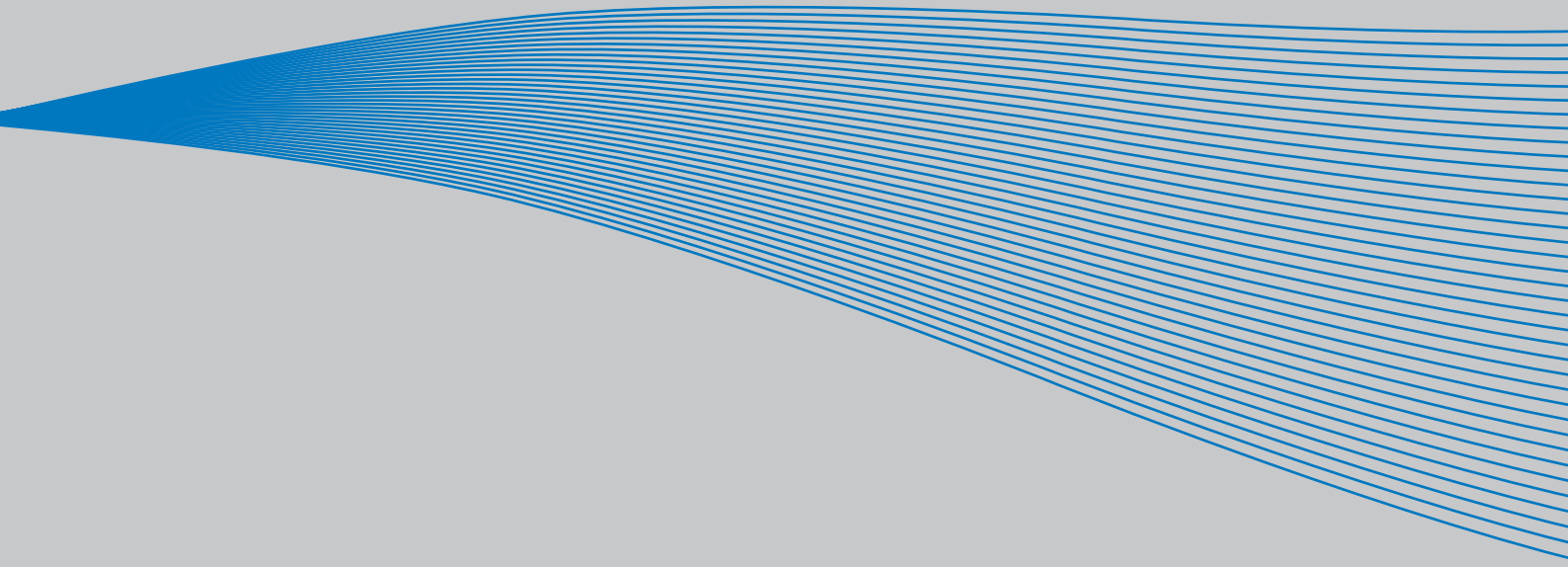
VACON® NXP
AC DRIVES

SYSTEM DRIVE
HARDWARE MANUAL



VACON®
DRIVEN BY DRIVES

GREETINGS,

Thank you for considering VACON® as your drives supplier.

VACON is the largest company in the world concentrating on drives only. We are proud of what we do.

- We provide AC drives in the power range 0.25 kW – 5 MW.
- We focus on the entire lifecycle of AC drives from R&D to after market services.
- VACON's experts understand the important stages of the customer's business.
- VACON's expertise is available in all cases that affect the customer's total cost of ownership.

Passion for excellence

- VACON is dedicated towards providing the best variable speed AC drives around.
- As much as 6% of the revenue is invested in R&D.

Global with a local presence

- VACON has manufacturing plants in Finland, China, Italy, India and the USA.
- Our AC drives are sold in more than 100 countries with subsidiaries, business partners and service centres around the world.

Growing at a fast pace

- For many years, VACON has been growing at twice the speed of the global AC drive market.

Once again, thank you and I hope that you find that our engineered sectional drives will meet your requirements.

Please visit us at www.vacon.com.

Best Regards,

Jarmo Tirkkonen

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Table 1. Manual revision history

Revision	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”.

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1. INTRODUCTION

VACON® has been at the forefront of the drive systems business for twenty years. However, we're now changing the way we work on projects a little, to ensure that you receive the same outstanding level of quality and service, each and every time.

VACON® NXP System Drive sets out to ensure that our partners receive a system drive solution which delivers a level of quality that's as consistent as it is excellent. Complex solutions are simplified through standardization, so that you can rely on a product that will easily integrate into the process at hand.

1.1 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 Vacon Plc's scope of supply.

1.2 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

1.3 RELATED BROCHURES AND MANUALS

All Vacon user manuals and brochures are available in PDF format on the Vacon website at www.vacon.com/downloads/.

Table 2. Related user manuals and brochures

Document ID	Name of manual
BC00169	Vacon Common DC Bus Products Brochure
DPD01172	Vacon NXN NFE User manual
DPD00906	Vacon NX AFE User Manual
UD01047	Vacon NX Inverters FI4-8 User Manual
UD01063	Vacon NX Inverters FI9-14 User Manual

Also manuals for different applications and option boards are available on the Vacon website at www.vacon.com/downloads/.

1.4 PROJECT SPECIFICATIONS

1.4.1 PARAMETERS

Project parameters are selected with the line-up configuration tool.

Table 3. 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

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1.4.2 SECTIONS AND OPTIONS

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

The available sections and options are introduced in Chapter 2.

Table 4. 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

1.4.2.1 System layout and footprint drawing

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

The documentation supplied with the project delivery is introduced in Chapter 6.

2. AVAILABLE SECTIONS

2.1 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 5. 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.

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2.2 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 6. 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 1):

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)
- Earth 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.

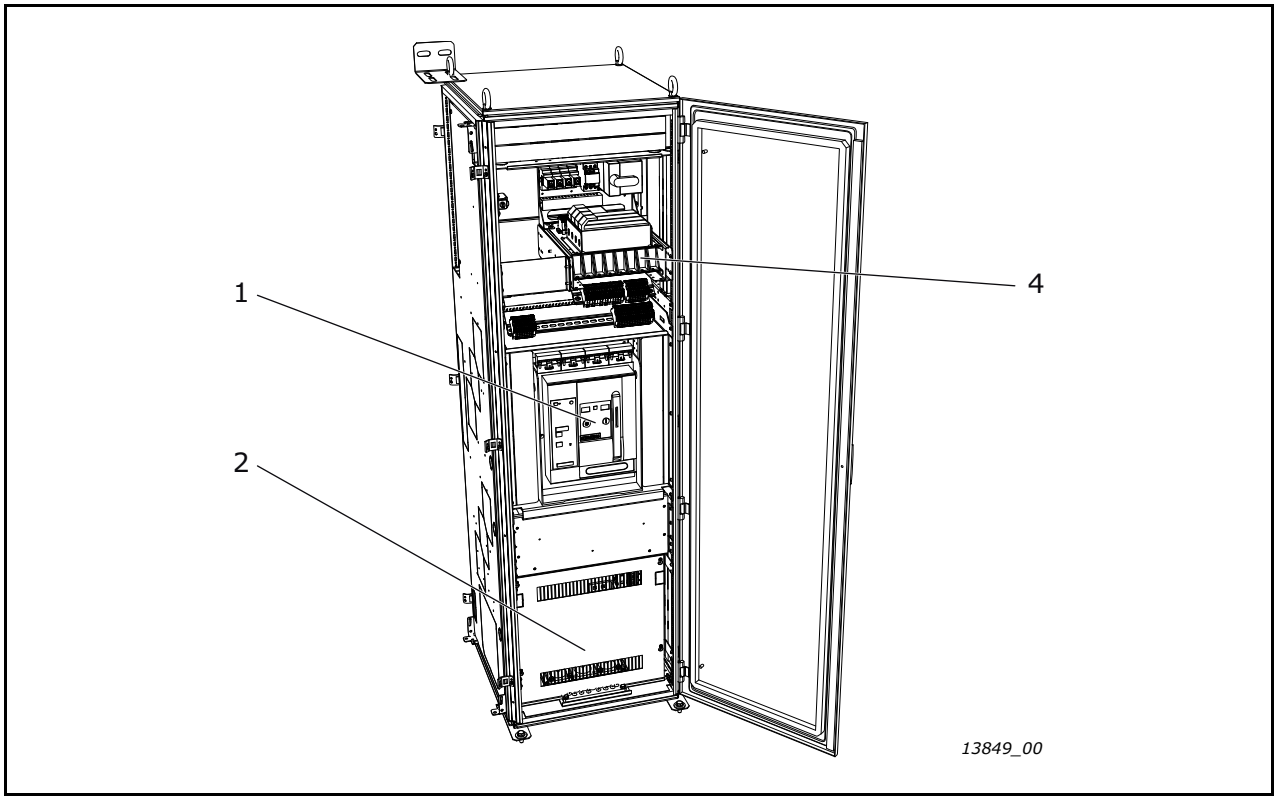

Figure 1. Example of main incoming section MIS_1600

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2.3 NON-REGENERATIVE FRONT-END SECTION

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

Table 7. 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	1000 x 2100 x 605

* _M selection for mirrored design.

As standard the NFS section includes the following (see Figure 2):

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)

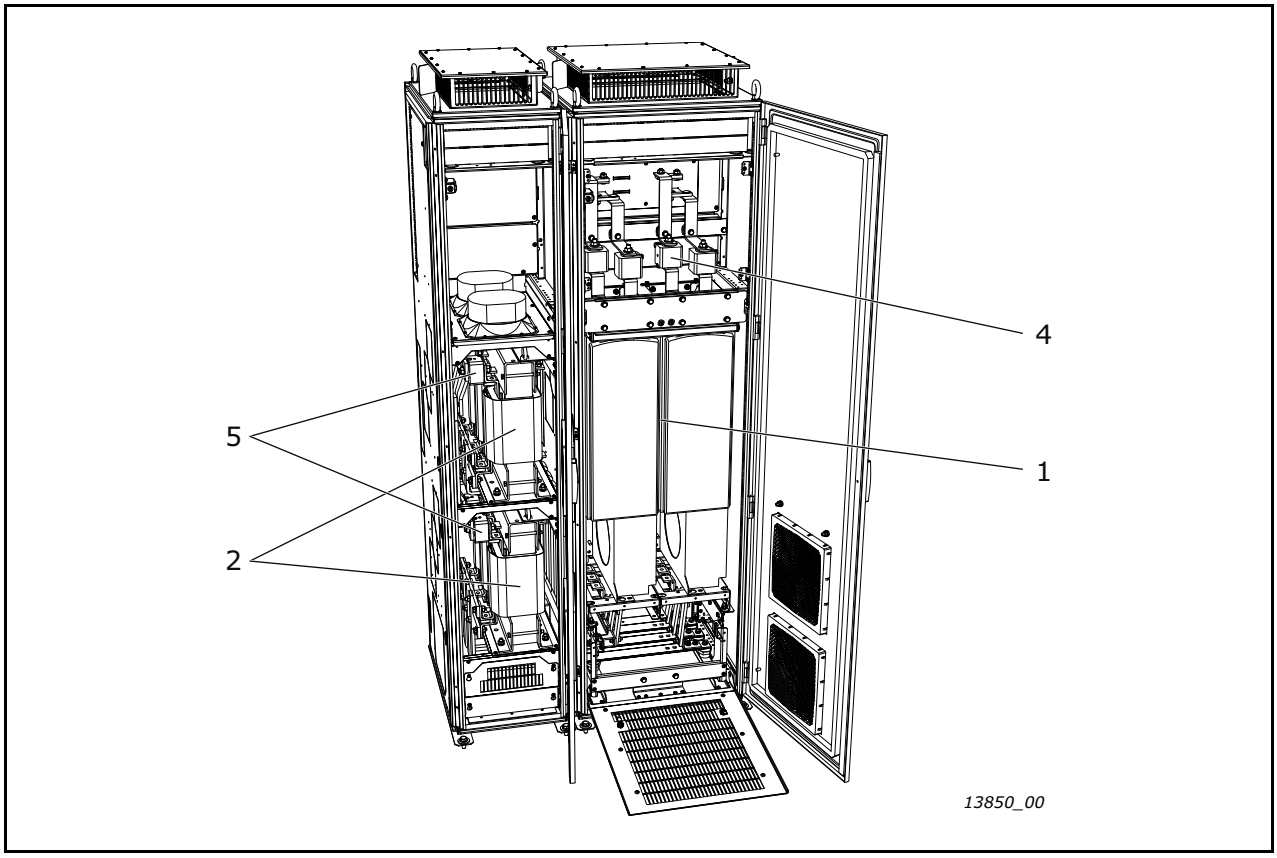

Figure 2. Example of non-regenerative front-end section NFS_2x

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2.4 ACTIVE FRONT-END SECTION

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

Table 8. 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 2300 x 605***

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

As standard the AFS sections include the following (see Figure 3):

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)

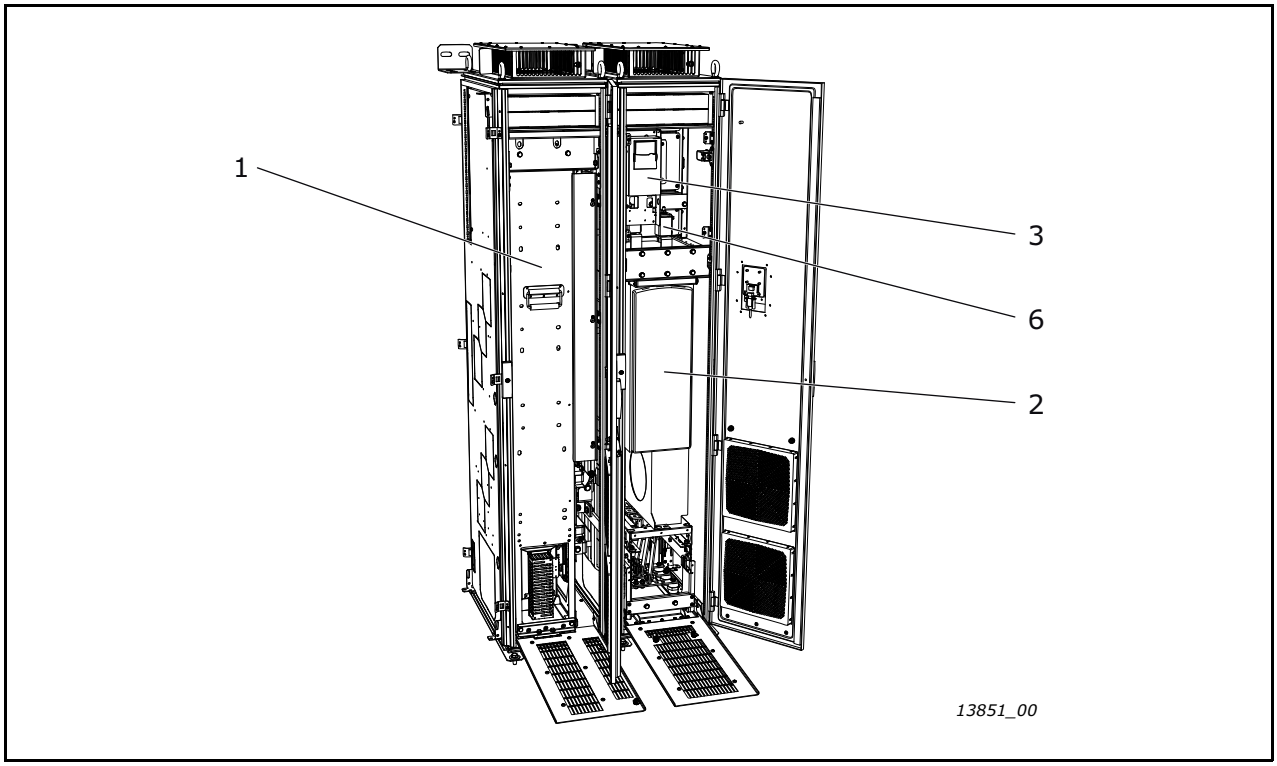

Figure 3. Example of active front-end section AFS_9

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2.5 INVERTER UNIT SECTION

2.5.1 DRIVE SIZES FR4-FR8

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

Table 9. 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 +400mm can be shared between two sections
*** Section for cabling with top cabling option (+COT)

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

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)

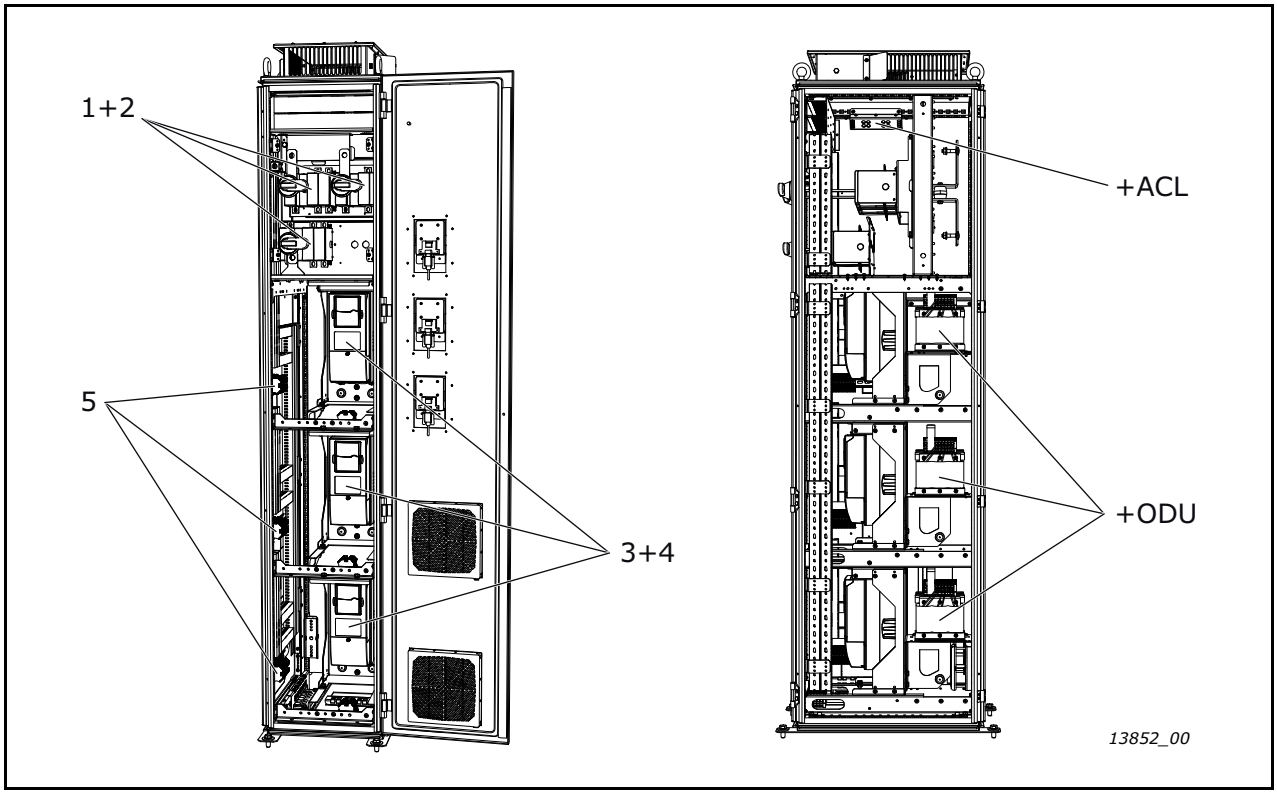

Figure 4. Example of inverter unit IUS_4

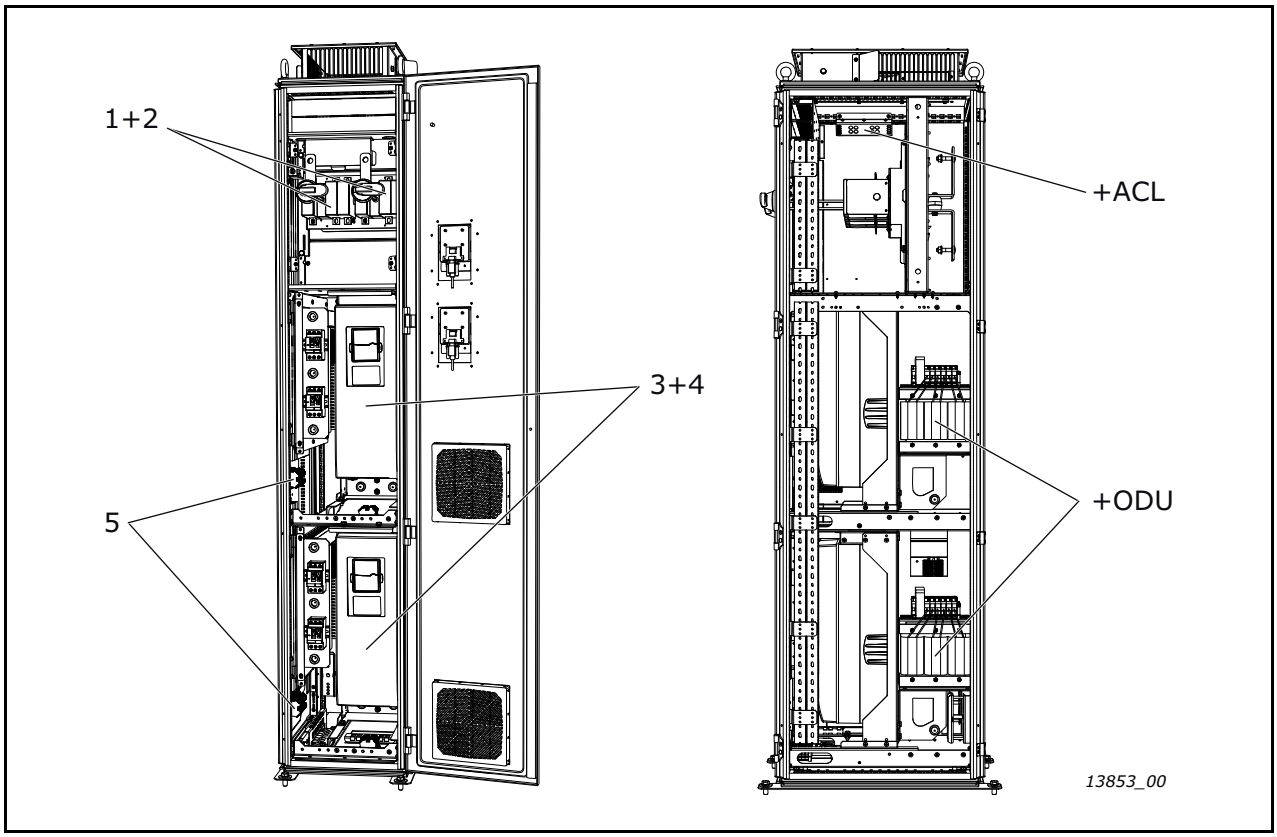

Figure 5. Example of inverter unit IUS_6

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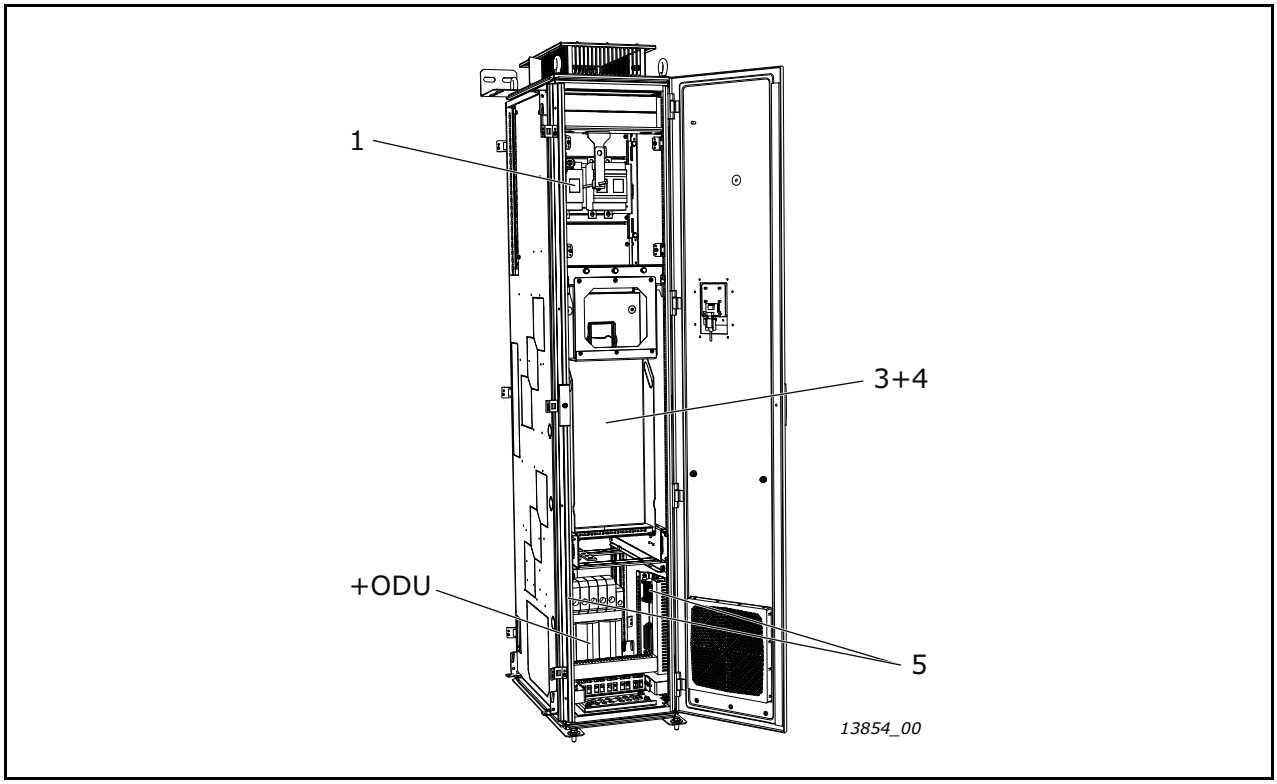

Figure 6. Example of inverter unit IUS_8

2.5.2 DRIVE SIZES FI9-FI14

The inverter unit section (IUS) includes the largest NXI drives from the VACON® product family. The inverter units are all Vacon's premium NXP dirves.

Table 10. 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 7):

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)

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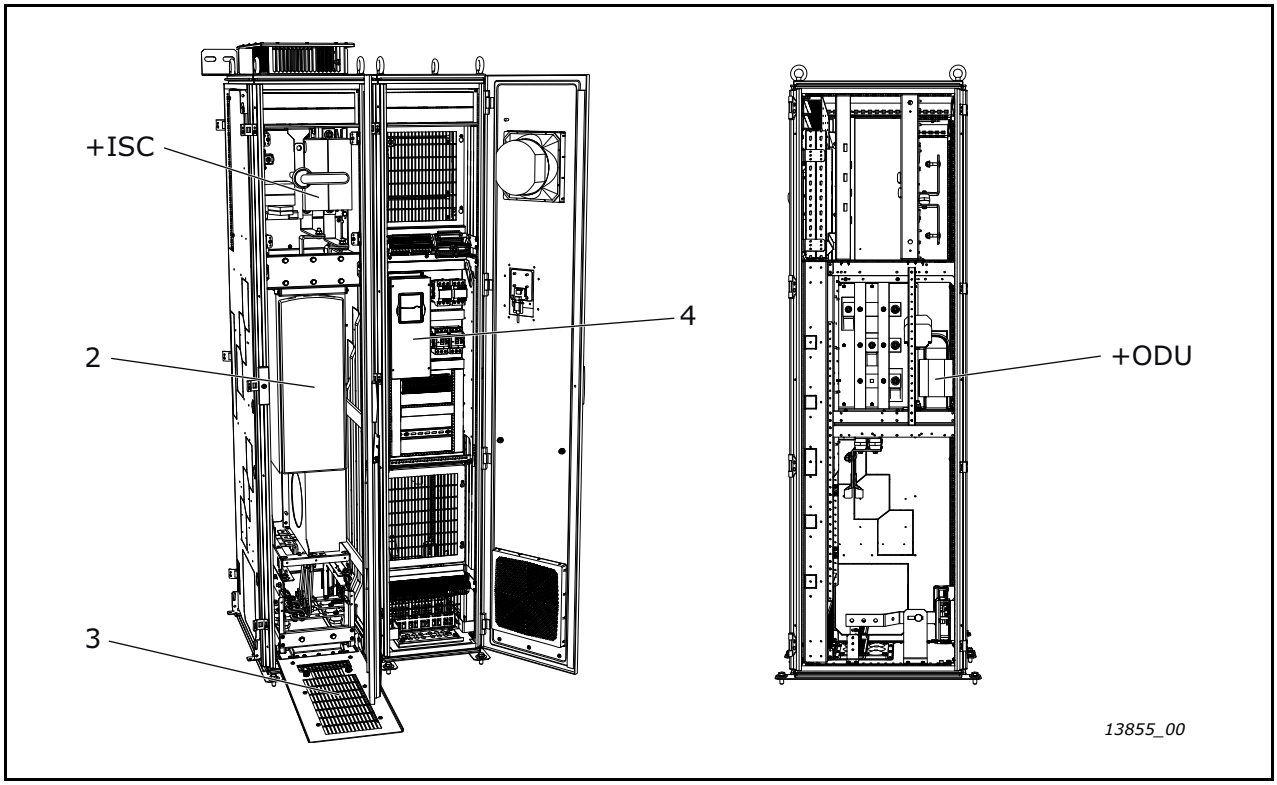

Figure 7. Example of inverter unit IUS_9

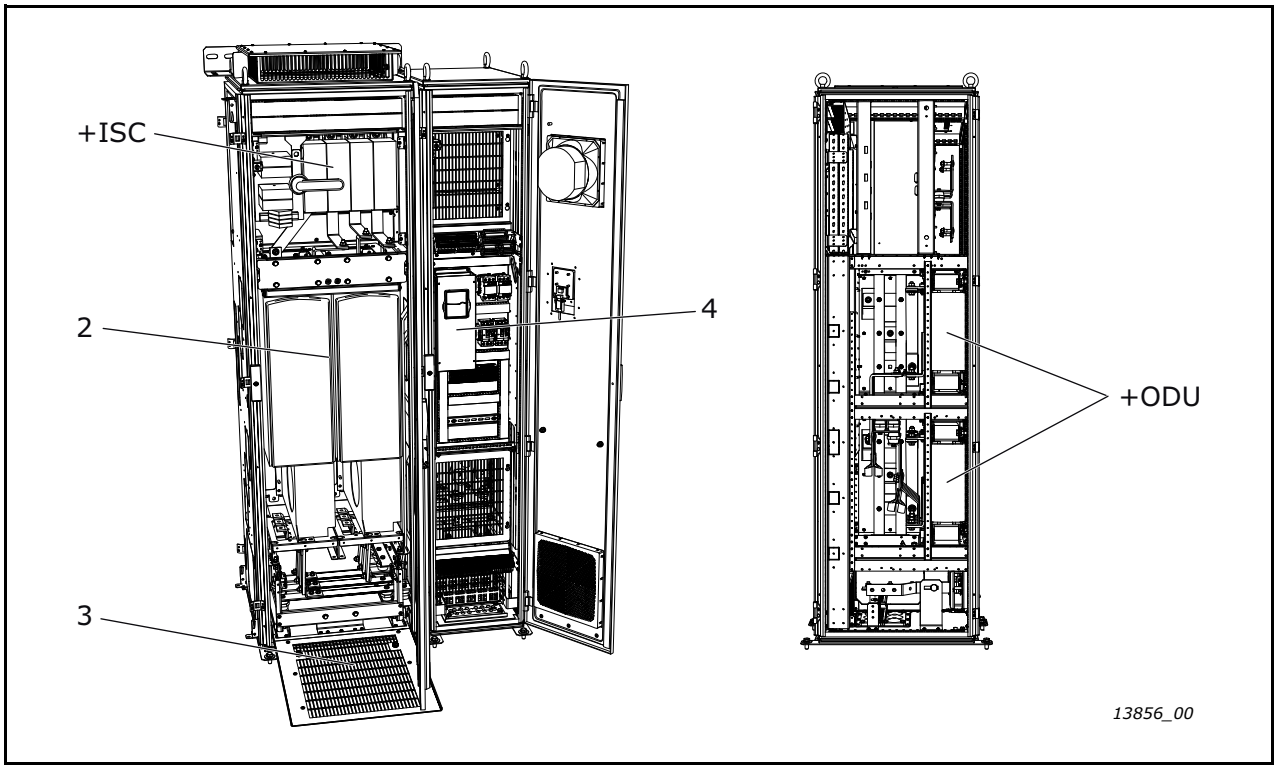

Figure 8. Example of inverter unit IUS_12

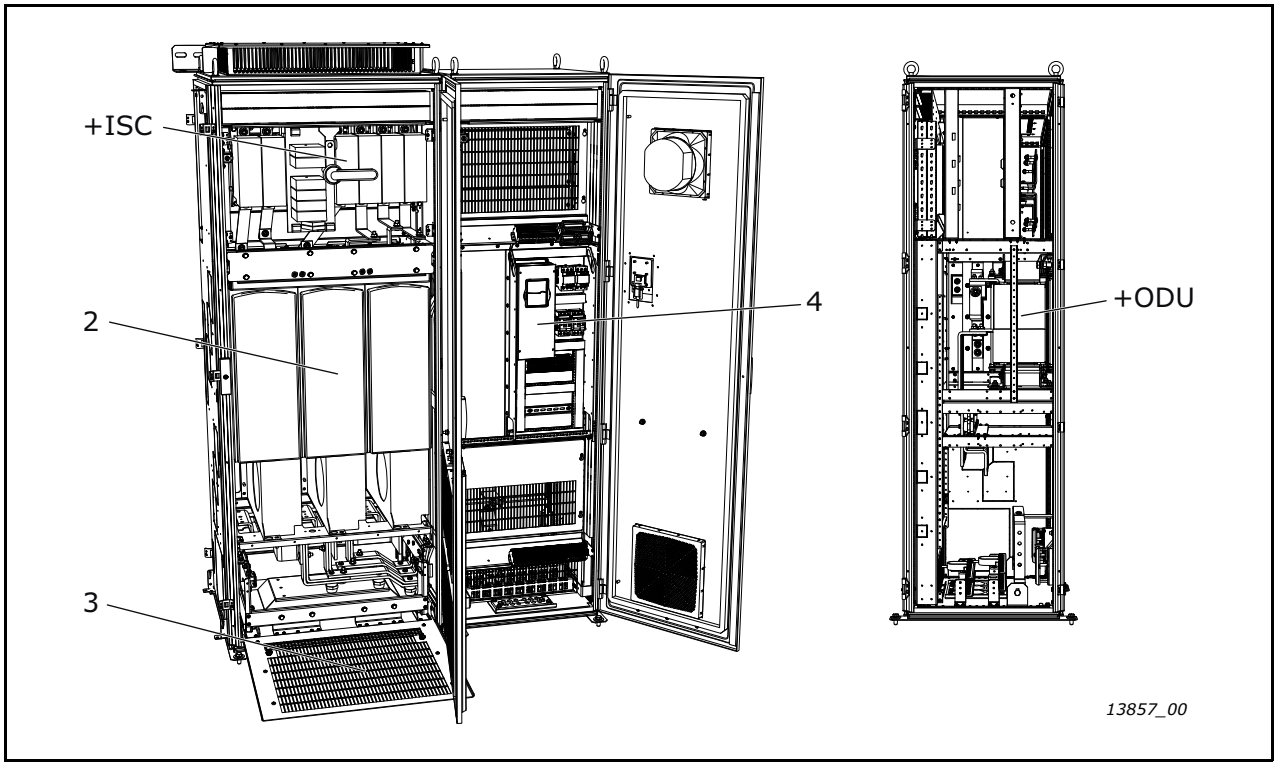

Figure 9. Example of inverter unit IUS_13

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2.6 Dynamic brake section

The dynamic brake section (DBS) includes the largest NXI drives from the VACON® product family. The brake units are all Vacon's premium NXP 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 2.5.2.

2.7 TRANSPORT SPLIT UNIT

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

Table 11. 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

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3. INSTALLATION

3.1 SAFETY NOTES

NOTE! You can download the English and French product manuals with applicable safety, warning and caution information from www.vacon.com/downloads.
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 www.vacon.com/downloads.

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!

3.1.1 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.

3.1.2 CAUTIONS

	Vacon 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 3.1.3.
	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 Vacon 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.

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3.1.3 EARTHING AND EARTH FAULT PROTECTION

CAUTION!

The AC drive must always be earthed with an earthing conductor connected to the earthing 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 earthing 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 earthing conductor**, or
- provision of an additional terminal for a second **protective earthing conductor** of the same cross-sectional area as the original **protective earthing conductor**.

Table 12. Protective earthing conductor cross-section

Cross-sectional area of phase conductors (S) [mm^2]	Minimum cross-sectional area of the corresponding **protective earthing 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 earthing conductor is made of the same metal as the phase conductors. If this is not so, the cross-sectional area of the protective earthing 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 earthing 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 earthing 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 earthing 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.

3.2 STORAGE

If the frequency converter 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 converter should be well protected to make sure dust does not get into the converter.

If the converter is to be stored during longer periods, the power should be connected to the converter 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 300-500mA 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 ($1.35 \times U_{n\ AC}$) 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.

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3.3 LIFTING AND MOVING THE SECTIONS

The sections are delivered either in a wooden box or a wooden cage. The boxes may be transported either horizontally or vertically, while transportation of the cages in a horizontal position is not allowed. Always refer to shipping marks for more detailed information. To lift the section out of the box, use lifting equipment capable of handling the weight of the cabinet.

There are lifting lugs on the top of the cabinet and these lugs can be used to lift the cabinet into an upright position and to move it to the place needed.

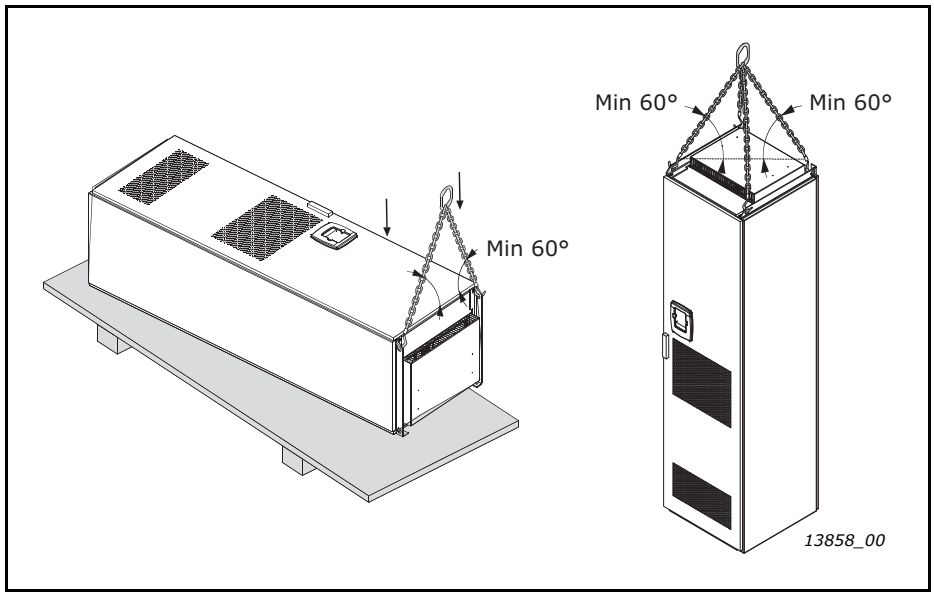

Figure 10. Lifting sections

Moving of the sections 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

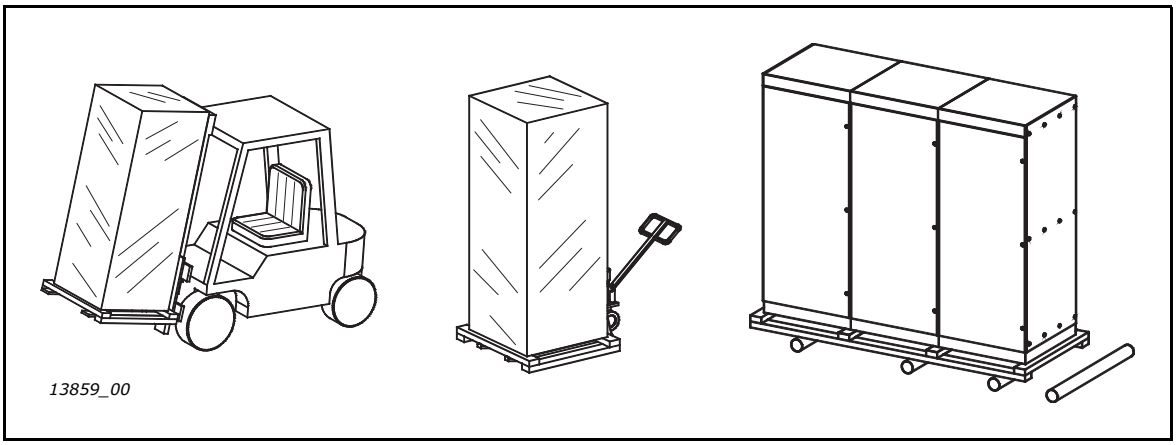

Figure 11. Moving sections

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.

3.4 FIXING THE SECTIONS

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.

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.

3.4.1 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.

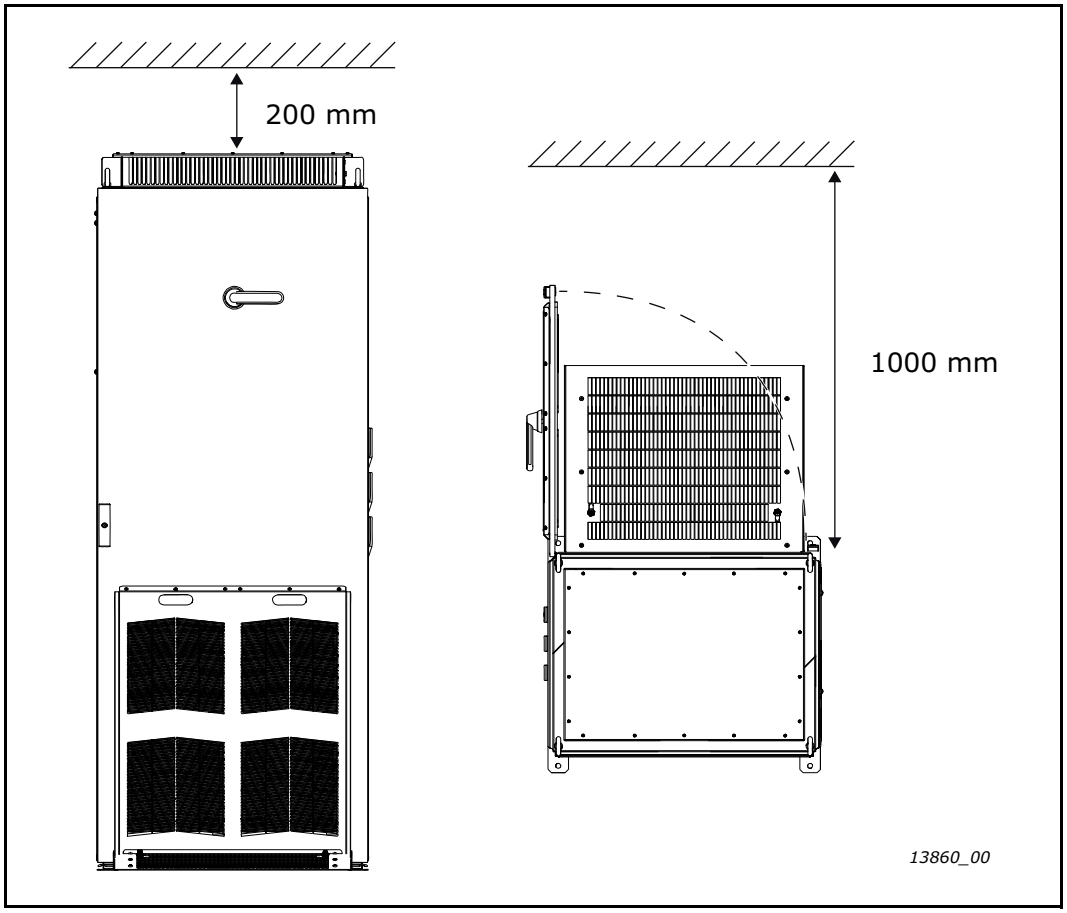

Figure 12. Required space around the cabinet

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3.4.2 FIXING THE CABINET TO THE FLOOR OR WALL

In installations where the cabinet is mounted against the 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 back (3) with bolts.

Fix all cabinet sections in the same way.

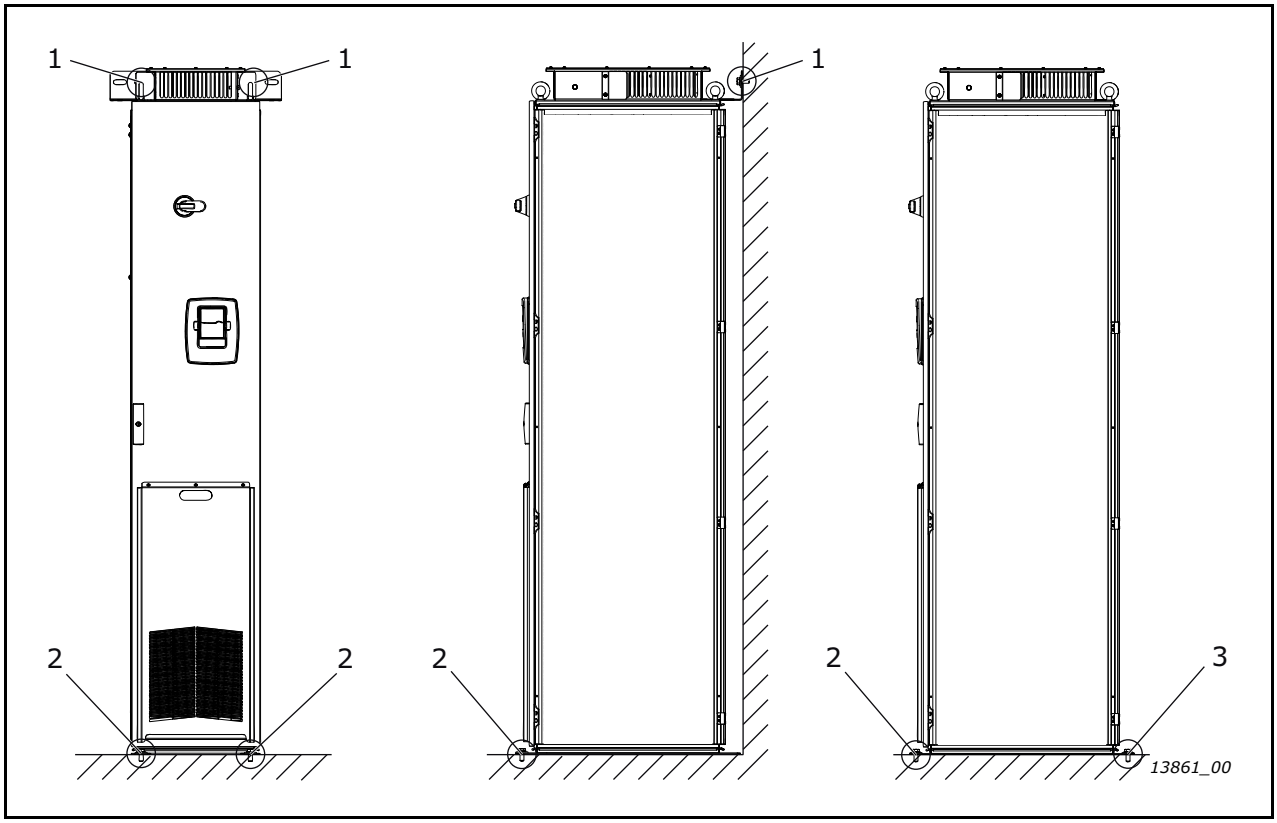

Figure 13. Fixing the cabinet to the wall and floor

3.4.3 BACK-TO-BACK INSTALLATION

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

Leave a 95 mm gap between the backs of the cabinets.

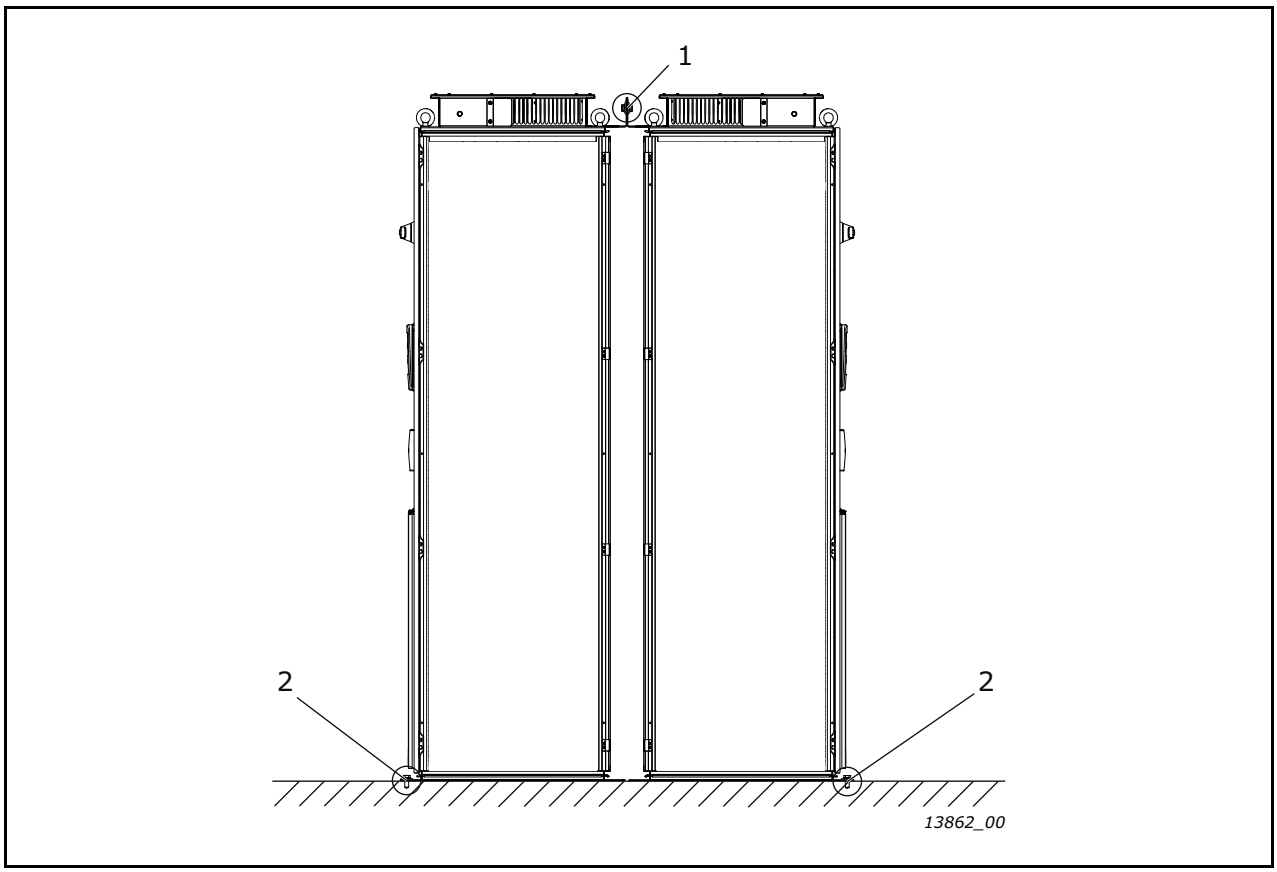

Figure 14. Fixing the cabinets back-to-back

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3.5 CONNECTING SECTIONS

The cabinet sections included in the delivery must be joined to each other. This is done by connecting the DC and PE busbars of the sections and by connecting the section cabinets to each other. All necessary parts are included in the delivery.

3.5.1 FIXING CABINETS TO EACH OTHER

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.

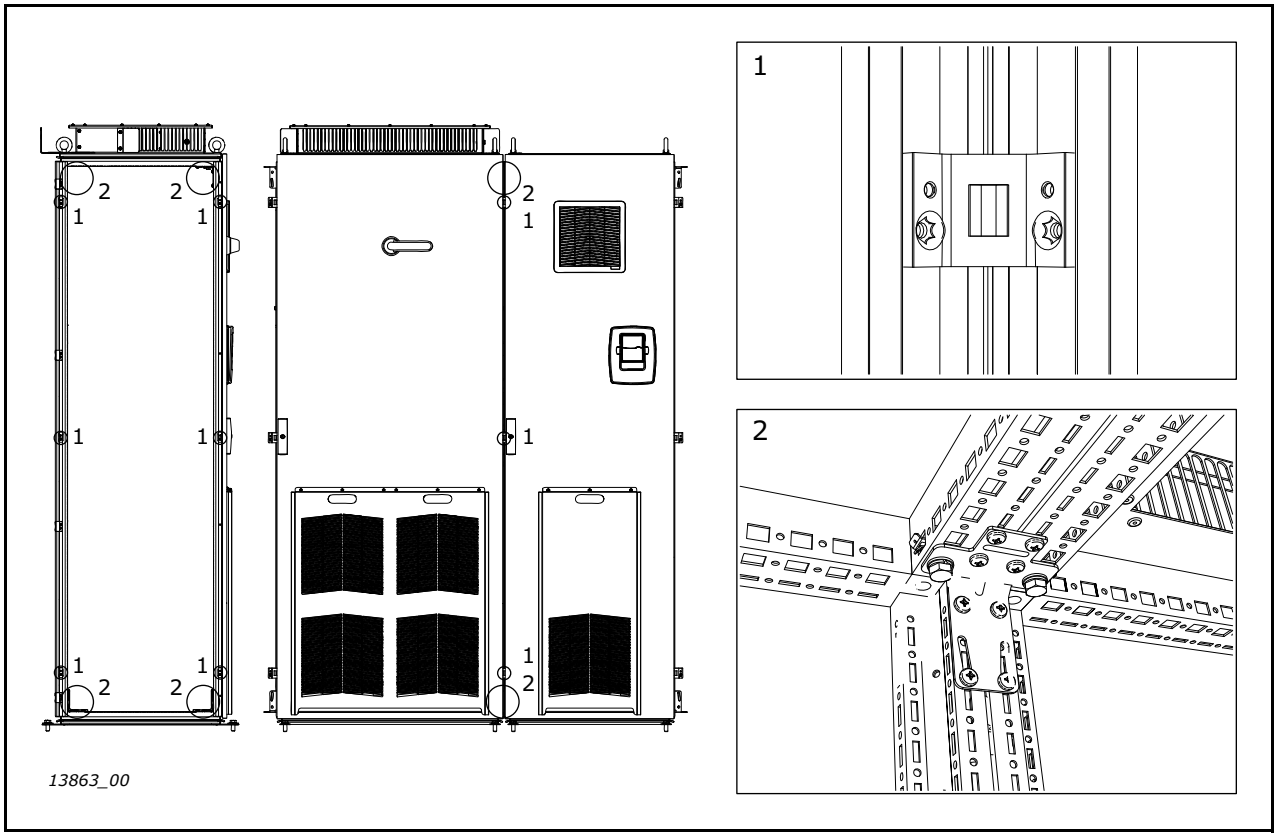

Figure 15. Quick-fit baying clamps

3.5.2 COMMON 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 4.3.

Join together the PE busbars and DC busbars by bolting them together with baying brackets.

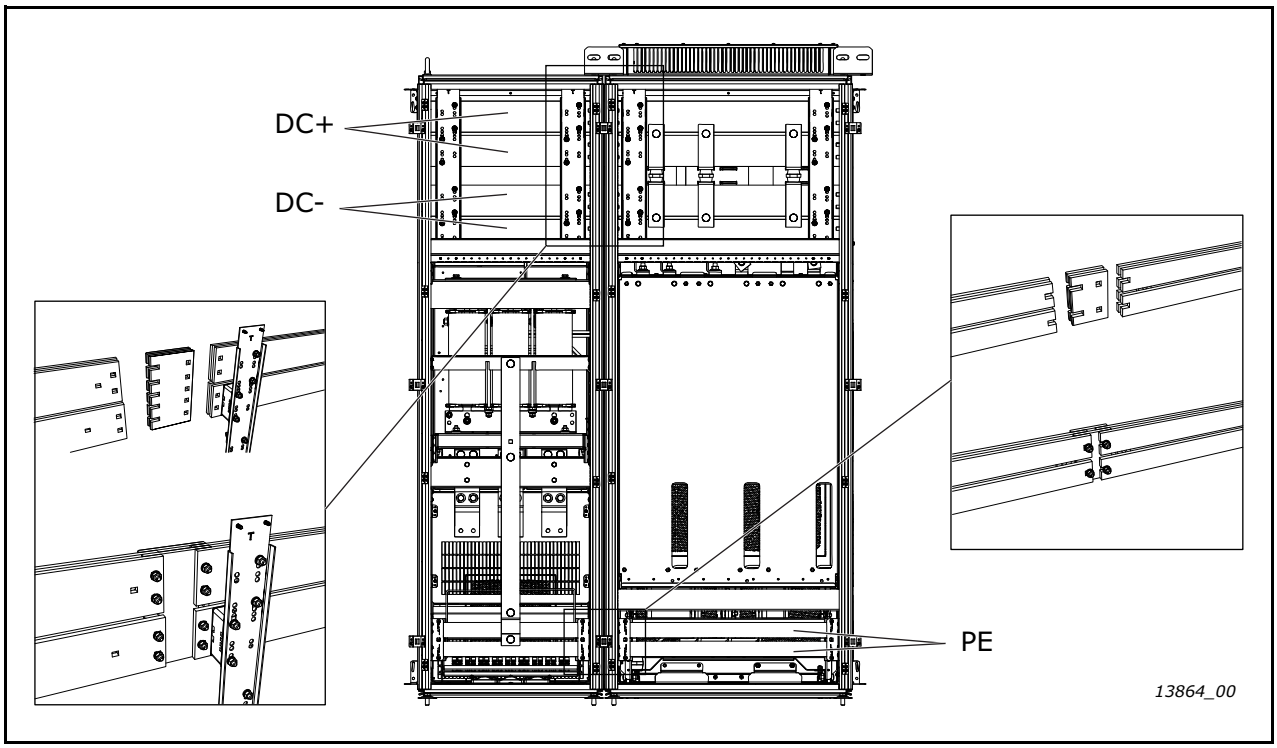

Figure 16. Connecting the common DC and PE busbars

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3.6 CABLING

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

3.6.1 EARTHING

PE conductors are connected to the PE busbar. The PE busbars in each section are connected (see Figure 16 on page 32) and the PE busbars must be connected to earth.

See the earthing and earth fault protection instructions in Chapter 3.1.3.

3.6.2 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 17 on page 34). 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 Table 2 on page 5).

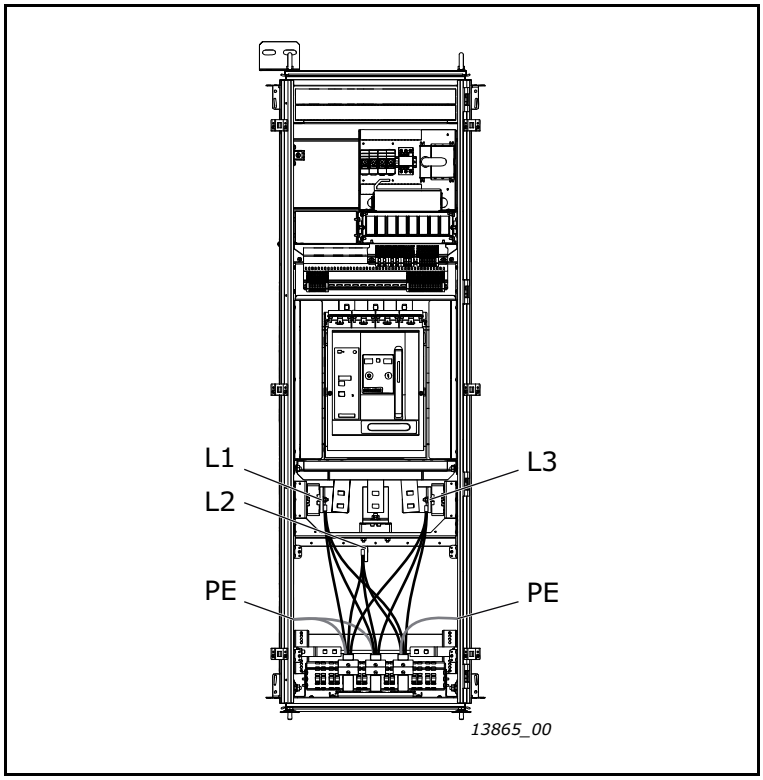

Figure 17. Cabling of the main incoming section (MIS)

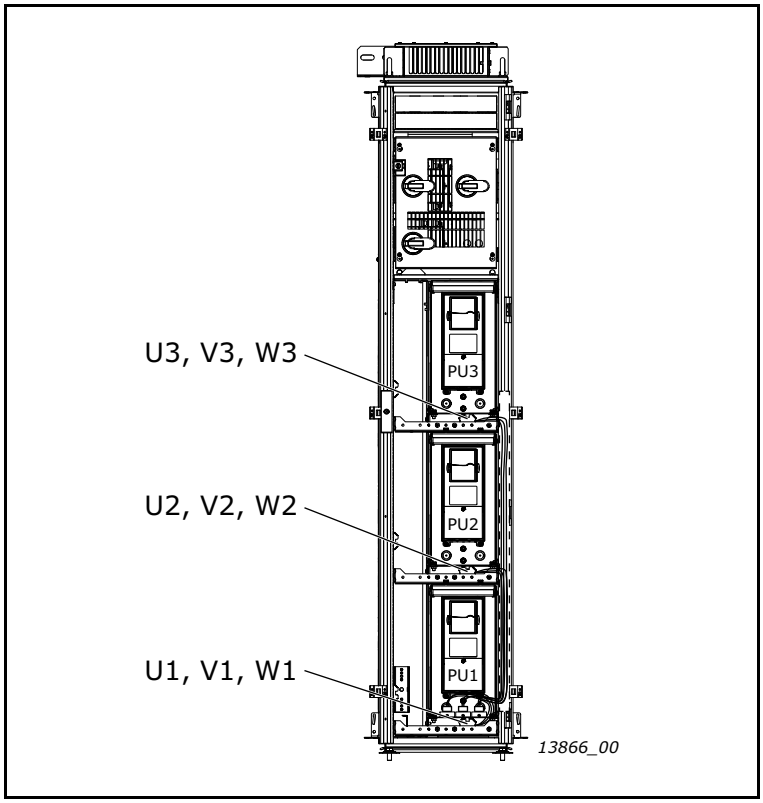

Figure 18. Cabling of inverter section IUS_4

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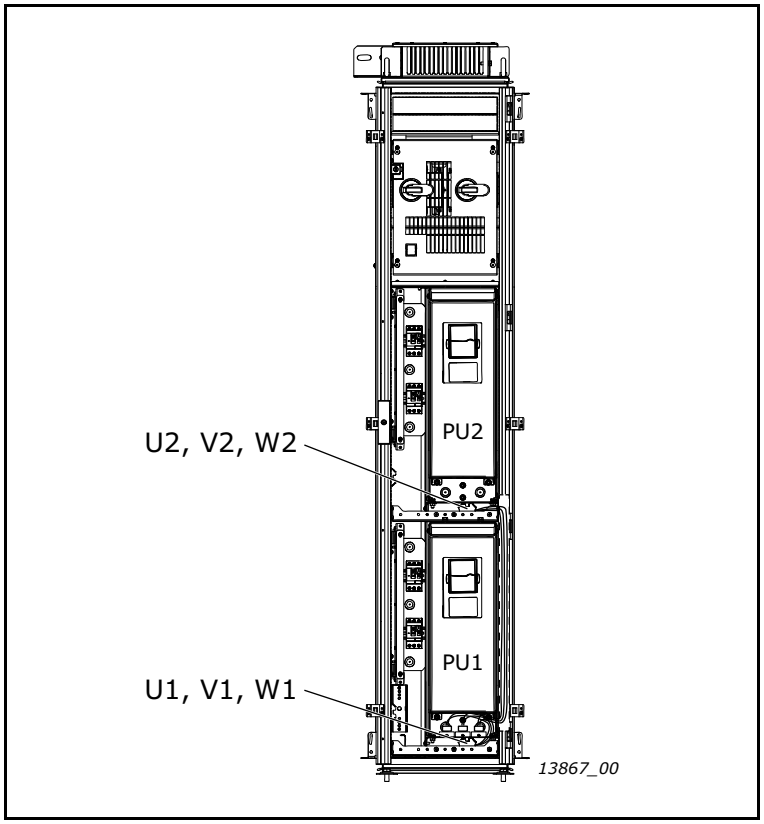

Figure 19. Cabling of inverter section IUS_6

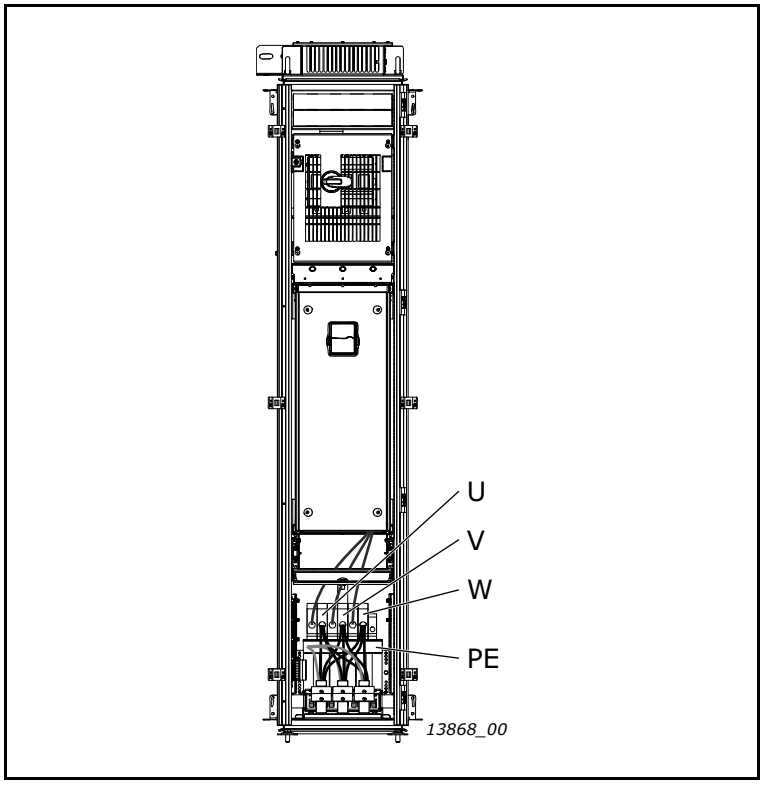

Figure 20. Cabling of inverter section IUS_8

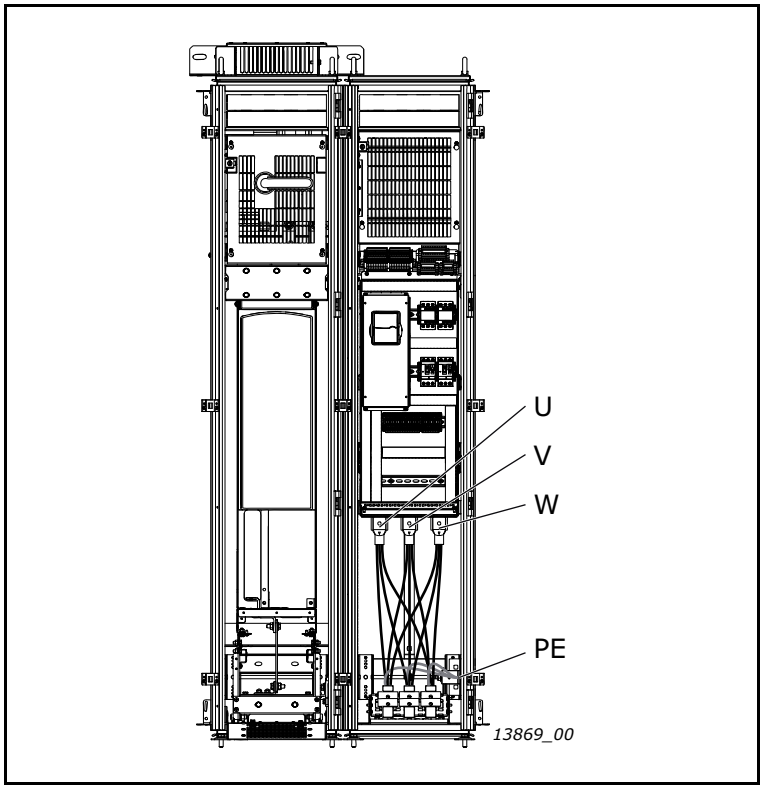

Figure 21. Cabling of inverter sections IUS_9 and IUS_10

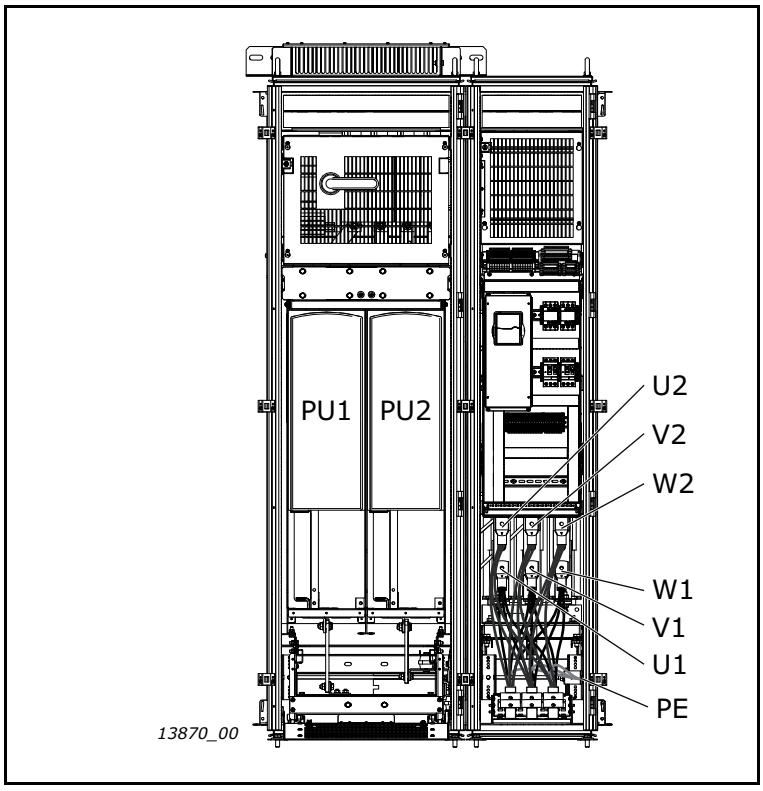

Figure 22. Cabling of inverter section IUS_12

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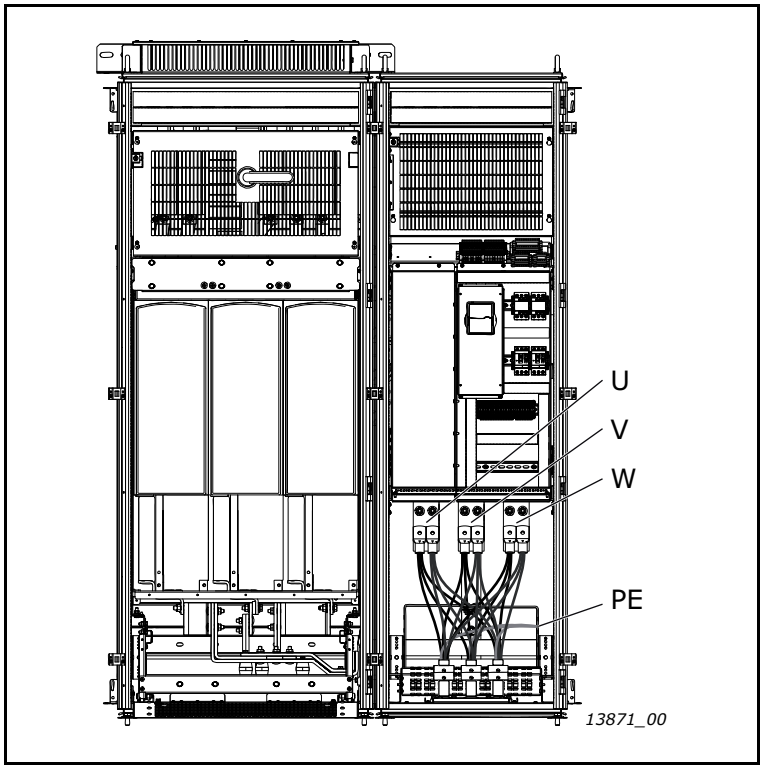

Figure 23. Cabling of inverter section IUS_13

3.6.3 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 (+24V, ±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.

For more detailed cabling instructions, see the corresponding user manual (see Table 2 on page 5).

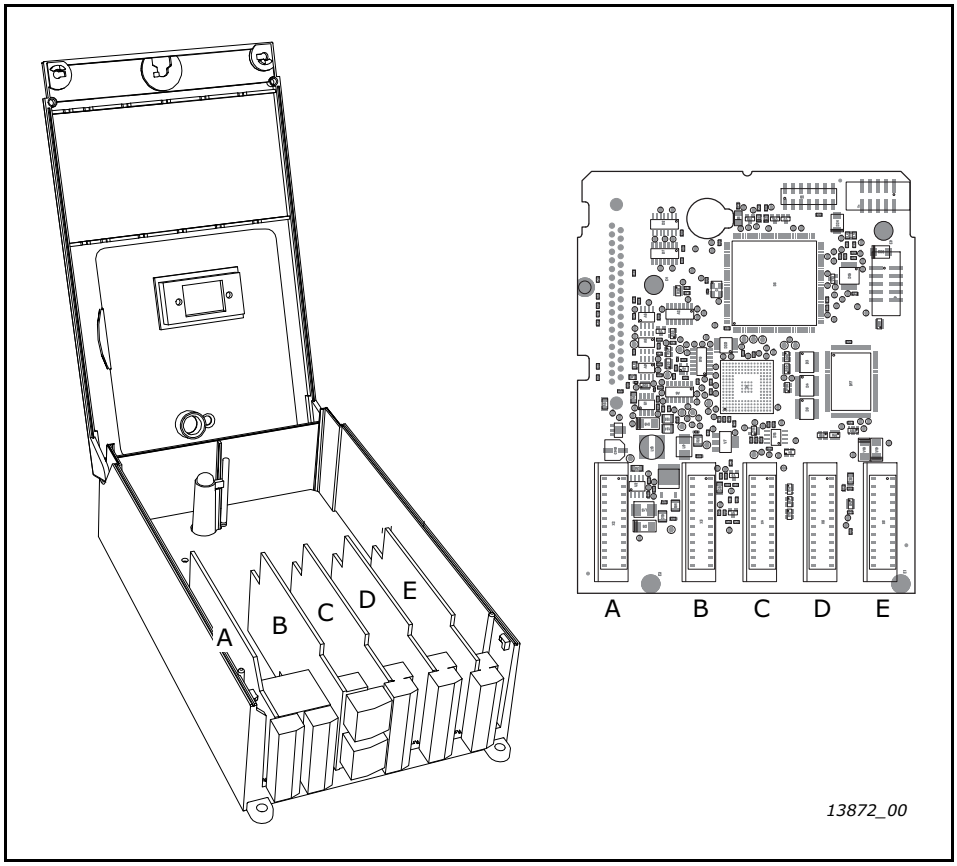

Figure 24. Control unit, control board (right) and option boards (A-E)

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3.7 SCREW TIGHTENING TORQUES

The tightening torques of all power connections (cables and busbars) for different screw and bolt sizes are given in table below.

Table 14. Tightening torques of power connections

Screw/bolt size	Tightening torque (Nm) ±15%
M6	8
M8	20
M10	40
M12	70

The tightening torques for control unit terminals are given below.

Table 15. Tightening torques of control unit terminals

Terminal screw	Tightening torque (Nm)
Relay and thermistor terminals (screw M3)	0.5
Other terminals (screw M2.6)	0.2

4. SERVICE

4.1 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 (VACON® PLC 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. Vacon assumes no responsibility for any other warranties than that granted by Vacon itself.

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

4.2 MAINTENANCE

All technical devices, drives as well, need a certain amount of care-taking and failure preventive maintenance. To maintain trouble-free operation of 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 Vacon drives. At least the following things should be included in the regular maintenance.

Table 16. 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 main fans • LCL filter fans
5-10 years	Change the DC bus 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.

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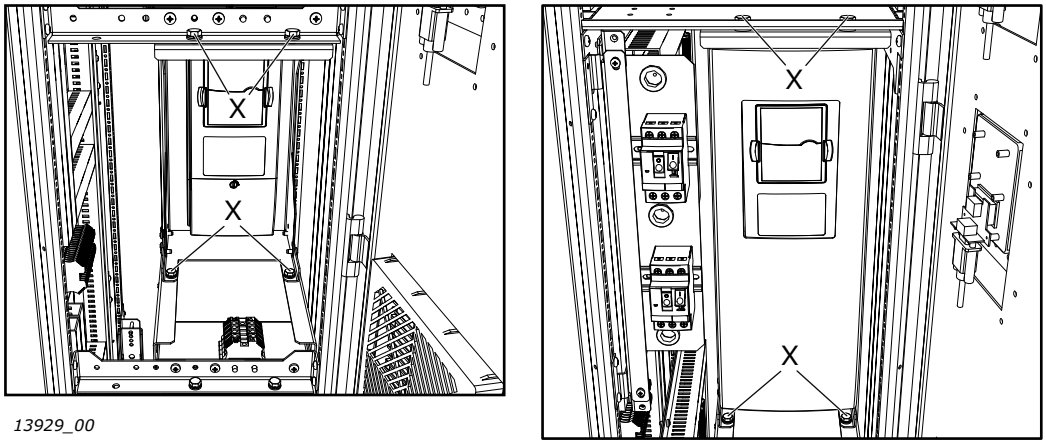
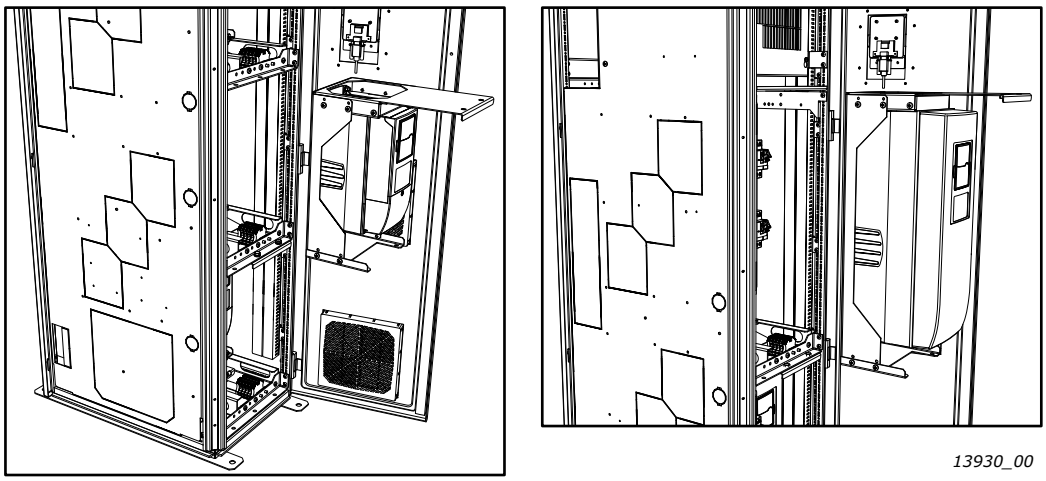
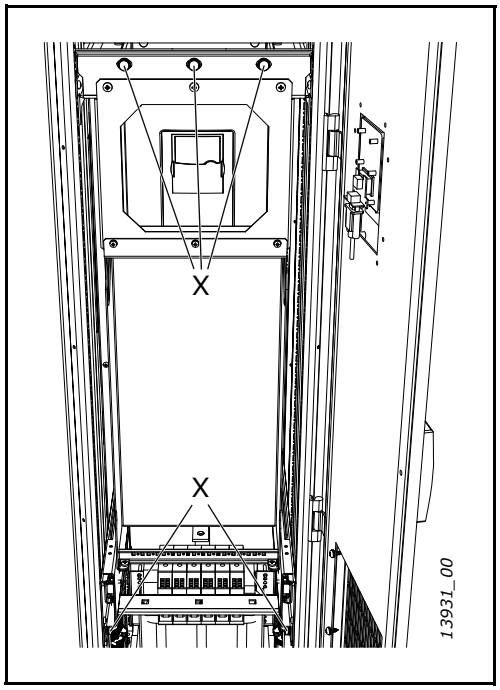
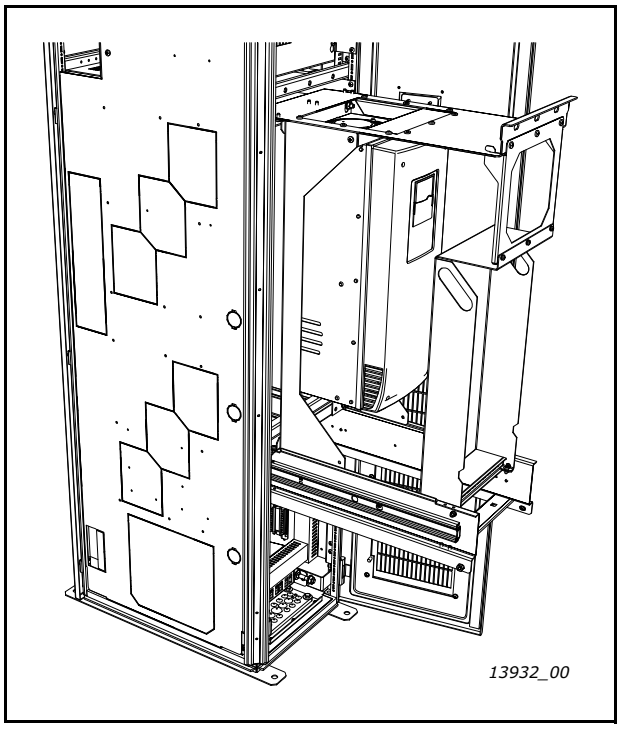
4.3 REMOVING THE DRIVES FROM THE CABINET

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

4.3.1 IUS_4 / IUS_6

1	Open the cabinet door.
2	Disconnect all cables from the drive. See Chapter 3.6.
3	Release the drive assembly. Remove the four M8x20 bolts (tightening torque 20Nm).  13929_00 *Figure 25. Drive assembly mounting bolts (X) in IUS_4 (left) and IUS_6 (right)*
4	Pull out the drive assembly.  13930_00 *Figure 26. Pulling the drive assembly in IUS_4 (left) and IUS_6 (right)*

4.3.2 IUS_7 / IUS_8

1	Open the cabinet door.
2	Release the drive assembly. Remove the five M8x20 bolts (tightening torque 20Nm).  *Figure 27. Drive assembly mounting bolts (X)*
3	Pull out the drive assembly.  *Figure 28. Pulling the drive assembly out of the cabinet*
4	Disconnect all cables from the drive. See Chapter 3.6.

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4.3.3 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 5mm from the level of the cabinet installation.

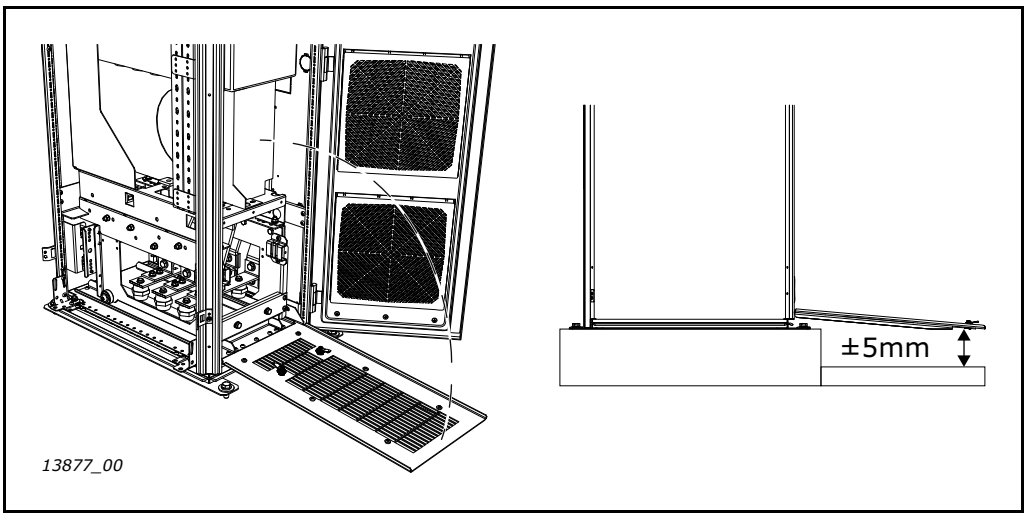

Figure 29. Lowering the service ramp

3

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

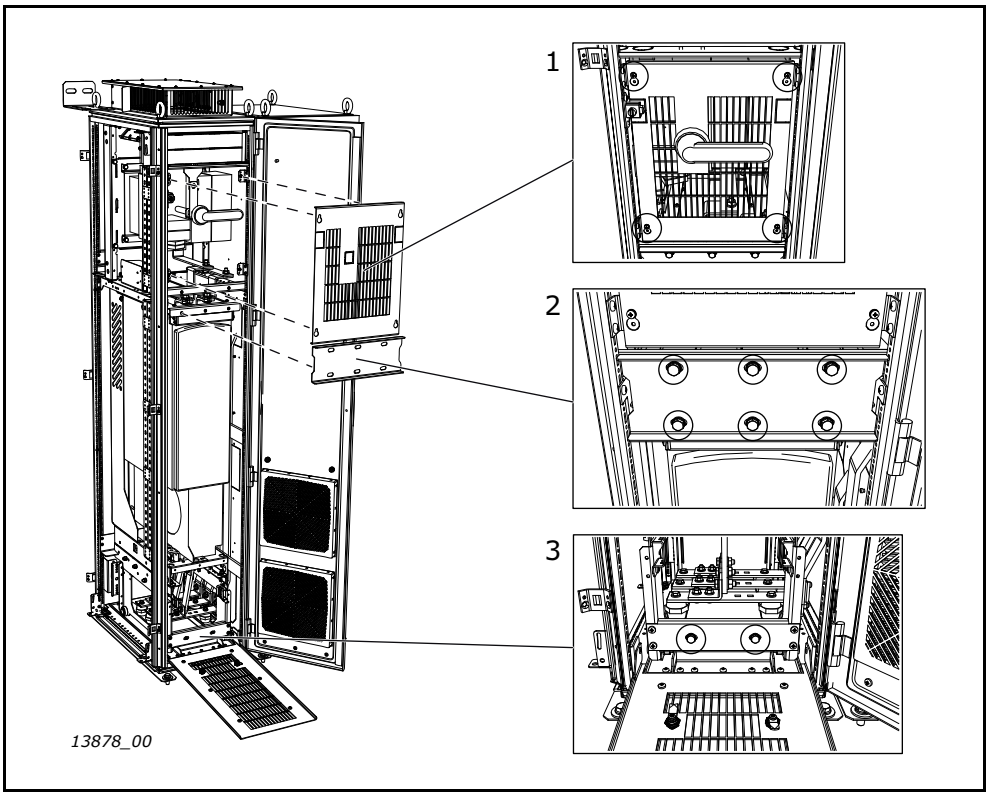

Figure 30. Removing the drive touch cover and holder plates

4

Release the input busbar assemblies. Remove:

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

Take out the busbar assemblies, including the fuses.

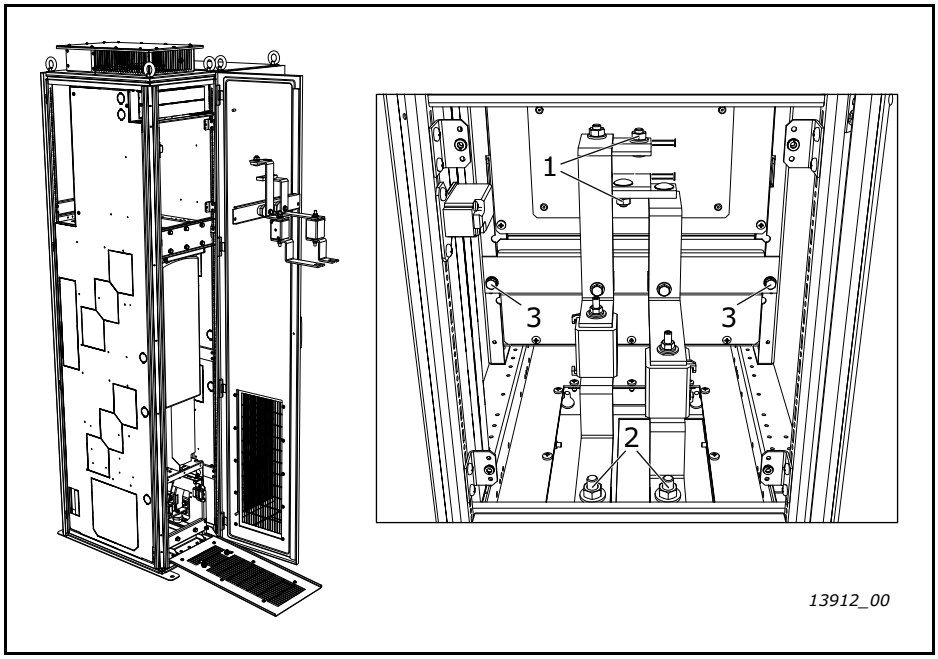

Figure 31. Releasing the input busbar assembly

5

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

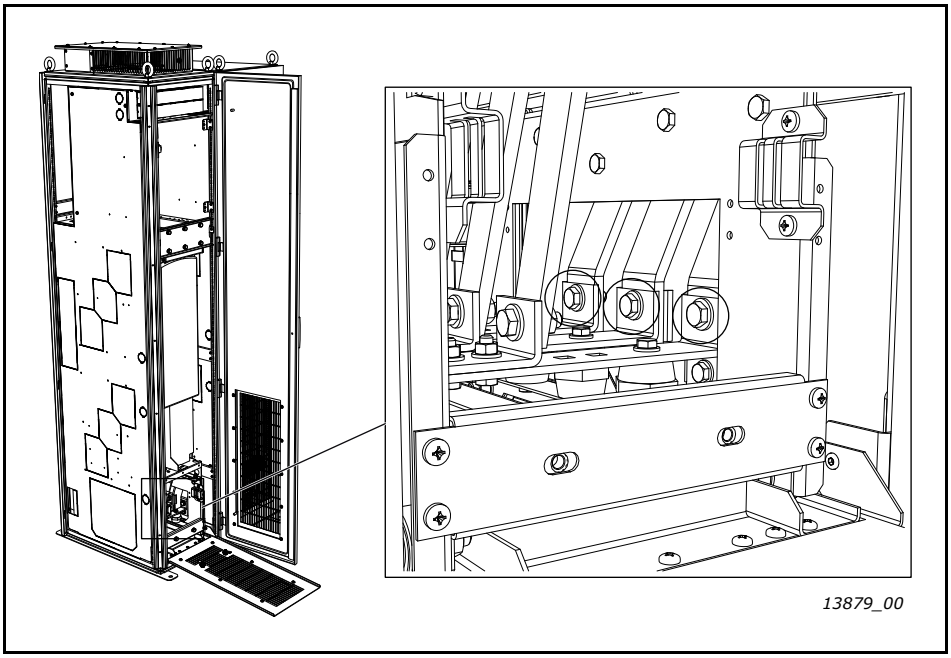

Figure 32. Busbar mounting screws

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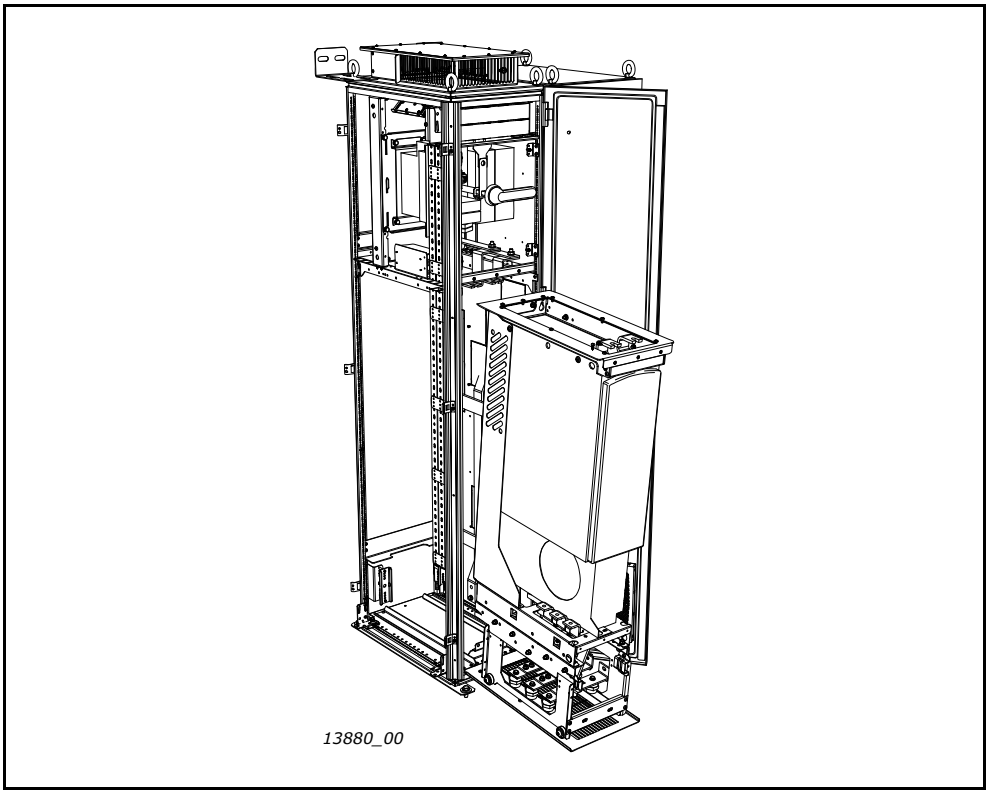
6	Pull the drive out on the service ramp.  *Figure 33. Pulling the drive out of the cabinet*

4.3.4 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 5mm from the level of the cabinet installation.

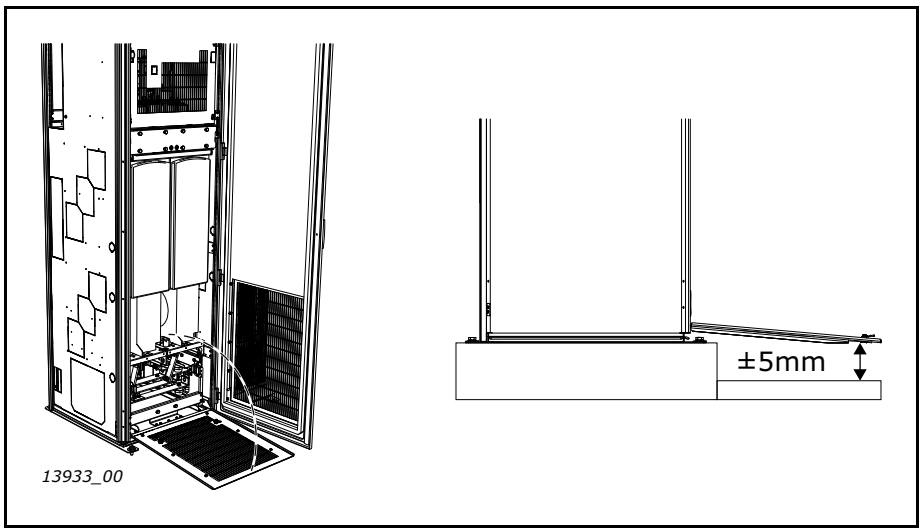


Figure 34. Lowering the service ramp

3

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

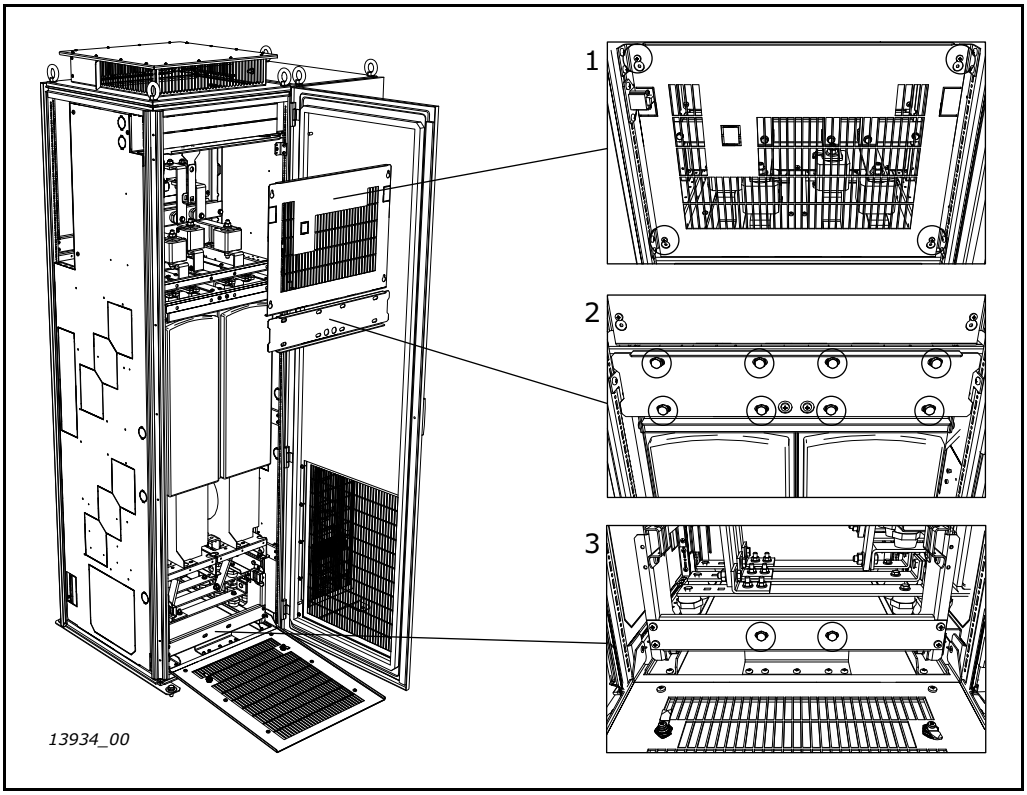


Figure 35. Removing the drive touch cover and holder plates

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4

Release the input busbar assembly. Remove:

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

Take out the busbar assemblies, including the fuses.

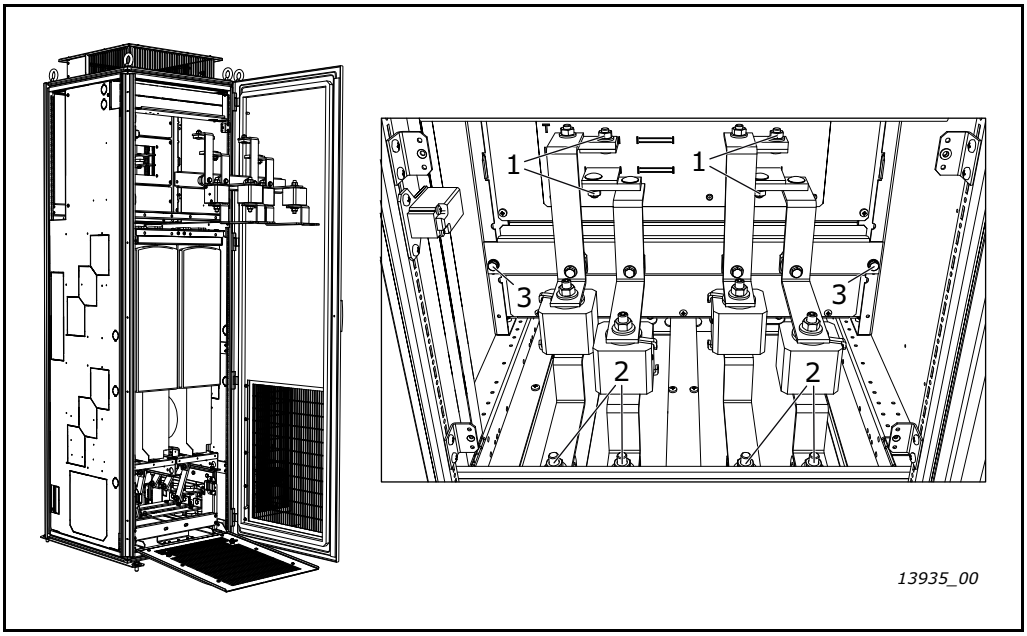


Figure 36. Releasing the input busbar assembly

5

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

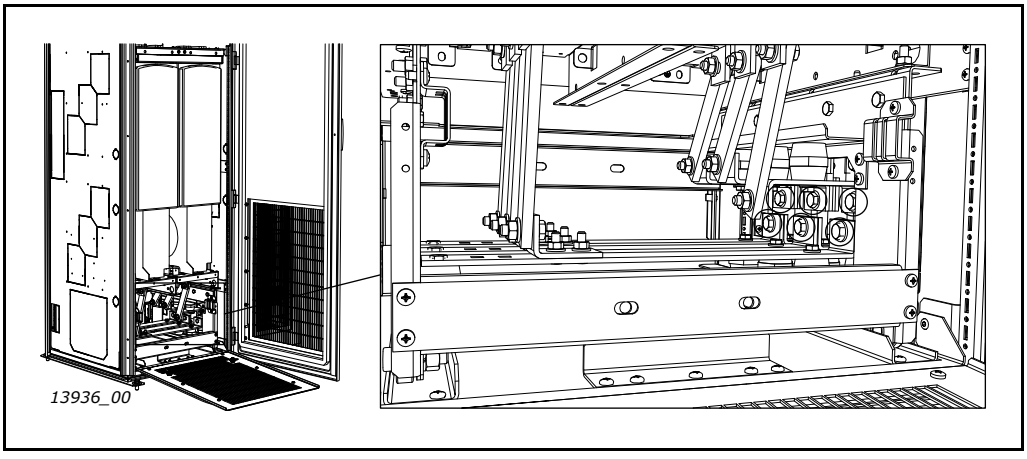
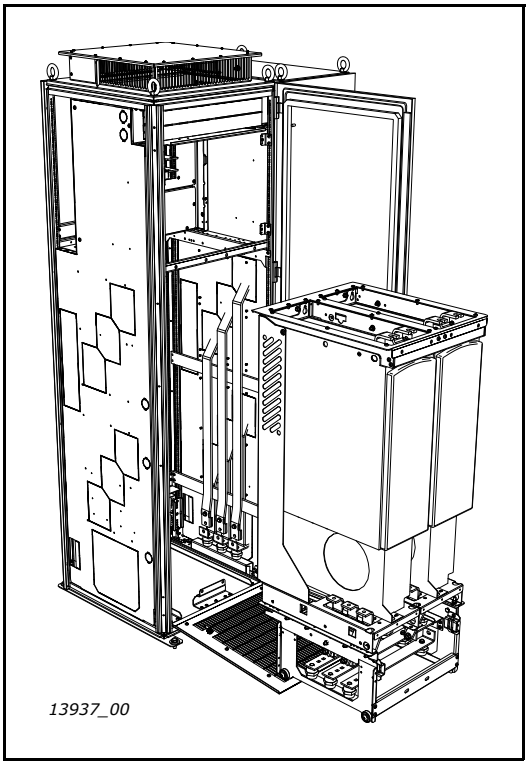


Figure 37. Output busbar mounting screws

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

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4.3.5 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.

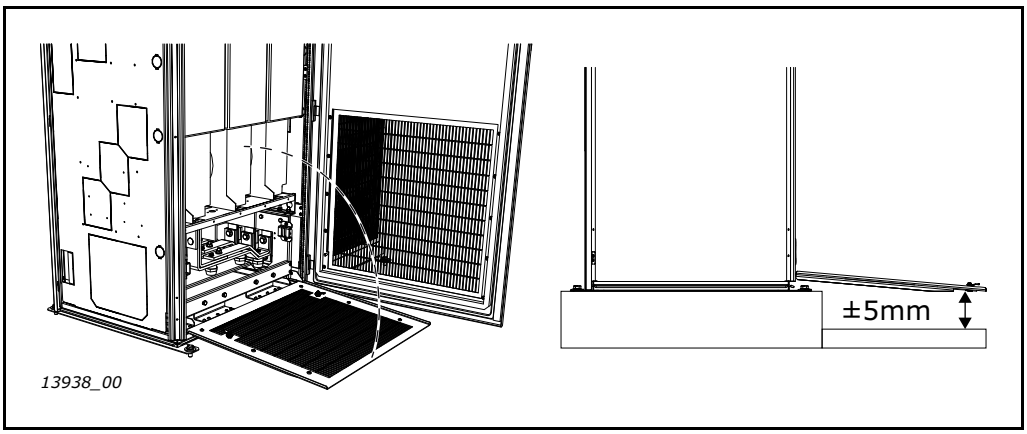

Figure 39. Lowering the service ramp

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

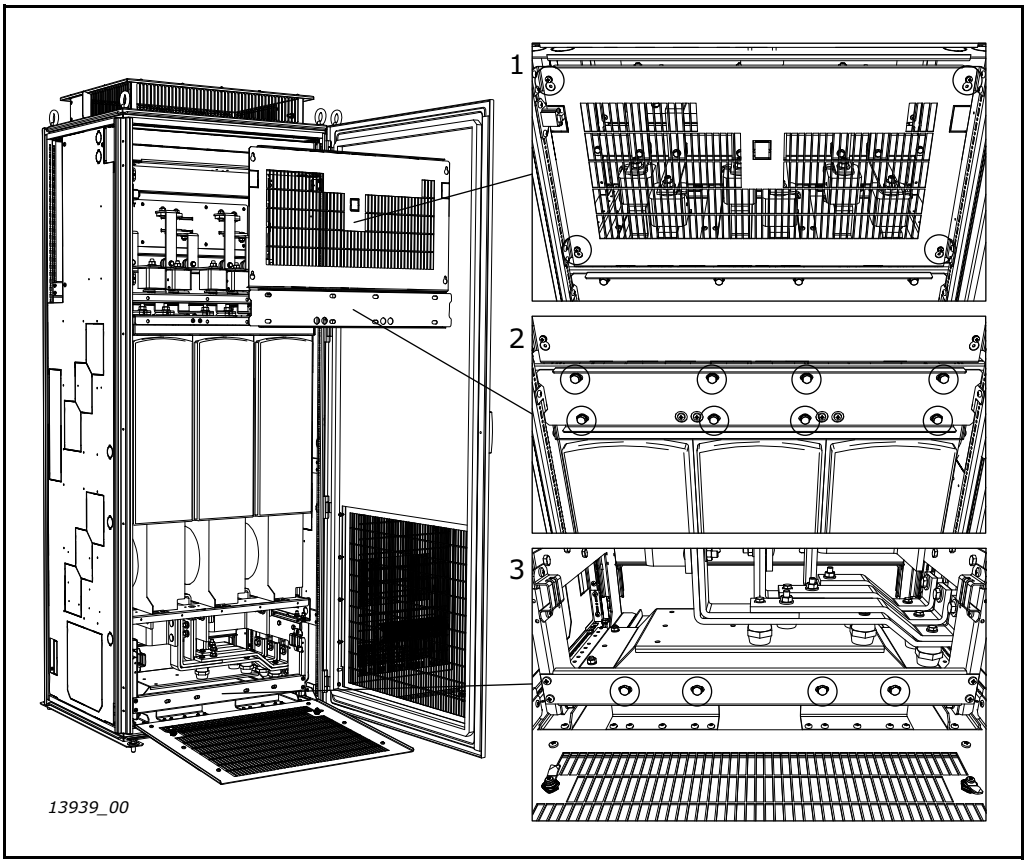

Figure 40. Removing the drive touch cover and holder plates

4

Release the input busbar assembly. Remove:

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

Take out the busbar assemblies, including the fuses.

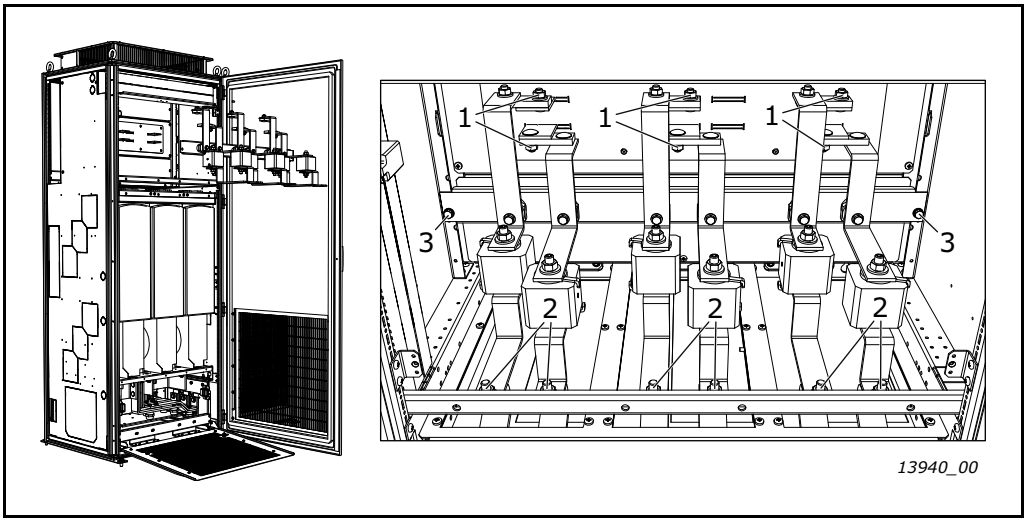

Figure 41. Releasing the input busbar assembly

5

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

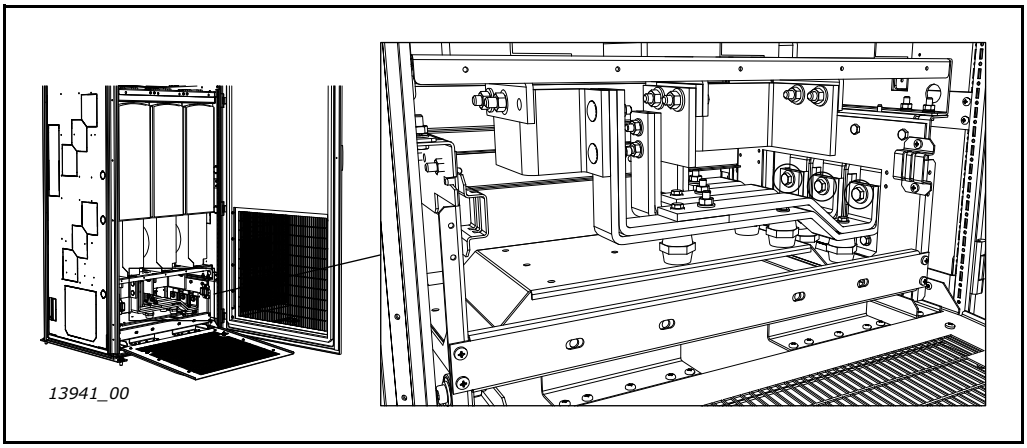

Figure 42. Output busbar mounting screws

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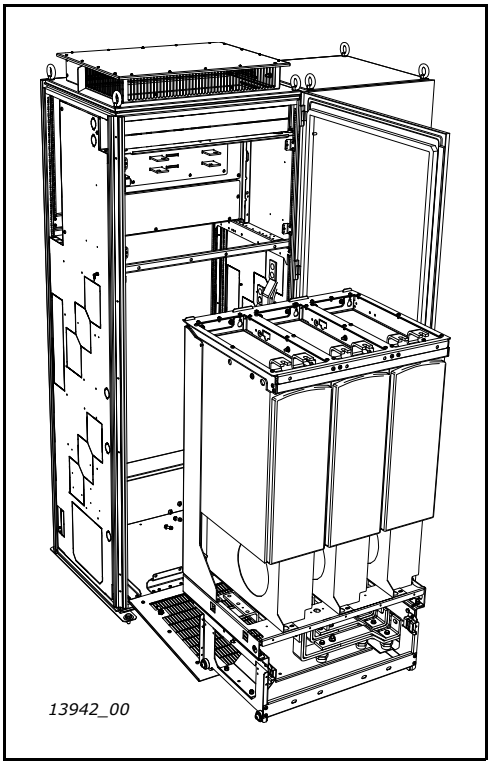
6	Pull the drive out on the service ramp.  *Figure 43. Pulling the drive out of the cabinet*

5. TECHNICAL INFORMATION

5.1 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.

5.1.1 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

5.1.2 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 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%

5.2 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. VACON® Plc 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.

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5.2.1 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).

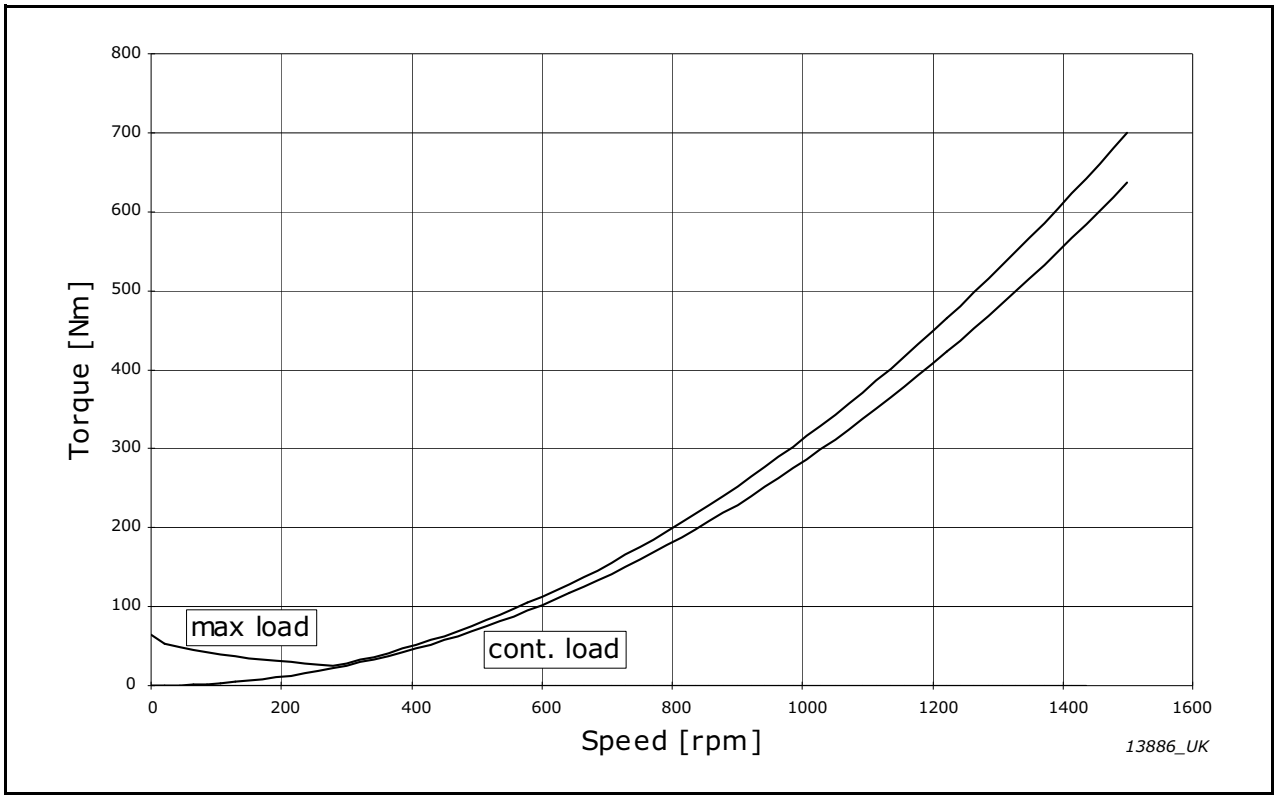

Figure 44. Example: pump and fan load

5.2.2 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.

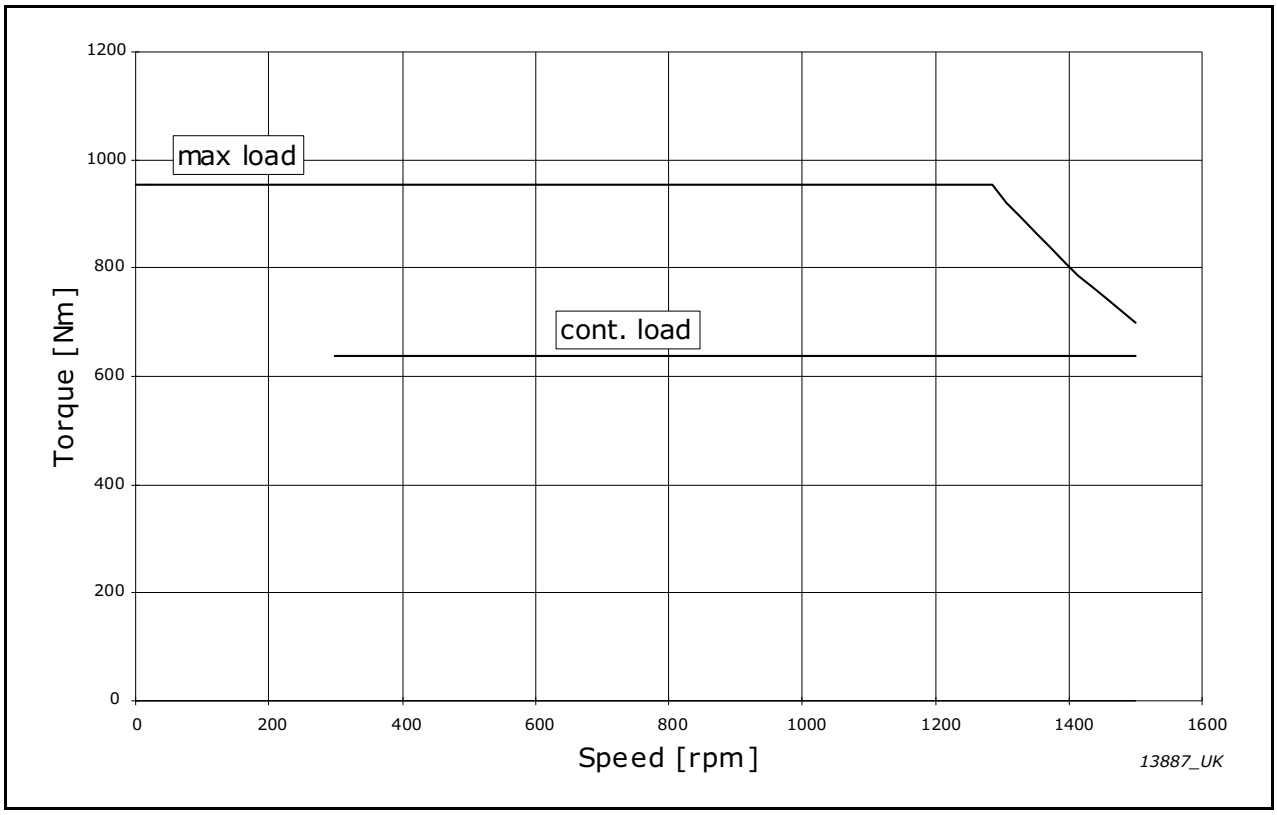

Figure 45. Example: OL(n_{base}) > OL(n_{max}) for constant torque load

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5.2.3 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.

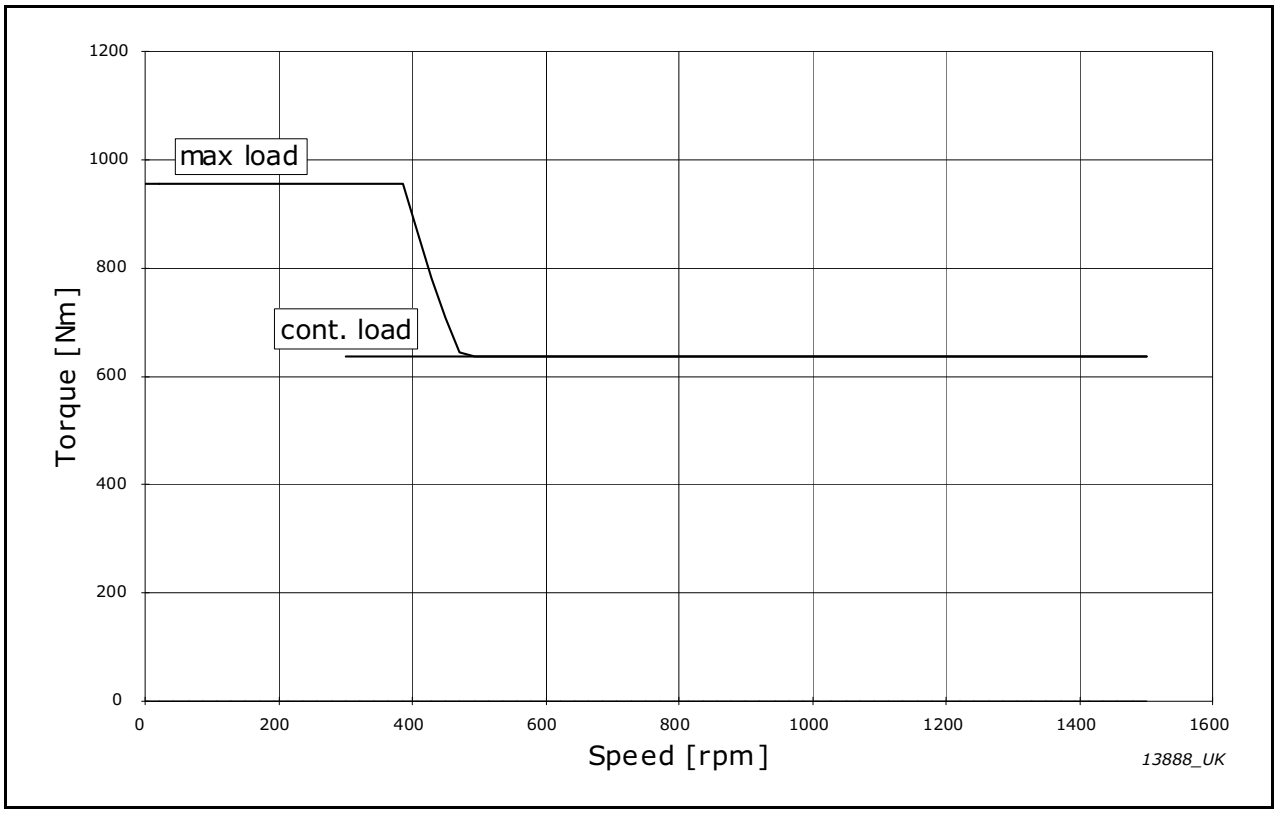

Figure 46. Example: Starting torque >> OL(n_{max}) for constant torque load

5.2.4 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.

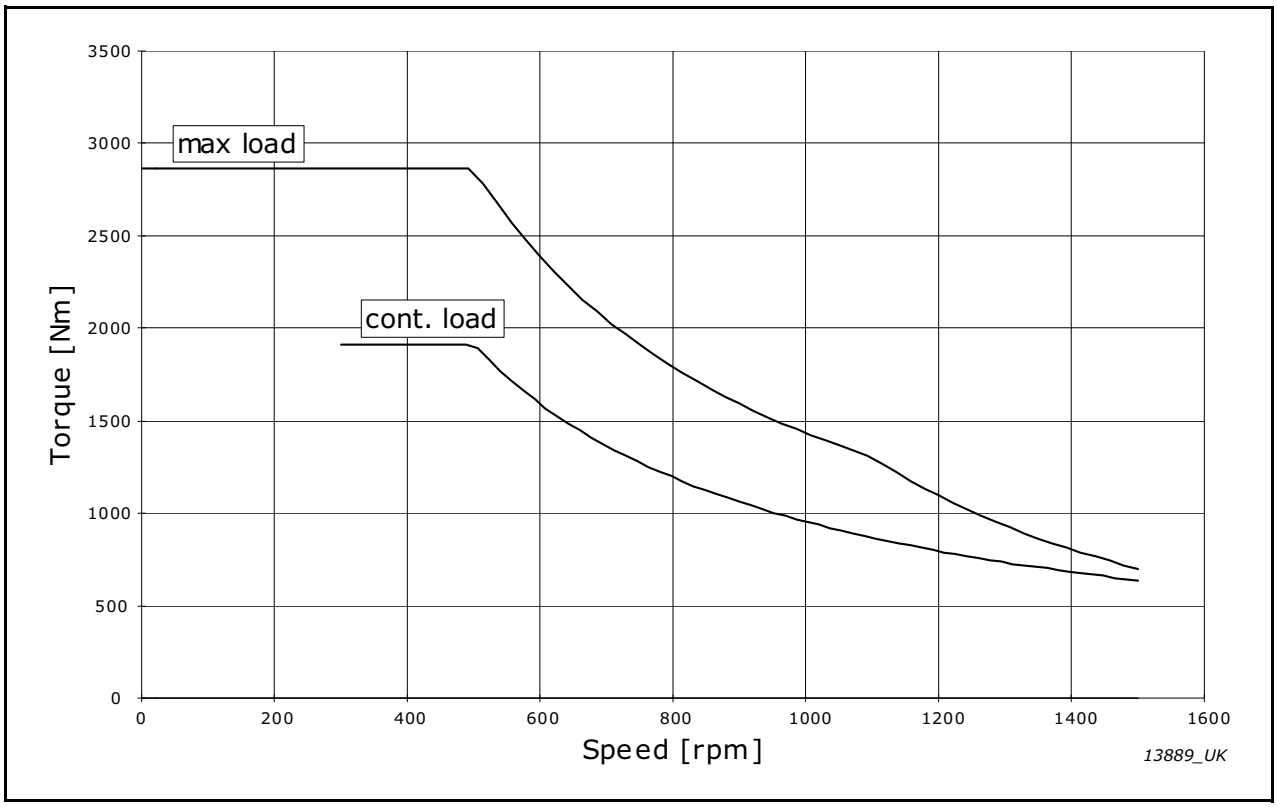

Figure 47. Example: OL(n_{base}) > OL(n_{max}) for constant power load

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5.2.5 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.

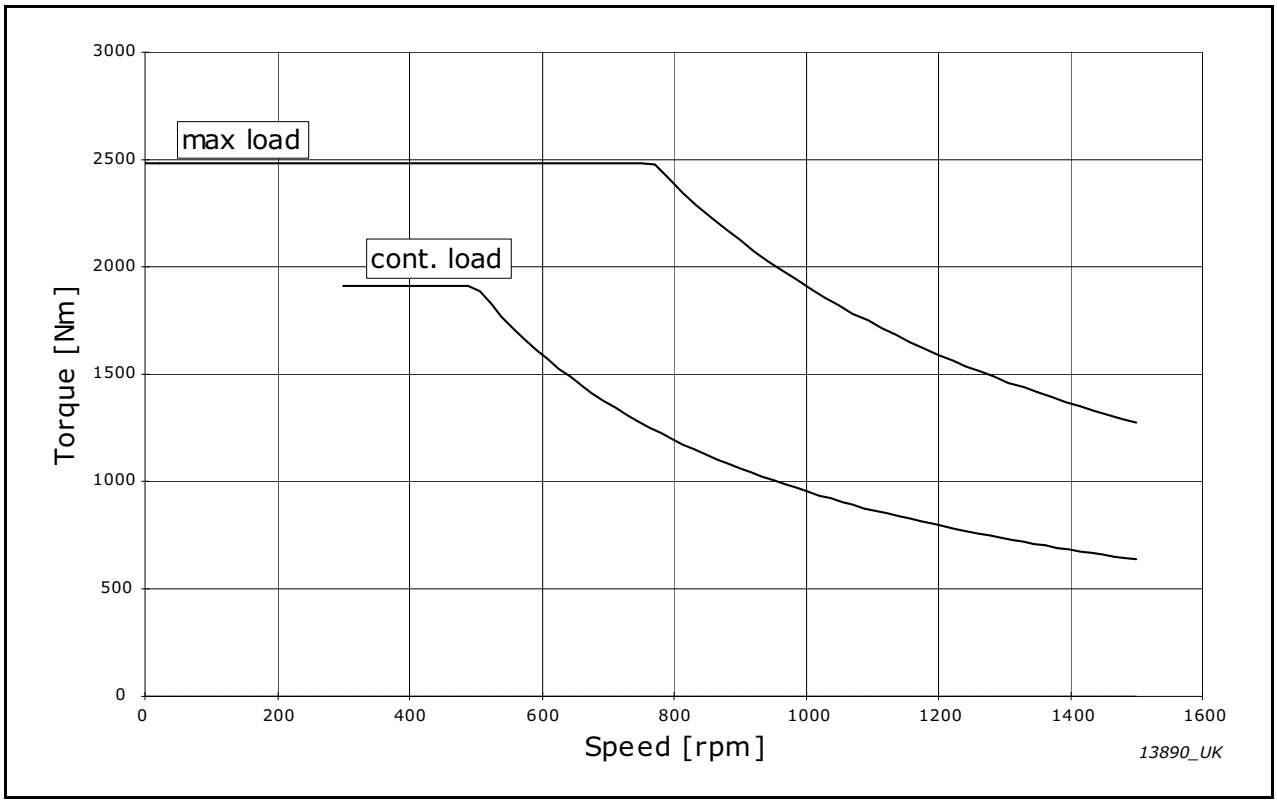

Figure 48. Example: OL(n_{base}) < OL(n_{max}) for constant power load

5.3 TECHNICAL SPECIFICATIONS FOR VACON® DRIVES

5.3.1 NXN - NON-REGENERATIVE FRONT END UNITS

Table 17. 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 100m 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.

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Table 17. 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)

5.3.2 NXA - ACTIVE FRONT-END UNITS

Table 18. 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 (380-500 V_{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)

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Table 18. 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}
	Earth fault protection	In case of an earth fault in the supply cable, the earth 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

5.3.3 NXI - INVERTER UNITS

5.3.3.1 Drive sizes FR4-FR8

Table 19. 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

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Table 19. 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 100m 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	FR4-7: 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 19. 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}
	Earth fault protection	In case of an earth 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

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5.3.3.2 Drive sizes FI9-FI14

Table 20. 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 20. 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 100m 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.

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Table 20. 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}
	Earth fault protection	In case of an earth 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

5.3.4 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 5.3.3.2).

6. SUPPLIED DOCUMENTATION

VACON® delivers technical documentation for the switchgear assembled AC drives according to Vacon Plc's design standard. The documentation is provided in english.

Vacon Plc's scope of supply regarding documentation does not include:

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

Table 21. 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

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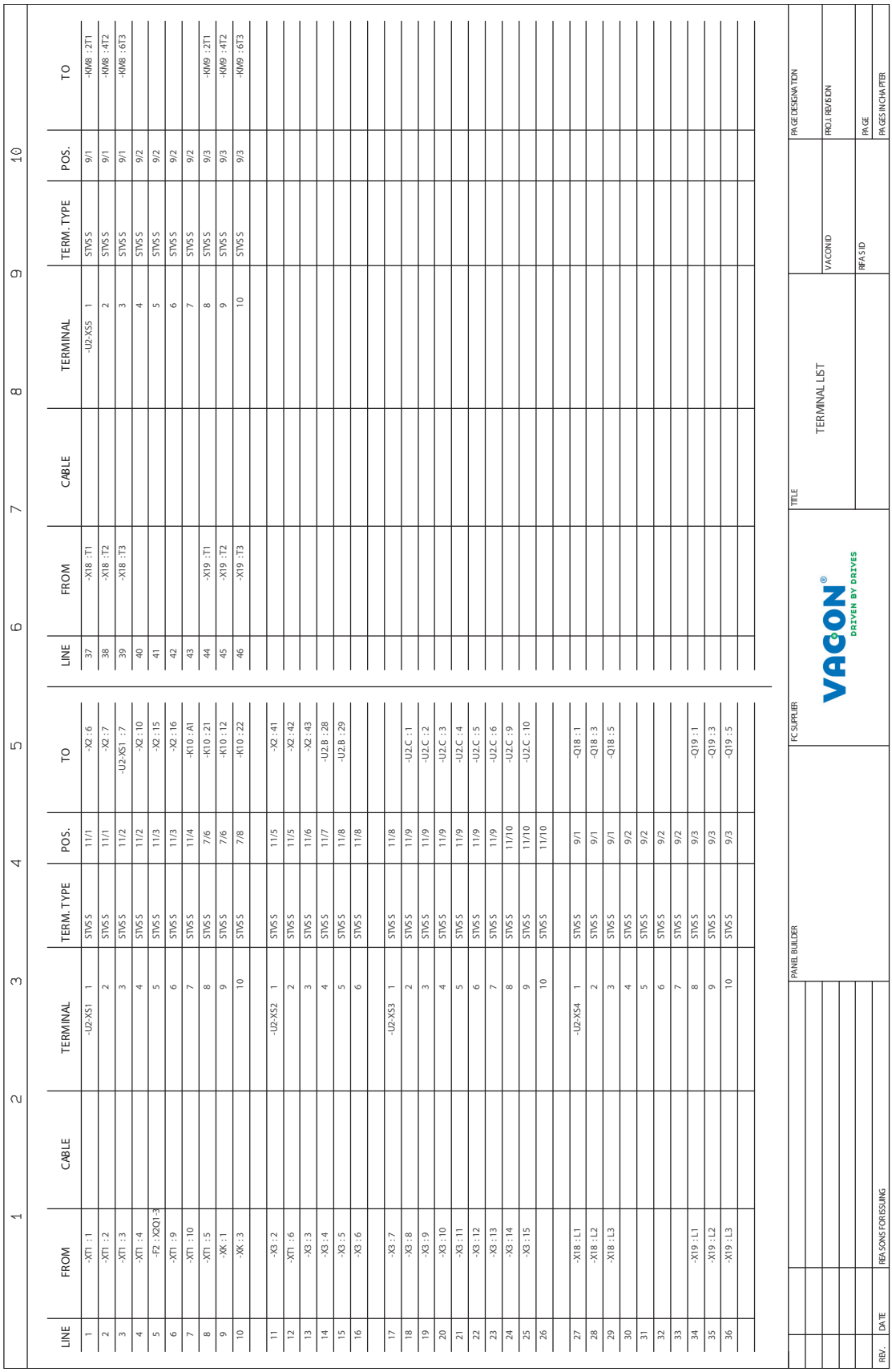
6.1 DOCUMENTATION EXAMPLES

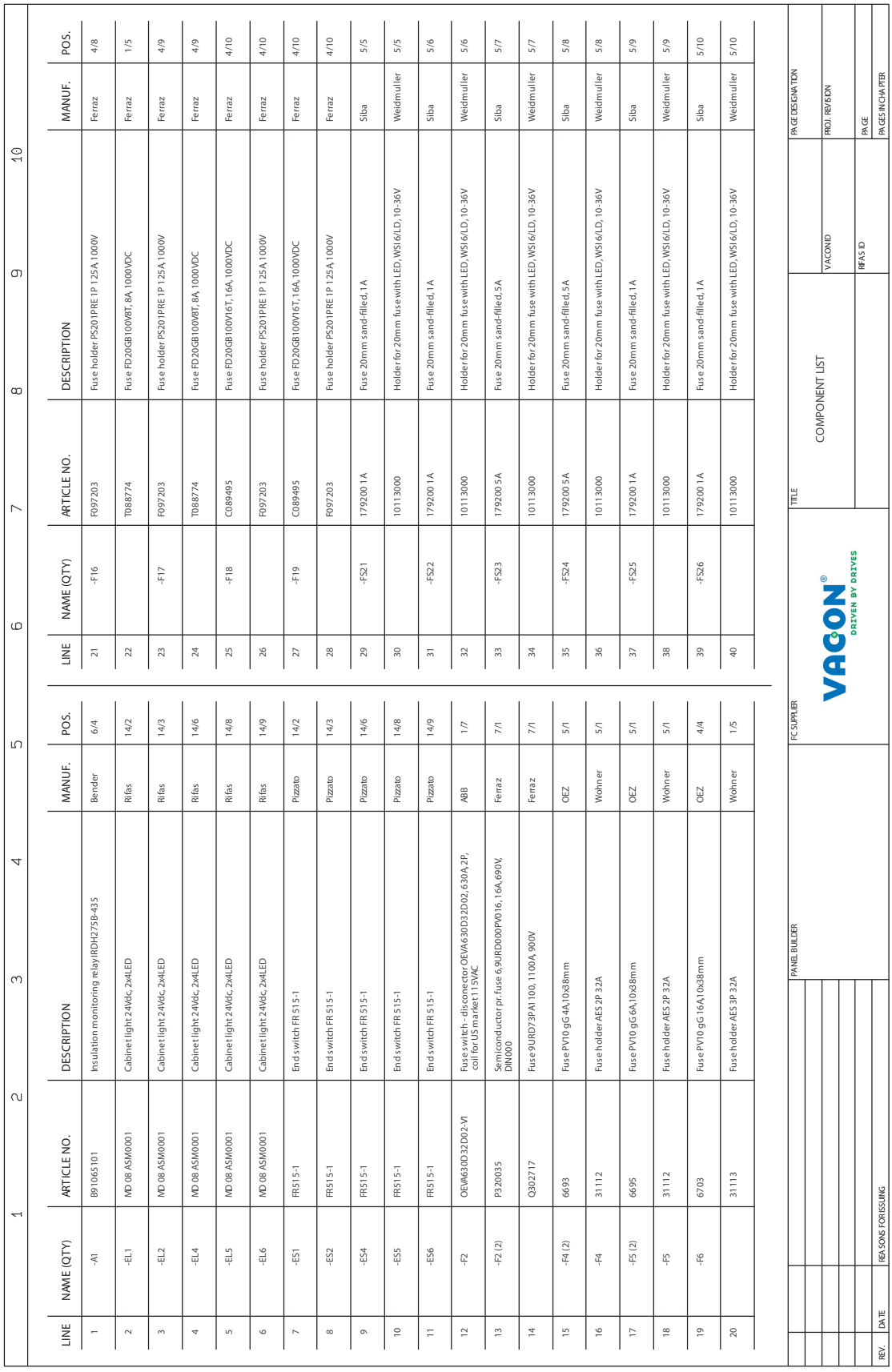
6.1.1 CABLE CONNECTION TABLE



LINE	FROM	CABLE	TERMINAL		TERM. TYPE	POS.	TO	LINE	FROM	CABLE	TERMINAL		TERM. TYPE	POS.	TO
1	-XT1 : 1		-U2-XS1	1	ST/V/S/S	11/1	-X2 : 6	37	-X18 : T1		-U2-XS5	1	ST/V/S/S	9/1	-KM8 : 2T1
2	-XT1 : 2			2	ST/V/S/S	11/1	-X2 : 7	38	-X18 : T2			2	ST/V/S/S	9/1	-KM8 : 4T2
3	-XT1 : 3			3	ST/V/S/S	11/2	-U2-XS1 : 7	39	-X18 : T3			3	ST/V/S/S	9/1	-KM8 : 6T3
4	-XT1 : 4			4	ST/V/S/S	11/2	-X2 : 10	40				4	ST/V/S/S	9/2	
5	-F2 : X2Q1-3			5	ST/V/S/S	11/3	-X2 : 15	41				5	ST/V/S/S	9/2	
6	-XT1 : 9			6	ST/V/S/S	11/3	-X2 : 16	42				6	ST/V/S/S	9/2	
7	-XT1 : 10			7	ST/V/S/S	11/4	-K10 : A1	43				7	ST/V/S/S	9/2	
8	-XT1 : 5			8	ST/V/S/S	7/6	-K10 : 21	44	-X19 : T1			8	ST/V/S/S	9/3	-KM9 : 2T1
9	-XK : 1			9	ST/V/S/S	7/6	-K10 : 12	45	-X19 : T2			9	ST/V/S/S	9/3	-KM9 : 4T2
10	-XK : 3			10	ST/V/S/S	7/8	-K10 : 22	46	-X19 : T3			10	ST/V/S/S	9/3	-KM9 : 6T3
11	-X3 : 2		-U2-XS2	1	ST/V/S/S	11/5	-X2 : 41								
12	-XT1 : 6			2	ST/V/S/S	11/5	-X2 : 42								
13	-X3 : 3			3	ST/V/S/S	11/6	-X2 : 43								
14	-X3 : 4			4	ST/V/S/S	11/7	-U2.B : 28								
15	-X3 : 5			5	ST/V/S/S	11/8	-U2.B : 29								
16	-X3 : 6			6	ST/V/S/S	11/8									
17	-X3 : 7		-U2-XS3	1	ST/V/S/S	11/8									
18	-X3 : 8			2	ST/V/S/S	11/9	-U2.C : 1								
19	-X3 : 9			3	ST/V/S/S	11/9	-U2.C : 2								
20	-X3 : 10			4	ST/V/S/S	11/9	-U2.C : 3								
21	-X3 : 11			5	ST/V/S/S	11/9	-U2.C : 4								
22	-X3 : 12			6	ST/V/S/S	11/9	-U2.C : 5								
23	-X3 : 13			7	ST/V/S/S	11/9	-U2.C : 6								
24	-X3 : 14			8	ST/V/S/S	11/10	-U2.C : 9								
25	-X3 : 15			9	ST/V/S/S	11/10	-U2.C : 10								
26				10	ST/V/S/S	11/10									
27	-X18 : L1		-U2-XS4	1	ST/V/S/S	9/1	-Q18 : 1								
28	-X18 : L2			2	ST/V/S/S	9/1	-Q18 : 3								
29	-X18 : L3			3	ST/V/S/S	9/1	-Q18 : 5								
30				4	ST/V/S/S	9/2									
31				5	ST/V/S/S	9/2									
32				6	ST/V/S/S	9/2									
33				7	ST/V/S/S	9/2									
34	-X19 : L1			8	ST/V/S/S	9/3	-Q19 : 1								
35	-X19 : L2			9	ST/V/S/S	9/3	-Q19 : 3								
36	-X19 : L3			10	ST/V/S/S	9/3	-Q19 : 5								

Figure 49. Example: cable connection table

6.1.2 PARTS LIST



LINE	NAME (QTY)	ARTICLE NO.	DESCRIPTION	MANUF.	POS.
1	-A1	B91065101	Insulation monitoring relay IRDH275B-435	Bender	6/4
2	-EL1	MD 08 ASM0001	Cabinet light 24Vdc, 2x4LED	Rifas	14/2
3	-EL2	MD 08 ASM0001	Cabinet light 24Vdc, 2x4LED	Rifas	14/3
4	-EL4	MD 08 ASM0001	Cabinet light 24Vdc, 2x4LED	Rifas	14/6
5	-EL5	MD 08 ASM0001	Cabinet light 24Vdc, 2x4LED	Rifas	14/8
6	-EL6	MD 08 ASM0001	Cabinet light 24Vdc, 2x4LED	Rifas	14/9
7	-ES1	FR515-1	End switch FR 515-1	Pizzato	14/2
8	-ES2	FR515-1	End switch FR 515-1	Pizzato	14/3
9	-ES4	FR515-1	End switch FR 515-1	Pizzato	14/6
10	-ES5	FR515-1	End switch FR 515-1	Pizzato	14/8
11	-ES6	FR515-1	End switch FR 515-1	Pizzato	14/9
12	-F2	OEVA630D32D02-VI	Fuse switch - disconector OEVA630D32D02, 630A 2P, coil for US market 115VAC	ABB	1/7
13	-F2 (2)	P320035	Semiconductor pr. fuse 6,9URD000PV016, 16A 690V, DIN000	Ferraz	7/1
14		Q302717	Fuse 9URD73PA1100, 1100A 900V	Ferraz	7/1
15	-F4 (2)	6693	Fuse PV10 gG 4A 10x38mm	OEZ	5/1
16	-F4	31112	Fuse holder AES 2P 32A	Wohner	5/1
17	-F5 (2)	6695	Fuse PV10 gG 6A 10x38mm	OEZ	5/1
18	-F5	31112	Fuse holder AES 2P 32A	Wohner	5/1
19	-F6	6703	Fuse PV10 gG 16A 10x38mm	OEZ	4/4
20		31113	Fuse holder AES 3P 32A	Wohner	1/5
21	-F16	R097203	Fuse holder PS201PRE 1P 125A 1000V	Ferraz	4/8
22		T088774	Fuse FD20GB100V8T, 8A, 1000VDC	Ferraz	1/5
23	-F17	R097203	Fuse holder PS201PRE 1P 125A 1000V	Ferraz	4/9
24		T088774	Fuse FD20GB100V8T, 8A, 1000VDC	Ferraz	4/9
25	-F18	C089495	Fuse FD20GB100V16T, 16A, 1000VDC	Ferraz	4/10
26		R097203	Fuse holder PS201PRE 1P 125A 1000V	Ferraz	4/10
27	-F19	C089495	Fuse FD20GB100V16T, 16A, 1000VDC	Ferraz	4/10
28		R097203	Fuse holder PS201PRE 1P 125A 1000V	Ferraz	4/10
29	-FS21	179200 1A	Fuse 20mm sand-filled, 1A	Siba	5/5
30		10113000	Holder for 20mm fuse with LED, WSI 6/LD, 10-36V	Weidmuller	5/5
31	-FS22	179200 1A	Fuse 20mm sand-filled, 1A	Siba	5/6
32		10113000	Holder for 20mm fuse with LED, WSI 6/LD, 10-36V	Weidmuller	5/6
33	-FS23	179200 5A	Fuse 20mm sand-filled, 5A	Siba	5/7
34		10113000	Holder for 20mm fuse with LED, WSI 6/LD, 10-36V	Weidmuller	5/7
35	-FS24	179200 5A	Fuse 20mm sand-filled, 5A	Siba	5/8
36		10113000	Holder for 20mm fuse with LED, WSI 6/LD, 10-36V	Weidmuller	5/8
37	-FS25	179200 1A	Fuse 20mm sand-filled, 1A	Siba	5/9
38		10113000	Holder for 20mm fuse with LED, WSI 6/LD, 10-36V	Weidmuller	5/9
39	-FS26	179200 1A	Fuse 20mm sand-filled, 1A	Siba	5/10
40		10113000	Holder for 20mm fuse with LED, WSI 6/LD, 10-36V	Weidmuller	5/10

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Figure 50. Example: parts list

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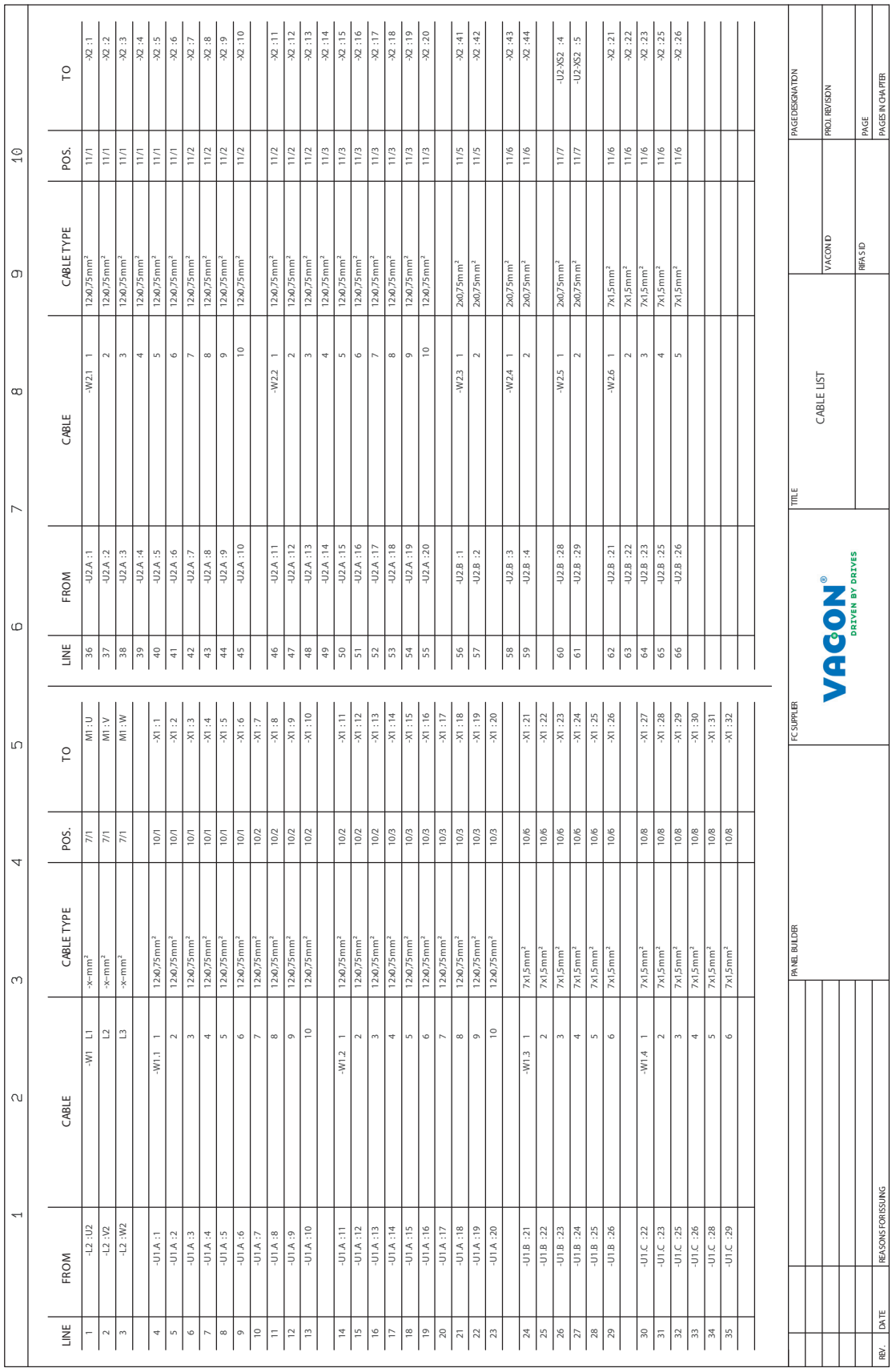
6.1.3 WIRING LIST



LINE	FROM	CABLE		CABLE TYPE	POS.	TO
1	-L2 :U2	-W1	L1	-x-mm²	7/1	M1 :U
2	-L2 :V2		L2	-x-mm²	7/1	M1 :V
3	-L2 :W2		L3	-x-mm²	7/1	M1 :W
4	-U1.A :1	-W1.1	1	12x0,75mm²	10/1	-X1 :1
5	-U1.A :2		2	12x0,75mm²	10/1	-X1 :2
6	-U1.A :3		3	12x0,75mm²	10/1	-X1 :3
7	-U1.A :4		4	12x0,75mm²	10/1	-X1 :4
8	-U1.A :5		5	12x0,75mm²	10/1	-X1 :5
9	-U1.A :6		6	12x0,75mm²	10/1	-X1 :6
10	-U1.A :7		7	12x0,75mm²	10/2	-X1 :7
11	-U1.A :8		8	12x0,75mm²	10/2	-X1 :8
12	-U1.A :9		9	12x0,75mm²	10/2	-X1 :9
13	-U1.A :10		10	12x0,75mm²	10/2	-X1 :10
14	-U1.A :11	-W1.2	1	12x0,75mm²	10/2	-X1 :11
15	-U1.A :12		2	12x0,75mm²	10/2	-X1 :12
16	-U1.A :13		3	12x0,75mm²	10/2	-X1 :13
17	-U1.A :14		4	12x0,75mm²	10/3	-X1 :14
18	-U1.A :15		5	12x0,75mm²	10/3	-X1 :15
19	-U1.A :16		6	12x0,75mm²	10/3	-X1 :16
20	-U1.A :17		7	12x0,75mm²	10/3	-X1 :17
21	-U1.A :18		8	12x0,75mm²	10/3	-X1 :18
22	-U1.A :19		9	12x0,75mm²	10/3	-X1 :19
23	-U1.A :20		10	12x0,75mm²	10/3	-X1 :20
24	-U1.B :21	-W1.3	1	7x1,5mm²	10/6	-X1 :21
25	-U1.B :22		2	7x1,5mm²	10/6	-X1 :22
26	-U1.B :23		3	7x1,5mm²	10/6	-X1 :23
27	-U1.B :24		4	7x1,5mm²	10/6	-X1 :24
28	-U1.B :25		5	7x1,5mm²	10/6	-X1 :25
29	-U1.B :26		6	7x1,5mm²	10/6	-X1 :26
30	-U1.C :22	-W1.4	1	7x1,5mm²	10/8	-X1 :27
31	-U1.C :23		2	7x1,5mm²	10/8	-X1 :28
32	-U1.C :25		3	7x1,5mm²	10/8	-X1 :29
33	-U1.C :26		4	7x1,5mm²	10/8	-X1 :30
34	-U1.C :28		5	7x1,5mm²	10/8	-X1 :31
35	-U1.C :29		6	7x1,5mm²	10/8	-X1 :32

LINE	FROM	CABLE		CABLE TYPE	POS.	TO
36	-U2.A :1	-W2.1	1	12x0,75mm²	11/1	-X2 :1
37	-U2.A :2		2	12x0,75mm²	11/1	-X2 :2
38	-U2.A :3		3	12x0,75mm²	11/1	-X2 :3
39	-U2.A :4		4	12x0,75mm²	11/1	-X2 :4
40	-U2.A :5		5	12x0,75mm²	11/1	-X2 :5
41	-U2.A :6		6	12x0,75mm²	11/1	-X2 :6
42	-U2.A :7		7	12x0,75mm²	11/2	-X2 :7
43	-U2.A :8		8	12x0,75mm²	11/2	-X2 :8
44	-U2.A :9		9	12x0,75mm²	11/2	-X2 :9
45	-U2.A :10		10	12x0,75mm²	11/2	-X2 :10
46	-U2.A :11	-W2.2	1	12x0,75mm²	11/2	-X2 :11
47	-U2.A :12		2	12x0,75mm²	11/2	-X2 :12
48	-U2.A :13		3	12x0,75mm²	11/2	-X2 :13
49	-U2.A :14		4	12x0,75mm²	11/3	-X2 :14
50	-U2.A :15		5	12x0,75mm²	11/3	-X2 :15
51	-U2.A :16		6	12x0,75mm²	11/3	-X2 :16
52	-U2.A :17		7	12x0,75mm²	11/3	-X2 :17
53	-U2.A :18		8	12x0,75mm²	11/3	-X2 :18
54	-U2.A :19		9	12x0,75mm²	11/3	-X2 :19
55	-U2.A :20		10	12x0,75mm²	11/3	-X2 :20
56	-U2.B :1	-W2.3	1	2x0,75mm²	11/5	-X2 :41
57	-U2.B :2		2	2x0,75mm²	11/5	-X2 :42
58	-U2.B :3	-W2.4	1	2x0,75mm²	11/6	-X2 :43
59	-U2.B :4		2	2x0,75mm²	11/6	-X2 :44
60	-U2.B :28	-W2.5	1	2x0,75mm²	11/7	-U2:XS2 :4
61	-U2.B :29		2	2x0,75mm²	11/7	-U2:XS2 :5
62	-U2.B :21	-W2.6	1	7x1,5mm²	11/6	-X2 :21
63	-U2.B :22		2	7x1,5mm²	11/6	-X2 :22
64	-U2.B :23		3	7x1,5mm²	11/6	-X2 :23
65	-U2.B :25		4	7x1,5mm²	11/6	-X2 :25
66	-U2.B :26		5	7x1,5mm²	11/6	-X2 :26

Figure 51. Example: wiring list

6.1.4 CIRCUIT DIAGRAM

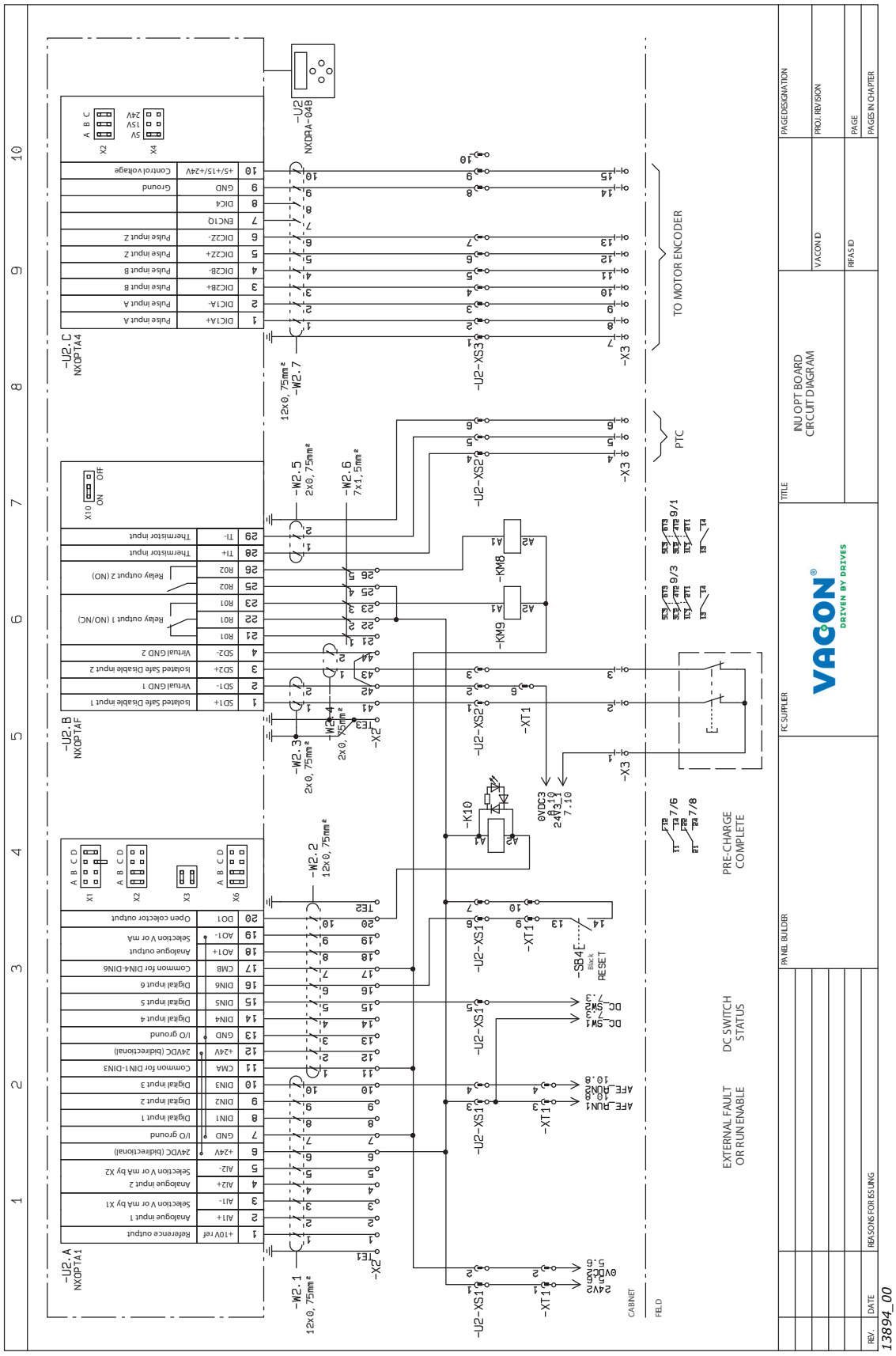


Figure 52. Example: circuit diagram

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6.1.5 SWITCHGEAR LAYOUT DRAWING

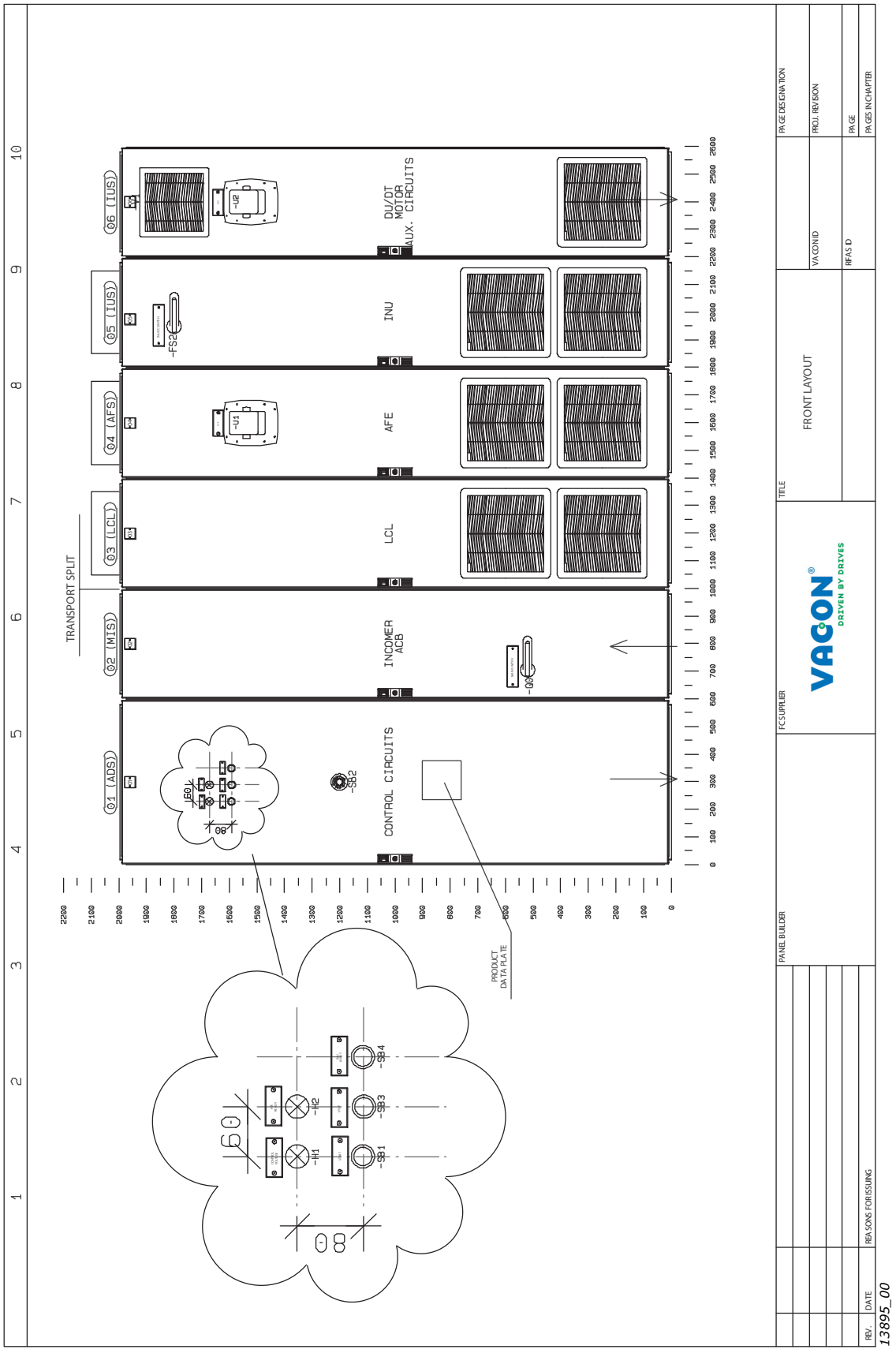

Figure 53. Example: switchgear layout drawing

6.1.6 DEVICE LAYOUT DRAWING

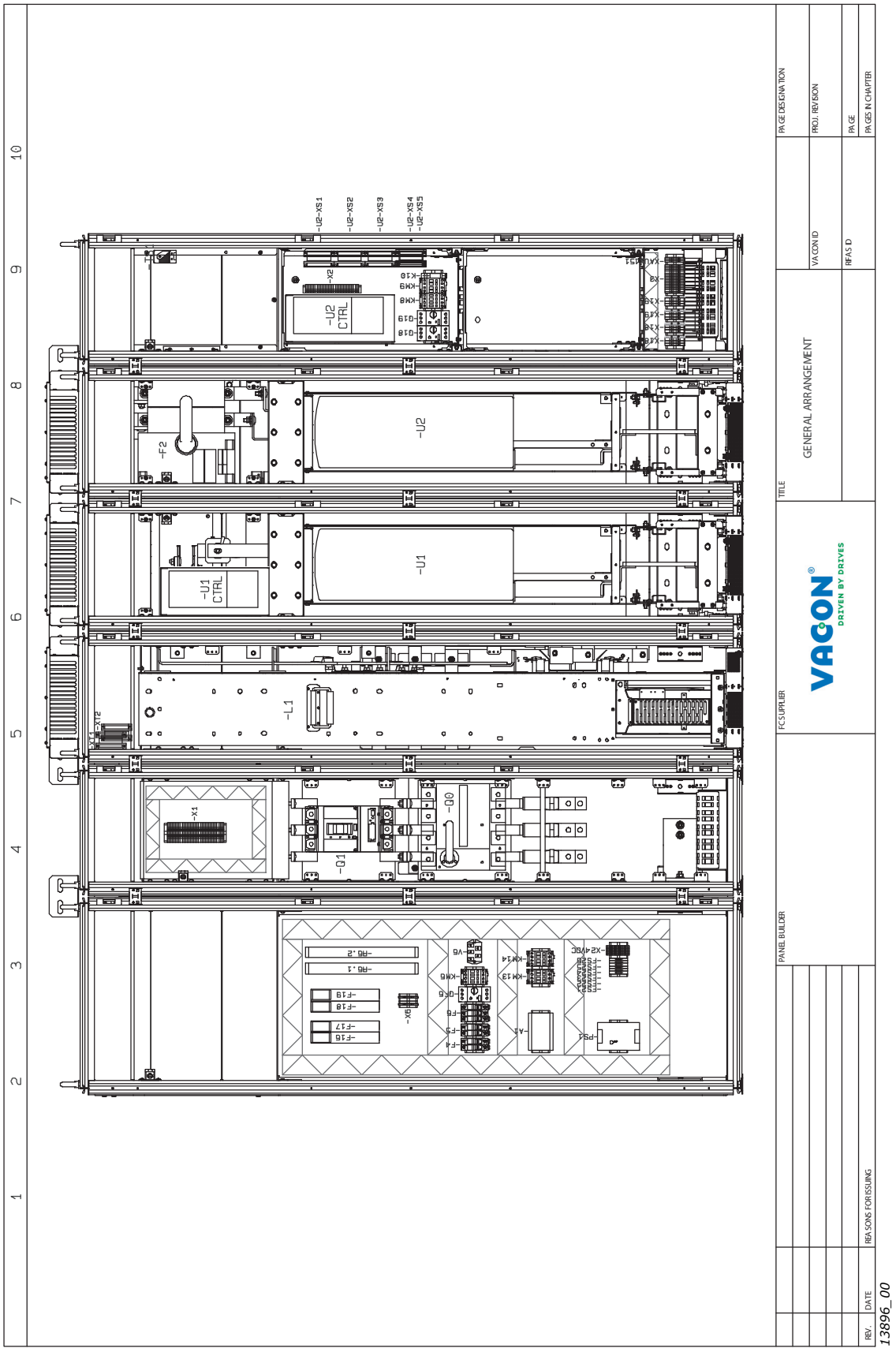

Figure 54. Example: device layout drawing

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