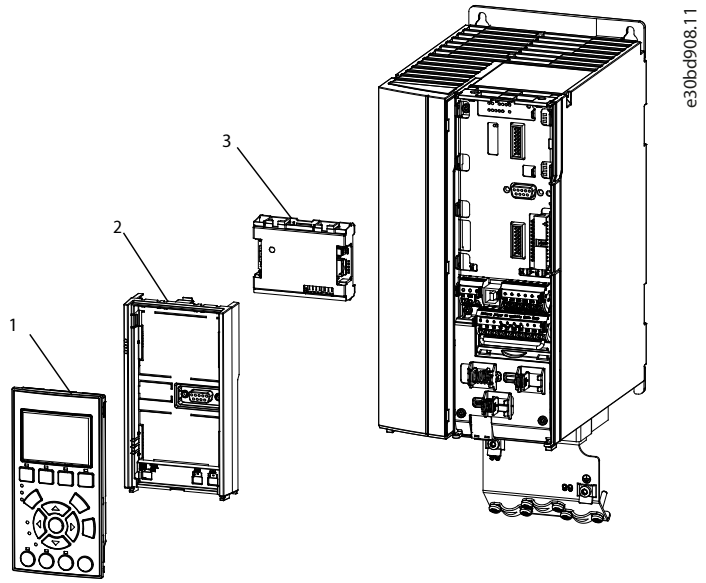


Figure 6: Exploded View of Drive and Fieldbus Option

1	LCP	2	LCP cradle
3	Fieldbus option		

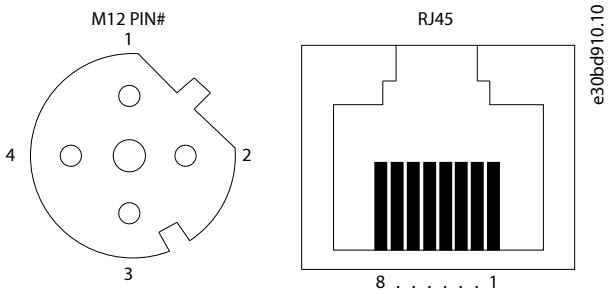


Figure 7: Ethernet Connectors

Table 2: Connector Signals

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

1. Check whether the fieldbus option is already mounted in the drive. If the option is already mounted, go to step 6.
2. Remove the LCP or blind cover from the drive.
3. Use a screwdriver to remove the front cover and the LCP cradle.
4. Mount the fieldbus option with the Ethernet port facing upwards for top cable entry (enclosure sizes A1–A3) or facing downwards (enclosure sizes A4–A5, B–E).

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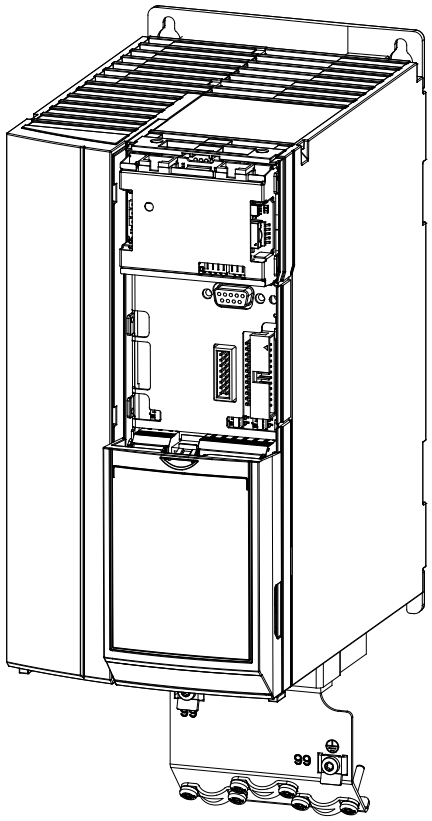


Figure 8: Option Mounted with the Ethernet Port Facing Upwards (A1–A3 Enclosures)

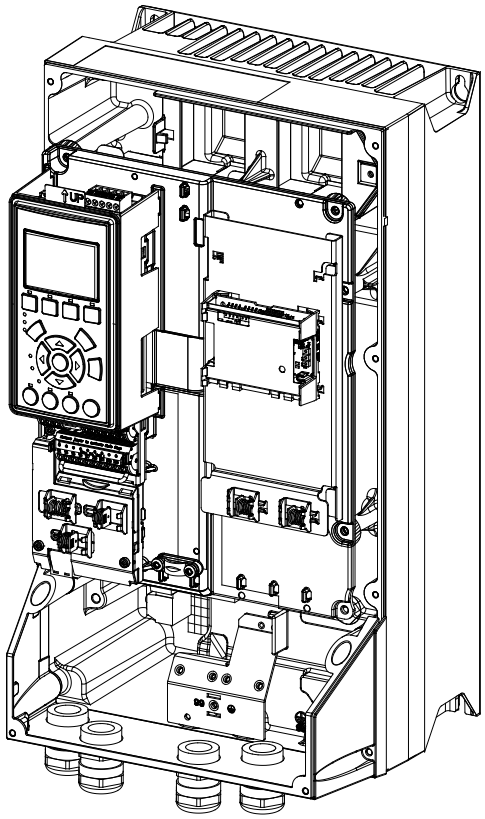


Figure 9: Option Mounted with the Ethernet Port Facing Downwards (A4, A5, B, C, D, and E Enclosures)

5. Remove the knockout plate from the new LCP cradle.

6. Mount the new LCP cradle.

3.7 Electrical Installation

3.7.1 Cabling Requirements

- Select cables suitable for Ethernet data transmission. Normally, CAT5e and CAT6e cables are recommended for industrial applications.
- Both types are available as unshielded twisted pair and shielded twisted pair. Shielded cables are recommended for use in industrial environments and with drives.
- A maximum cable length of 100 m (328 ft) is allowed between the switches.
- Use optical fibers for gapping longer distances and for providing galvanic isolation.
- For connecting Modbus TCP devices, both hubs and switches can be used. It is, however, always recommended to use suitable industrial graded Ethernet switches. For more information regarding IP switching, refer to the *VLT® Modbus TCP MCA 122 Programming Guide*.

3.7.2 Wiring - Enclosure Sizes A1–A3

1. Mount the preconfigured cable wires with the connectors on the fieldbus option.

   For A1 and A2 enclosures, mount the supplied strain relief on top of the drive with 2 screws, as shown in Figure 10. For cable specifications, refer to 3.7.1 Cabling Requirements.

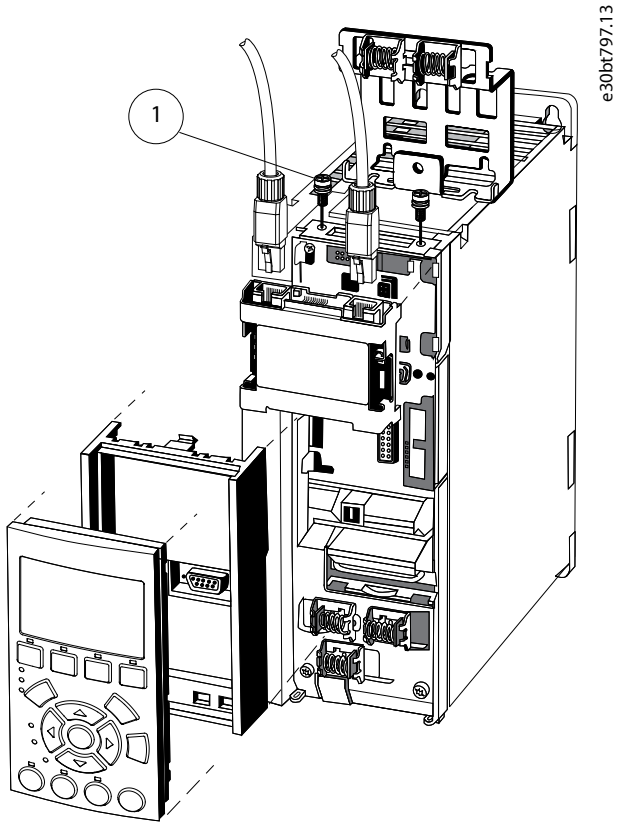


Figure 10: Wiring of Enclosures A1–A3

1	Strain relief mounted with screws

2. Position the cable shield between the spring-loaded metal clamps to ensure mechanical fixation.

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For grounding procedure, refer to 3.3.1 Grounding.

3.7.3 Wiring - Enclosure Sizes A4, A5, B1–B4, and C1–C4

1. Put the cable through the cable glands.
2. Mount the preconfigured cable wires with the connectors on the fieldbus option. For cable specifications, refer to 3.7.1 Cabling Requirements.
3. Fix the cable shield to the metal base plate using the springs.

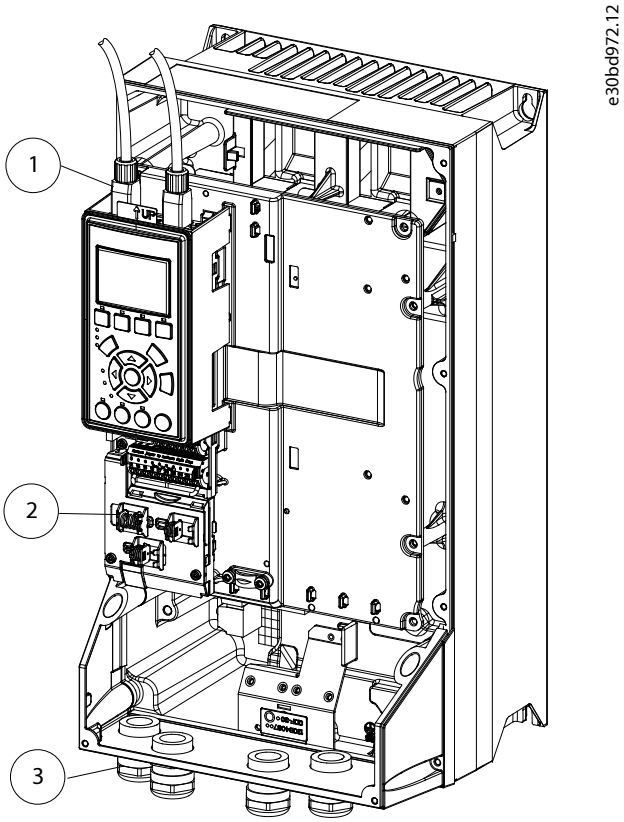


Figure 11: Wiring of Enclosure Sizes A4, A5, B1–B4, and C1–C4

1	Cable wires with connectors	2	Springs
3	Cable glands		

4. Tighten the cable glands securely.

3.7.4 Wiring - Enclosure Sizes D and E

IMPORTANT: Do not strip the Ethernet cable. Do not ground it via the strain relief plate. Ground the shielded Ethernet cables through the RJ45 connector on the Ethernet interface.

1. Mount the preconfigured cable wires with the connectors on the fieldbus option. For cable specifications, refer to 3.7.1 Cabling Requirements.
2. Fix the cable to the metal base plate using the springs.

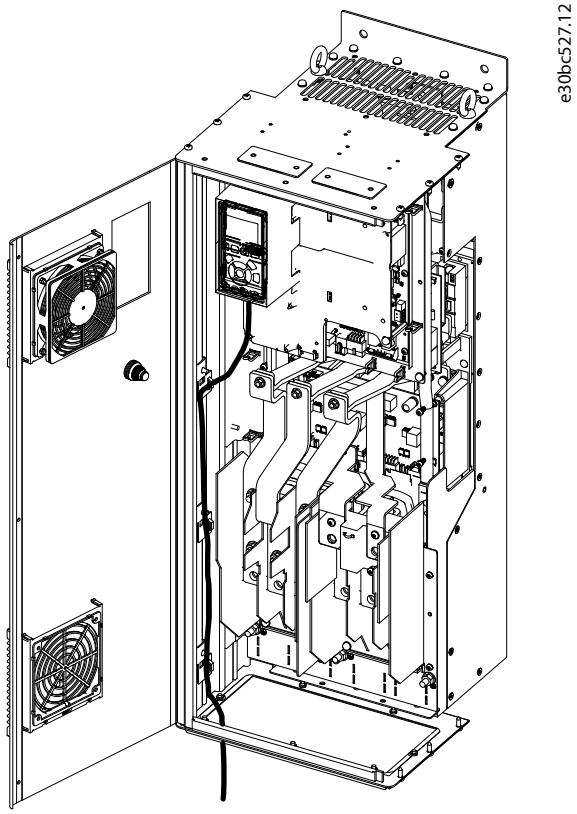


Figure 12: Wiring of Enclosure Sizes D and E

3. Tie down the cable and route it with other control wires inside the unit as shown in Figure 12.

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 drive-specific operating guide to commission the drive. The drive automatically detects the Modbus TCP interface. Parameter group ***12-4* Modbus TCP*** appears.

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4 Troubleshooting

4.1 Warnings and Alarms

IMPORTANT: Refer to the drive-specific operating guide for an overview of warning and alarm types, and for the full list of warnings and alarms.

Alarm words and warning words are shown in the display in hex format. When there is more than 1 warning or alarm, the sum of all warnings and alarms is shown. Warning words and alarm words are shown in parameter ***16-90 Alarm Word*** to parameter ***16-99 Ext. Status Word 3*** and in parameter ***18-67 Alarm Word 4*** to parameter ***18-68 Warning Word 4***.

4.2 LED Status

The VLT® Modbus TCP MCA 122 has 3 bicolored LEDs that allow a fast and detailed diagnosis. Each LED is linked to its unique part of the interface, see Table 3.

Table 3: LED Label

LED label	Description
MS	Module status, reflects the activity on the option module.
NS1	Network status 1, reflects the activity on port 1.
NS2	Network status 2, reflects the activity on port 2.

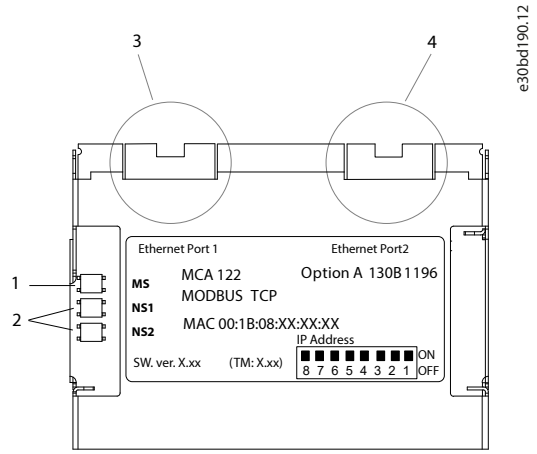


Figure 13: Overview of the VLT® Modbus TCP MCA 122 Option Module

1	MS LED	2	NS LEDs
3	Ethernet port 1	4	Ethernet port 2

IMPORTANT: In VLT® Motion Control Tool MCT 10, when the drive is scanned via Ethernet TSC, right-clicking the drive and selecting *Start Winking* causes the MS/NS LEDs to flash yellow (50% duty cycle at 1 Hz).

IMPORTANT: When link speed for port 1 or port 2 is 10 Mbps, the NS1 and NS2 LEDs go steady yellow.

Table 4: MS: Module Status

State	LED		Description
Off	Off	No power	No power is supplied to the device. The module status indicator is steady off.
Steady green		Device operational	The device has at least 1 conncetion from a Modbus client at port 502.
Flashing green		Standby	There are no client connected to the Modbus server at port 502.
Flashing red		Minor fault	The device has detected a recoverable minor fault, which is the failure to read/write a parameter from the control card. An address conflict is detected.
Steady red		Major fault	The device has detected a non-recoverable major fault. A major fault is hardware failure on the option, such as ram test, flash/EEPROM access error.
Flashing red/green	Red: 	Self test	The device is performing its power-up testing.
	Green: 		
Steady yellow		No IP address	An IP address has not been configured or obtained.
Flashing yellow		Wink	Flash for 20 s for identification.

Table 5: NS1 + NS2: Network Status (1 per Port)

State	LED		Description
Not powered, no link	Off	Off	The device is powered off, or no link is present.
Connected		Solid green	A link is present but not winked, and no address conflict is detected.
Address conflict		Solid red	The IP address assigned to the device is already in use.
Self test	Red: 	Flashing red/green	The device is performing its power-up testing.
	Green: 		
Device has been winked		Flashing yellow	Flash for 20 s
Link present at 10 Mbps		Steady yellow	A link is present, but it is not winked, and there is no ACD.

4.3 No Communication with the Drive

If there is no communication with the drive, proceed with the following checks:

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Check the link status

The status of the Ethernet link can be directly identified using the LEDs when no Modbus connection is established. Verify presence of the link in parameter ***12-10 Link Status***.

Verify that the link is steadily present in parameter ***12-11 Link Duration***. The parameter shows the duration of the present link and is preset to 00:00:00:00 when the link is broken.

Check the cabling

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

Check the IP address

Verify that the option has a valid IP address in parameter ***12-01 IP Address***. If the option has identified a duplicate IP address, the NS LEDs are solid red. If the option is set up for BOOTP or DHCP, verify that a BOOTP or DHCP server is connected in parameter ***12-04 DHCP Server***. If no server is connected, the parameter shows 000.000.000.000.

5 Appendix

5.1 Abbreviations

Abbreviation	Definition
API	Actual packet interval
CTW	Control word
DHCP	Dynamic host confiuration protocol
EMC	Electromagnetic compatibility
IGMP	Internet group management protocol
I/O	Input/output
IP	Internet protocol
LCP	Local control panel
LED	Light-emitting diode
LSB	Least significant bit
MAV	Main actual value (actual output)
MSB	Most significant bit
MRV	Main reference value
ODVA	Open DeviceNet Vendor Association
PC	Personal computer
PLC	Programmable logic controller
PNU	Parameter number
REF	Reference (=MRV)
s	Second
STP	Spanning tree protocol
STW	Status word
TCP	Transmission control protocol

5.2 Conventions

- Numbered lists indicate procedures that are to be followed sequentially.
- Bulleted and dashed lists indicate listings of other information where the order of the information is not relevant.
- Bolded text indicates important information and section headings.
- Italicized text indicates the following:
  - Cross-reference.
  - Link.
  - Footnote.
  - Alarms/warnings.
- Bolded and italicized text indicates the following:
  - Parameter name.
  - Parameter option.

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  - Parameter group name.
- All measurements and weights are shown first in metric, followed by imperial in brackets.
- An asterisk (*) indicates the default setting of a parameter.

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