VACON® NXP
AC DRIVES

SYSTEM DRIVE
HARDWARE MANUAL

VACON®

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1. INTRODUCTION

The VACON® NXP System Drive is a comprehensive configured common DC bus drive line up for heavy-industry needs where round-the-clock activity is required leaving little time for maintenance.

All sections are grouped depending on their functionality, making it possible to plan each installation phase according to your requirements. The engineered sections slot in alongside each other allowing you to arrange integrated transport splits to save space. Alternatively, you can add extra transport sections to speed up installation. All larger modules have slide-out mechanics for easier set-up and maintenance.

The VACON® NXP System Drive is built to last. Items such as busbar systems and high/low power devices are separated into individual compartments away from each other. This means that, if an issue occurs, it is compartmentalized and doesn't cause widespread failure helping to reduce lifetime and maintenance costs.

1.1 REVISION HISTORY

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

The original language of this manual is English.

Table 1. Manual revision history

Rev.	Release date	Changes/updates
A	17.12.2013	First version
B	07.01.2015	Updated Chapter 2 "Available sections". Updated Chapter 4.3 "Removing the drives from the cabinet".
C	23.06.2020	Changes to the chapter structure of the manual. Added Chapter 4.1 "Installation procedure". Updated Chapter 4.4 "Connecting the busbars". Added Chapter 4.6.3 "EMC grounding". Added Chapter 4.6.4 "Installation of ferrite rings (+OCM) on the motor cable". Added Chapter 4.6.6 "Auxiliary low-voltage connections". Added Chapter 4.7 "Screw tightening torques".

1.2 SCOPE OF SUPPLY

The scope of supply is limited to the drives listed in this manual. Process, machine or drive control systems are not part of the scope of supply.

1.3 RELATED BROCHURES AND MANUALS

VACON® NX user manuals and brochures are available in PDF format on the Danfoss website at www.danfoss.com.

- VACON® NXP Common DC Bus Selection Guide
- VACON® NXN NFE User manual
- VACON® NX Active Front End User Manual
- VACON® NX Inverters FI4-FI8 Operating Guide
- VACON® NX Inverters FI9-FI14 Operating Guide

Also manuals for different applications and option boards are available on the Danfoss website at www.danfoss.com.

1.4 DEFINITIONS AND ABBREVIATIONS

ADS	Auxiliary Device Section
AFS	Active Front-end Section
DBS	Dynamic Brake Section
DRL	Drive List
IUS	Inverter Unit Section
LV	Low Voltage
MIS	Main Incoming Section
NFS	Non-regenerative Front-end Section
SLD	Single Line Diagram
TSU	Transport Split Unit

1.5 PROJECT SPECIFICATIONS

1.5.1 PARAMETERS

Project parameters are selected with the line-up configuration tool. Table 2 shows an example of parameters selected with the configuration tool.

Table 2. Example of parameters selected from the configuration tool

Parameter	Selection
Mains network type	IT
Mains voltage	690 V AC
Frequency	50 Hz
Mains maximum current	2500 A
Busbar system	DC+, DC-, PE
Busbar system voltage	1100 V DC
Busbar system maximum current	2500 A
I_{cw}, 1 s	50 kA
PE design	50%
Busbars and flexibars	Tinned
Cabinet type	Rittal TS8
Height	2000 mm
Depth	600 mm
Cabinet material	Powder coated steel
Sheet steel parts within the enclosure	Without coating
Colour	RAL 7035
Ingress protection of enclosure	Protection against accidental touching of live parts
Protection barriers and covers	IP 21
Ambient temperature	35°C
Halogen free wires and ducts	No
Mimic diagram	No
Type of packing	Sea freight box
Application	Industry

1.5.2 SECTIONS AND OPTIONS

Sections and options are selected using the line-up configuration tool.

The available sections and options are introduced in Chapter 3.

Table 3. Example of selected sections and options from the configuration tool

#	Section type	Section category	Options
1	ADS_600	Control	+PES
2	MIS_2500	Incoming power	+ICB
3	AFS_13	Incoming power	-
4	IUS_4	Outgoing power	+ODU
5	IUS_10	Outgoing power	+ODU
6	IUS_10	Outgoing power	+ODU
7	IUS_12	Outgoing power	+ISC, +ODU
8	IUS_7	Outgoing power	+ODU
9	IUS_12	Outgoing power	+ISC, +ODU

1.5.3 SYSTEM LAYOUT AND FOOTPRINT DRAWINGS

System layout and footprint drawings are created based on the sections and options selected with the line-up configuration tool.

1.6 SUPPLIED DOCUMENTATION

Danfoss delivers technical documentation for the switchgear assembled AC drives according to the Danfoss design standard. The documentation is provided in english.

The scope of supply regarding documentation does not include:

- Special requirements
- Delivery specific requirements
- Customer specific requirements (e.g. marking, naming, coding etc.)

Table 4. Supplied documentation

Document type	Electronic format	Paper copies
Cable connection table	dwg, dxf or pdf	3 sets
Parts list	dwg, dxf or pdf	3 sets
Wiring list	dwg, dxf or pdf	3 sets
Circuit diagram	dwg, dxf or pdf	3 sets
Switchgear layout drawing	dwg, dxf or pdf	3 sets
Device layout drawing	dwg, dxf or pdf	3 sets
VACON® manuals (as applicable)	pdf	3 sets

1.7 STORAGE

If the system drive is to be kept in store before use, make sure that the ambient conditions are acceptable:

- Storing temperature –40...+70 °C
- Relative humidity <95%, no condensation

The environment should also be free from dust. If there is dust in the air, the drive should be well protected to make sure dust does not get into the drive.

If the drive is to be stored during longer periods, the power should be connected to the drive once in 24 months and kept on for at least 2 hours. If the storage time exceeds 24 months the electrolytic DC capacitors need to be charged with caution. Therefore, such a long storage time is not recommended.

If the storing time is much longer than 24 months, the recharging of the capacitors has to be carried out so that the possible high leakage current through the capacitors is limited. The best alternative is to use a DC power supply with adjustable current limit. The current limit has to be set for example to 300-500 mA and the DC power supply has to be connected to the B+/B- terminals (DC supply terminals).

DC voltage must be adjusted to nominal DC voltage level of the unit (1.35xU_n AC) and supplied at least for 1 hour.

If DC voltage is not available and the unit has been stored de-energized much longer than 1 year, consult factory before connecting power.

1.8 LIFTING AND MOVING THE CABINET SECTIONS

For transport, the system drive is split into smaller sections. The cabinet sections are delivered either in a wooden box or a wooden cage. The cabinets are transported vertically. Always refer to shipping marks for more detailed information. To lift the cabinet sections, use lifting equipment capable of handling the weight of the cabinets.

There are lifting beams on the top of the cabinets. Use the beams to lift and to move the cabinets to the required location.

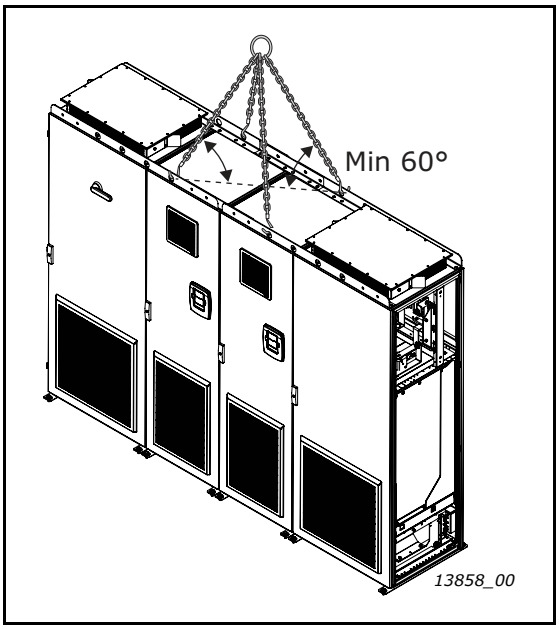


Figure 1. Lifting the cabinet sections

Moving of the cabinets on site can be carried out as follows by a forklift truck, a hoist or on rollers:

- Lower the package onto a level base
- Remove the package covering only at the site of installation
- Low, narrow or convoluted transport routes may require removal of the pallet prior to movement
- Move packages in the upright position only

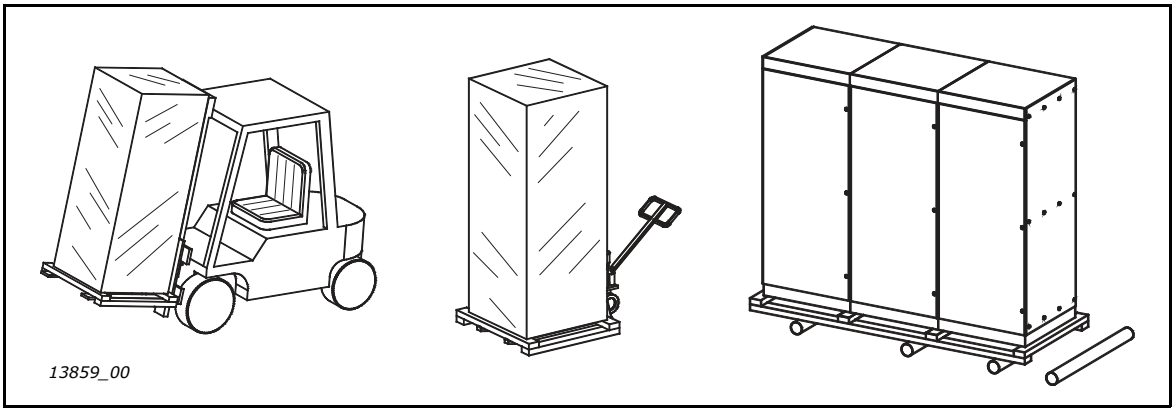


Figure 2. Moving the cabinet sections

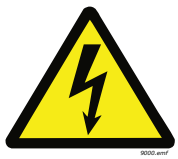
Switchgear parts can easily topple backwards when manoeuvring on rollers or manual trolleys because their centre of gravity is typically located high up at the rear of the unit.

2. SAFETY

NOTE! You can download the English and French product manuals with applicable safety, warning and caution information from https://www.danfoss.com/en/service-and-support/.
REMARQUE Vous pouvez télécharger les versions anglaise et française des manuels produit contenant l'ensemble des informations de sécurité, avertissements et mises en garde applicables sur le site https://www.danfoss.com/en/service-and-support/.

Please, read the information in cautions and warnings carefully.

The cautions and warnings are marked as follows:

	**= WARNING, dangerous voltage!**
	**= CAUTION, possible damage to equipment!**

Installation is only permitted to be carried out by a competent electrician!

2.1 WARNINGS

	The **components of the power unit and all cabinet mounted devices are live** when the drive is connected to mains potential. Coming into contact with this voltage is **extremely dangerous** and may cause death or severe injury.
	The **motor terminals U, V, W, the DC bus/brake resistor terminals and all other mains devices are potentially live** when the drive is connected to mains, even if the motor is not running.
	**After disconnecting** the AC drive from the mains, **wait** until the fan stops and the indicators on the keypad go out (if no keypad is attached see the indicators on the cover). Wait 5 more minutes before doing any work on the connections of the drive. Do not open the cabinet door before this time has expired. After expiration of this time, use measuring equipment to absolutely ensure that no voltage is present. **Always ensure the absence of voltage before starting any electrical work!**
	The control I/O-terminals are isolated from the mains potential. However, the **relay outputs and other I/O-terminals may have a dangerous control voltage** present even when the drive is disconnected from mains.
	**Before connecting** the drive to mains make sure that the drive front and cable covers as well as the cabinet doors are closed.
	Wear protective gloves when you do mounting, cabling or maintenance operations. There can be sharp edges in the AC drive that can cause cuts.

2.2 CAUTIONS

	VACON® AC drives are meant for **fixed installations only**.
	**Do not perform any measurements** when the AC drive is connected to mains.
	The **touch current** of VACON® AC drives exceeds 3.5 mA_{AC}. According to standard EN61800-5-1, **a reinforced protective ground connection** must be ensured. See Chapter 2.3.
	If the drive is used as a part of a machine, the **machine manufacturer is responsible** for providing the machine with a supply disconnecting device (EN60204-1).
	Only **spare parts** delivered by Danfoss can be used.
	At power-up, power brake or fault reset **the motor will start immediately** if the start signal is active, unless the pulse control for Start/Stop logic has been selected. Futhermore, the I/O functionalities (including start inputs) may change if parameters, applications or software are changed. Disconnect, therefore, the motor if an unexpected start can cause danger.
	The **motor starts automatically** after automatic fault reset if the autoreset function is activated. See the Application Manual for more detailed information.
	**Prior to measurements on the motor or the motor cable**, disconnect the motor cable from the drive.
	**Do not touch the components on the circuit boards**. Static voltage disharge may damage the components.
	Check that the **EMC level** of the AC drive corresponds to the requirements of the supply network.
	Make sure that the cooling is sufficient. If the AC drive becomes frequently too hot, the lifetime of the drive will be shorter than usually.

2.3 GROUNDING AND GROUND FAULT PROTECTION

CAUTION!

The AC drive must always be grounded with a grounding conductor connected to the grounding terminal marked with:

The touch current of the AC drive exceeds 3.5 mA AC. According to EN61800-5-1, one or more of the following conditions for the associated protective circuit shall be satisfied:

A fixed connection and

- the **protective grounding conductor** shall have a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al, or
- an automatic disconnection of the supply in case of discontinuity of the **protective grounding conductor**, or
- provision of an additional terminal for a second **protective grounding conductor** of the same cross-sectional area as the original **protective grounding conductor**.

Table 5. Protective grounding conductor cross-section

Cross-sectional area of phase conductors (S) [mm^2]	Minimum cross-sectional area of the corresponding **protective grounding conductor** [mm^2]
$S \leq 16$ $16 < S \leq 35$ $35 < S$	S 16 $S/2$
The values above are valid only if the protective grounding conductor is made of the same metal as the phase conductors. If this is not so, the cross-sectional area of the protective grounding conductor shall be determined in a manner which produces a conductance equivalent to that which results from the application of this table.	

The cross-sectional area of every protective grounding conductor which does not form part of the supply cable enclosure shall, in any case, be no less than:

- 2.5 mm^2 if mechanical protection is provided or
- 4 mm^2 if mechanical protection is not provided. For cord-connected equipment, provisions shall be made so that the protective grounding conductor in the cord shall, in the case of failure of the strain-relief mechanism, be the last conductor to be interrupted.

However, always follow the local regulations for the minimum size of the protective grounding conductor.

NOTE! Due to the high capacitive currents present in the AC drive, fault current protective switches may not function properly.

Do not perform any voltage withstand tests on any part of the AC drive. There is a certain procedure according to which the test shall be performed. Ignoring this procedure may result in a damaged product.

3. AVAILABLE SECTIONS

3.1 AUXILIARY DEVICE SECTION

The auxiliary device section (ADS) includes the common line-up controls. This section can be customized for all application and segment needs. There are three ADS sizes available.

Table 6. ADS section size

ADS type	Width x Height x Depth (mm)
ADS_400	400 x 2000 x 605
ADS_600	600 x 2000 x 605
ADS_800	800 x 2000 x 605

As standard the ADS section has the following equipment:

1. Control for the circuit breaker with +ICB selected
2. Indication of the mains status (fault, pre-charging and ON)
3. Auxiliary power supply 24 V, 5 A
4. Auxiliary Transformer, 2500 VA 1-phase supply (in bottom of cabinet)
5. Terminals for control and monitoring

As pre-engineered standard options, we can provide the following:

- Emergency stop CAT0 (+PES)
- Emergency stop CAT1 (+PED)
- Insulation fault sensor (+PIF)
- Arc protection relay (+PAP)
- Cabinet heater (+ACH)
- Cabinet light (+ACL)
- Auxiliary voltage transformer 4000 VA (+AT4)
- Auxiliary voltage 110 V AC (+AT1)
- Auxiliary power supply 24 V, 10 A (+ADC)
- Cabling from the top (+CIT)
- Empty auxiliary 600 mm cabinet with door (+G60)
- UL approved design and components (+NAR)
- Customer specific option (+CSO)

+PAP will have sub units in selected sections if needed, please refer to the circuit diagrams.

3.2 MAIN INCOMING SECTION

The main incoming section (MIS) includes the main incoming device. The main incoming device and size is dependent on the required current of the complete line-up.

Table 7. Available MIS sizes

MIS type	Input current	Width x Height x Depth (mm)
MIS_630	630 A	400 x 2000 x 605
MIS_800	800 A	600 x 2000 x 605
MIS_1000	1000 A	600 x 2000 x 605
MIS_1250	1250 A	600 x 2000 x 605
MIS_1600	1600 A	600 x 2000 x 605
MIS_2000	2000 A	600 x 2000 x 605
MIS_2500	2500 A	600 x 2000 x 605
MIS_3200	3200 A	800 x 2000 x 605
MIS_4000	4000 A	800 x 2000 x 605
MIS_5000	5000 A	800 x 2000 x 605

As standard the MIS section has the following equipment (see Figure 3):

1. Air circuit breaker
2. Mains connections
3. Digital multi instrument with field bus connection
4. Pre-charging components for AFE

As pre-engineered standard options we can provide the following:

- Cabling from the top (+CIT)
- Ground Switch (+ILE)
- Current transducers (+ITR)
- UL approved design and components (+NAR)
- Arc detection (+ADU)
- Cabinet heater (+ACH)
- Cabinet light (+ACL)

+ILE requires an additional section.

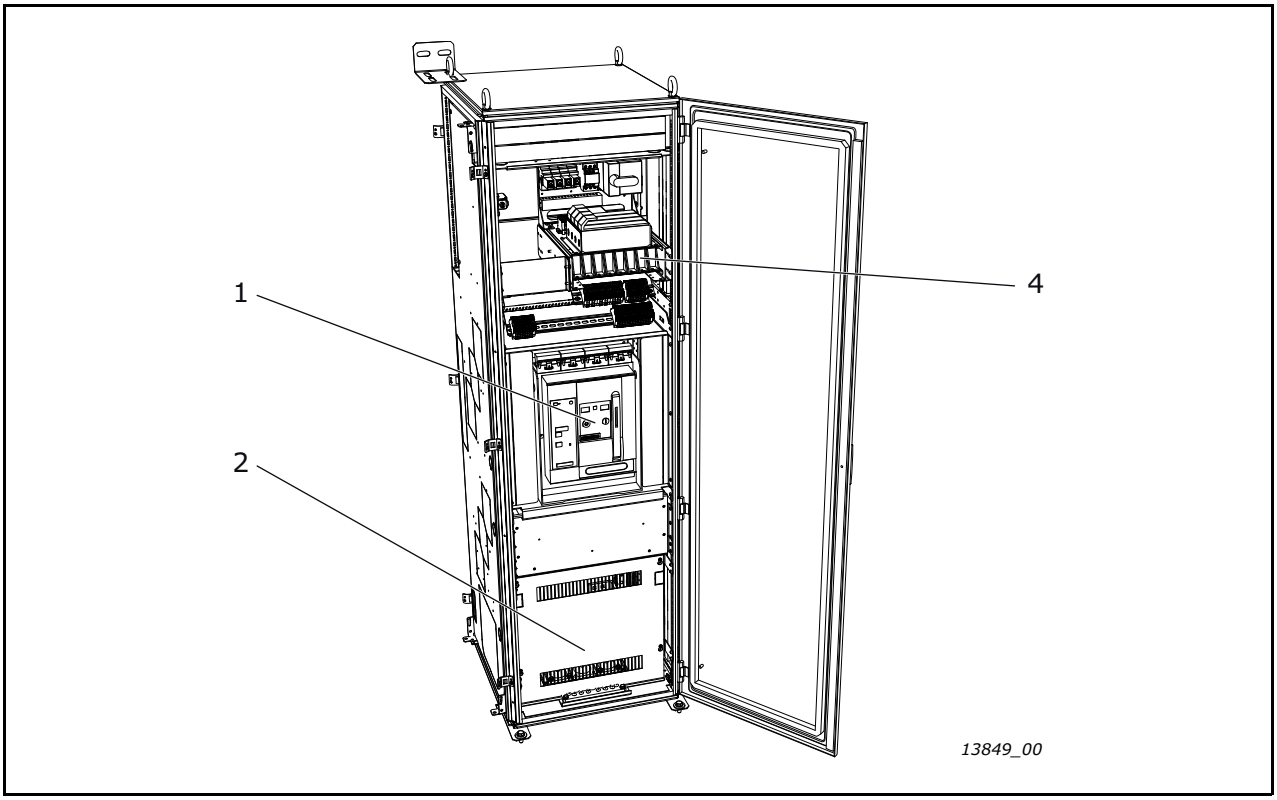


Figure 3. Example of main incoming section MIS_1600

3.3 NON-REGENERATIVE FRONT-END SECTION

The non-regenerative front-end section (NFS) includes one or multiple NXN units from the VACON® NXP product series. The NXN is a non-regenerative supply unit that can be utilized in 6-pulse, 12-pulse, 18-pulse and 24-pulse systems.

Table 8. Available NFS sections

NFS type	Number of NXN units	Width x Height x Depth (mm)
NFS_1x*	1	800 x 2100 x 605
NFS_2x*	2	800 x 2100 x 605

* _M selection for mirrored design.

As standard the NFS section includes the following (see Figure 4):

1. The NXN unit(s)
2. Chokes
3. Terminals for control and indication signals (installed in MIS or ADS section)
4. DC fuses for the Supply Unit
5. AC fuses for the filter

As pre-engineered standard options we can provide the following:

- UL approved design and components (+NAR)
- Arc detection (+ADU)
- Cabinet heater (+ACH)
- Cabinet light (+ACL)

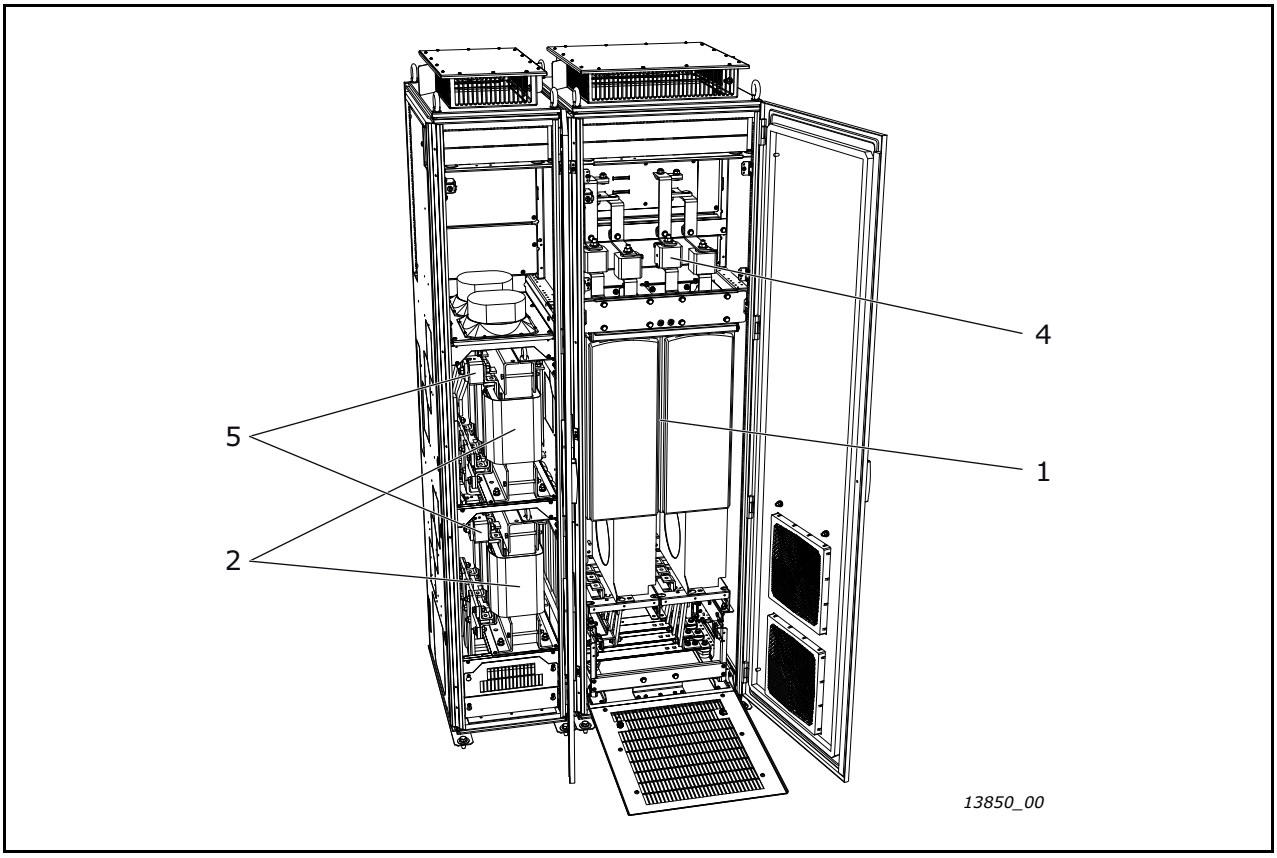


Figure 4. Example of non-regenerative front-end section NFS_2x

3.4 ACTIVE FRONT-END SECTION

The active front-end section (AFS) includes an LCL-filter and an NXA unit from the VACON® NXP product series. The active front-end provides low THD(I) and several units can be connected in parallel providing full or reduced redundancy.

Table 9. Available AFS sections

AFS type	Drive size	Width x Height x Depth (mm)
AFS_9*/**	FI9	800 x 2100 x 605***
AFS_10*/**	FI10	800 x 2100 x 605***
AFS_13*/**	FI13	1400 x 2100 x 605***
AFS_13_2x*/**	FI13	3200 x 2100 x 605***

* _M selection for mirrored design.
** +AC, AC busbars for two or more AFS sections after the MIS section, limited to 2600 A per side of the MIS.
*** Dimensions including LCL.

As standard the AFS sections include the following (see Figure 5):

1. LCL Filter
2. The NXA unit
3. Control unit
4. Pre-charging components (installed in MIS section)
5. Terminals for control and indication signals (installed in MIS or ADS section)
6. DC fuses for the Supply Unit
7. AC fuses for the filter (installed in MIS section)

As pre-engineered standard options we can provide the following:

- UL approved design and components (+NAR)
- Arc detection (+ADU)
- Cabinet heater (+ACH)
- Cabinet light (+ACL)

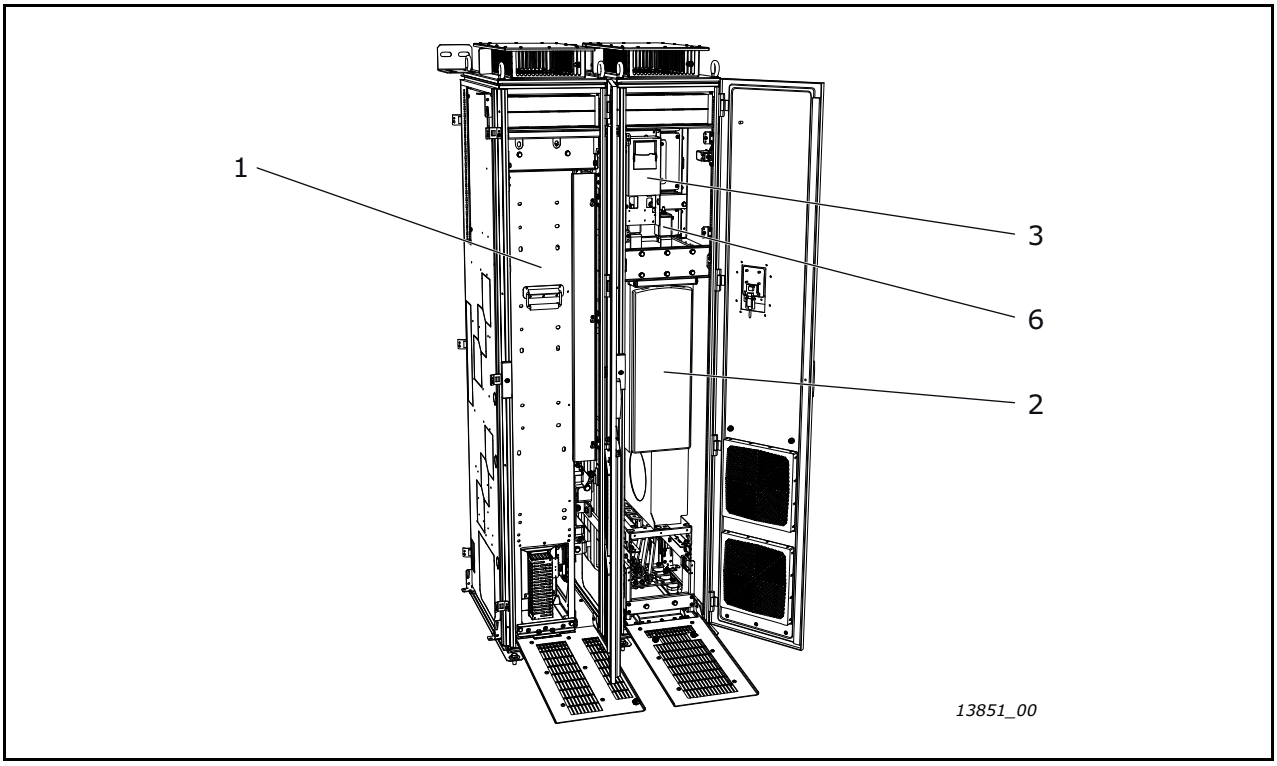


Figure 5. Example of active front-end section AFS_9

3.5 INVERTER UNIT SECTION

3.5.1 DRIVE SIZES FR4-FR8

The inverter unit section (IUS) includes one or several smaller NXI drives from the VACON® NXP product series. The inverter units are all VACON® NXP premium drives.

Table 10. Available IUS section sizes FR4-FR8

IUS type	Drive size	Number of drives/ section	Width x Height x Depth (mm)
IUS_4_x	FR4*	1-3	400 x 2100 x 605**
		4-14	1200 x 2100 x 605**
IUS_6_x	FR6	1-2	400 x 2100 x 605**
IUS_7	FR7	1	400 x 2100 x 605**
IUS_8	FR8	1	400 x 2100 x 605**
COT_4-8***	-	-	400 x 2000 x 605

* Only option board and fieldbus options
**Top exit +400 mm can be shared between two sections
*** Section for cabling with top cabling option (+COT)

As standard the IUS section includes the following (see Figure 6):

1. Input fuses (DC fuses)
2. Fuse switch (IEC FR4-FR6)
3. The NXI drive(s)
4. Control box (integrated into the module)
5. Terminals for control and indication signals

As pre-engineered standard options we can provide the following:

- dU/dt (+ODU)
- Input Switch, DC disconnect (+ISD)
- Arc detection (+ADU)
- Motor fan control (+AMF)
- Motor heater feeder (+AMH)
- Mechanical break control (+AMB)
- Top cabling (+COT)
- UL approved design and components (+NAR)
- Cabinet heater (+ACH)
- Cabinet light (+ACL)

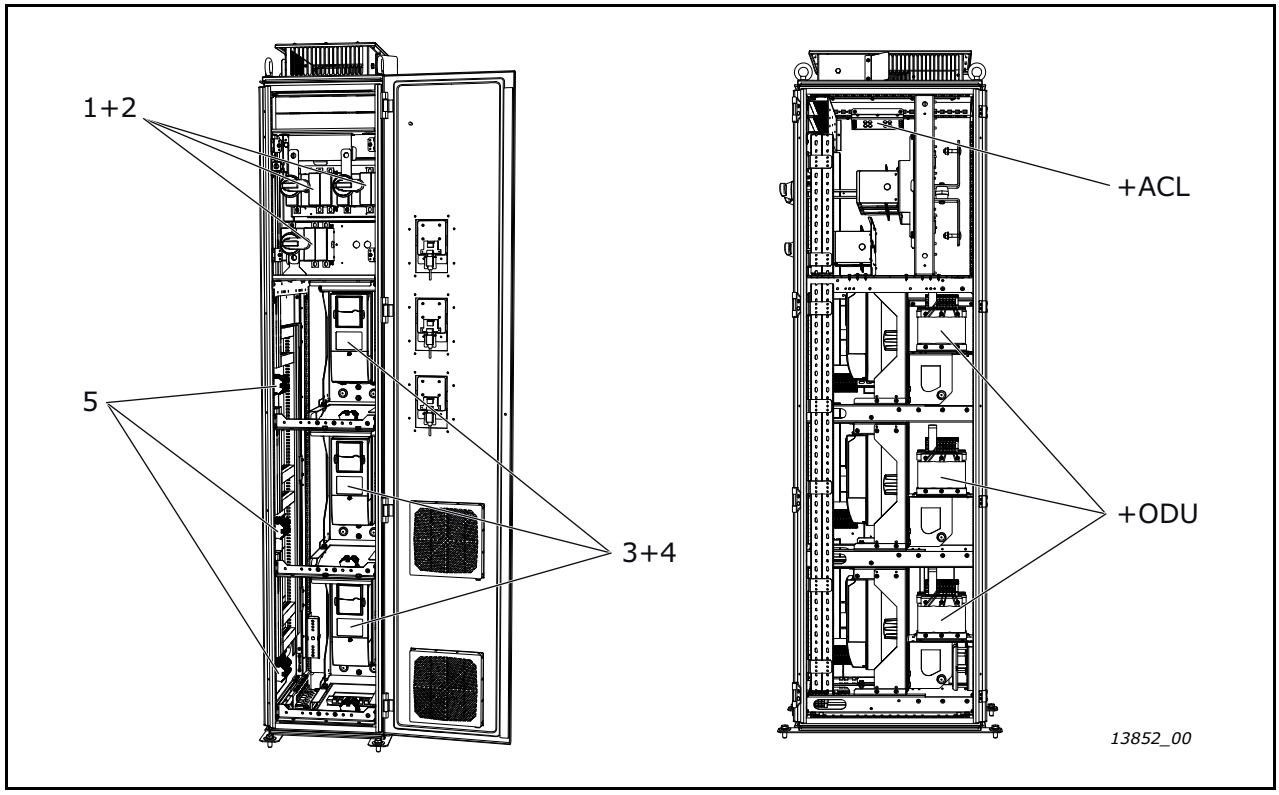


Figure 6. Example of inverter unit IUS_4

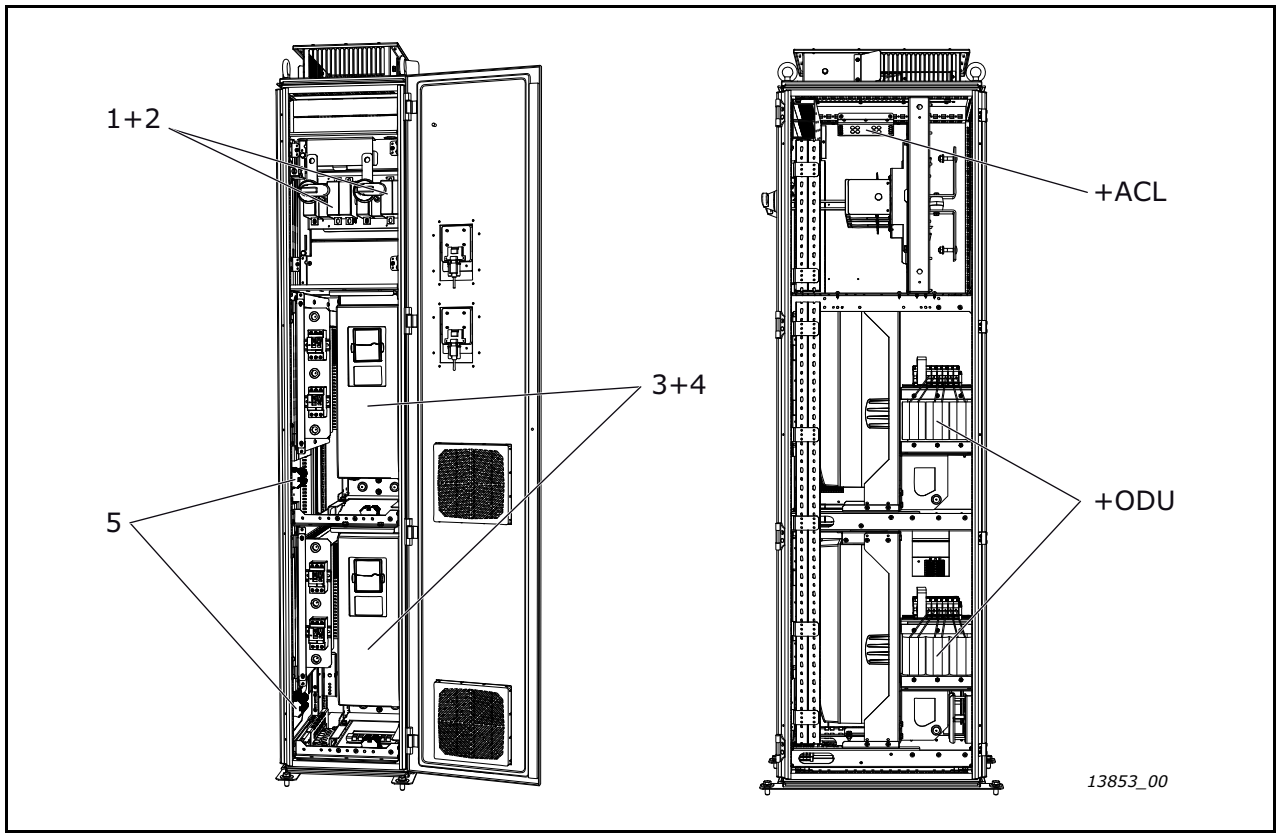


Figure 7. Example of inverter unit IUS_6

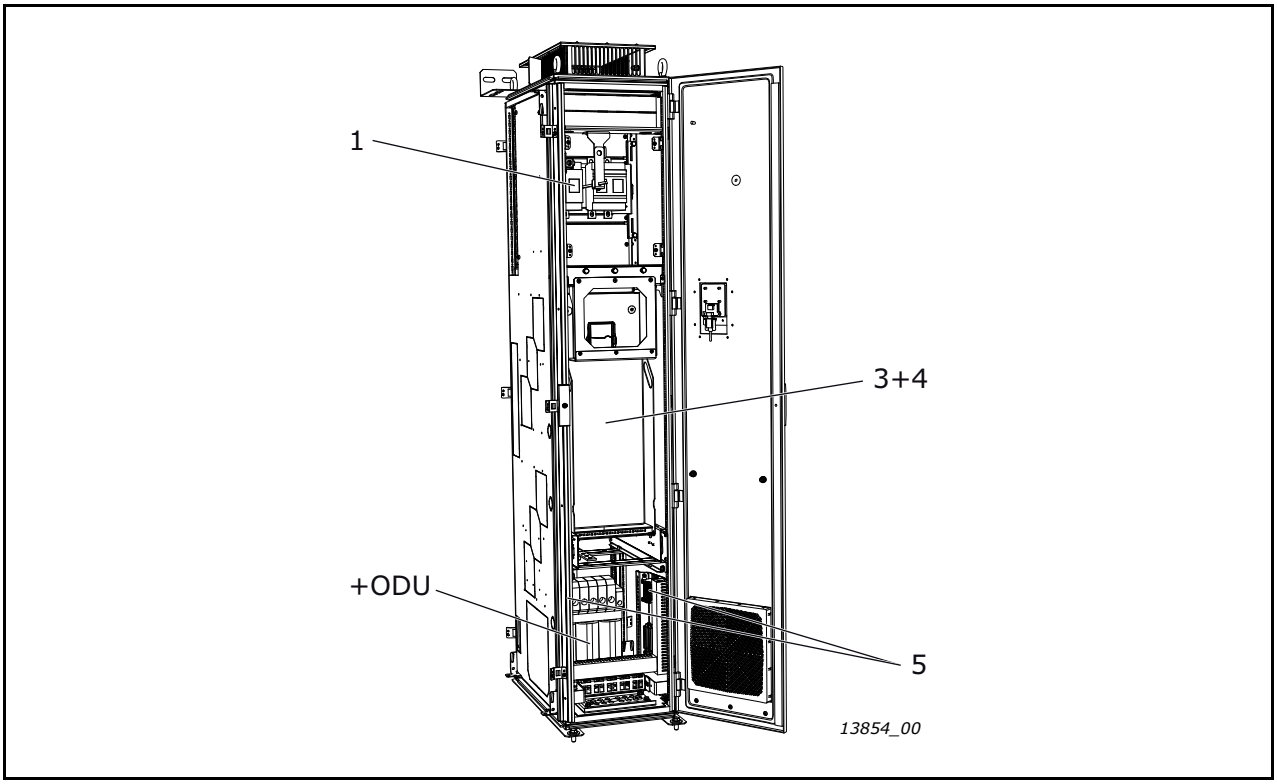


Figure 8. Example of inverter unit IUS_8

3.5.2 DRIVE SIZES FI9-FI14

The inverter unit section (IUS) includes the largest NXI drives from the VACON® product series. The inverter units are all VACON® NXP premium drives.

Table 11. Available IUS section sizes FI9-FI14

IUS type	Drive size	Width x Height x Depth (mm)	Width x Height x Depth (mm), with +ODU
IUS_9	FI9	800 x 2100 x 605	800 x 2100 x 605
IUS_9_2x	FI9	1200 x 2100 x 605	1200 x 2100 x 605
IUS_10	FI10	800 x 2100 x 605	800 x 2100 x 605
IUS_10_2x	FI10	1200 x 2100 x 605	1200 x 2100 x 605
IUS_12	FI12	1000 x 2100 x 605	1000 x 2100 x 605
IUS_12_2x	FI12	1800 x 2100 x 605	Not available
IUS_13	FI13	1400 x 2100 x 605	1400 x 2100 x 605
IUS_14	FI14	2800 x 2100 x 605	2800 x 2100 x 605

As standard the IUS section includes the following (see Figure 9):

1. Input fuses (DC fuses)
2. The NXI drive
3. Service platform/module removal
4. Control section and fixed external terminals, 70 pcs

As pre-engineered standard options we can provide the following:

- dU/dt (+ODU)
- Common mode filter (+OCM)
- Input Switch with charging (+ISC)
- Arc detection (+ADU)
- Motor fan control (+AMF)
- Motor heater feeder (+AMH)
- Mechanical break control (+AMB)
- Top cabling (+COT)
- UL approved design and components (+NAR)
- Cabinet heater (+ACH)
- Cabinet light (+ACL)

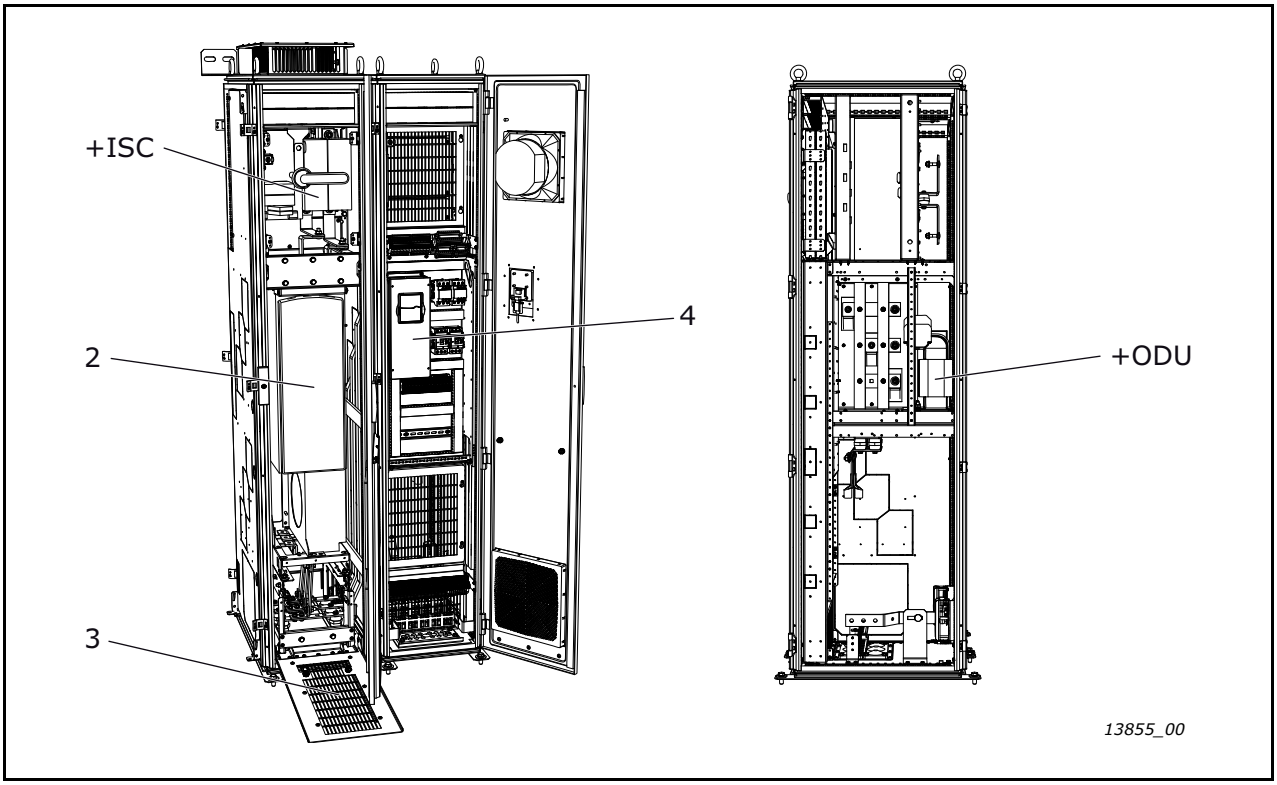


Figure 9. Example of inverter unit IUS_9

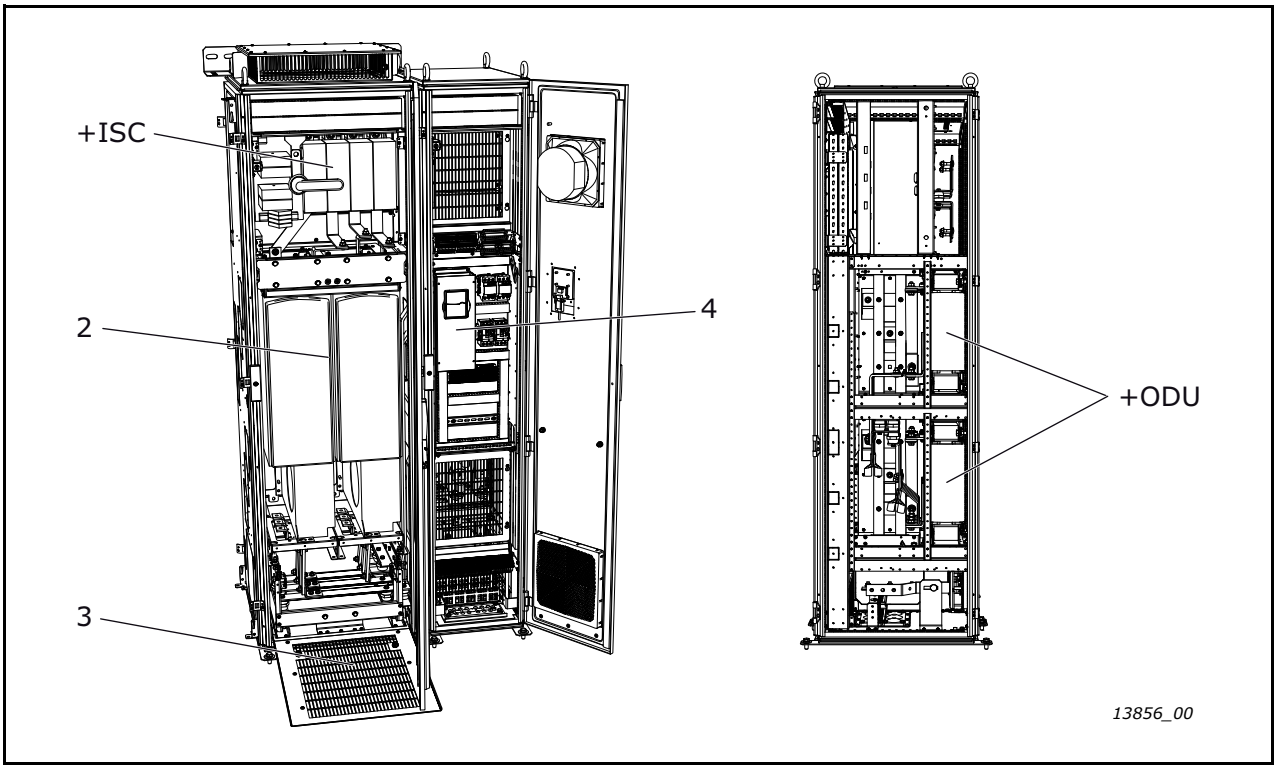


Figure 10. Example of inverter unit IUS_12

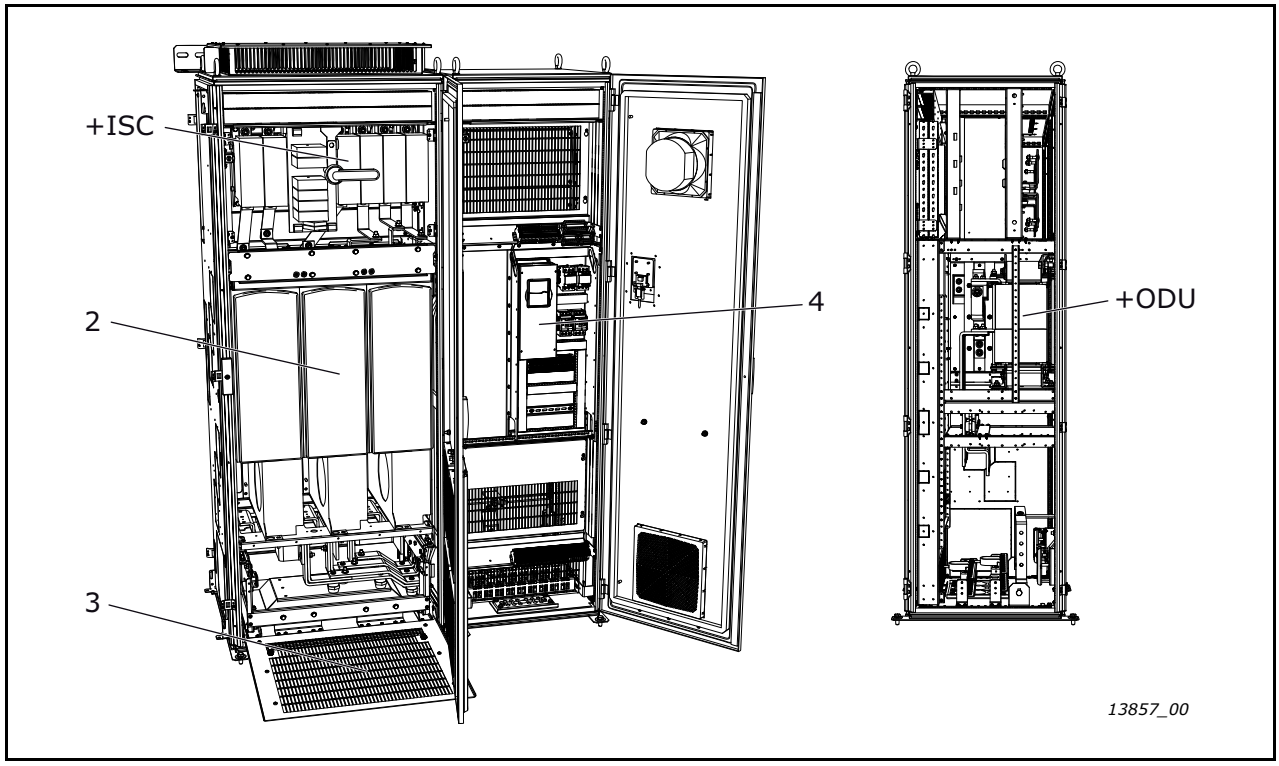


Figure 11. Example of inverter unit IUS_13

3.6 DYNAMIC BRAKE SECTION

The dynamic brake section (DBS) includes the largest NXI drives from the VACON® NXP product series. The brake units are all VACON® NXP premium drives.

As standard the DBS section includes the following:

1. Input fuses (DC fuses)
2. The NXI brake chopper
3. Service platform/module removal
4. Control section and fixed external terminals, 70 pcs

As pre-engineered standard options we can provide the following:

- Input Switch (with charging) (+ISC)
- Input Switch (DC-disconnect) (+ISD)
- Arc detection (+ADU)
- Top cabling (+COT)
- UL approved design and components (+NAR)
- Cabinet heater (+ACH)
- Cabinet light (+ACL)

The dynamic brake sections are similar to the inverter unit sections. See the dimensions and example figures in Chapter 3.5.2.

3.7 TRANSPORT SPLIT UNIT

Transport Split Units are available for easy access to main bus joints between sections.

Table 12. Available TSU section sizes

TSU type	Width x Height x Depth (mm)
TSU_200	200 x 2000 x 605
TSU_300	300 x 2000 x 605

4. INSTALLATION

4.1 INSTALLATION PROCEDURE

Each VACON® NXP System Drive delivery is project specific. The following installation sequence is a general description of the process of connecting the cabinet sections and installing the system drive.

As each installation is project specific, the instructions and illustrations in the following chapters are general examples. More detailed instructions, such as layout drawings, dimensions and wiring diagrams, are included in the project delivery.

1	Before starting the installation, read the safety instructions in Chapter 2 carefully.
2	Make sure that the ambient conditions at the installation site are according to the specifications. See the specifications in Chapter 6.3. Remove the package covering from the product only at the installation site and in the specified ambient conditions.
3	Before moving the cabinets to the installation site, make sure that the space is properly prepared for the installation. See Chapter 4.2.
4	Move the cabinets to the installation site. See the instructions in Chapter 1.8.
5	Make sure that there is enough free space around the cabinets. See Chapter 4.2.1.
6	Lift the first cabinet section into the desired installation location. See Chapter 4.3.
7	Fix the first cabinet section to the floor or wall. See Chapter 4.3.
8	Lift the second cabinet section next to the first section, in a position from which it can be pushed into place.
9	Before pushing the cabinets together, loosen the nuts and bolts on the ends of the busbars to be connected. See Chapter 4.4.
10	Push the cabinets together, make sure that the busbars come together properly.
11	Connect the busbars by tightening the nuts and bolts on the busbars. See Chapter 4.4.
12	Mount the cabinet frames to each other. See Chapter 4.5.
13	Mount the second section to the floor or wall.
14	Install the rest of the sections following the same procedure.
15	Once all the cabinets are connected, remove the lifting beams from the top of the cabinets, so that they do not block the air flow. After the beams are removed, mount the bolts back on the cabinet roof.
16	Do the cabling between cabinets (auxiliary low-voltage connections, fiber connections, etc.). See the project specific wiring diagrams, which are included in the delivery.
17	Connect the motor and mains cables to the system drive. Pay attention to grounding of the cables. See Chapter 4.6.

4.2 PREPARING THE INSTALLATION SITE

Before starting the installation work make sure that the level of the floor is within acceptable limits. The maximum deviation from the basic level can be no more than 5 mm over a 3 m distance. The maximum acceptable height difference between cabinet front and rear edges should be within +2/-0 mm limit.

4.2.1 FREE SPACE AROUND THE CABINET

Enough space must be left above and in front of the cabinet to ensure sufficient cooling and space for maintenance.

It is recommended to leave at least 200 mm above and 1000 mm in front of the cabinets.

Also make sure that the temperature of the cooling air does not exceed the maximum ambient temperature of the drives.

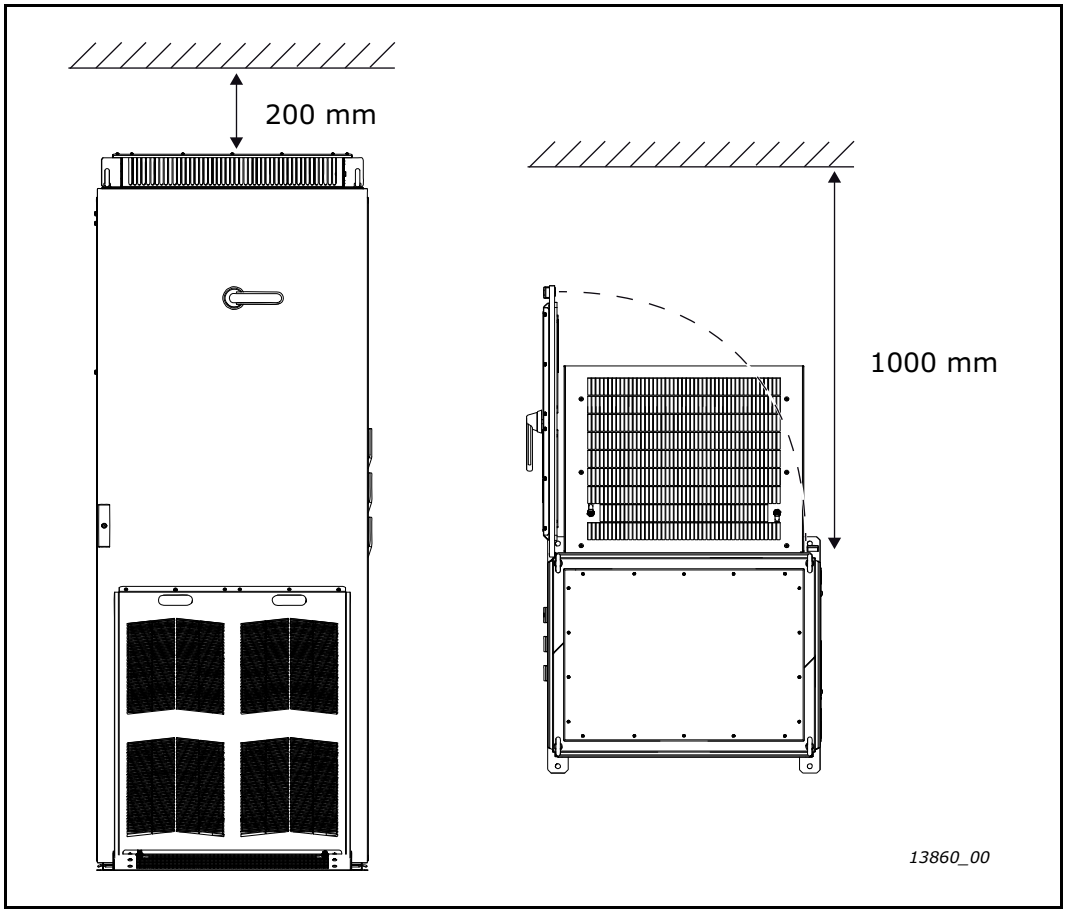


Figure 12. Required space around the cabinet

4.3 MOUNTING THE CABINETS

The cabinet should always be fixed to the floor or to the wall. Depending on installation conditions, the cabinet sections can be fixed in different ways. There are holes in the front and back corners which can be used for fixing. Additionally, the rails on the top of the cabinet have fixing lugs for fixing the cabinet to the wall or to another cabinet.

4.3.1 FIXING THE CABINET TO THE FLOOR AND WALL

If the cabinet is installed against a wall, fix the top of the cabinet to the wall (1) and the front corners to the floor (2) with bolts.

If bottom-only fixing is used, fix the cabinet to the floor in the front (2) and in the back (3) with bolts.

Fix all the cabinet sections in the same way.

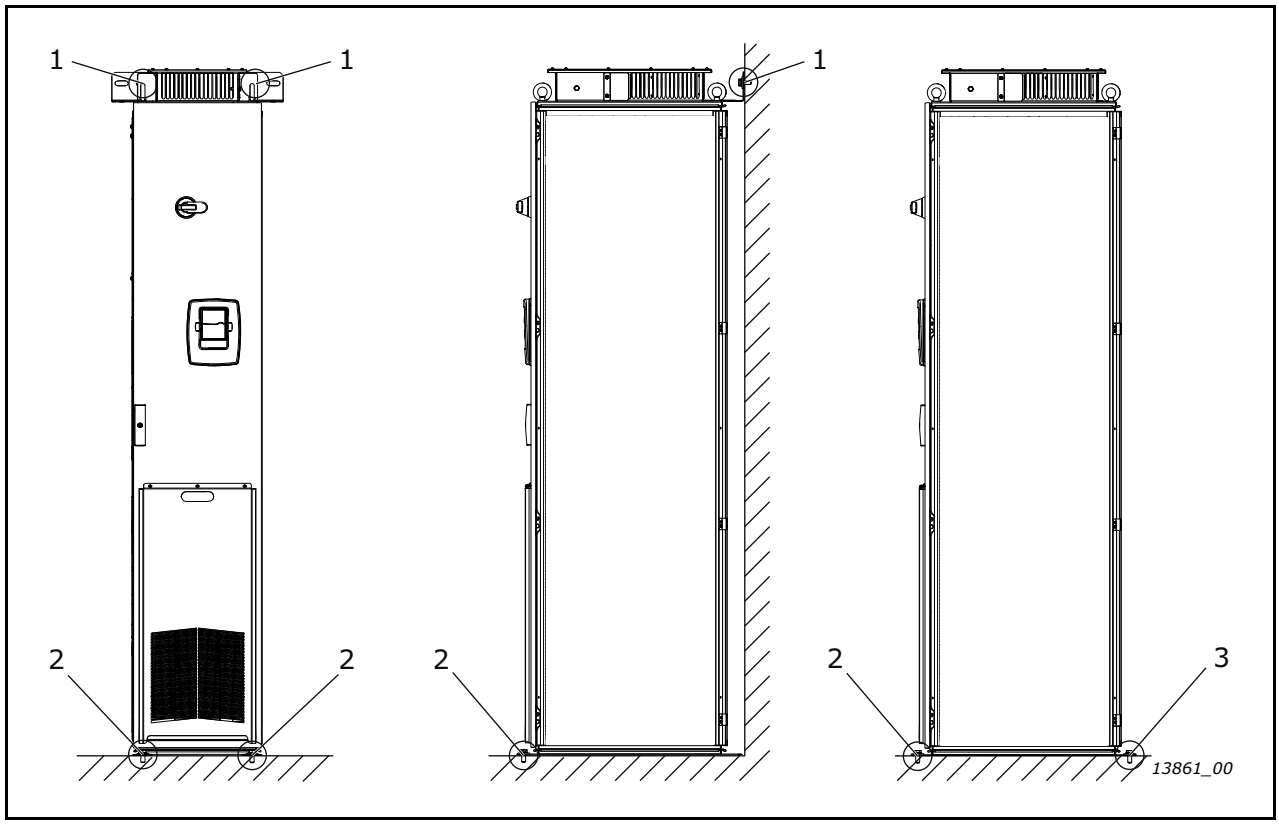


Figure 13. Fixing the cabinet to the wall and floor

4.3.2 BACK-TO-BACK INSTALLATION

The sections can also be installed back-to-back. In this case, fix the top parts of the cabinets together (1) and the front corners to the floor (2) with bolts.

Leave a gap between the backs of the cabinets. Check the correct dimensions from the documents included in the delivery.

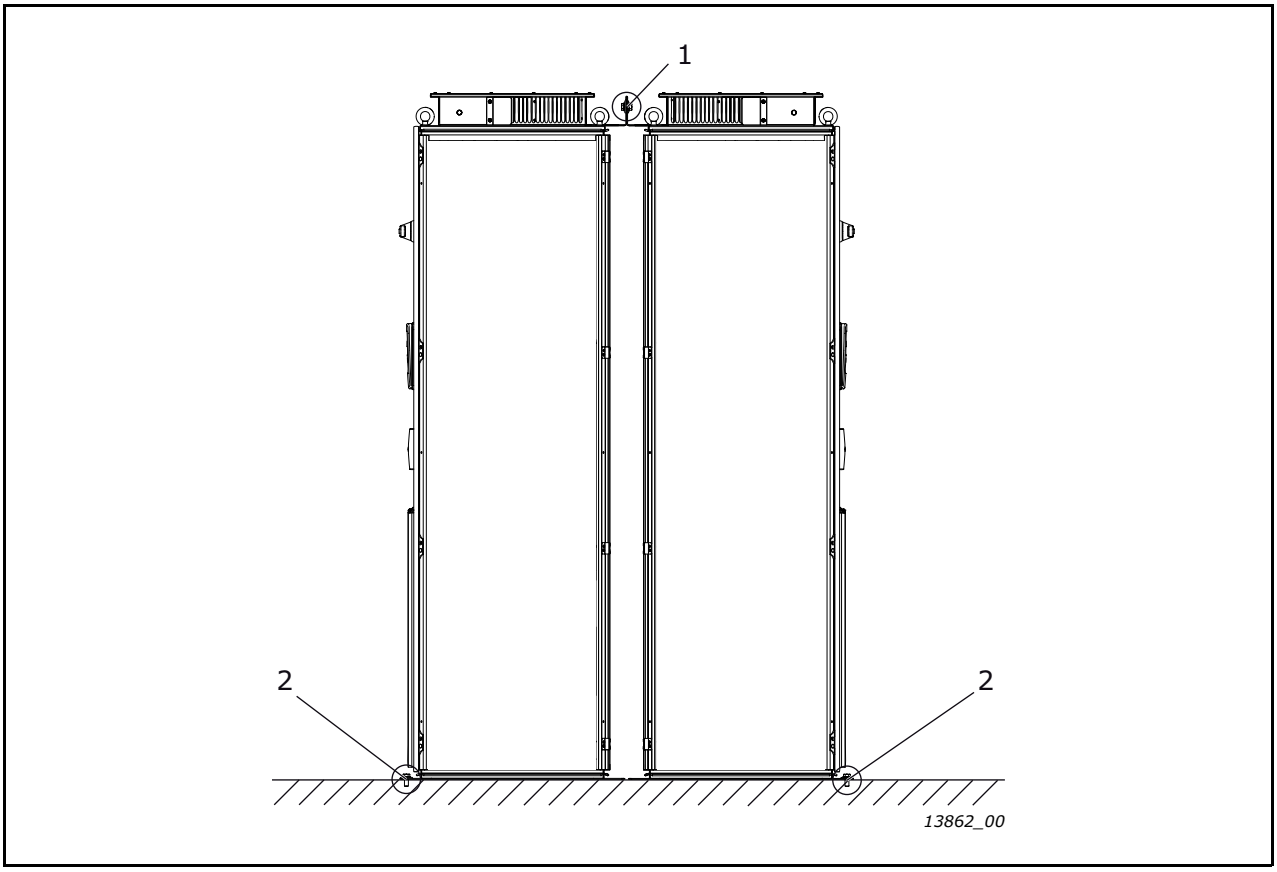


Figure 14. Fixing the cabinets back-to-back

4.4 CONNECTING THE BUSBARS

The busbars are located in the back of the cabinets. To access them, it might be necessary to take out the drives. See the instructions in Chapter 5.3.

Join together the DC, AC and PE busbars by bolting them together with baying brackets. The mounting bolts, nuts and washers are delivered in place.

The busbars, size of the nuts and bolts differ case-by-case. See the correct tightening torque values for different size bolts and different types of connections in Chapter 4.7.

4.4.1 SIDE-BY-SIDE CONNECTION

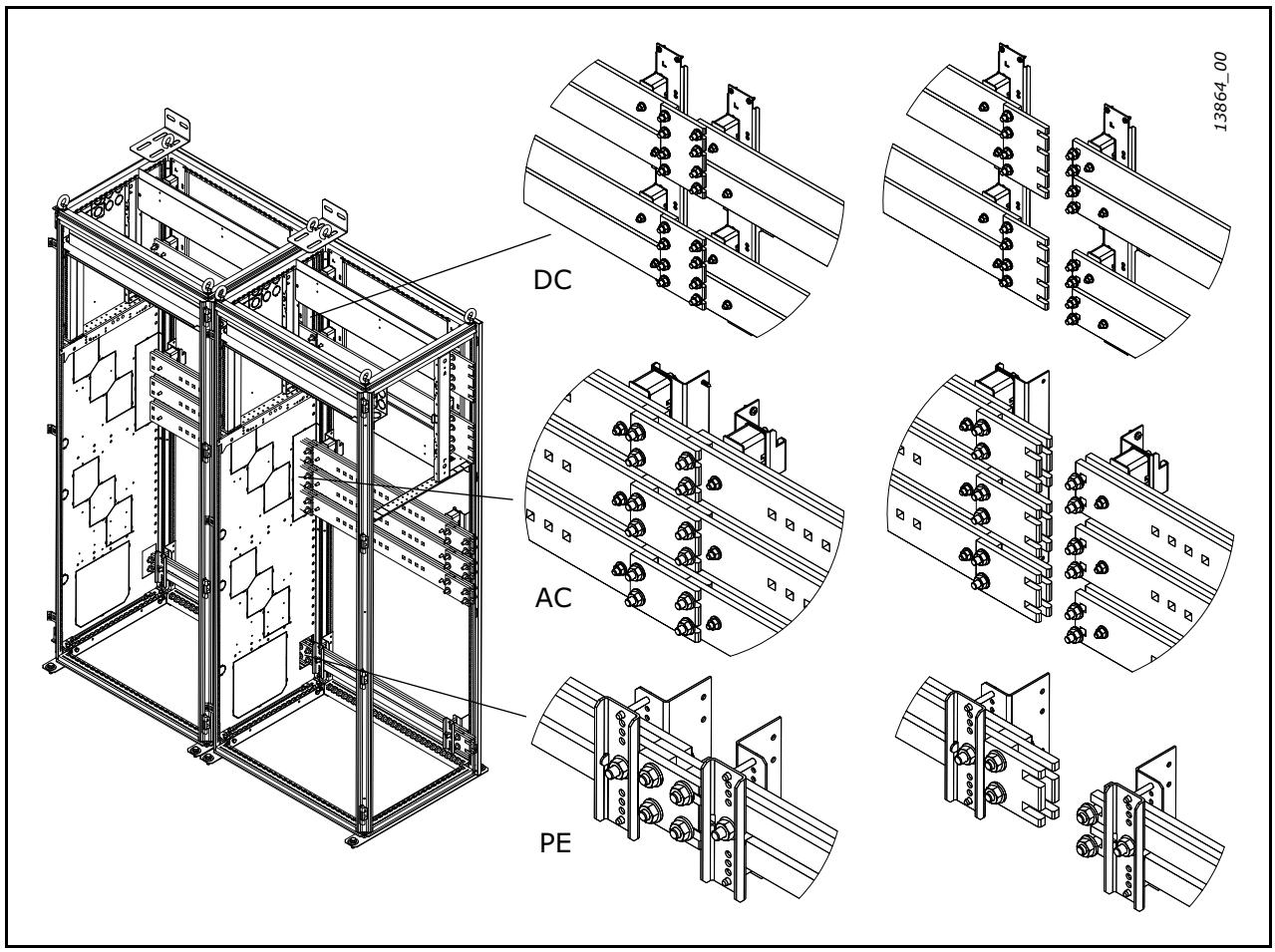


Figure 15. Connecting the common DC, AC and PE busbars

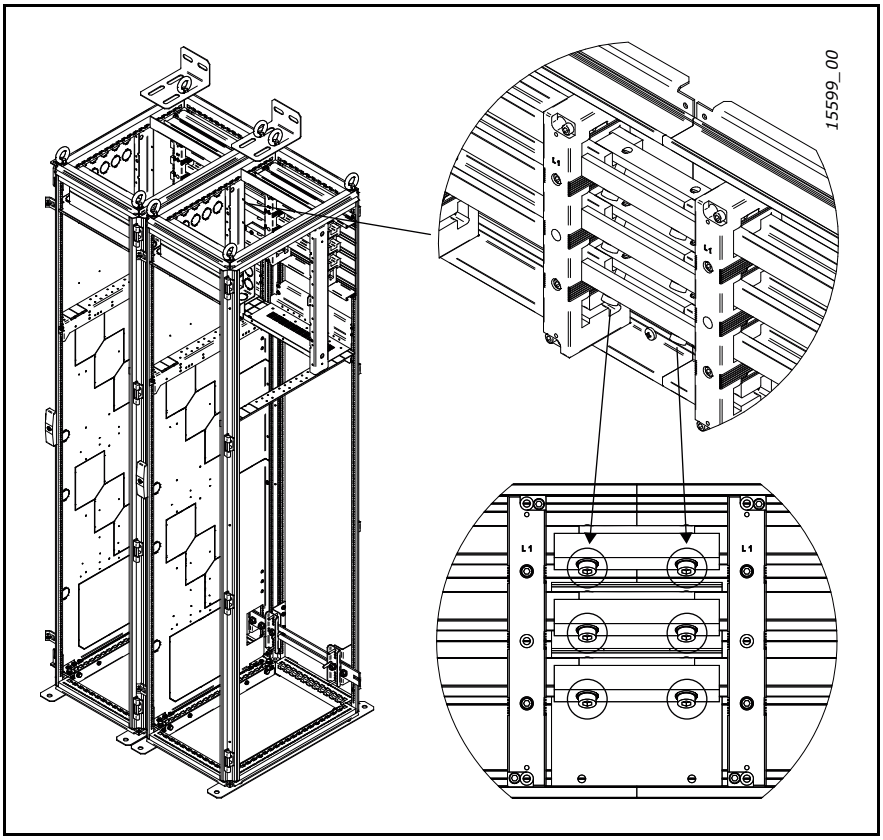


Figure 16. Connecting the common AC busbars in UL cabinets

4.4.2 BACK-TO-BACK CONNECTION

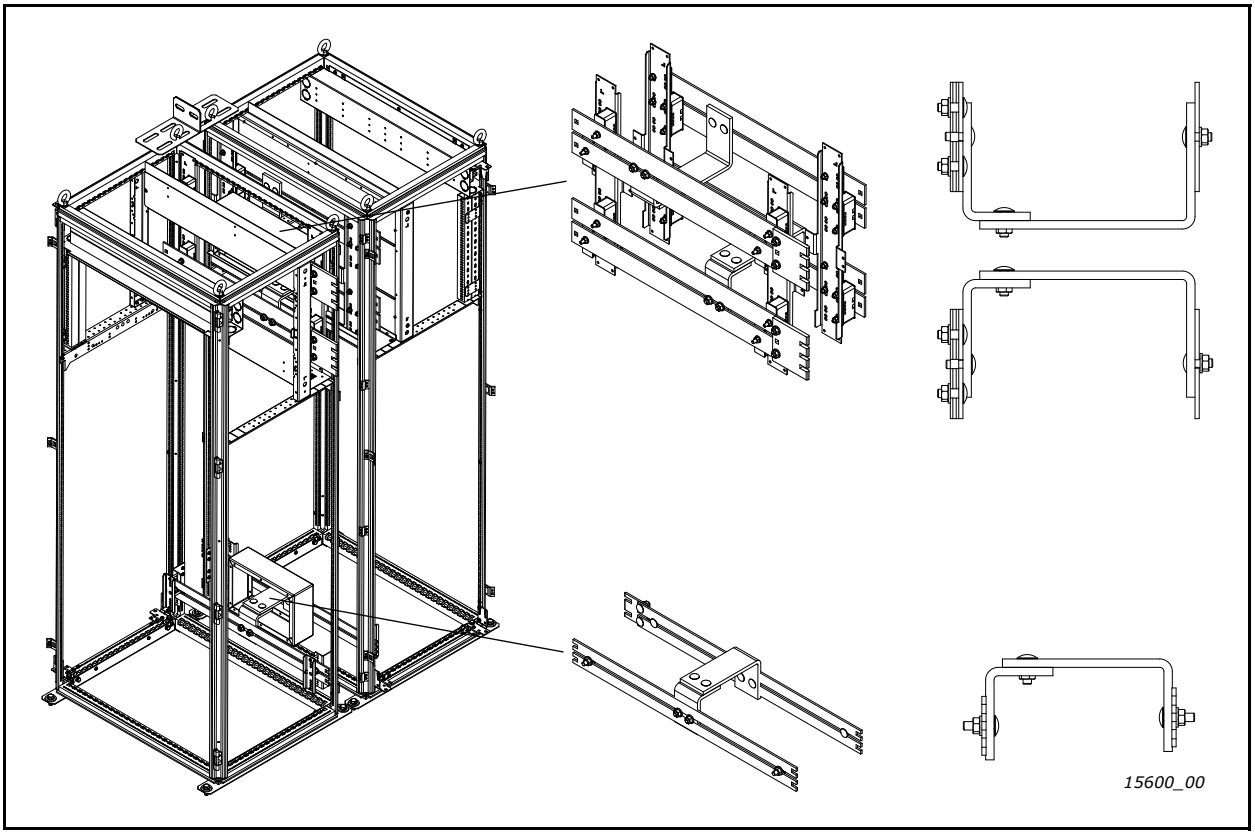


Figure 17. Connecting the common DC and PE busbars in back-to-back cabinet installation

4.5 FIXING THE CABINET FRAMES TO EACH OTHER

All the necessary parts for fixing the cabinet frames to each other are included in the delivery.

To join two cabinet sections to each other you need six quick-fit baying clamps (1 in figure below) and four angular baying brackets (2 in figure). The four angular baying brackets are installed in the top and bottom corners on the inside of the cabinet. Three of the quick-fit baying brackets are installed in the front and three in the back on the outside of the cabinet.

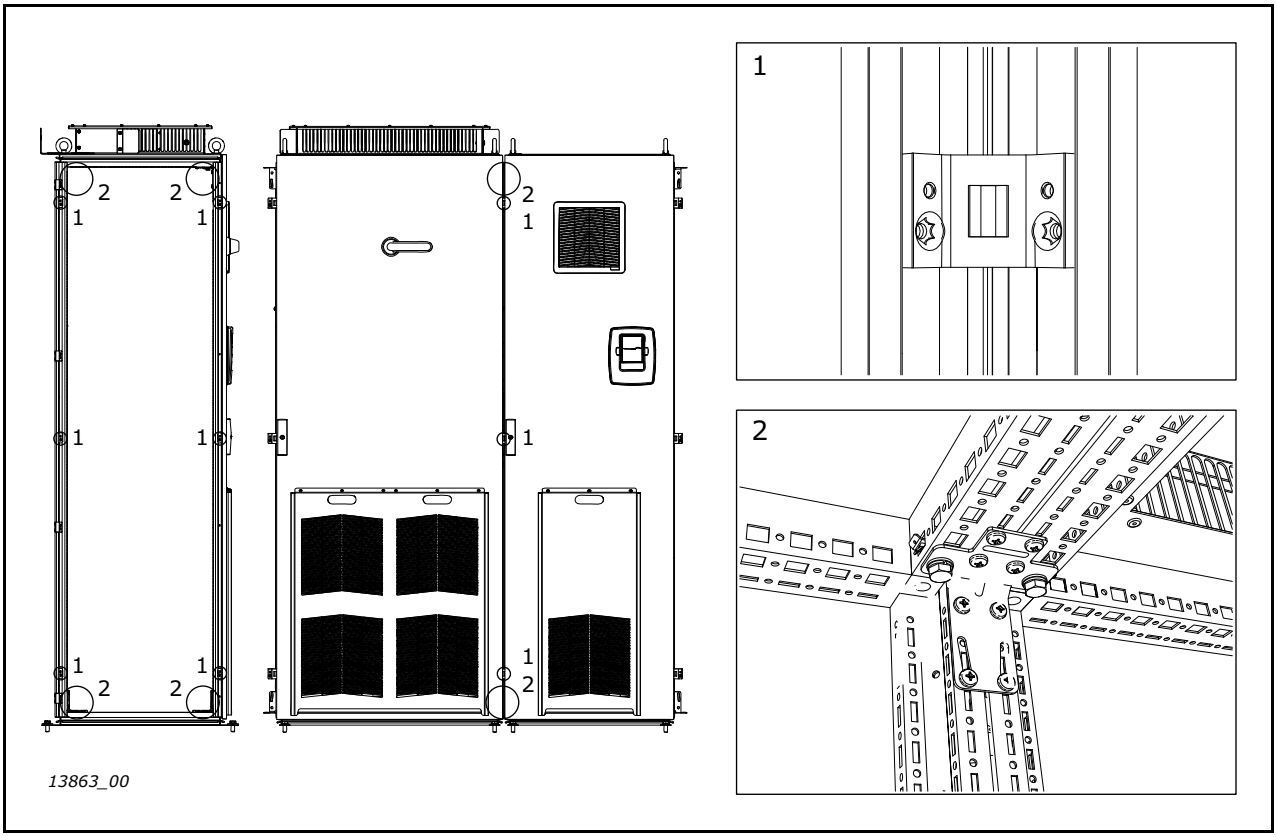


Figure 18. Quick-fit baying clamps

4.6 CABLING

Before connecting any cables, use a multimeter to check that the cables to be connected are not live.

4.6.1 GROUNDING

PE conductors are connected to the PE busbar. The PE busbars in each section are connected (see Figure 15 on page 34) and the PE busbars must be connected to ground.

See the grounding and ground fault protection instructions in Chapter 2.3.

4.6.2 MAINS AND MOTOR CONNECTION

The power supply terminals can be reached through the bottom part of the cabinet. The mains cables are connected to terminals L1, L2 and L3 on the main input section (see Figure 19 on page 38). The motor cables are connected to inverter section terminals marked with U, V and W. Make openings for the cables in the grommets on the bottom of the cabinet and lead through the cables. Use cable clamps to fix the cables.

Use cables with a temperature rating of at least +70°C. As a rule of thumb, cables and fuses can be dimensioned according to the frequency converter nominal output current, which you can find on the rating plate. Dimensioning according to the output current is recommended because the frequency converter input current never significantly exceeds the output current.

Table 13. Cable types required to meet standards

Cable type	Level L (2nd environment)	Level T
Mains cable	1	1
Motor cable	2	1/2*
Control cable	4	4

* Recommended

Level L = EN61800-3, 2nd environment

Level T = For IT networks

1 = Power cable intended for fixed installation and the specific mains voltage. Shielded cable not required (DRAKA NK CABLES - MCMK or similar recommended).

2 = Symmetrical power cable equipped with concentric protection wire and intended for the specific mains voltage (DRAKA NK CABLES - MCMK or similar recommended).

4 = Screened cable equipped with compact low-impedance shield (DRAKA NKCABLES - JAMAK, SAB/ÖZCuY-O or similar).

See the more detailed cabling and fuse selection instructions in the corresponding user manual (see Chapter 1.5).

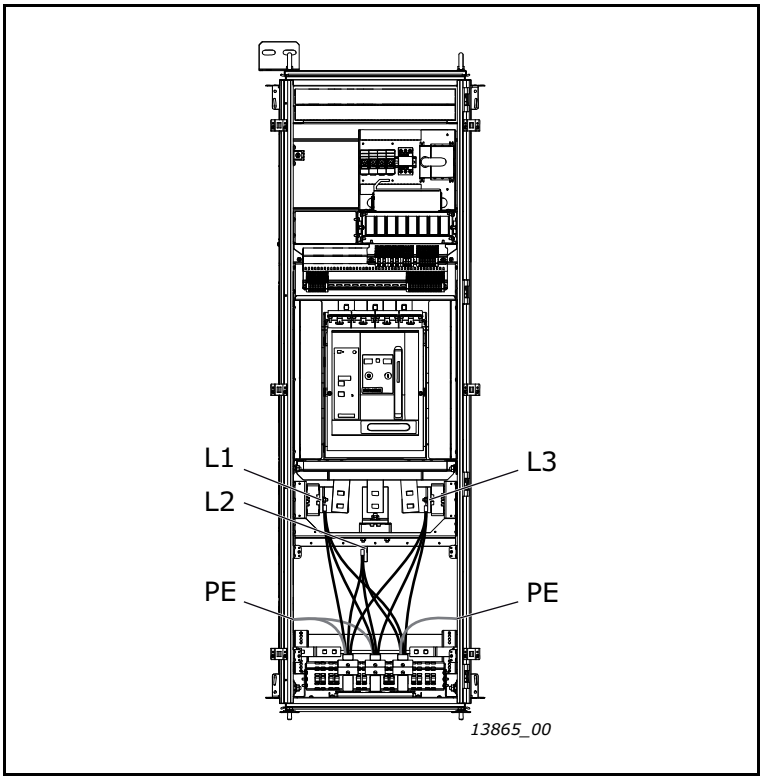


Figure 19. Cabling of the main incoming section (MIS)

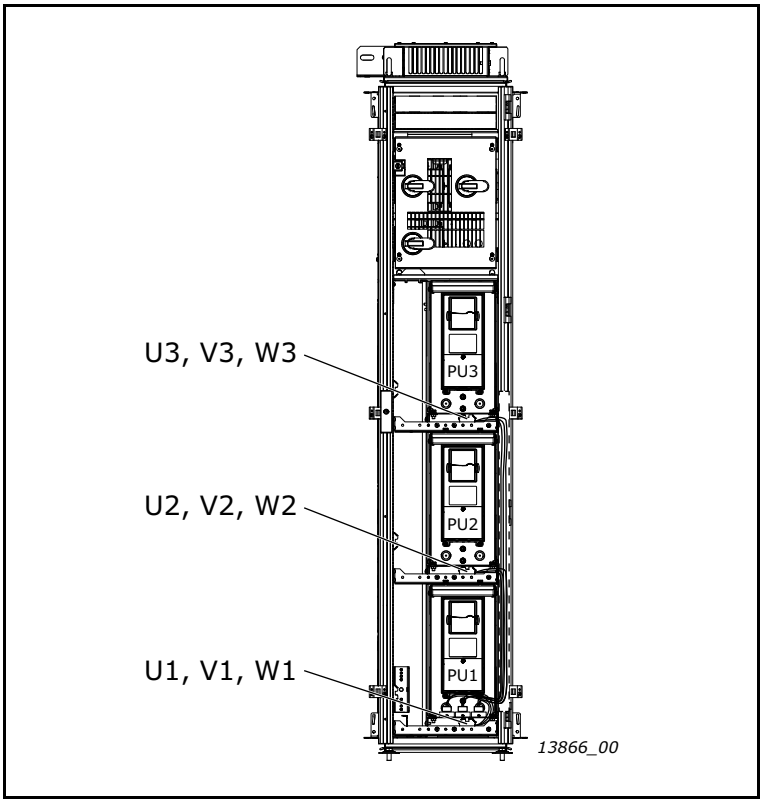


Figure 20. Cabling of inverter section IUS_4

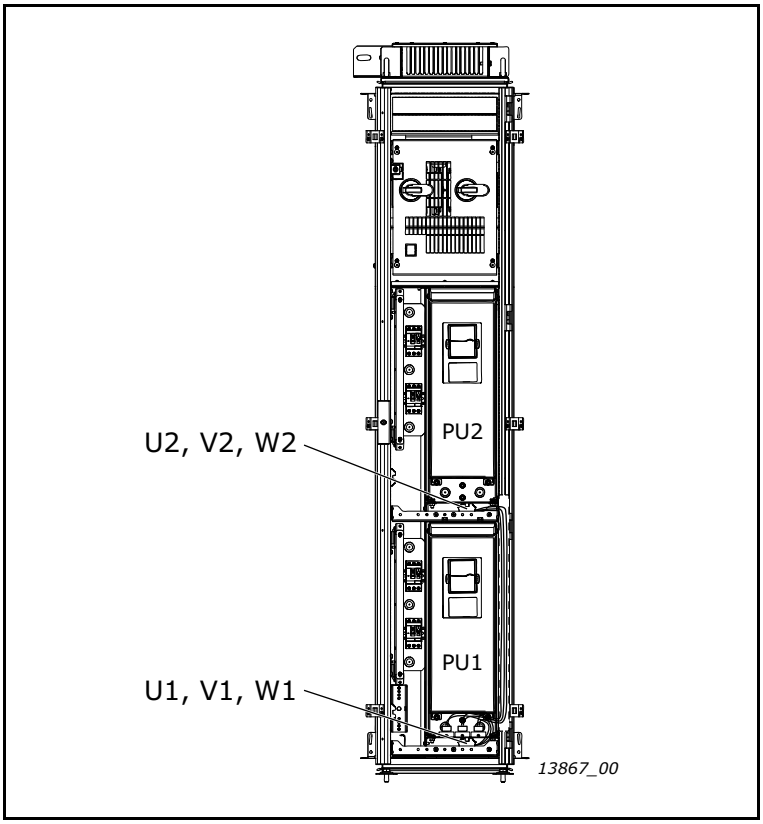


Figure 21. Cabling of inverter section IUS_6

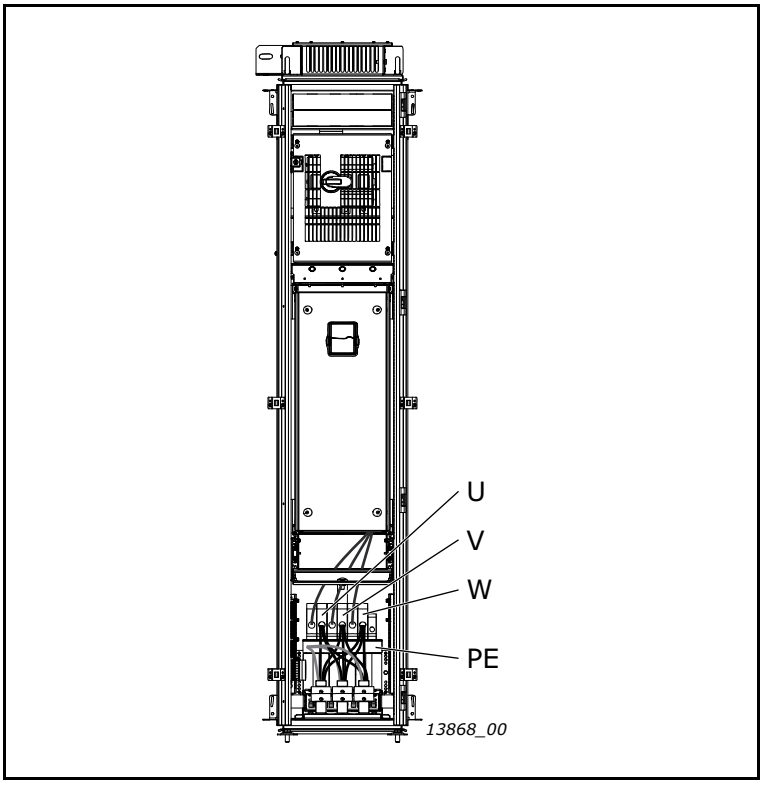


Figure 22. Cabling of inverter section IUS_8

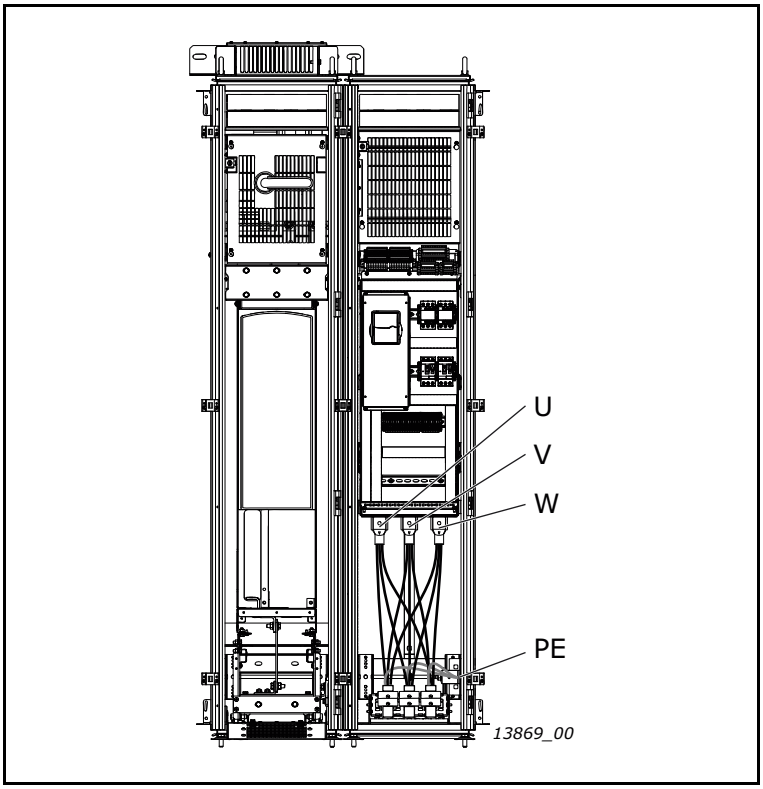


Figure 23. Cabling of inverter sections IUS_9 and IUS_10

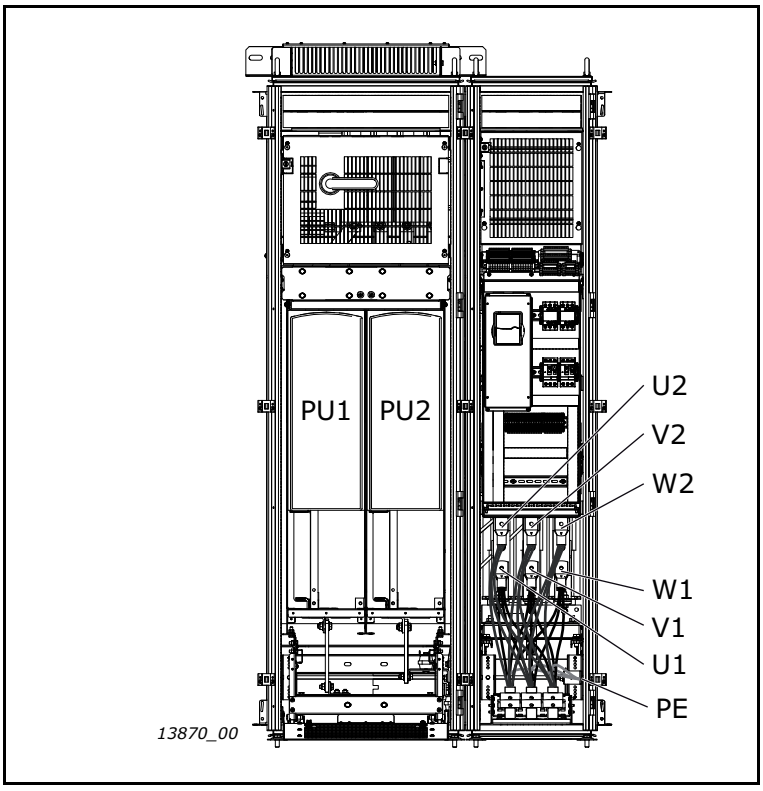


Figure 24. Cabling of inverter section IUS_12

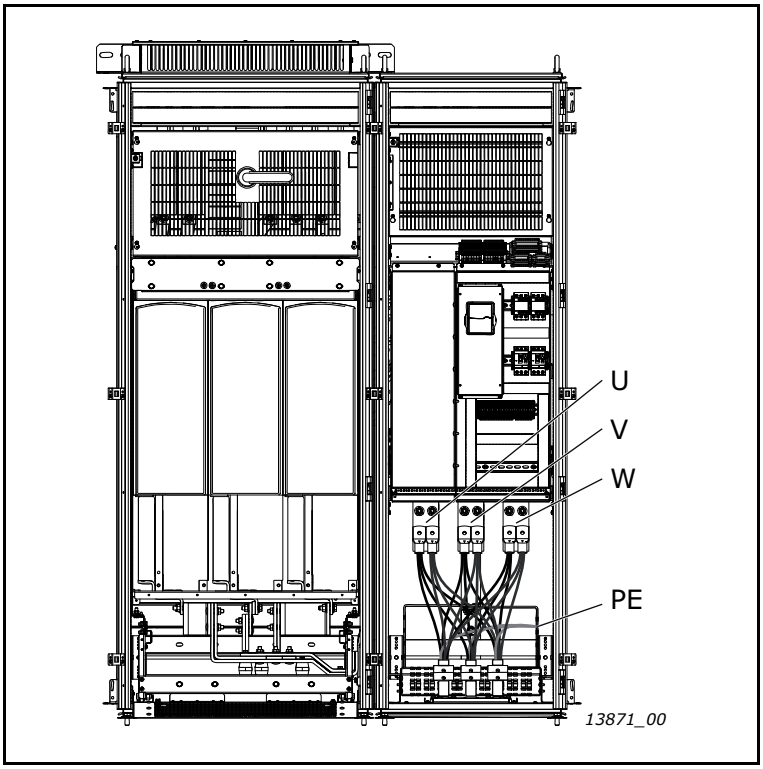


Figure 25. Cabling of inverter section IUS_13

4.6.3 EMC GROUNDING

For the EMC levels C1 and C2, it is necessary to have a 360º grounding of the shield on both ends of the motor cable. The EMC grounding clamps must be suited to the output cable diameter to give a 360º contact with the cables. To make a 360° connection with the grounding clamp, expose the shield of the motor cables.

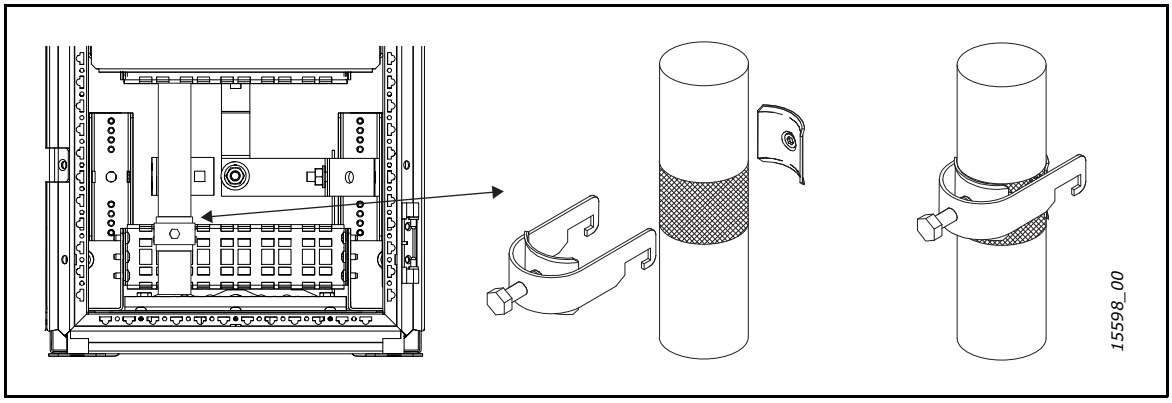


Figure 26. 360º grounding

4.6.4 INSTALLATION OF FERRITE RINGS (+0CM) ON THE MOTOR CABLE

Route only the motor phase conductors through the ferrite rings. Do not route the PE/ground wire through the ferrite rings. Leave the cable screen below and outside the rings. Mount the PE/ground wire or pigtail on the ground busbar.

In case of parallel motor cables, reserve an equal amount of ferrite ring sets for each cable. Route all the phase conductors of one cable through one set of rings.

The delivery consists of fixed sets of ferrite rings (option). When ferrite rings are used to attenuate the risk of bearing damage, always use two ferrite ring sets per motor cable.

NOTE! The ferrite rings are only additional protection. The basic protection against bearing currents is an insulated bearing.

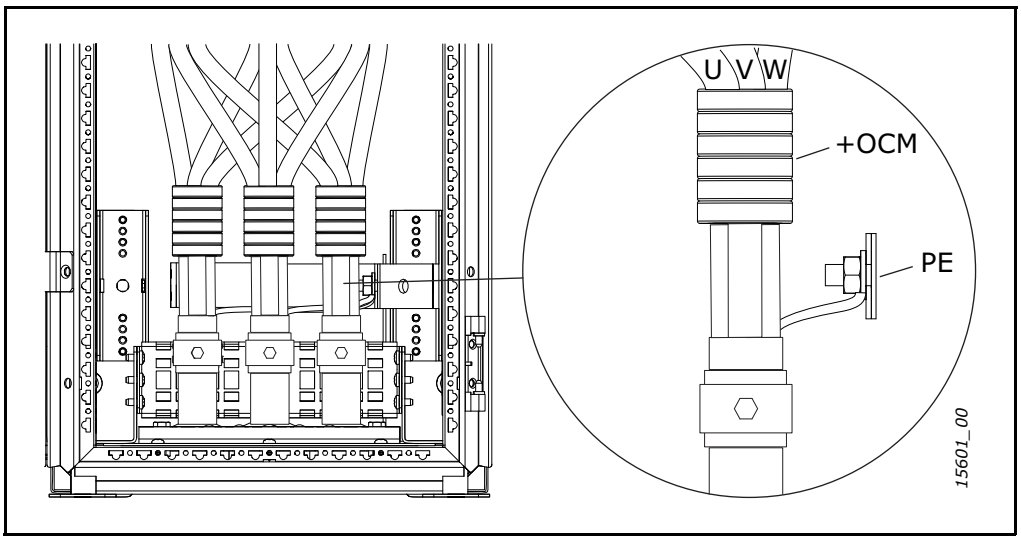


Figure 27. Installation of ferrite rings on motor cables

4.6.5 CONTROL CONNECTIONS

The control unit of the AC drive consists roughly of the control board and additional boards connected to the five slot connectors (A to E) of the control board. The control board is connected to the power unit through a D-connector or fibre optic cables.

Usually, when the frequency converter is delivered from the factory, the control unit includes at least the standard compilation of two basic boards (I/O board and relay board) which are normally installed in slots A and B.

The control board can be powered externally (+24 V, ±10%) by connecting the external power source to either of the bidirectional terminals. This voltage is sufficient for parameter setting and for keeping the fieldbus active.

The tightening torques for the control unit terminals:

- Relay and thermistor terminals (screw M3): 0.5 Nm.
- Other terminals (screw M2.6): 0.2 Nm.

For more detailed cabling instructions, see the corresponding user manual (see Chapter 1.5).

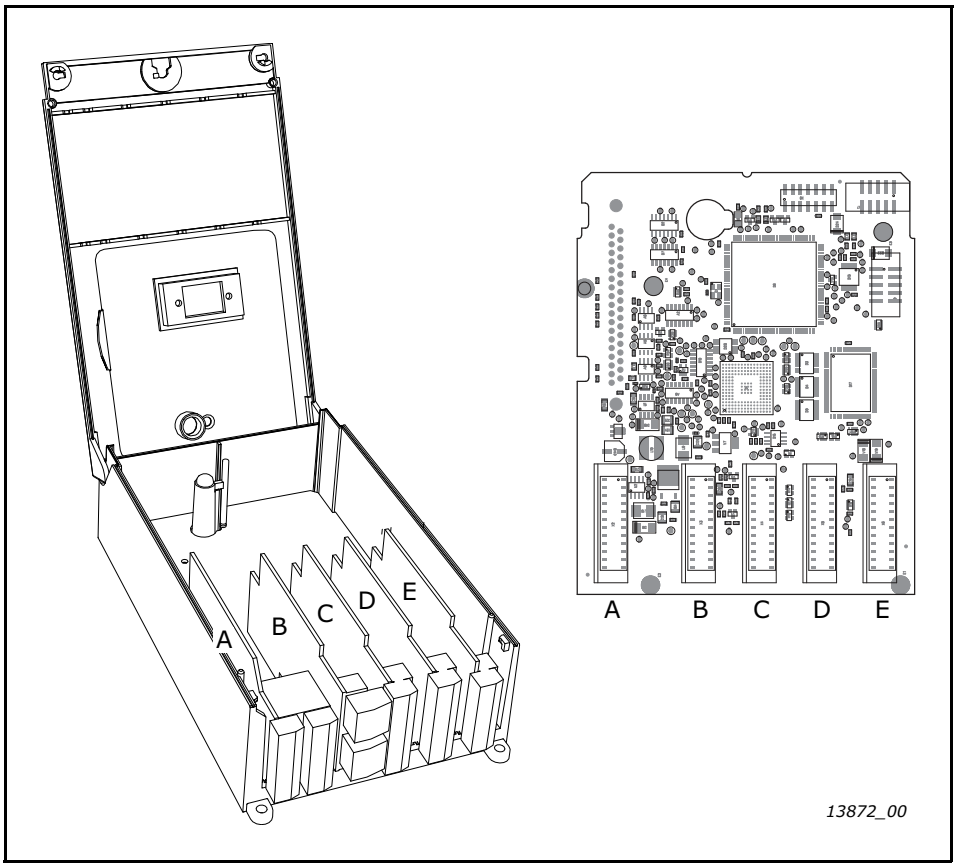


Figure 28. Control unit, control board (right) and option boards (A-E)

4.6.6 AUXILIARY LOW-VOLTAGE CONNECTIONS

The auxiliary low-voltage connections between cabinets can be done with wiring or with busbars.

For transport, the wires between two separately transported cabinets are disconnected from the terminals. The wiring diagrams for the connections are delivered with the system drive.

Auxiliary low-voltage busbars (Auxigaine) are available as an option. In this case, the busbars of two cabinets are connected with quick-connect bridge connectors. The bridge connectors are installed by simply pressing them into place.

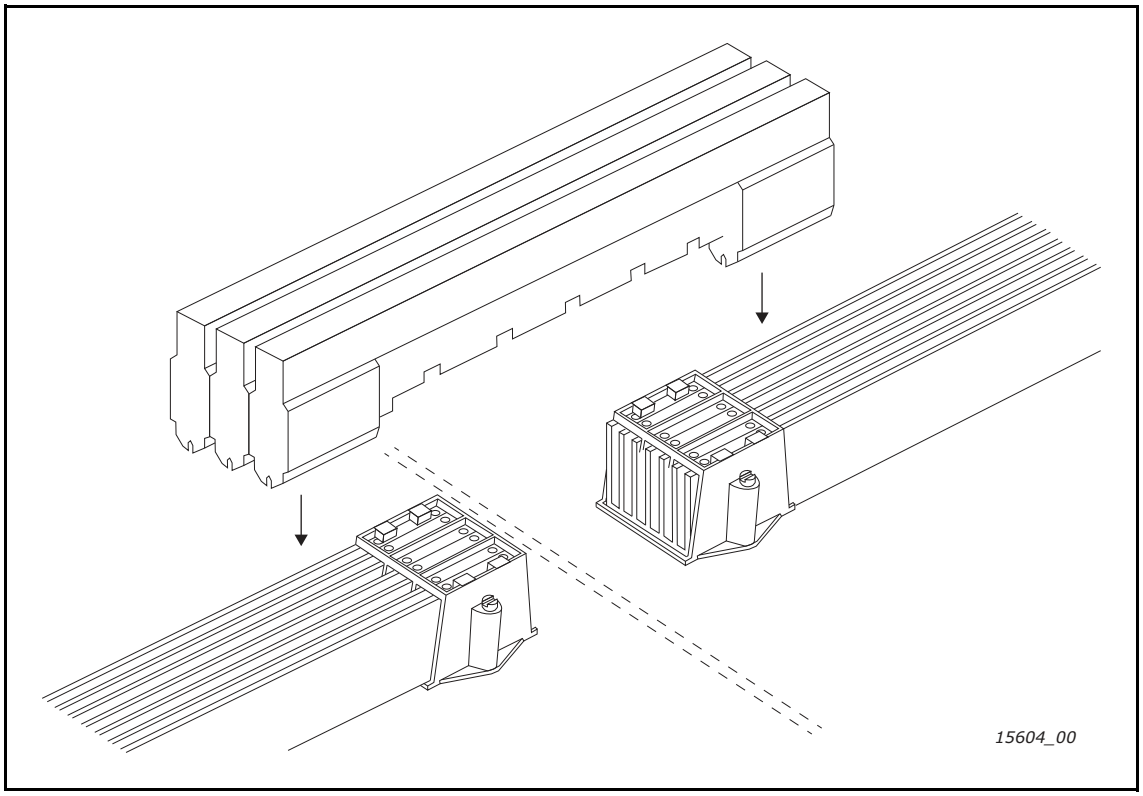


Figure 29. Installing the bridge connectors on the auxiliary low-voltage busbars

4.7 SCREW TIGHTENING TORQUES

Table 14. Tightening torques

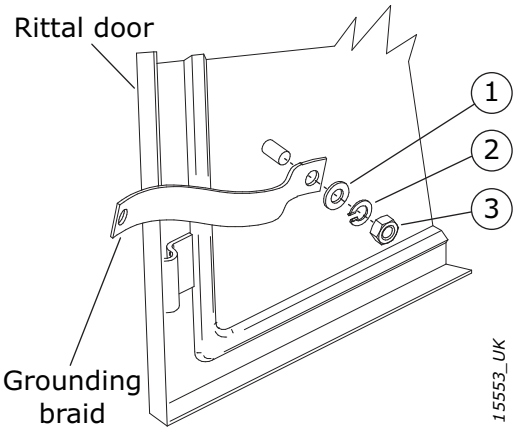
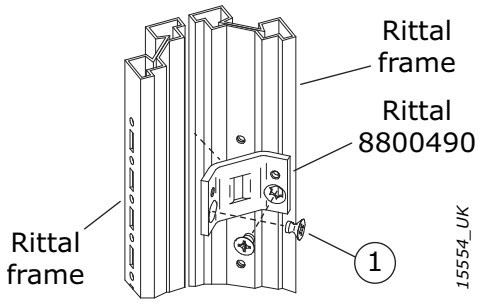
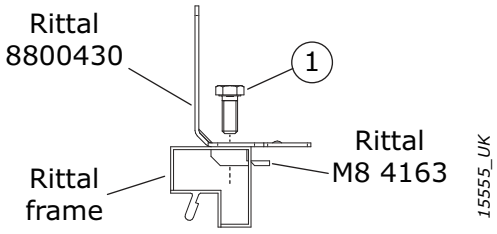
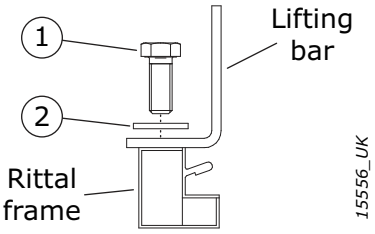
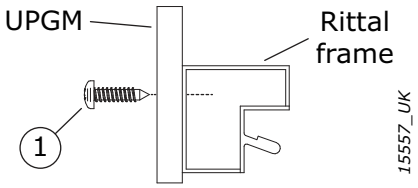
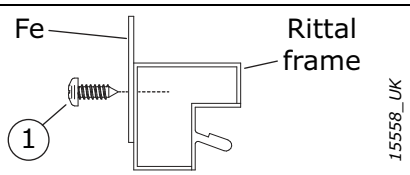
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Plain washer, DIN 125		-
	2	Spring washer, DIN 128		-
	3	Nut, DIN 934	M8	10
	1	Rittal tapered thread forming screw M6x8	M6	9
	1	Rittal hex head bolt 8x16 with toothed neck	M8	9
	1	Hex head bolt, DIN 933	M12	20
	2	Rittal IP rubber washer		-
	1	Self tapping screw, DIN 7049		ST 5.5 5
	1	Self tapping screw, DIN 7049		ST 5.5 5

Table 14. Tightening torques

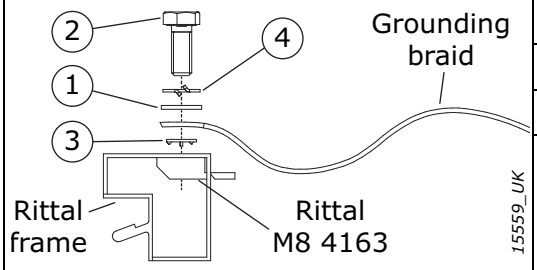
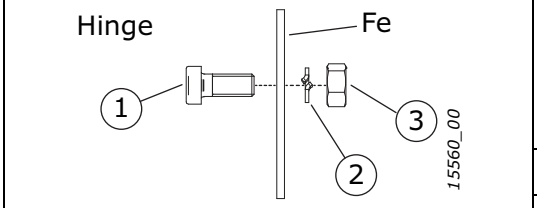
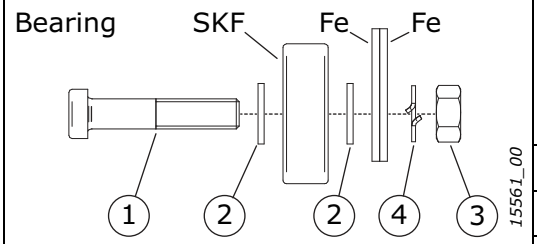
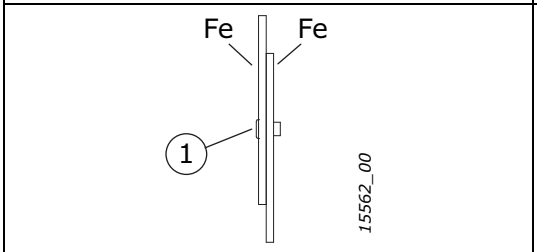
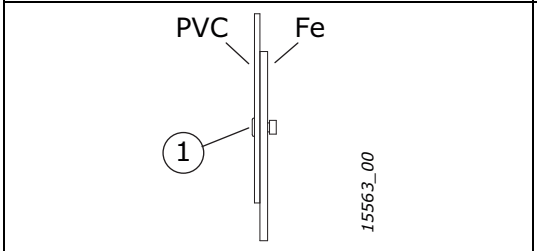
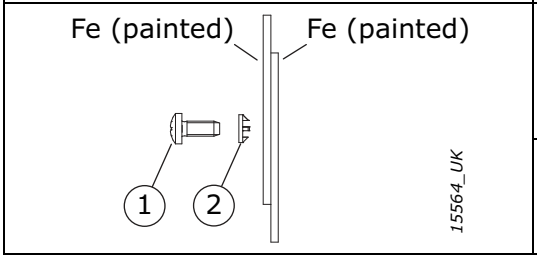
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Plain washer, DIN 125		-
	2	Hex head bolt, DIN 933	M8	9
	3	Toothed washer, DIN 6797		-
	4	Spring washer, DIN 128		-
	1	Socket head bolt, DIN 912	M6	6
			M8	20
			M10	40
			M12	70
	2	Spring washer, DIN 128		-
	3	Nut, DIN 934		-
	1	Socket head bolt, DIN 7984	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer, DIN 125		-
	3	Nut, DIN 934		-
	4	Spring washer, DIN 128		-
	1	Rivet		-
	1	Rivet		-
	1	Self-tapping screw, DIN 7500	M4	1.5
			M5	3
			M6	6
	2	Toothed washer, DIN 6797		-

Table 14. Tightening torques

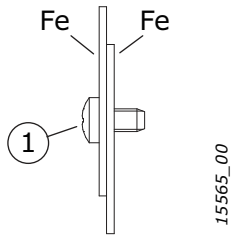
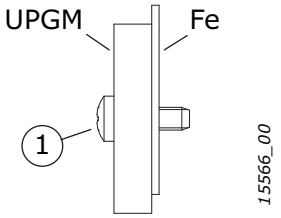
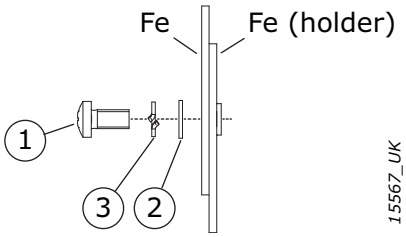
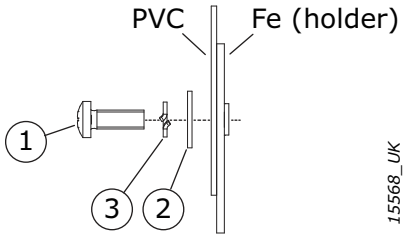
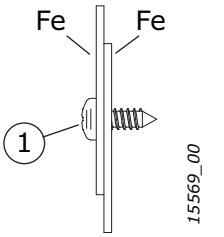
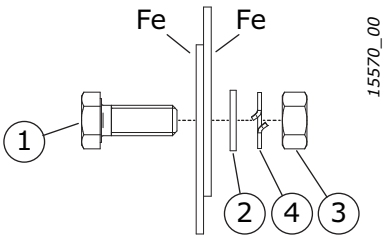
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Self-tapping screw, DIN 7500	M4	1.5
			M5	3
			M6	6
	1	Self-tapping screw, DIN 7500	M4	1.5
			M5	3
			M6	6
	1	Screw, DIN 7045	M4	1.5
			M5	3
			M6	6
	2	Plain washer, DIN 125		-
	3	Spring washer, DIN 128		-
	1	Screw, DIN 7045	M4	1.5
			M5	3
			M6	6
	2	Plain washer large, DIN 9021		-
	3	Spring washer, DIN 128		-
	1	Self-tapping screw, DIN 7049		ST 5.5 5
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer, DIN 125		-
	3	Nut, DIN 934		-
	4	Spring washer, DIN 128		-

Table 14. Tightening torques

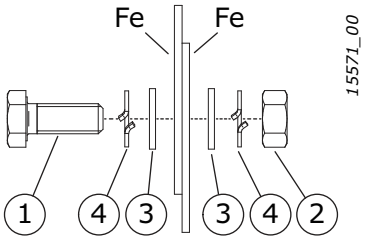
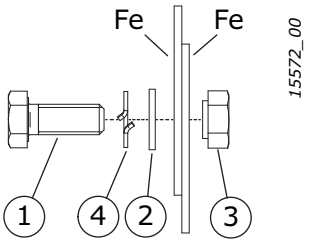
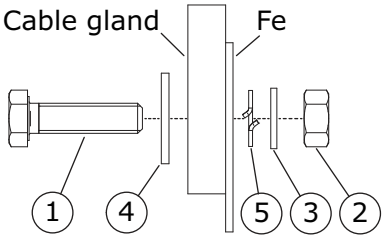
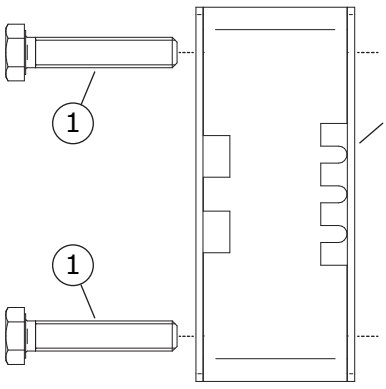
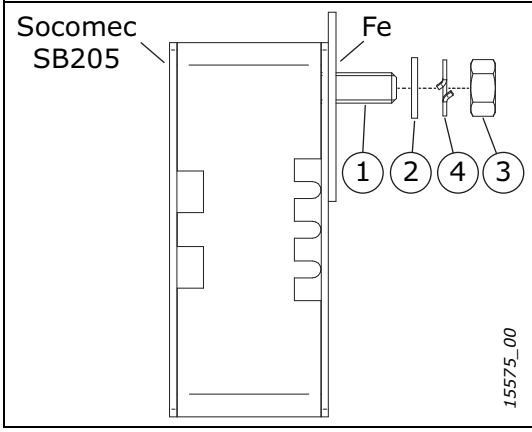
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Plain washer, DIN 125		-
	4	Spring washer, DIN 128		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer, DIN 125		-
	3	Press nut		-
	4	Spring washer, DIN 128		-
	1	Hex head bolt, DIN 933	M8	2
	2	Nut, DIN 934		-
	3	Plain washer, DIN 125		-
	4	Plain washer large, DIN 9021		-
	5	Spring washer, DIN 128		-
	1	Hex head bolt, DIN 933	M8	10
	1	Hex head bolt, DIN 933	M8	10
	2	Plain washer, DIN 125		-
	3	Nut, DIN 934		-
	4	Spring washer, DIN 128		-

Table 14. Tightening torques

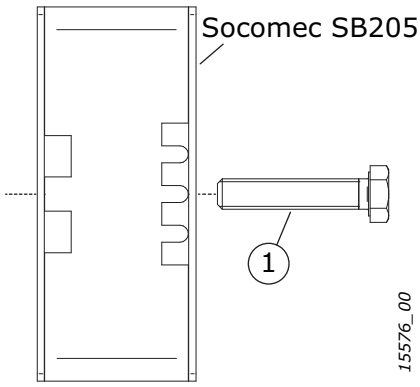
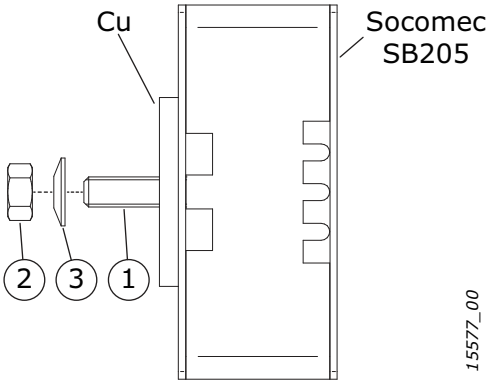
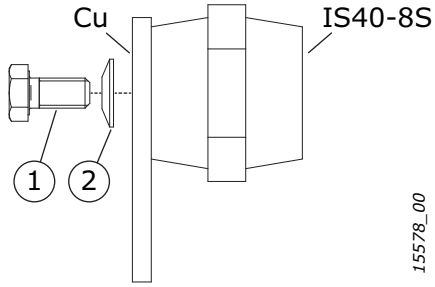
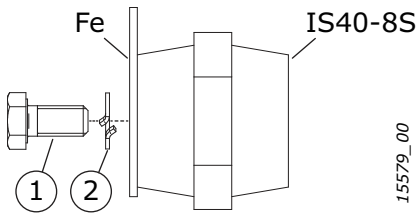
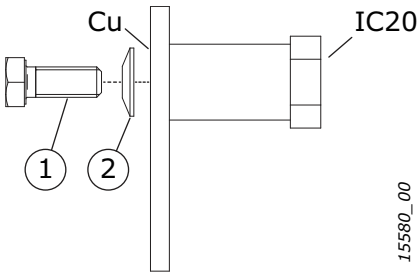
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Hex head bolt, DIN 933	M8	10
	1	Hex head bolt, DIN 933	M8	10
	2	Nut, DIN 934		-
	3	Conical spring washer, DIN 6796		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Conical spring washer, DIN 6796		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Spring washer, DIN 128		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Conical spring washer, DIN 6796		-

Table 14. Tightening torques

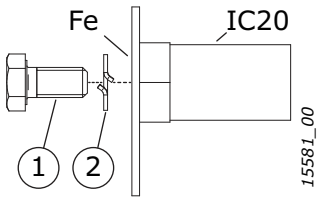
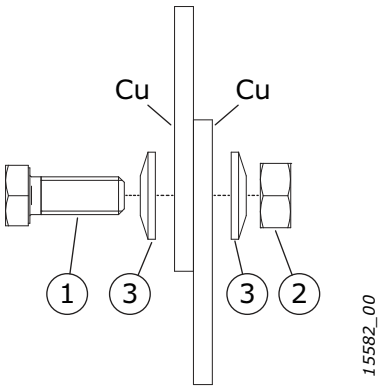
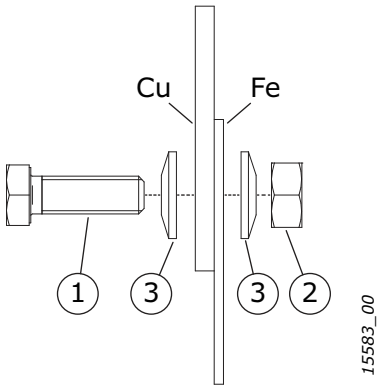
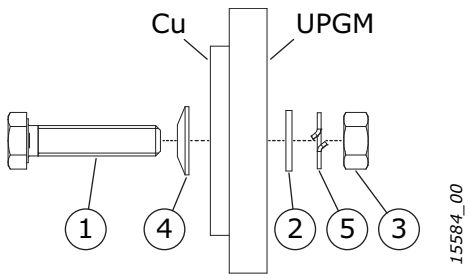
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Spring washer, DIN 128		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Conical spring washer, DIN 6796		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Conical spring washer, DIN 6796		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer, DIN 125		-
	3	Nut, DIN 934		-
	4	Conical spring washer, DIN 6796		-
	5	Spring washer, DIN 128		-

Table 14. Tightening torques

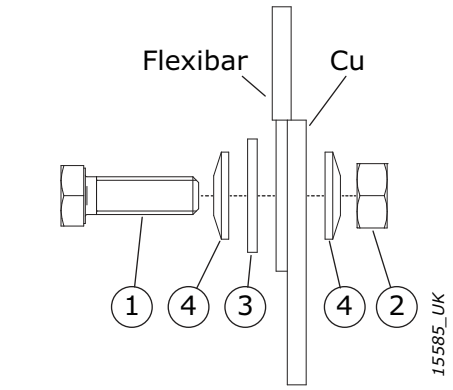
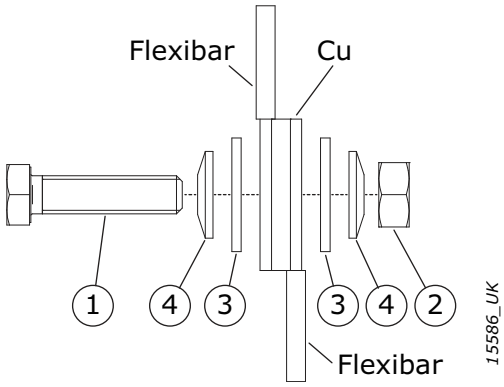
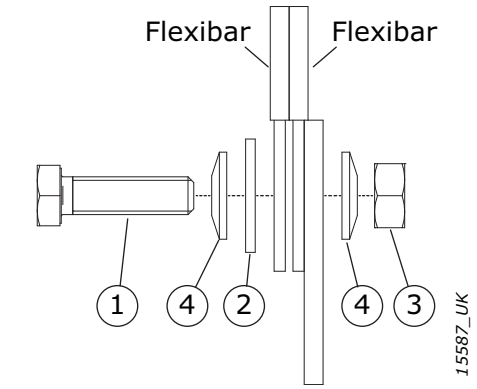
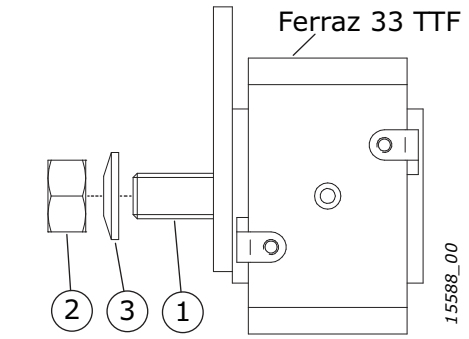
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Plain washer large, DIN 9021		-
	4	Conical spring washer, DIN 6796		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Plain washer large, DIN 9021		-
	4	Conical spring washer, DIN 6796		-
	1	Hex head bolt, DIN 933	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer large, DIN 9021		-
	3	Nut, DIN 934		-
	4	Conical spring washer, DIN 6796		-
	1	Stud, DIN 913	M8	10
			M10	15
			M12	15
	2	Nut, DIN 934	M8	13.5
			M10	26
			M12	46
	3	Conical spring washer, DIN 6796		-

Table 14. Tightening torques

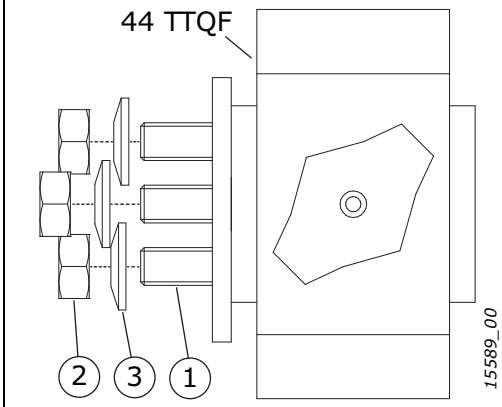
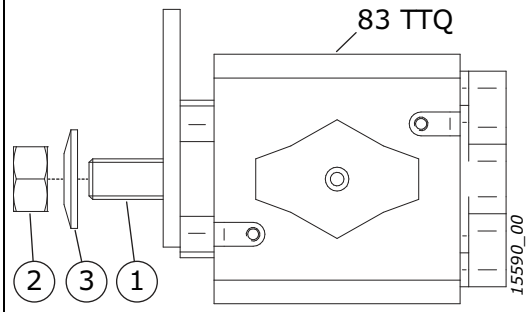
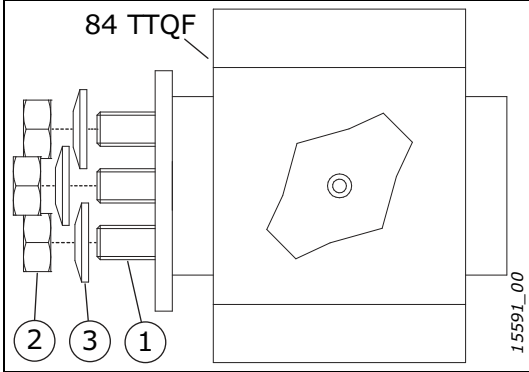
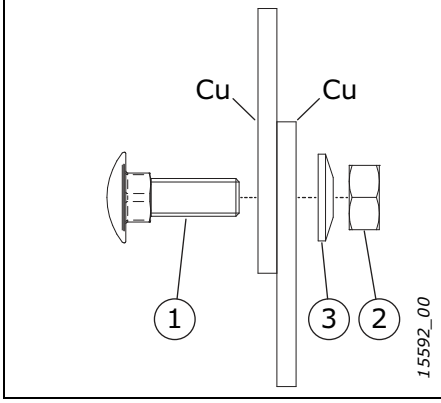
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Stud, DIN 913	M8	10
			M10	15
			M12	15
	2	Nut, DIN 934	M8	13.5
			M10	26
			M12	46
	3	Conical spring washer, DIN 6796		-
	1	Stud, DIN 913	M8	10
			M10	15
			M12	15
	2	Nut, DIN 934	M8	13.5
			M10	26
			M12	46
	3	Conical spring washer, DIN 6796		-
	1	Stud, DIN 913	M8	10
			M10	15
			M12	15
	2	Nut, DIN 934	M8	13.5
			M10	26
			M12	46
	3	Conical spring washer, DIN 6796		-
	1	Cup square neck bolt, DIN 603	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Conical spring washer, DIN 6796		-

Table 14. Tightening torques

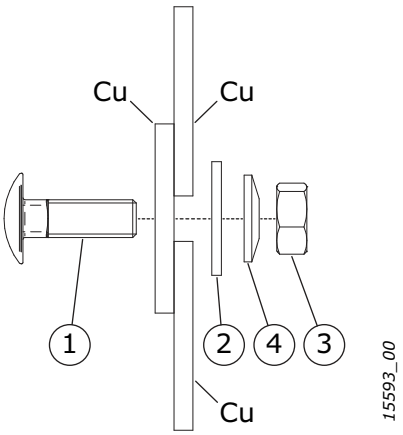
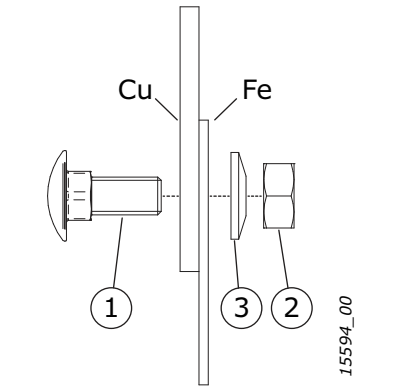
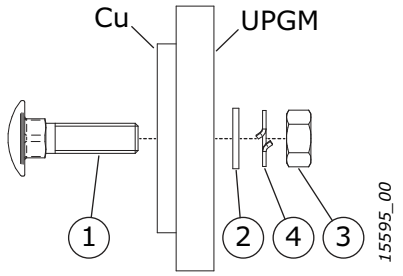
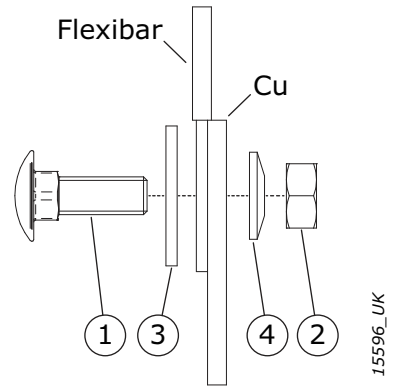
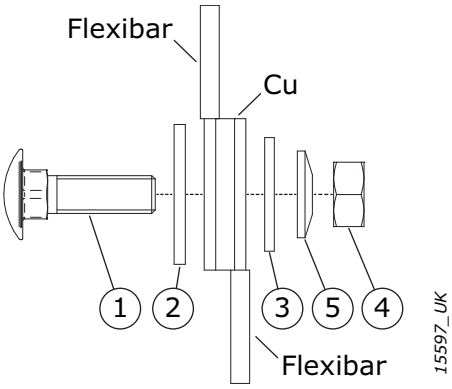
Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Cup square neck bolt, DIN 603	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer large, DIN 9021		-
	3	Nut, DIN 934		-
	4	Conical spring washer, DIN 6796		-
	1	Cup square neck bolt, DIN 603	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Conical spring washer, DIN 6796		-
	1	Cup square neck bolt, DIN 603	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer, DIN 125		-
	3	Nut, DIN 934		-
	4	Spring washer, DIN 128		-
	1	Cup square neck bolt, DIN 603	M6	6
			M8	20
			M10	40
			M12	70
	2	Nut, DIN 934		-
	3	Plain washer large, DIN 9021 (1 size bigger)		-
	4	Conical spring washer, DIN 6796		-

Table 14. Tightening torques

Detail	#	Part	Size	Tightening torque (Nm), ±15%
	1	Cup square neck bolt, DIN 603	M6	6
			M8	20
			M10	40
			M12	70
	2	Plain washer large, DIN 9021 (1 size bigger)		-
	3	Plain washer large, DIN 9021		-
	4	Nut, DIN 934		-
	5	Conical spring washer, DIN 6796		-

5. SERVICE

5.1 WARRANTY

Only manufacturing defects are covered by the warranty. The manufacturer assumes no responsibility for damages caused during or resulting from transport, receipt of the delivery, installation, commissioning or use.

The manufacturer shall in no event and under no circumstances be held responsible for damages and failures resulting from misuse, wrong installation, unacceptable ambient temperature, dust, corrosive substances or operation outside the rated specifications.

Neither can the manufacturer be held responsible for consequential damages.

The Manufacturer's warranty period is 18 months from the delivery or 12 months from the commissioning whichever expires first (Danfoss general terms and conditions of sale).

The local distributor may grant a warranty time different from the above. This warranty time shall be specified in the distributor's sales and warranty terms. Danfoss assumes no responsibility for any other warranties than that granted by Danfoss itself.

In all matters concerning the warranty, please contact your distributor first.

5.2 MAINTENANCE

All technical devices, drives as well, need a certain amount of care-taking and failure preventive maintenance. To maintain trouble-free operation of the VACON® drives, environmental conditions, as well as load, line power, process control, etc. have to be within specifications, determined by manufacturer.

If all conditions are in accordance with the manufacturer's specifications, there are no other concerns, but to provide a cooling capacity high enough for the power- and control circuits. This requirement can be met by making sure, that the cooling system works properly. Operation of cooling fans and cleanness of the heat sink should be verified regularly.

Regular maintenance is recommended to ensure trouble free operation and long lifetime of the VACON® drives. At least the following things should be included in the regular maintenance.

Table 15. Maintenance schedule

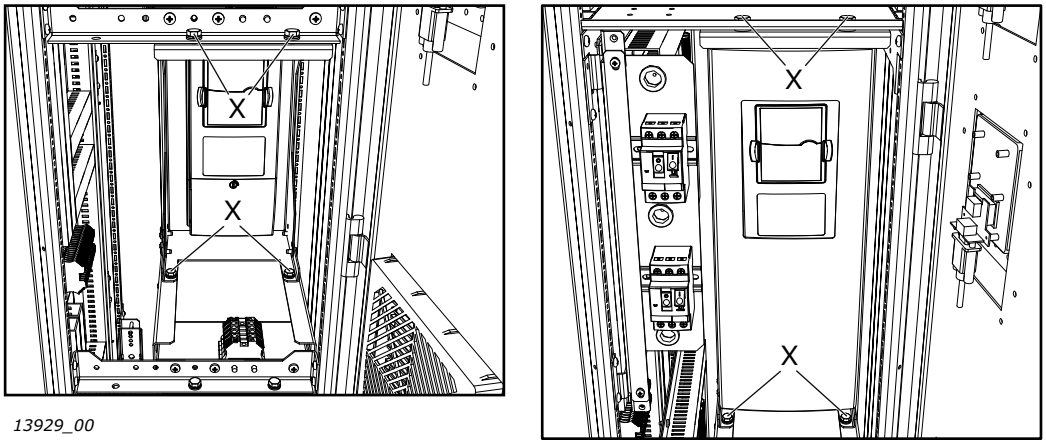
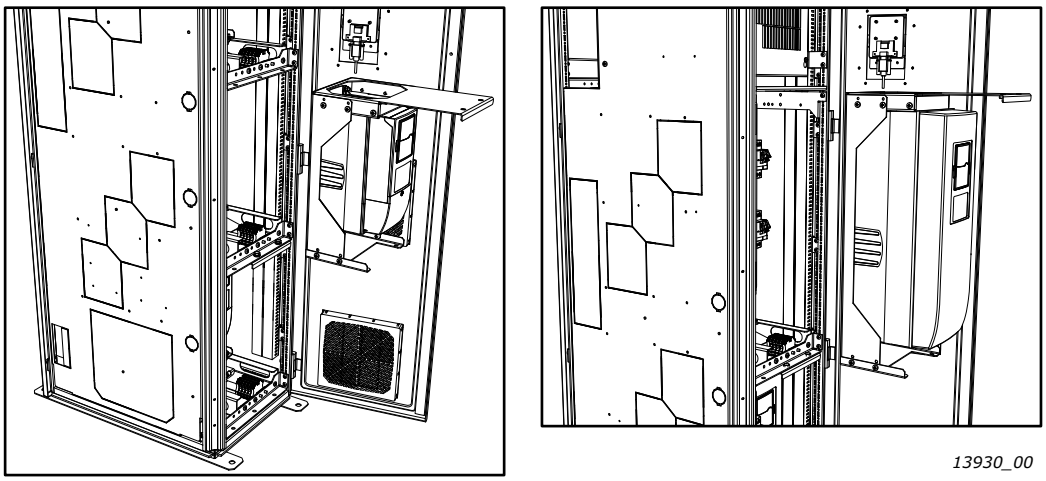
Interval	Maintenance
12 months (if unit is stored)	Reform the capacitors
6-24 months (depending on environment)	Check the tightening torques of the input and output terminals and I/O terminals. Clean the cooling tunnel. Check operation of the cooling fan, check for corrosion on terminals, busbars and other surfaces.
5-7 years	Change the cooling fans: • Cabinet fans • Drive fans • LCL filter fans
5-10 years	Change the DC-link capacitors if DC voltage ripple is high.

It is also recommended to record all actions and counter values with dates and time for follow up of maintenance.

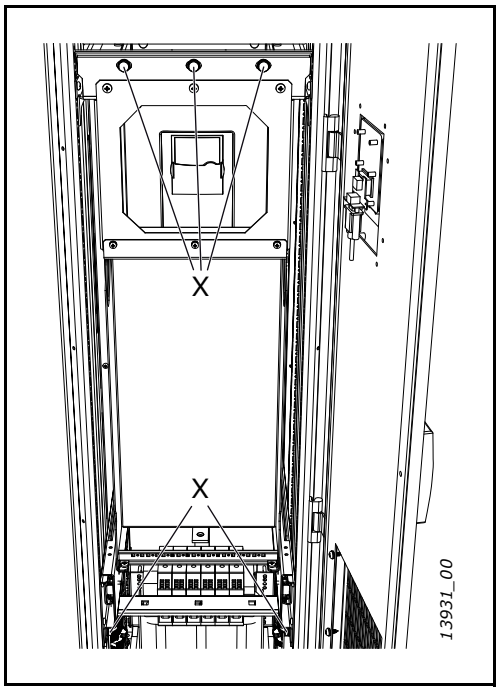
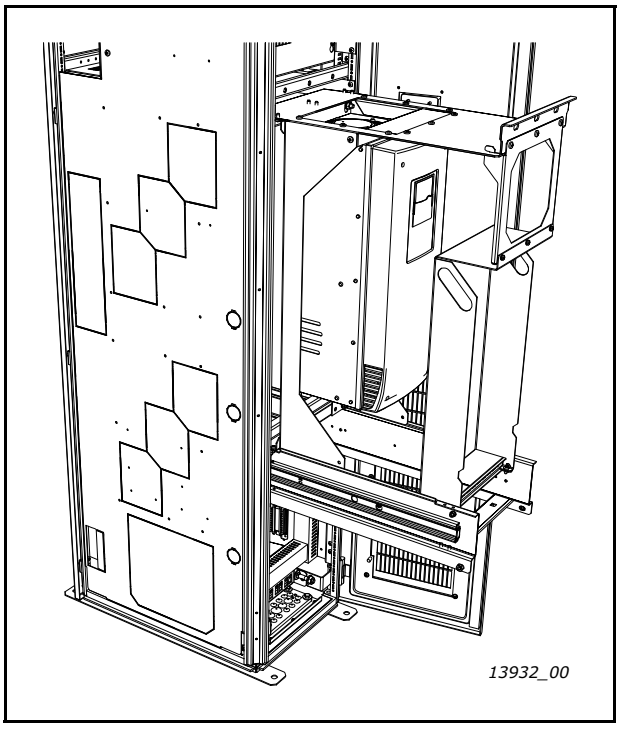
5.3 REMOVING THE DRIVES FROM THE CABINET

Servicing is only permitted to be carried out by Danfoss-trained service personnel!

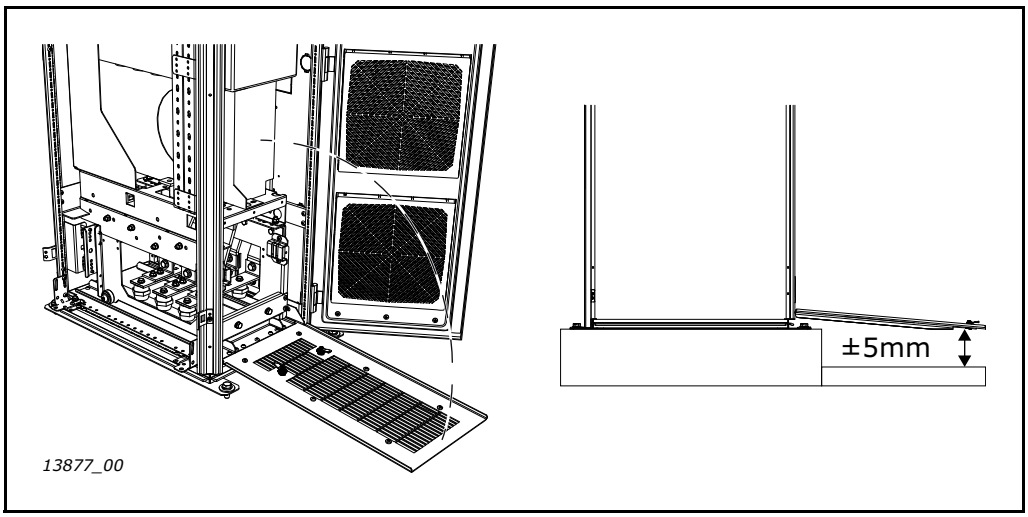
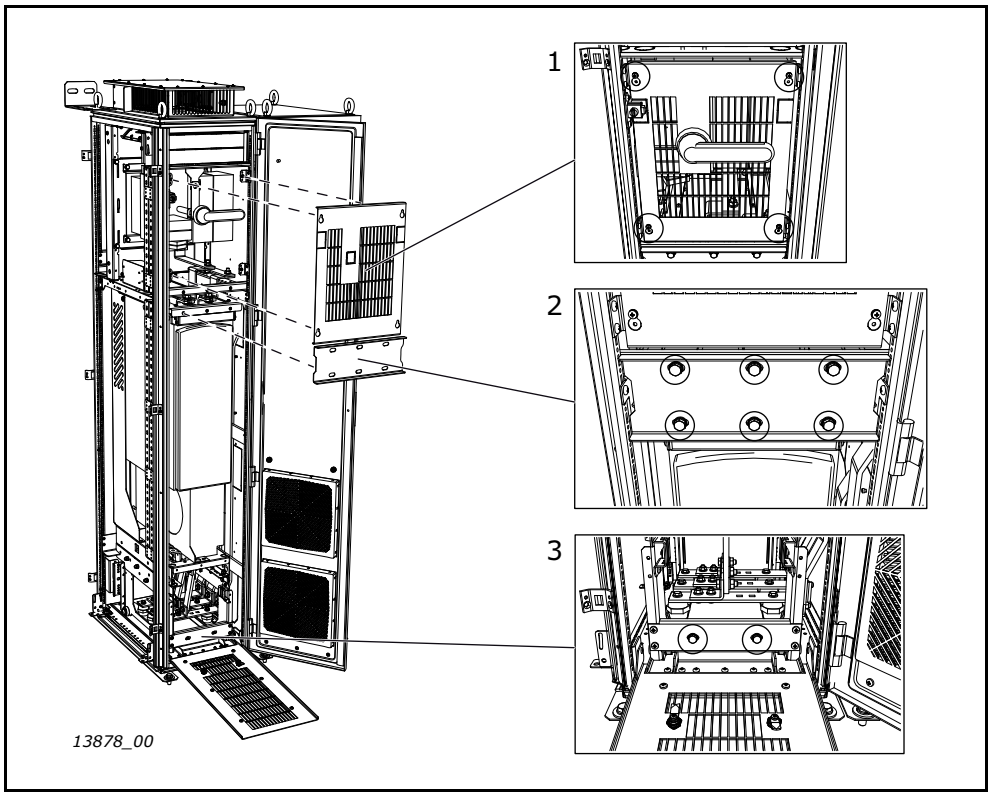
5.3.1 IUS_4 / IUS_6

1	Open the cabinet door.
2	Disconnect all cables from the drive. See Chapter 4.6.
3	Release the drive assembly. Remove the four M8x20 bolts (tightening torque 20 Nm).  13929_00 *Figure 30. Drive assembly mounting bolts (X) in IUS_4 (left) and IUS_6 (right)*
4	Pull out the drive assembly.  13930_00 *Figure 31. Pulling the drive assembly in IUS_4 (left) and IUS_6 (right)*

5.3.2 IUS_7 / IUS_8

1	Open the cabinet door.
2	Release the drive assembly. Remove the five M8x20 bolts (tightening torque 20 Nm).  *Figure 32. Drive assembly mounting bolts (X)*
3	Pull out the drive assembly.  *Figure 33. Pulling the drive assembly out of the cabinet*
4	Disconnect all cables from the drive. See Chapter 4.6.

5.3.3 IUS_9 / IUS_10

1	Open the cabinet door.
2	Release the service ramp and turn it down in front of the drive. **NOTE!** The height of the surface in front of the cabinet should not differ more than 5 mm from the level of the cabinet installation.  *Figure 34. Lowering the service ramp*
3	1. Loosen the four M5 screws (tightening torque 3 Nm) and remove the touch cover. 2. Remove the six M8 screws (torque 20 Nm) and remove the upper holder plate. 3. Remove the two M8 screws (torque 20 Nm) from the drive bottom holder plate.  *Figure 35. Removing the drive touch cover and holder plates*

4

Release the input busbar assemblies. Remove:

1. two M10 nuts and M10x30 bolts (torque 40 Nm) from the upper busbars,
2. two M12 nuts and M12x40 bolts (torque 70 Nm) from the lower busbars,
3. two M8x20 screws (torque 20 Nm) from the back plate.

Take out the busbar assemblies, including the fuses.

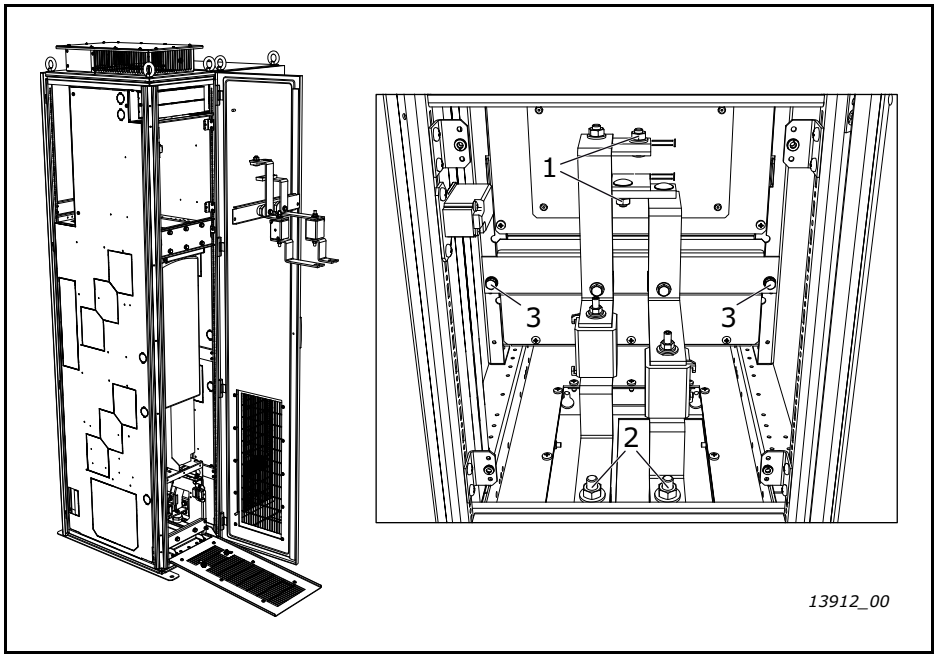


Figure 36. Releasing the input busbar assembly

5

Release the output busbars. Remove three M10 nuts/bolts (tightening torque 40 Nm).

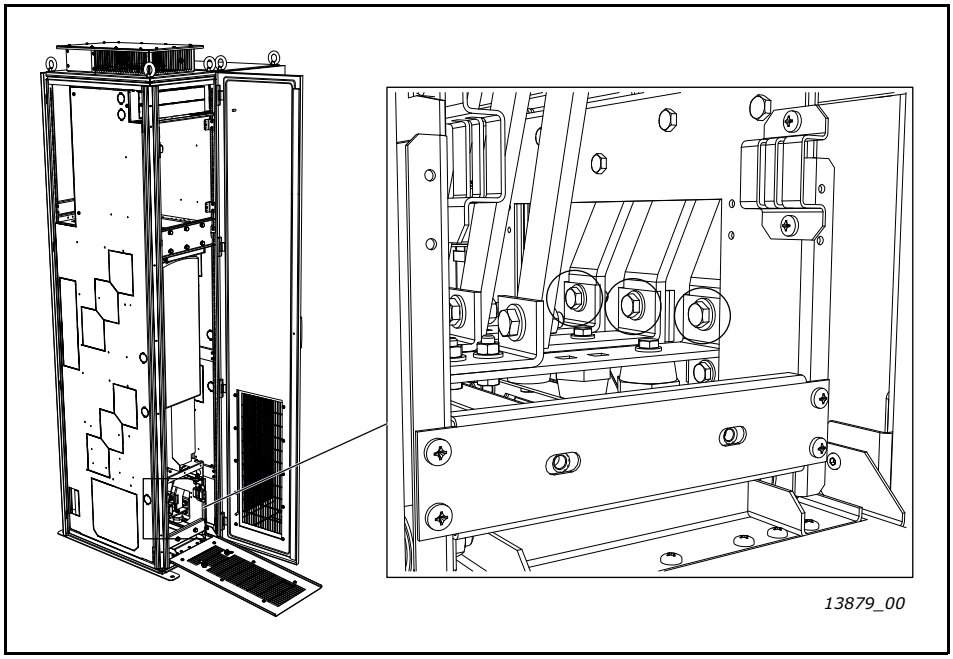
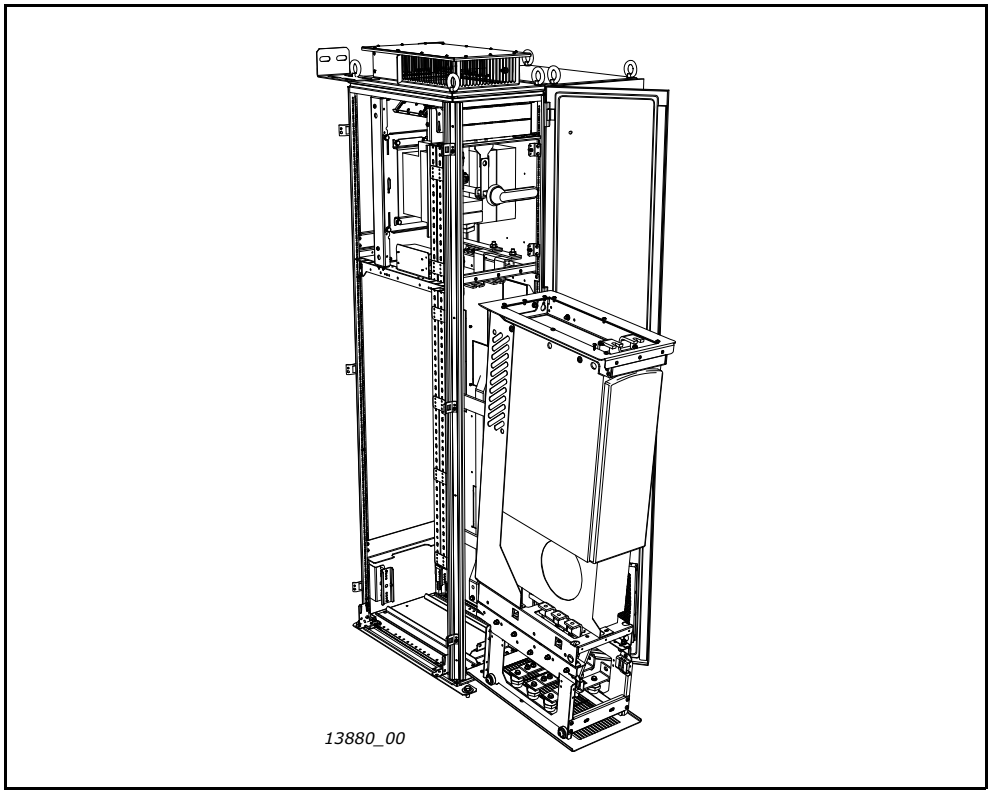
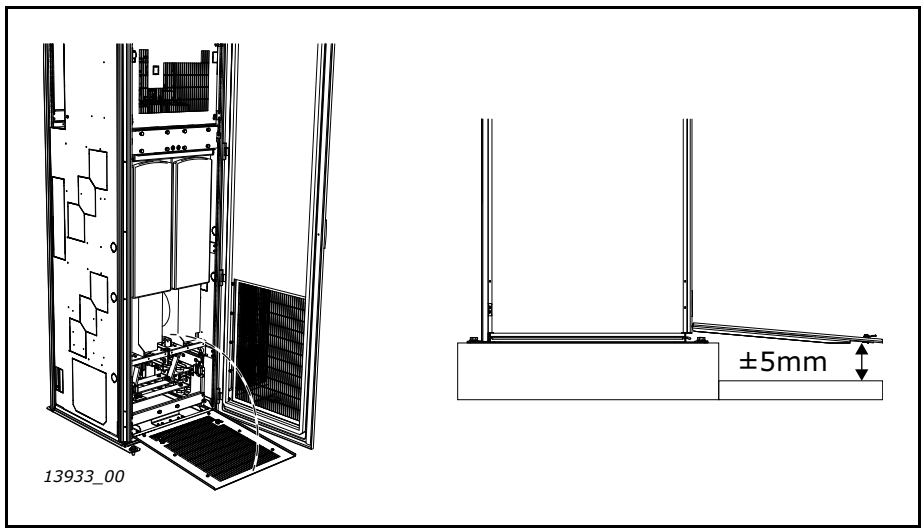
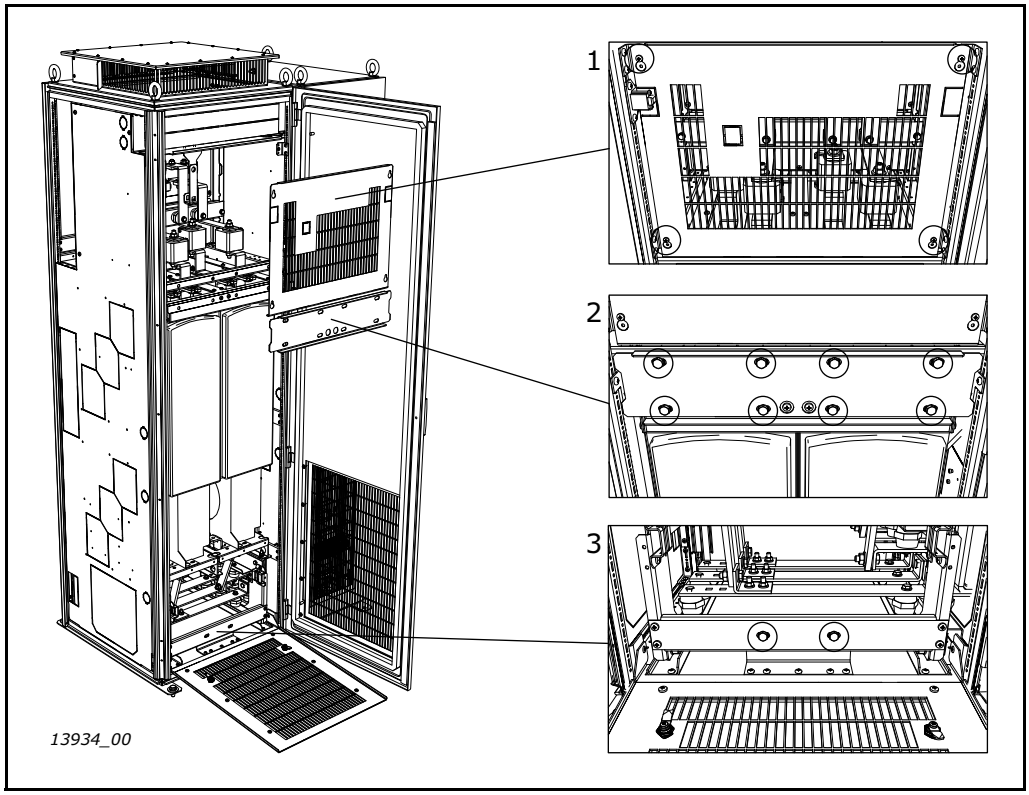


Figure 37. Busbar mounting screws

6	Pull the drive out on the service ramp.  *Figure 38. Pulling the drive out of the cabinet*

5.3.4 IUS_12

1	Open the cabinet door.
2	Release the service ramp and turn it down in front of the drive. **NOTE!** The height of the surface in front of the cabinet should not differ more than 5 mm from the level of the cabinet installation.  *Figure 39. Lowering the service ramp*
3	1. Loosen the four M5 screws (tightening torque 3 Nm) and remove the touch cover. 2. Remove the eight M8 screws (torque 20 Nm) and remove the upper holder plate. 3. Remove the two M8 screws (torque 20 Nm) from the drive bottom holder plate.  *Figure 40. Removing the drive touch cover and holder plates*

4

Release the input busbar assembly. Remove:

1. four M10 nuts and M10x30 bolts (torque 40 Nm) from the upper busbars,
2. four M12 nuts and M12x40 bolts (torque 70 Nm) from the lower busbars,
3. two M8x20 screws (torque 20 Nm) from the back plate.

Take out the busbar assemblies, including the fuses.

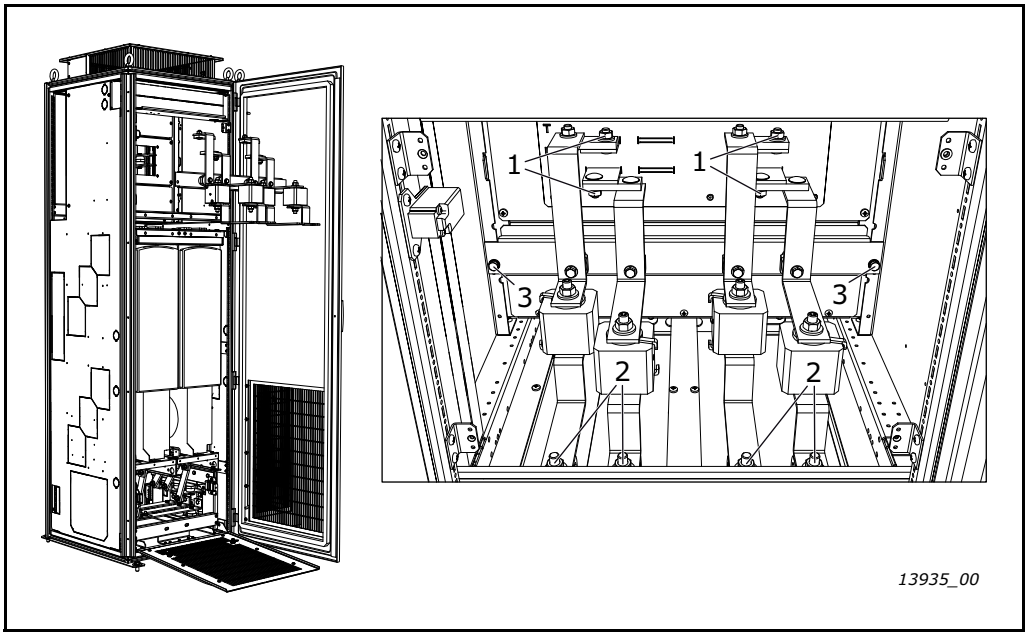


Figure 41. Releasing the input busbar assembly

5

Release the output busbars. Remove six M10 nuts/bolts (tightening torque 40 Nm).

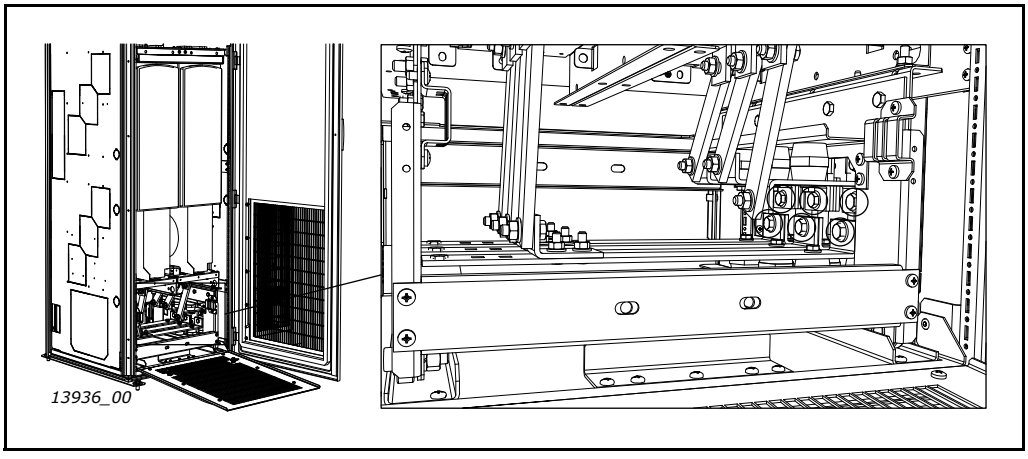
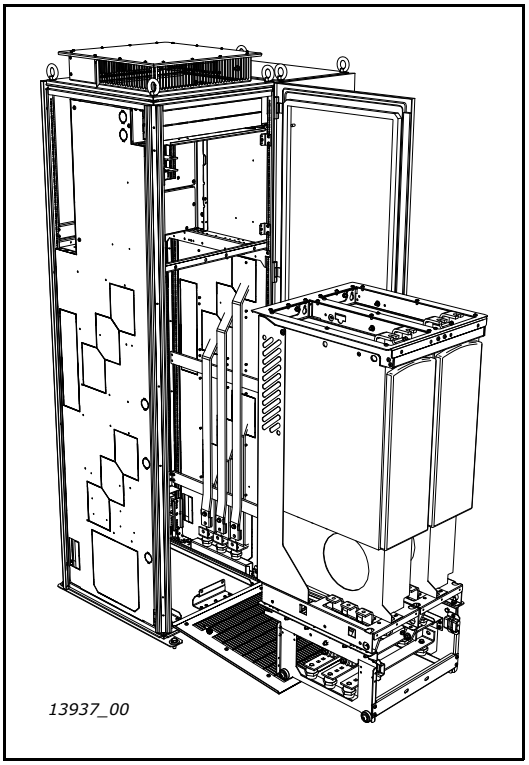


Figure 42. Output busbar mounting screws

6	Pull the drive out on the service ramp.  *Figure 43. Pulling the drive out of the cabinet*

5.3.5 IUS_13 / IUS_14

1	Open the cabinet door.
2	Release the service ramp and turn it down in front of the drive. **NOTE!** The height of the surface in front of the cabinet should not differ more than 5mm from the level of the cabinet installation.

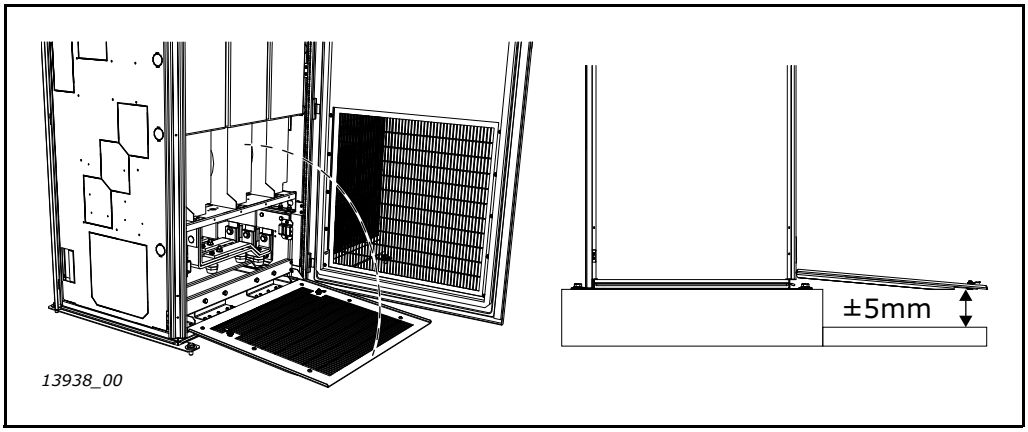


Figure 44. Lowering the service ramp

3	1. Loosen the four M5 screws (tightening torque 3 Nm) and remove the touch cover. 2. Remove the eight M8 screws (torque 20 Nm) and remove the upper holder plate. 3. Remove the four M8 screws (torque 20 Nm) from the drive bottom holder plate.

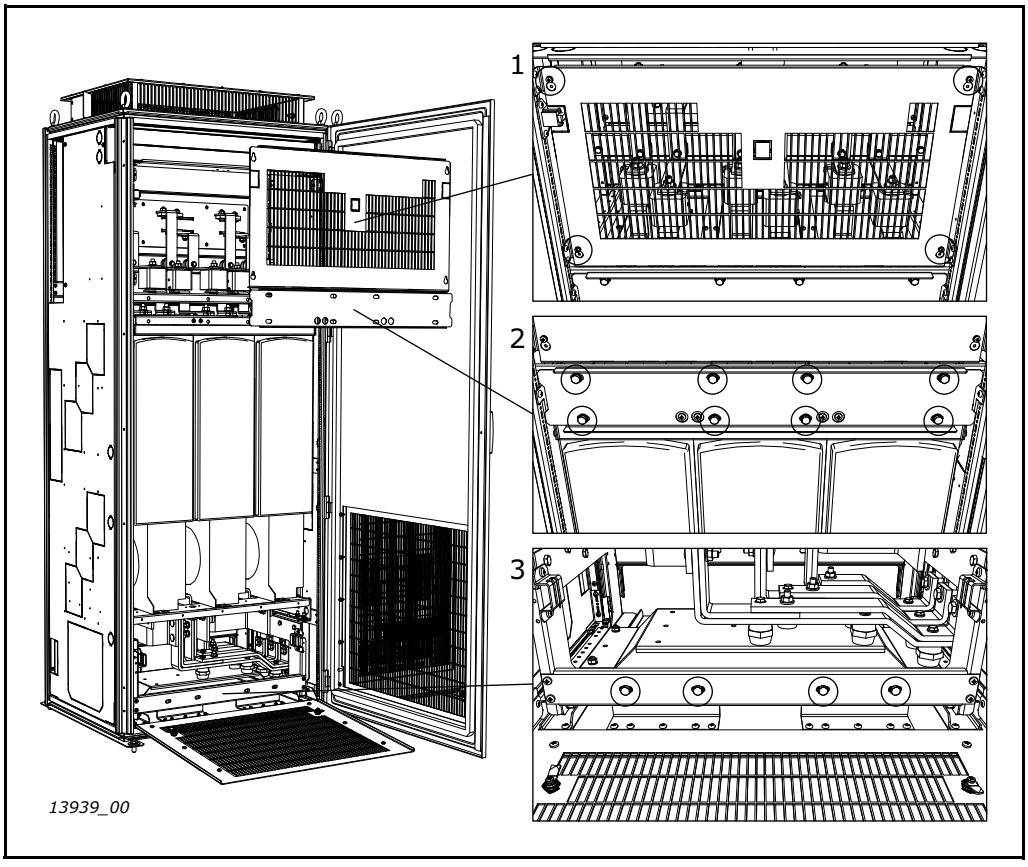


Figure 45. Removing the drive touch cover and holder plates

4

Release the input busbar assembly. Remove:

1. six M10 nuts and M10x30 bolts (torque 40 Nm) from the upper busbars,
2. six M12 nuts and M12x40 bolts (torque 70 Nm) from the lower busbars,
3. two M8x20 screws (torque 20 Nm) from the back plate.

Take out the busbar assemblies, including the fuses.

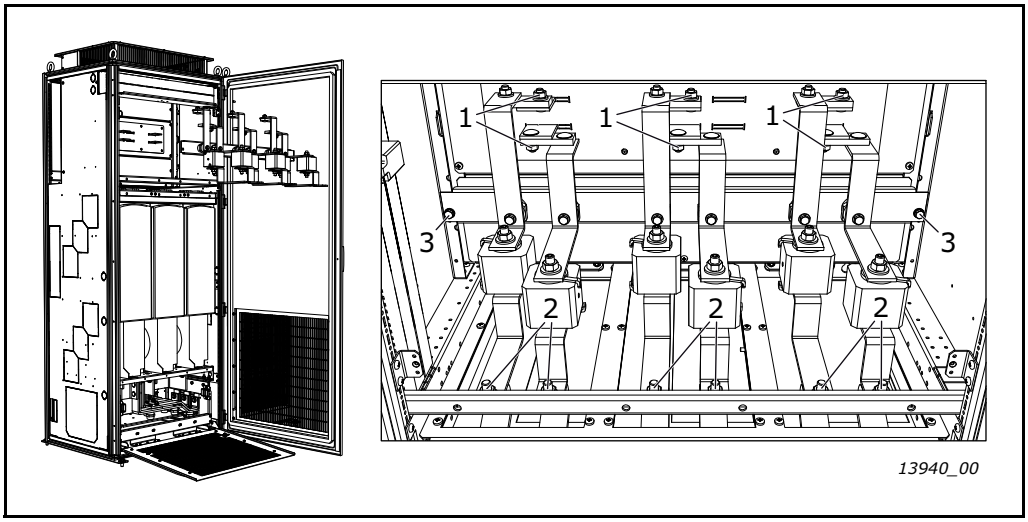


Figure 46. Releasing the input busbar assembly

5

Release the output busbars. Remove three M12 nuts/bolts (tightening torque 70 Nm).

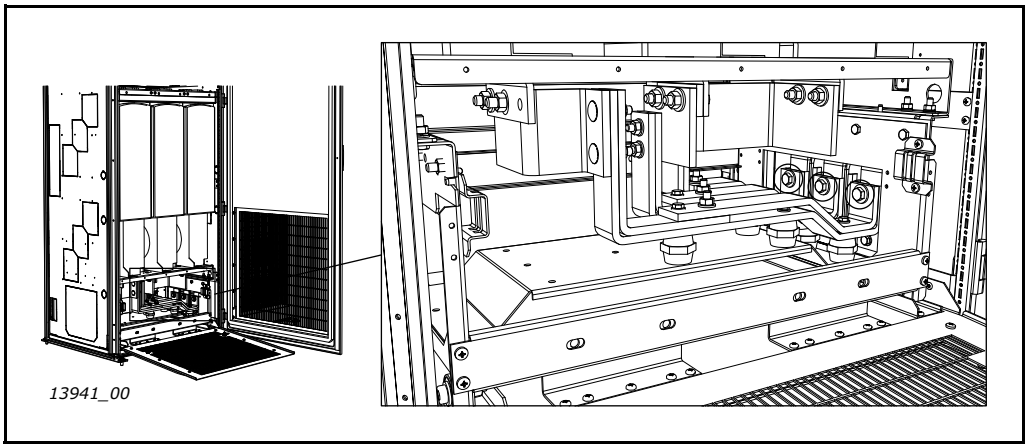
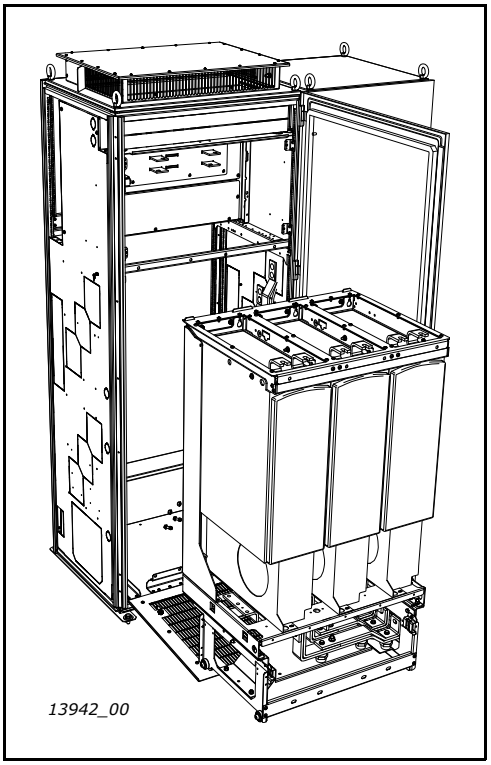


Figure 47. Output busbar mounting screws

6	Pull the drive out on the service ramp.  *Figure 48. Pulling the drive out of the cabinet*

6. TECHNICAL INFORMATION

6.1 CONTROL AND INTERFACE

Speed and/or torque control functions are available in the drive. Speed and/or torque reference as well as command word is generated by the overriding line control system and individually transmitted to each drive either via fieldbus or hardwired signals. The drive transmits selected actual values as well as status words back to the line control system.

6.1.1 CONTROL WITHOUT SPEED FEEDBACK (OPEN LOOP)

- Speed error in steady state typically <0.5%
- Torque rise time <10 ms
- Torque error in steady state typically <3%
- Suitable also for multimotor configuration

6.1.2 CONTROL WITH SPEED FEEDBACK (CLOSED LOOP)

Full torque control at zero speed cannot be maintained without speed feedback. When a speed error of less than 0.5% or full torque control at all speeds is required, motor control based on feedback from an encoder is a necessity. This capability is incorporated into the VACON® NXP drive. In addition to the current measurement system used, the NXP drive utilizes feedback values from the encoder to determine the motor state. The enhanced microprocessor provided with the NXP drive is capable of calculations every 150 microseconds. This control can be used for applications requiring high precision, such as sectional drives.

- Speed error in steady state typically <0.01% (pulse encoder type dependent)
- Pulse encoder: 250-5000 ppr at 5, 12 or 24 V (option board dependent)
- Torque rise time <10 ms
- Torque error in steady state typically <3%

6.2 LOAD DEFINITIONS

The drives are normally selected based on the load definition shown in the drive list, where:

- n_{min} = minimum speed [RPM], beginning of the continuous constant torque load speed range
- n_{base} = base speed [RPM], end of the continuous constant torque load speed range (and beginning of the continuous constant power load speed range)
- n_{max} = maximum speed [RPM], end of the continuous constant power load speed range (also maximum allowed motor speed)
- $P[n_{base}]$ = base power [kW], motor shaft power at the end of the continuous constant torque load speed range (also motor shaft power of the continuous constant power load speed range)
- $T[n_{base}]$ = base torque [Nm], motor shaft torque of the continuous constant torque load speed range (also motor shaft torque at the beginning of the continuous constant power load speed range)
- *OL* = overload [%], short time maximum load, 1 min. / 10 min. (100% = no overload)

NOTE! Load is defined based on the information received. Danfoss is not responsible for verifying that the information is sufficient and accurate.

There are various possibilities to define the load curve. Below are some examples.

6.2.1 PUMP AND FAN LOAD

Set all speeds to the same value (n_{min} = n_{base} = n_{max}) to have the typical pump and fan curve, i.e. quadratically increasing load.

The overload is now set as starting torque and as OL at maximum speed (the overload is now defined as percent of torque at maximum speed).

The calculation of current is also here done assuming nominal flux in the motor from 0 to field weakening point (current calculation according to "optimized flux curve" is not available).

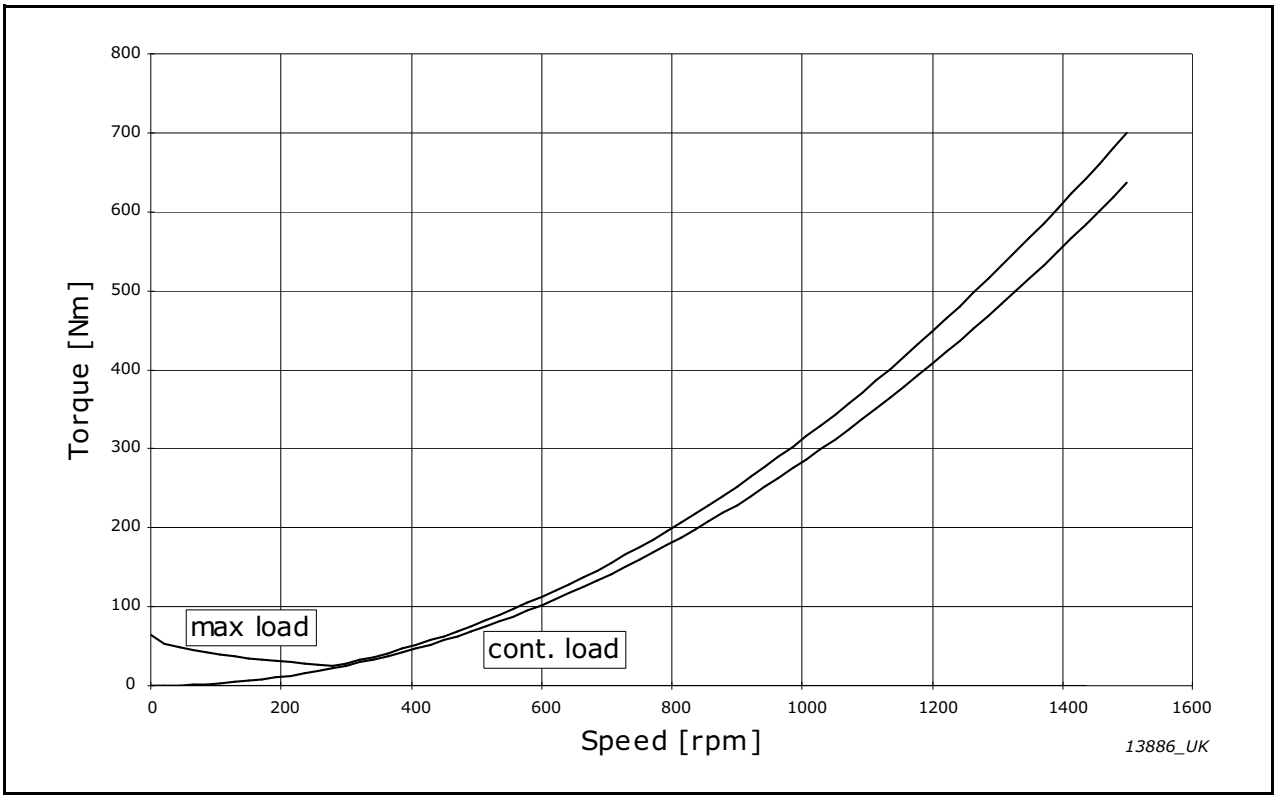


Figure 49. Example: pump and fan load

6.2.2 OL(n_{BASE}) > OL(n_{MAX}) FOR CONSTANT TORQUE LOAD

It is possible to set the overload at base speed smaller than the overload at maximum speed, i.e. OL(n_{base}) < OL(n_{max}).

This can be useful when selecting the correct AC drive for constant torque drives where the overload demand at low speeds is higher than at high speeds.

This possibility is usually used when the field weakening point is higher than base speed.

The benefit from this can be the possibility to use a size smaller AC drive.

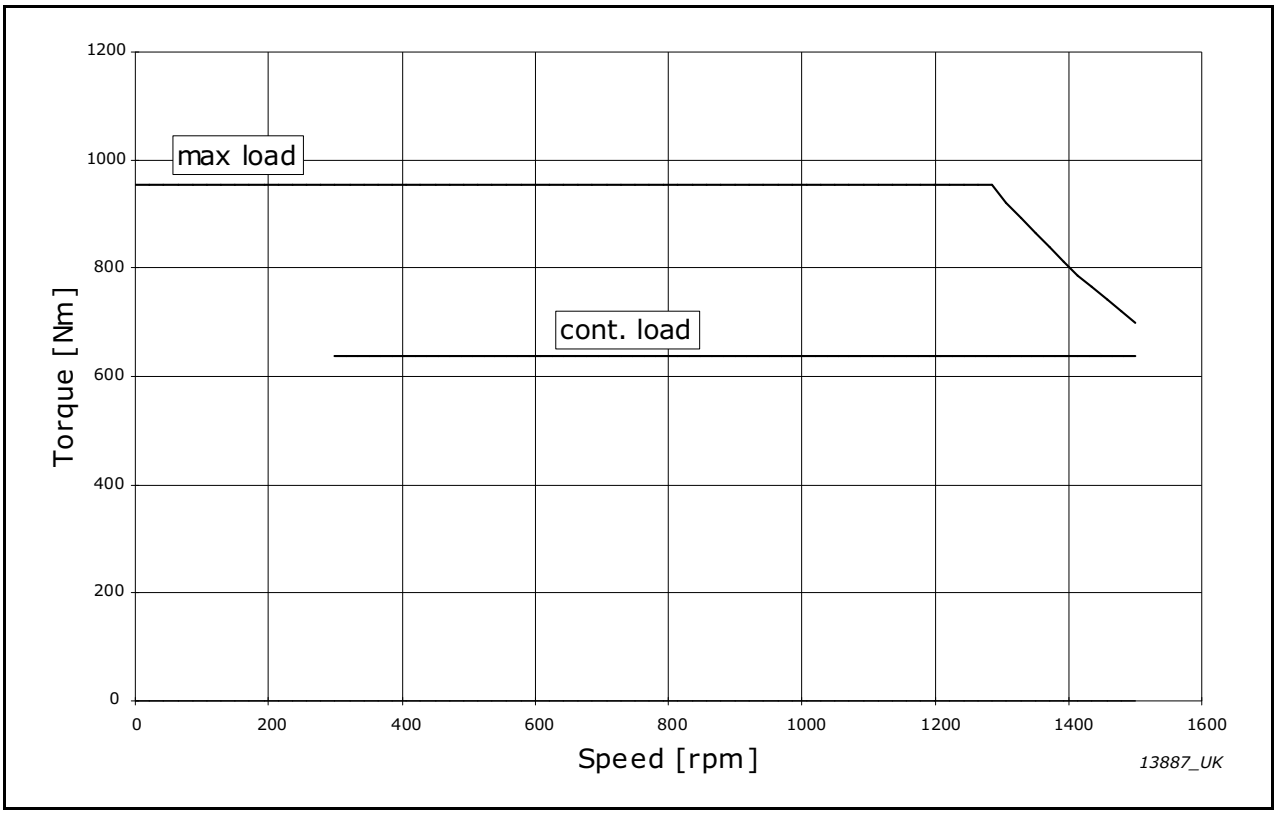


Figure 50. Example: OL(n_{base}) > OL(n_{max}) for constant torque load

6.2.3 STARTING TORQUE >> OL(n_{MAX}) FOR CONSTANT TORQUE LOAD

It is possible to set the starting torque higher than the overload at maximum speed, i.e. OL(n_{base}) < OL(n_{max}).

This can be useful when selecting the correct AC drive for constant torque drives where the starting torque requirement is much higher than the maximum load requirement at maximum speed.

This possibility is usually used when the field weakening point is higher than base speed and when the starting torque is needed for a very short time.

The benefit from this can be the possibility to use a size smaller AC drive.

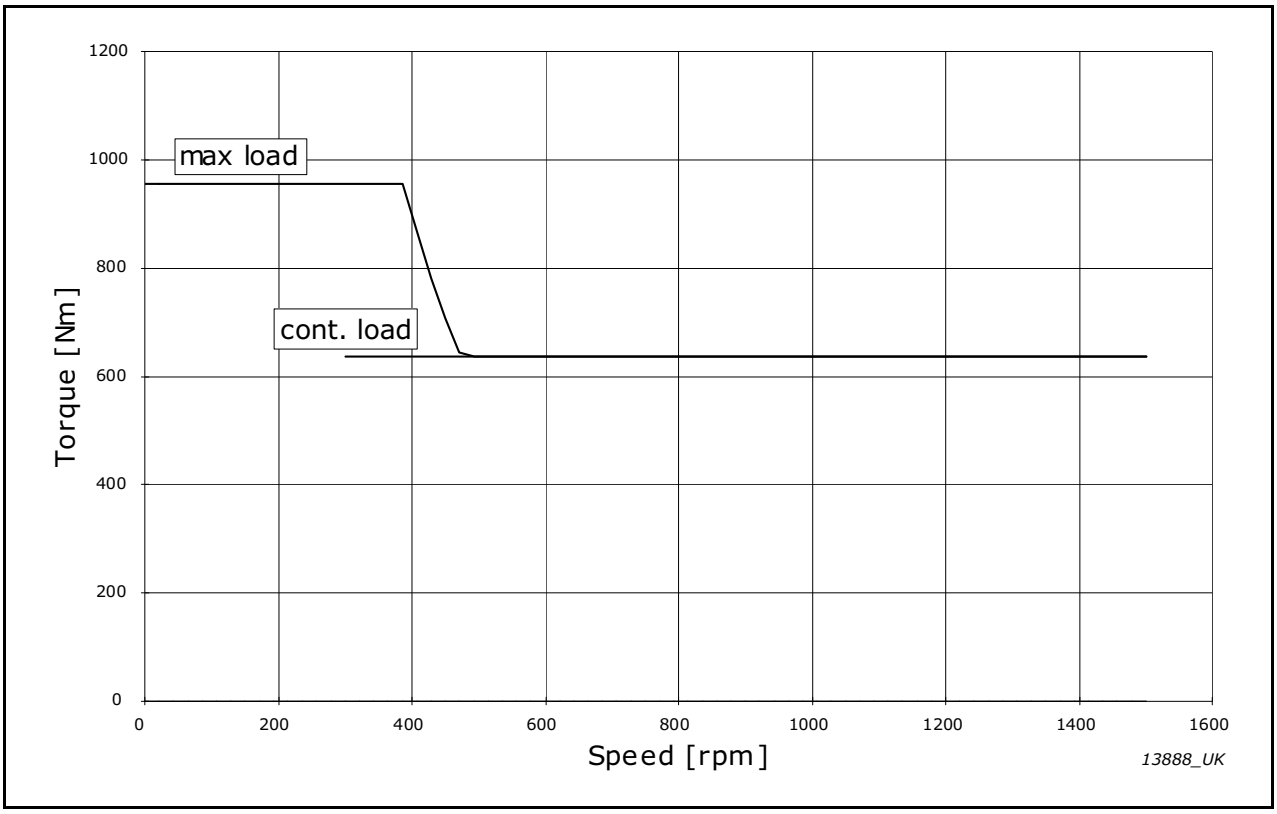


Figure 51. Example: Starting torque >> OL(n_{max}) for constant torque load

6.2.4 OL(n_{BASE}) > OL(n_{MAX}) FOR CONSTANT POWER LOAD

Some constant power drives require less overload at max speed than at lower speeds. It is therefore possible to set the relative overload at base speed higher than the relative overload at maximum speed, i.e. OL(n_{base}) > OL(n_{max}).

This will decrease the size of the motor when/if thermal loadability is not the dimensioning limit.

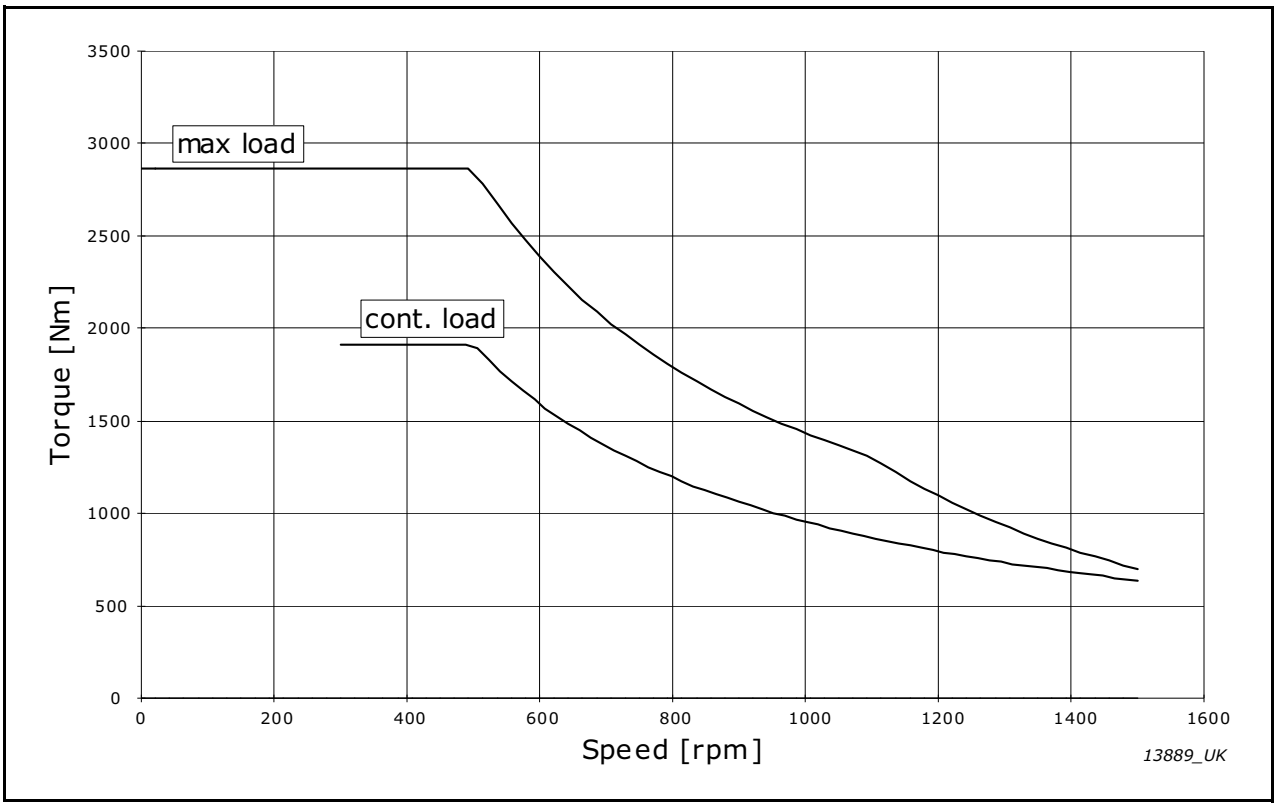


Figure 52. Example: OL(n_{base}) > OL(n_{max}) for constant power load

6.2.5 OL(n_{BASE}) < OL(n_{MAX}) FOR CONSTANT POWER LOAD

It is possible to set the overload at base speed smaller than the overload at max speed, i.e. OL(n_{base}) < OL(n_{max}).

This can be useful when selecting the correct motor and AC drive for constant power drives where the relative OL requirement is higher at maximum speed than the relative OL requirement at base speed.

The benefit from this can be the possibility to use a size smaller AC drive.

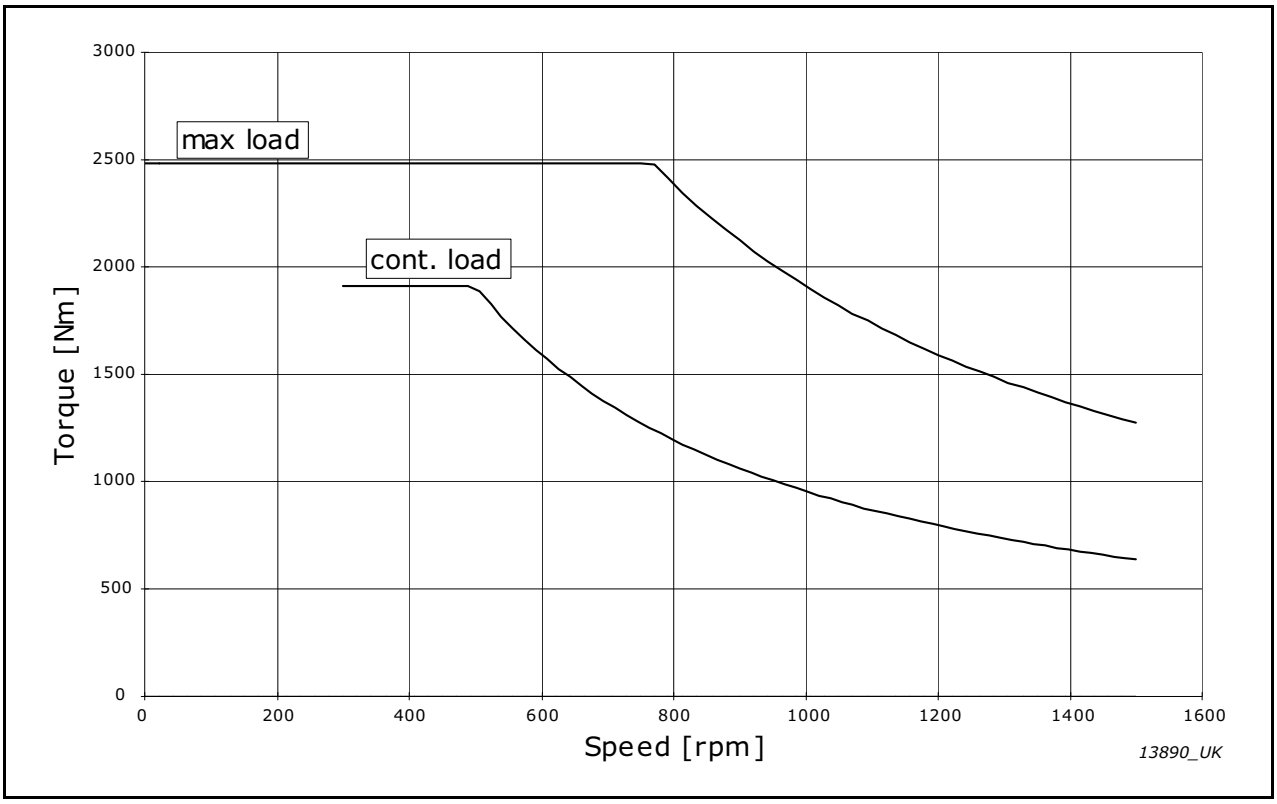


Figure 53. Example: OL(n_{base}) < OL(n_{max}) for constant power load

6.3 TECHNICAL SPECIFICATIONS FOR VACON® DRIVES

6.3.1 NXN - NON-REGENERATIVE FRONT END UNITS

Table 16. Technical specifications for non-regenerative front-end (NFE) drives

Mains connection	Input voltage U_{in}	380-690 V AC; -15%...+10%, EN 60204-1
	Input frequency f_{in}	45-66 Hz
	Continuous input current	I_H: Ambient temperature max. +40°C, overloadability 1.5 x I_H (1 min./10 min.) I_L: Ambient temperature max. +40°C, overloadability 1.1 x I_L (1 min./10 min.)
	Connection to mains	Unlimited (internal overload protections)
	Current THD	Depends on additional chokes (normal case < 40%)
	Starting delay	Depend on DC bus capacitance (max. 10 s)
	Unexpected input power break	Shorter breaks than 40 ms work normally if DC does not drop remarkably. A longer break means normal starting operation (charging current varies according to load).
DC connection	Output voltage U_{out}	465-800 V DC (380-500 V AC) 640-1100 V DC (525-690 V AC)
	Efficiency	>98%
	DC bank capacitance	6.8 µF (includes 10 MΩ discharging resistor)
Control characteristics	Control method	NFE is an independent power unit. Charging and protections are controlled by the NFE itself.
Ambient conditions	Ambient operating temperature	–10°C (no frost)...+40°C: I_H –10°C (no frost)...+40°C: I_L
	Storage temperature	–40°C...+70°C
	Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water
	Air quality: - chemical vapours - mechanical particles	 IEC 721-3-3, unit in operation, class 3C2 IEC 721-3-3, unit in operation, class 3S2
	Altitude	100% load capacity (no derating) up to 1000 m, 1% derating for each 100 m above 1000 m; max. 2000 m
	Vibration EN50178, EN60068-2-6	5-150 Hz Vibration amplitude 0.25 mm (peak) at 5-31 Hz Max acceleration 1 G at 31-150 Hz
	Shock EN50178, EN60068-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max. 15 G, 11 ms (in package)
	Cooling air required	1150 m^3/h
	Enclosure class	IP00
EMC (at default settings)	Immunity	Fulfil all EMC immunity requirements. Can be chosen N-, L- or T-level.

Table 16. Technical specifications for non-regenerative front-end (NFE) drives

Safety		CE, UL, CUL EN 61800-5-1 (2003) (see unit nameplate for more detailed approvals)
Control connections	Display	7-segment (optional)
	Trip information	Relay I/O (optional)
Protection	Unit over temperature protection	Trips if temperature rises over trip level (default)
	Current measurement	Trips if current rises over trip level (default)
	Supply phase supervision	Trips if any of the output phases is missing (default)

6.3.2 NXA - ACTIVE FRONT-END UNITS

Table 17. Technical specifications for active front-end (AFE) drives

AC input connection	Input voltage U_{in}	380-500 V AC; 525-690 V AC; -10%...+10%
	Input frequency f_{in}	48-63 Hz
	Starting delay	FI9-FI13: 5 s
DC output connection	Output voltage U_{out}	1.35 x U_{in} x 1.1 (default DC bus voltage boosting is 110%)
	Continuous output current	I_H: Ambient temperature max. +40°C, overloadability 1.5 x I_H (1 min./10 min.) I_L: Ambient temperature max. +40°C, overloadability 1.1 x I_L (1 min./10 min.)
Control characteristics	Control method	Open loop vector control
	Switching frequency	NXA_xxxx 5: 3.6 kHz NXA_xxxx 6: 3.6 kHz
Ambient conditions	Ambient operating temperature	–10°C (no frost)...+40°C: I_H –10°C (no frost)...+40°C: I_L 1.5% derating for each 1°C above +40°C; maximum temperature +50°C.
	Storage temperature	–40°C...+70°C
	Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water
	Air quality: - chemical vapours - mechanical particles	EN 60721, unit in operation, Class 3C3. IEC 721-3-3, unit in operation, Class 3S2.
	Altitude	100% load capacity (no derating) up to 1000 m, 1.5% derating for each 100m above 1000 m. Max. 2000 m (525-690 V AC) and 4000 m (380-500V AC), Relay I/O: max. 3000 m (240 V) and 4000 m (120 V)
	Vibration EN50178, EN60068-2-6	5-150 Hz Vibration amplitude 1 mm (peak) at 3-15.8 Hz Max acceleration 1 G at 15.8-150 Hz
	Shock EN50178, EN60068-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max. 15 G, 11 ms (in package)
	Enclosure class	IP00/NEMA1 standard size in the kW/HP range.
EMC (at default settings)	Immunity	EN 61800-3 (2nd edition 2004), second environment
Safety		EN 50178 (1997), EN 60204-1 (1996-2009), EN 60950 (2000, 3. edition, as relevant), CE, UL, cUL, FI, GOST R, IEC-EN 61800-5 (for approvals, see the unit nameplate)

Table 17. Technical specifications for active front-end (AFE) drives

Control connections	Analogue input voltage	0...+10 V, R_i = 200 kΩ. Resolution 0.1%, accuracy ±1%
	Analogue input current	0(4)...20 mA, R_i = 250 Ω differential
	Digital inputs (6)	Positive or negative logic; 18-30 V DC
	Auxiliary voltage	+24 V, ±15%, max. 250 mA
	Output reference voltage	+10 V, +3%, max. load 10 mA
	Analogue output (1)	0(4)...20 mA; R_L max. 500 Ω; Resolution 10 bit; Accuracy ±2%
	Digital outputs	Open collector output, 50 mA / 48 V
	Relay outputs	2 programmable change over relay outputs Switching capacity: 24 V DC / 8 A, 250 V AC / 8 A, 125 V DC / 0.4 A. Min. switching load: 5 V / 10 mA.
Protection	Overvoltage protection Undervoltage protection	NXA_5: 911 V DC; NXA_6: 1200 V DC NXA_5: 333 V DC; NXA_6: 460 V DC
	Ground fault protection	In case of an ground fault in the supply cable, the ground fault protection only protects the NX AFE itself.
	Input phase monitoring	Trips if any of the input phases is missing.
	Over current protection	Yes
	Unit over temperature protection	Yes
	Short circuit protection of +24 V and +10 V reference voltages	Yes

6.3.3 NXI - INVERTER UNITS

6.3.3.1 Drive sizes FR4-FR8

Table 18. Technical specifications for size FR4-FR8 inverter units (INU)

AC input connection	Input voltage U_{in}	465-800 V DC; 640-1100 V DC; –0%...+0% , The ripple voltage of the inverter supply voltage generated during the rectification of the fundamental frequency AC voltage must be less than 50 V peak-to-peak.
	Connection to DC supply	Once per minute or less (normal)
	Starting delay	2 s
Motor connection	Output voltage U_{out}	3~ 0 - U_{in} / 1.4
	Continuous output current	I_H: Ambient temperature max. +50°C, overloadability 1.5 x I_H (1 min./10 min.) I_L: Ambient temperature max. +40°C, overloadability 1.1 x I_L (1 min./10 min.)
	Starting torque	I_S for two seconds, depends on the motor
	Peak current	I_S for 2 s every 20 s
	Output frequency	0-320 Hz; 7200 Hz (special use)
	Frequency resolution	Depends on application
Control characteristics	Control method	Frequency control U/f Open loop sensorless vector control Closed loop frequency control Closed loop vector control
	Switching frequency	NXI_xxxx 5: 1-16 kHz; Factory default 10 kHz (NXI_0072 and greater: 1-10 kHz; Factory default 3.6 kHz) NXI_xxxx 6: 1-6 kHz; Factory default 1.5 kHz
	Frequency reference: - Analogue input - Panel reference	 Resolution 0.1% (10-bit), accuracy ±1% Resolution 0.01 Hz
	Field weakening point	30-320 Hz
	Acceleration time	0-3000 s
	Deceleration time	0-3000 s

Table 18. Technical specifications for size FR4-FR8 inverter units (INU)

Ambient conditions	Ambient operating temperature	–10°C (no frost)...+50°C: I_H –10°C (no frost)...+40°C: I_L
	Storage temperature	–40°C...+70°C
	Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water
	Air quality: - chemical vapours - mechanical particles	 IEC 721-3-3, unit in operation, Class 3C2. IEC 721-3-3, unit in operation, Class 3S2.
	Altitude	100% load capacity (no derating) up to 1000 m, 1% derating for each 100 m above 1000 m; max. 3000 m
	Vibration EN50178, EN60068-2-6	5-150 Hz Vibration amplitude 0.25 mm (peak) at 5-15.8 Hz Max acceleration 1 G at 15.8-150 Hz
	Shock EN50178, EN60068-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max. 15 G, 11 ms (in package)
	Enclosure class	FR4-FR7: IP21/NEMA1 standard FR8: IP00 standard
EMC (at default settings)	Immunity	Fulfils all EMC standards
Safety		EN 50178 (1997), EN 60204-1 (1996), EN 60950 (2000, 3rd edition, as relevant), CE, UL, CUL, FI, GOST R, IEC 61800-5; (see unit nameplate for more detailed approvals)
Control connections	Analogue input voltage	0...+10 V, R_i = 200 kΩ, (–10 V...+10 V joystick control) Resolution 0.1%, accuracy ±1%
	Analogue input current	0(4)...20 mA, R_i = 250 Ω differential
	Digital inputs (6)	Positive or negative logic; 18-30 V DC
	Auxiliary voltage	+24 V, ±15%, max. 250 mA
	Output reference voltage	+10 V, +3%, max. load 10 mA
	Analogue output	0(4)...20 mA; R_L max. 500 Ω; Resolution 10 bit; Accuracy ±2%
	Digital outputs	Open collector output, 50 mA / 48 V
	Relay outputs	2 programmable change over relay outputs Switching capacity: 24 V DC / 8 A, 250 V AC / 8 A, 125 V DC / 0.4 A. Min. switching load: 5 V / 10 mA.

Table 18. Technical specifications for size FR4-FR8 inverter units (INU)

Protection	Overvoltage protection Undervoltage protection	NXI_5: 911 V DC; NXI_6: 1200 V DC NXI_5: 333 V DC; NXI_6: 460 V DC
	Ground fault protection	In case of an ground fault in the motor or motor cable, only the inverter is protected
	Output phase supervision	Trips if any of the output phases is missing
	Over current protection	Yes
	Unit over temperature protection	Yes
	Motor overload protection	Yes
	Motor stall protection	Yes
	Motor underload protection	Yes
	Short circuit protection of +24 V and +10 V reference voltages	Yes

6.3.3.2 Drive sizes FI9-FI14

Table 19. Technical specifications for size FI9-FI14 inverter units (INU)

AC input connection	Input voltage U_{in}	465-800 V DC (380-500 V AC) 640-1100 V DC (525-690 V AC) The ripple voltage of the inverter supply voltage generated during the rectification of the fundamental frequency AC voltage must be less than 50 V peak-to-peak.
	Input current I_{in}	$(\sqrt{3} \times U_{mot} \times I_{mot} \times \cos \varphi) / (U_{in} \times 0.98)$
	DC bank capacitance	FI9_5: 4950 µF; FI9_6: 3733 µF FI10_5: 9900 µF; FI10_6: 7467 µF FI12_5: 19800 µF; FI12_6: 14933 µF FI13_5: 29700 µF; FI13_6: 22400 µF FI14_5: 2 x 29700 µF; FI14_6: 2 x 22400 µF
	Starting delay	5 s
Motor connection	Output voltage U_{out}	3~ 0 - U_{in} / 1.4
	Continuous output current	I_H: Ambient temperature max. +40°C, overloadability 1.5 x I_H (1 min./10 min.) I_L: Ambient temperature max. +40°C, overloadability 1.1 x I_L (1 min./10 min.)
	Starting torque	I_S for two seconds, depends on the motor
	Peak current	I_S for 2 s every 20 s
	Output frequency	0-320 Hz; 7200 Hz (special use)
	Frequency resolution	Depends on application
Control characteristics	Control method	Frequency control U/f Open loop sensorless vector control Closed loop frequency control Closed loop vector control
	Switching frequency	NXI_5: 1-10 kHz; Factory default 3.6 kHz NXI_6: 1-6 kHz; Factory default 1.5 kHz
	Frequency reference: - Analogue input - Panel reference	 Resolution 0.1% (10-bit), accuracy ±1% Resolution 0.01 Hz
	Field weakening point	30-320 Hz
	Acceleration time	0-3000 s
	Deceleration time	0-3000 s
	Braking torque	DC brake: 30% x T_N (without brake)

Table 19. Technical specifications for size FI9-FI14 inverter units (INU)

Ambient conditions	Ambient operating temperature	–10°C (no frost)...+40°C
	Storage temperature	–40°C...+70°C
	Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water
	Air quality: - chemical vapours - mechanical particles	 IEC 721-3-3, unit in operation, Class 3C2 IEC 721-3-3, unit in operation, Class 3S2
	Altitude	100% load capacity (no derating) up to 1000 m, 1% derating for each 100 m above 1000 m; max. 2000 m
	Vibration EN50178, EN60068-2-6	Vibration amplitude 0.25 mm (peak) at 5-31 Hz Max acceleration 1 G at 31-150 Hz
	Shock EN50178, EN60068-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max. 15 G, 11 ms (in package)
	Heat loss	P_{loss} [kW] ≈ P_{mot} [kW] × 0.02
	Cooling air required	FI9: 1150 m^3/h FI10: 1400 m^3/h FI12: 2800 m^3/h FI13: 4200 m^3/h FI14: 2×4200 m^3/h
	Enclosure class	IP00
EMC (at default settings)	Immunity	Fulfil all EMC immunity requirements, Level T
Safety		CE, UL, CUL EN 61800-5-1 (2003) (see unit nameplate for more detailed approvals)
Control connections	Analogue input voltage	0...+10 V, R_i = 200 kΩ, (–10 V...+10 V joystick control) Resolution 0.1%, accuracy ±1%
	Analogue input current	0(4)...20 mA, R_i = 250 Ω differential
	Digital inputs (6)	Positive or negative logic; 18-30 V DC
	Auxiliary voltage	+24 V, ±15%, max. 250 mA
	Output reference voltage	+10 V, +3%, max. load 10 mA
	Analogue output	0(4)...20 mA; R_L max. 500 Ω; Resolution 10 bit; Accuracy ±2%
	Digital outputs	Open collector output, 50 mA / 48 V
	Relay outputs	2 programmable change over relay outputs Switching capacity: 24 V DC / 8 A, 250 V AC / 8 A, 125 V DC / 0.4 A. Min. switching load: 5 V / 10 mA.

Table 19. Technical specifications for size FI9-FI14 inverter units (INU)

Protection	Overvoltage protection Undervoltage protection	NXI_5: 911 V DC; NXI_6: 1200 V DC NXI_5: 333 V DC; NXI_6: 460 V DC
	Ground fault protection	In case of an ground fault in the motor or motor cable, only the inverter is protected
	Output phase supervision	Trips if any of the output phases is missing
	Over current protection	Yes
	Unit over temperature protection	Yes
	Motor overload protection	Yes
	Motor stall protection	Yes
	Motor underload protection	Yes
	Short circuit protection of +24 V and +10 V reference voltages	Yes

6.3.4 NXB - BRAKE CHOPPER UNITS

Brake chopper units are available in frame sizes FI9-FI14. The technical specifications for brake chopper units are the same as for inverter units (see Chapter 6.3.3.2).

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