VACON® NX
AC DRIVES

ACTIVE FRONT END UNIT (AFE)
AIR COOLED
USER MANUAL

VACON®

TABLE OF CONTENTS

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AT LEAST THE 11 FOLLOWING STEPS OF THE START-UP QUICK GUIDE MUST BE PERFORMED DURING THE INSTALLATION AND COMMISSIONING.

IF ANY PROBLEMS OCCUR, CONTACT YOUR LOCAL DISTRIBUTOR.

Start-up Quick Guide

1. Check that the delivery corresponds to your order, see Chapter 3.
2. Before taking any commissioning actions, read carefully the safety instructions in Chapter 1.
3. Before the mechanical installation, check the minimum clearances around the unit and check the ambient conditions in Chapter 5.
4. Check the size of the supply cable/bus bar, DC output cable/busbar, and mains fuses, DC fuses and check the cable connections.
5. Follow the installation instructions, see Chapter 5.
6. The sizes and grounding of control connections are explained in Chapter 5.
7. If the Start-up wizard is active, select the language you want the keypad and confirm by pressing the enter button. If the Start-up wizard is not active, follow the instructions in 8 below.
8. Select the language of the keypad from Menu M6, S6.1. Instructions on using the keypad are given in Chapter 6.
9. All parameters have factory default values. To ensure proper operation, check the rating plate data for the values below and the corresponding parameters of parameter group G2.1.
   - Nominal voltage of the supply (P2.1.1)
   - Digital input settings according to connections (P2.2.1.1-P2.2.1.8)
   - Change control place to I/O (P3.1)

   In case of parallel AFE:

   - Set drooping parameter to 5% (P2.5.1)
   - Set PWM Synch parameter to Enable (P2.5.2)

   All parameters are explained in the VACON® NX Active Front End (AFE) Application Manual.
10. Follow the commissioning instructions in the VACON® NX Active Front End Application Manual.
11. The VACON® NX Active Front End is now ready for use.

Danfoss is not responsible for the use of the Active Front End against the instructions.

ABOUT THE VACON® NX AFE USER MANUAL

Congratulations for choosing VACON® NX Active Front End!

The User's Manual will provide you with the necessary information about the installation, commissioning and operation of VACON® NX Active Front End. We recommend that you carefully study these instructions before powering up the active front end for the first time.

In the VACON® NX Active Front End Application Manual you will find information about the Active Front End application. Should that application not meet the requirements of your process, contact the manufacturer for information on special application.

This manual is available in both paper and electronic editions. We recommend you to use the electronic version if possible. If you have the electronic version at your disposal, you will be able to benefit from the following features:

The manual contains several links and cross-references to other locations in the manual, which makes it easier to move around in the manual. The reader can thus easily find and check things.

The manual also contains hyper links to web pages. To visit these web pages through the links, you must have an internet browser installed on your computer.

This manual is applicable only for Active Front End units, LCL filters and optional components that are introduced in this manual.

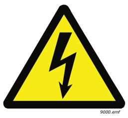
1. SAFETY

This manual contains warnings and cautions, which are identified with safety symbols. The warnings and cautions give important information on how to prevent injury and damage to the equipment or your system.

Read the warnings and cautions carefully and obey their instructions.

The cautions and warnings are marked as follows:

Table 1. Warning signs

	**WARNING!**
	**CAUTION!**
	**CAUTION! Hot surface**

IMPORTANT SAFETY INSTRUCTIONS
SAVE THESE INSTRUCTIONS
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/.

INSTRUCTIONS IMPORTANTES CONCERNANT LA SÉCURITÉ
CONSERVER CES INSTRUCTIONS
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/.

1.1 Warnings

Do not touch the components of the power unit, LCL filter or pre-charging circuit when the drive is connected to Mains, or the DC-link when DC-link is powered. The components are live when the drive is connected to mains or the DC-link is powered. A contact with this voltage is very dangerous.

Do not touch the line-in terminals U, V, W or the DC terminals when the drive is connected to mains or DC-link when DC-link is powered. These terminals are live when the drive is connected to mains or DC-link when DC-link is powered, also when the system does not operate.

Do not touch the control terminals. They can have a dangerous voltage also when the drive is disconnected from mains or DC-link when DC- link is powered.

Before you do electrical work on the drive, disconnect the drive from the mains and make sure that the system has stopped. Lock out and tag out the power sources to the drive. Make sure that no external source generates unintended voltage during work. Note that also the load side of the drive can generate voltage.

Wait 5 minutes before you open the cabinet door or the cover of the AC drive. Use a measuring device to make sure that there is no voltage. The terminal connections and the components of the drive can be live 5 minutes after it is disconnected from the mains and the system has stopped.

Before you connect the drive to mains, make sure that the front cover and the cable cover of the drive are closed. The connections of the AC drive are live when the drive is connected to mains.

When there is a power-up, a power break or a fault reset, the system starts immediately if the start signal is active, unless the pulse control for Start/Stop logic is selected. If the parameters, the applications or the software change, the I/O functions (including the start inputs) can change.

Wear protective gloves when you do mounting, cabling or maintenance operations. There can be sharp edges in the AC drive that can cause cuts.

1.2 Cautions

Do not move the AC drive, LCL filter or the optional components. Use a fixed installation to prevent damage to the drive.

Do not make measurements when the AC drive is connected to mains. It can cause damage to the drive.

Make sure that there is reinforced protective ground connection. It is mandatory, because the touch current of the AC drives is more than 3.5 mA AC (refer to EN 61800-5-1). See Chapter 1.3 "Grounding and earth fault protection".

Before you do any work on the Common DC Bus, make sure that the system is grounded.

After having disconnected the Active Front End from the AC supply, wait until the fan stops and the indicators on the keypad go out (if no keypad is attached see the indicator through the keypad base). Wait 5 more minutes before doing any work on Active Front End connections. Do not even open the cover before this time has expired.

Do not use spare parts that are not from the manufacturer. Using other spare parts can cause damage to the drive.

Do not touch the components on the circuit boards. Static voltage can cause damage to these components.

Prevent radio interference. The AC drive can cause radio interference in a domestic environment.

NOTE! If you activate the autoreset function, the system starts automatically after an automatic fault reset. See the VACON® NX AFE Application Manual.

NOTE! If you use the AC drive as a part of a machine, the machine manufacturer must supply a mains disconnection device (refer to EN 60204-1).

1.3 GROUNDING AND EARTH FAULT PROTECTION

The AC drive must always be grounded with a grounding conductor that is connected to the grounding terminal that is identified with the symbol ⏚ .
Not using a grounding conductor can cause damage to the drive.

The touch current of the drive is more than 3.5 mA AC. The standard EN 61800-5-1 tells that 1 or more of these conditions for the protective circuit must be true.

The connection must be fixed.

a) The protective grounding conductor must have a cross-sectional area of minimum 10 mm^2 Cu or 16 mm^2 Al. OR

b) There must be an automatic disconnection of the mains, if the protective grounding conductor breaks. See Chapter 5 "Installation". OR

c) There must be a terminal for a second protective grounding conductor in the same cross-sectional area as the first protective grounding conductor.

Table 2. Protective grounding conductor cross-section

Cross-sectional area of the phase conductors (S) [mm^2]	The minimum cross-sectional area of the protective grounding conductor in question [mm^2]
$S \leq 16$	S
$16 < S \leq 35$	16
$35 < S$	S/2

The values of the table 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 must be determined in a manner that produces a conductance equivalent to that which results from the application of this table.

The cross-sectional area of each protective grounding conductor that is not a part of the mains cable or the cable enclosure, must be a minimum of:

- 2.5 mm^2 if there is mechanical protection, and
- 4 mm^2 if there is not mechanical protection. If you have cord-connected equipment, make sure that the protective grounding conductor in the cord is the last conductor to be interrupted, if the strain-relief mechanism breaks.

Obey the local regulations on the minimum size of the protective grounding conductor.

NOTE! Because there are high capacitive currents in the AC drive, it is possible that the fault current protective switches do not operate correctly.

Do not do voltage withstand tests on the AC drive. The manufacturer has already done the tests. Doing voltage withstand tests can cause damage to the drive.

1.4 Electro-magnetic compatibility (EMC)

The drive must obey the standard IEC 61000-3-12. To obey it, the short-circuit power S_{SC} must be a minimum of 120 R_{SCE} at the interface point between your mains and the public mains. Make sure that you connect the drive and the motor to mains with a short-circuit power S_{SC} that is a minimum of 120 R_{SCE}. If necessary, contact your mains operator.

1.5 Using an RCD or an RCM device

The drive can cause a current in the protective grounding conductor. You can use a residual current-operated protective (RCD) device, or a residual current-operated monitoring (RCM) device to give protection against a direct or an indirect contact. Use a type B RCD or RCM device on the mains side of the drive.

2. EU DIRECTIVE

2.1 CE marking

The CE marking on the product guarantees the free movement of the product within the EEA (European Economic Area). It also guarantees that the product complies with applicable directives (for example, the EMC Directive and other possible so-called new method directives). VACON® NX Active Front End carries the CE label as a proof of compliance with the Low Voltage Directive (LVD), Electro Magnetic Compatibility (EMC) Directive and RoHS Directive.

2.2 EMC directive

2.2.1 Introduction

The EMC Directive provides that the electrical apparatus must not excessively disturb the environment it is used in, and, on the other hand, it shall have an adequate level of immunity toward other disturbances from the same environment.

The compliance of VACON® NX Active Front End with the EMC Directive is verified with Technical Construction Files (TCF) and checked and approved by SGS FIMKO, which is a Notified Body. The Technical Construction Files are used to authenticate the conformity of VACON® NX Active Front End with the Directive because it is impossible to test such a large product family in a laboratory environment and because the combinations of installation vary greatly.

2.2.2 Technical criteria

Our basic idea was to develop a range of VACON® NX Active Front End offering the best possible usability and cost efficiency. EMC compliance was a major consideration from the outset of the design.

2.2.3 VACON® Active Front End EMC classification

Factory delivered VACON® NX Active Front End are Class T equipment, which fulfils all EMC immunity requirements (standard EN 61800-3).

Class T:

Class T equipment have a small earth leaking current and can be used with floating DC input.

3. RECEIPT OF DELIVERY

VACON® NX Active Front End has undergone scrupulous tests and quality checks at the factory before they are delivered to the customer. However, after unpacking the product, check that no signs of transportation damage are to be found on the product and that the delivery is complete (compare the type of the product to the codes below, See Table 3, Table 4, Table 5).

Should the product have been damaged during the shipping, contact primarily the cargo insurance company or the carrier.

If the delivery does not correspond to your order, contact the supplier immediately.

3.1 TYPE CODE FOR THE AFE UNIT

In VACON® type code for Common DC Bus components, the Active Front End Unit is characterised by letter A and number 2. If the Active Front End unit is ordered by number 2 delivery does not include anything else than the unit itself.

NOTE! The delivery does not include the auxiliary devices, which are needed for the operation (the AC or DC fuses, the fuses bases, the main contactor or circuit breaker, etc.). The customer will take care of the auxiliary devices.

Table 3. Type code for the VACON® Active Front End

Code	Description
NX	Product Generation
A	Module type A = AFE Active Front End
AAAA	Nominal current (low overload) e.g. 0261 = 261 A, 1030 = 1030 A, etc.
V	Nominal supply voltage 5 = 380-500 V AC / 465-800 V DC 6 = 525-690 V AC / 640-1100 V DC
A	Control keypad A = Standard alpha-numeric display (LCD) B = No local control panel F = Dummy panel G = Graphical panel
0	Enclosure class 0 = IP00, FI9-13
T	EMC emission level T = IT networks (EN61800-3)
0	Internal brake shopper 0 = N/A (no brake chopper)
2	Delivery include 2 = AFE module
S	S = Standard air cooled drive O = DC fan external power supply
F	F = Fiber connection, standard boards, FI9-FI13 G = Fiber connection, varnished boards, FI9-FI13 N = IP54 Control Unit for OPT-AF, Fiber connection, standard boards, FI9-FI13 O = IP54 Control Unit for OPT-AF, Fiber connection, varnished boards, FI9-FI13

Table 3. Type code for the VACON® Active Front End

Code	Description
A1 A2 00 00 00	Option boards; each slot is represented by two characters: 00 = the slot is not used A = Basic I/O board B = Expander I/O board C = Special board D = Fieldbus board E = Fieldbus board

3.2 Type code for the LCL filter

LCL filters has two versions of cooling fan power supply, one without the integrated DC/DC power supply and one with it. The LCL filter is characterized without the integrated DC/DC power supply by letter A and with the integrated DC/DC power supply by letter B in version column, Table 4.

Table 4. Type code for the LCL filters

Code	Description
LCL	Product range LCL = LCL filter for AFE
AAAA	Nominal current (low overload) E.g. 0261 = 261 A, 0460 = 460 A and so on.
V	Voltage class 5 = 380–500 V AC 6 = 525–690 V AC
A	Version (hardware) A = DC fan without DC/DC power supply B = DC fan with integrated DC/DC power supply
0	Enclosure class: 0 = IP00
R	Reserve
0	Reserve
1	Reserve
1	Cooling fan type 1 = DC fan
T	Manufacturer T = Trafotek

3.3 Type code for the pre-charging components

The pre-charging components can be ordered separately. The pre-charging resistors are optimized for each Active Front End unit. Components of the pre-charging circuit are 2 pcs charging resistors, the contactor, the diode bridge and the snubber capacitor, see Table 5. Each pre-charging circuit has maximum charging capacity, see Table 27.

Table 5. Type code for the pre-charging components

FI9 AFE/CHARGING-AFE-FFE-FI9				
Item	**Q'ty**	**Description**	**Manufacturer**	**Product Code**
1	1	Diode Bridge	Semikron	SKD 82
2	2	Charging resistors	Danotherm	CAV150C47R
3	1	Snubber capacitor	Rifa	PHE448
4	1	Contactor	Telemecanique	LC1D32P7
FI10 AFE/CHARGING-AFE-FFE-FI10				
Item	**Q'ty**	**Description**	**Manufacturer**	**Product Code**
1	1	Diode Bridge	Semikron	SKD 82
2	2	Charging resistors	Danotherm	CBV335C20R
3	1	Snubber capacitor	Rifa	PHE448
4	1	Contactor	Telemecanique	LC1D32P7
FI13 AFE/CHARGING-AFE-FFE-FI13				
Item	**Q'ty**	**Description**	**Manufacturer**	**Product Code**
1	1	Diode Bridge	Semikron	SKD 82
2	2	Charging resistors	Danotherm	CAV335C11R
3	1	Snubber capacitor	Rifa	PHE448
4	1	Contactor	Telemecanique	LC1D32P7

3.4 STORAGE

If VACON® NX Active Front End is to be stored before use, make sure that the ambient conditions are acceptable:

Storage temperature	–40…+70 °C (-40…+158 °F)
Relative humidity	0–95%, no condensation

If you must keep the VACON® NX Active Front End in storage for a long time, you must connect the power to the VACON® NX Active Front End each year. Keep the power on for a minimum of 2 hours.

We do not recommend a long storage time. If the storage time is more than 12 months, you must charge the electrolytic DC capacitors with caution. To reform the capacitors, obey the instructions in Chapter 3.5 Capacitor reforming.

3.5 Maintenance

3.5.1 Preventive maintenance recommendations

Generally, all technical equipment, including VACON® AC Drives need a minimum level of preventive maintenance. Regular maintenance is recommended to ensure trouble-free operation and long life of the drive. It is also recommended, as a good service practice to record a maintenance log with counter values, date, and time describing the maintenance and service actions.

Danfoss recommends the following inspections and service intervals for air-cooled drives/systems.

NOTE! The service schedule for part replacements may vary depending on operation conditions. Under specific conditions, the combination of stressful operating and environment conditions work together to significantly reduce the lifetime of the components.These conditions can include, for example, extreme temperature, dust, high humidity, hours of use, corrosive environment, and loading.

For operation in stressful conditions, Danfoss offers the DrivePro® Preventive Maintenance service. DrivePro® services extend the lifetime and increase the performance of the product with scheduled maintenance including customized part replacements. DrivePro® services are tailored to your application and operating conditions.

Table 6. Maintenance schedule for air-cooled drives

Component	Inspection interval (1)	Service schedule (2)	Preventive maintenance actions
Installation			
Visual drive inspection	1 year	–	Check for the unusual, for example, for signs of overheating, aging, corrosion, and for dusty and damaged components.
Auxiliary equipment	1 year	According to manufacturer recommendations	Inspect equipment, switchgear, relays, disconnects or fuses/circuit breakers. Examine the operation and condition for possible causes of operational faults or defects. The continuity check on fuses is performed by trained service personnel.
EMC consideration	1 year	–	Inspect the installation wiring regarding the electromagnetic capability and the separation distance between control wiring and power cables.
Cable routing	1 year	–	Check for parallel routing of motor cables, mains wiring, and signal wiring. Parallel routing must be avoided. Avoid routing cables through free air without support. Check for aging and wearing of the cable insulation.
Control wiring	1 year	–	Check for tightness, damaged or crimped wires or ribbon wires. The connections should be terminated correctly with solid crimped ends. The use of screened cables and grounded EMC plate, or a twisted pair is recommended.

Table 6. Maintenance schedule for air-cooled drives

Component	Inspection interval (1)	Service schedule (2)	Preventive maintenance actions
Proper clearances	1 year	–	Check that the required external clearances for proper air flow for cooling are followed according to the frame designation and drive type. For clearances, refer to the local design regulations.
Seals condition	1 year	–	Check that the seals of the enclosure, the covers, and the cabinet doors are in good condition.
Corrosive environments	1 year	–	Conductive dust, and aggressive gases, such as sulphide, chloride, salt mist, and so on, can damage the electrical and mechanical components. Air filters will not remove air-borne corrosive chemicals. Act based on findings.
Drive			
Programming	1 year	–	Check that the AC drive parameter settings are correct according to the motor, drive application, and I/O configuration. Only trained service personnel may perform this action.
Control panel	1 year	–	Check that the display pixels are intact. Check the event log for warnings, alarms, and faults. Repetitive events are a sign of potential issues. Contact your local service center.
Drive Cooling capacity	1 year	–	Check for blockages or constrictions in the air passages of the cooling channel. The heat sinks must be free of dust and condensation.
Capacitors, DC link	1 year	8–15+ years	The expected lifetime of the capacitors is dependent on the loading profile of the application and the environmental temperature. For applications with heavy loads in demanding environments or high ripple current, replace electrolytic capacitors every 8 years. If within specification of the drive type, replace every 10–15+ years. Only trained service personnel may perform this action.
Cleaning and Filters	1 year	–	The interior of the enclosure should be cleaned annually, and more frequently if necessary. The level of dust in the filter or inside the enclosure is an indicator for when the next cleaning or filter replacement is required.

Table 6. Maintenance schedule for air-cooled drives

Component	Inspection interval (1)	Service schedule (2)	Preventive maintenance actions
Fans	1 year	5–10 years	Inspect the condition and operational status of all cooling fans. With the power off, the fan axis should feel tight, and spinning the fan with a finger, the rotation should be almost silent and not have abnormal rotation resistance. When in RUN mode, fan vibration, excessive or strange noise is a sign of the bearings wearing, and the fan should be replaced.
Grounding	1 year	–	The drive system requires a dedicated ground wire connecting the drive, the output filter, and the motor to the building ground. Check that the ground connections are tight and free of paint or oxidation. Daisy-chain connections are not allowed. Braided straps are recommended if applicable.
PCB	1 year	10–12 years	Visually inspect the PCBs for signs of damage or degrading due to aging, corrosive environments, dust, or environments with high temperatures. Only trained service personnel may perform the inspection and service action.
Power cables and wiring	1 year	–	Check for loose connections, aging, insulation condition, and proper torque to the drive connections. Check for proper rating of fuses and continuity check. Observe if there are any signs of operation in a demanding environment. For example, discoloration of the fuse housing may be a sign of condensation or high temperatures.
Vibration	1 year	–	Check for abnormal vibration or noise coming from the drive to ensure that the environment is stable for electronic components.
Insulator gaskets	1 year	10–15 years	Inspect the insulators for signs of degradation due to high temperature and aging. Replacement is based on findings or done at the same time as DC capacitor replacement. Only trained service personnel may perform this action.
Spare parts			
Spare parts	1 year	2 years	Stock spares in their original boxes in a dry and clean environment. Avoid hot storage areas. Electrolytic capacitors require reforming as stated in the service schedule. The reforming is performed by trained service personnel. See Chapter 3.5.2.

Table 6. Maintenance schedule for air-cooled drives

Component	Inspection interval (1)	Service schedule (2)	Preventive maintenance actions
Exchange units and units stored for long periods before commissioning	1 year	2 years	Visually inspect for signs of damage, water, high humidity, corrosion, and dust within the visual field of view without disassembly. The exchange units with mounted electrolytic capacitors require reforming as stated in the service schedule. The reforming is performed by trained service personnel. See Chapter 3.5.2.

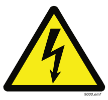
(1) Defined as the time after the commissioning/start-up or the time from the previous inspection.

(2) Defined as the time after the commissioning/start-up or the time from the previous service schedule actions.

3.5.2 Reforming the capacitors

The electrolytic capacitors in the DC link rely on a chemical process to provide the insulator between the two metal plates. This process can degrade over a period of years when the drive has been non-operational (stocked). The result is that the working voltage of the DC link gradually falls.

The correct course of action is to ensure that the insulation layer of the capacitor is 'reformed' by the application of a limited current using a DC supply. Current limiting ensures that the heat generated within the capacitor is kept at a sufficiently low level to prevent any damage.



DANGER! SHOCK HAZARD FROM CAPACITORS
The capacitors can be charged even when disconnected. Contact with this voltage can lead to death or serious injury.
If the AC drive or spare capacitors are intended to be stocked, discharge the capacitors before storage. Use a measuring device to make sure that there is no voltage. If in doubt, contact your Danfoss Drives representative.

Case 1: AC drive which has been non-operational or stocked for over 2 years.

1. Connect the DC supply to L1 and L2 or the B+/B terminals (DC+ to B+, DC- to B-) of the DC-link or directly to the capacitor terminals.
2. Set the current limit maximum to 800 mA.
3. Slowly increase the DC voltage to the nominal DC voltage level of the AC drive (1.35*Un AC).
4. Start to reform the capacitors. The time of reforming depends on the time of storage. See Figure 1.

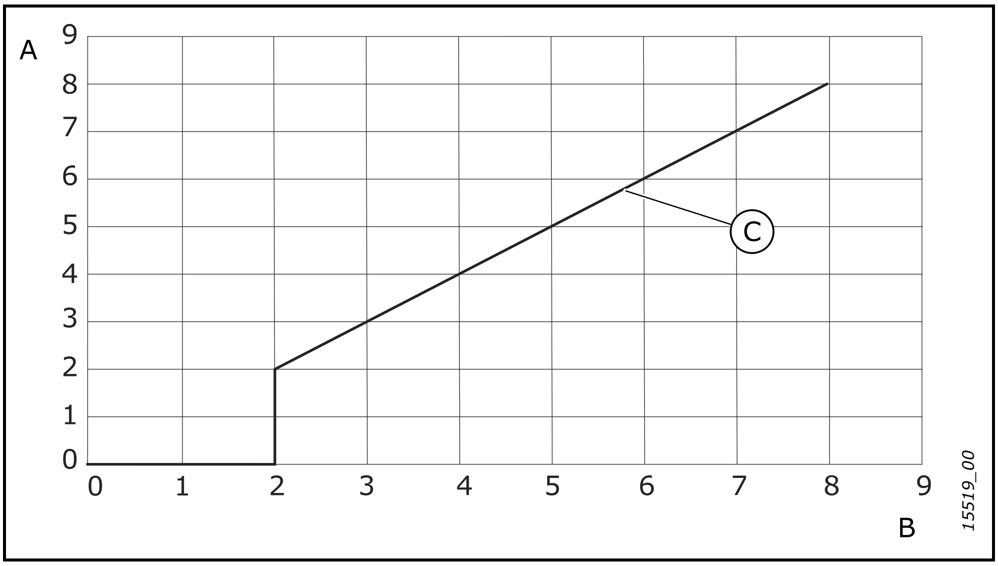


Figure 1. Storage Time and Reforming Time

A = Storage time (years) B = Reforming time (hours) C = Reforming time

5. After the reforming operation is done, discharge the capacitors.

Case 2: Spare capacitor which has been stocked for over 2 years.

1. Connect the DC supply to the DC+/DC- terminals.
2. Set the current limit maximum to 800 mA.
3. Slowly increase the DC voltage to the capacitor nominal voltage level. See information from component or service documentation.
4. Start to reform the capacitors. The time of reforming depends on the time of storage. See Figure 1.
5. After the reforming operation is done, discharge the capacitors.

3.6 Lifting the modules

The modules can be lifted by the holes on top. Place the lifting hooks symmetrically in at least four holes. The maximum allowed lifting angle is 45º. For enclosure sizes FI9 and FI10, see Figure 2 and for the enclosure size FI13, see Figure 3.

The lifting equipment must be able to carry the weight of the module.

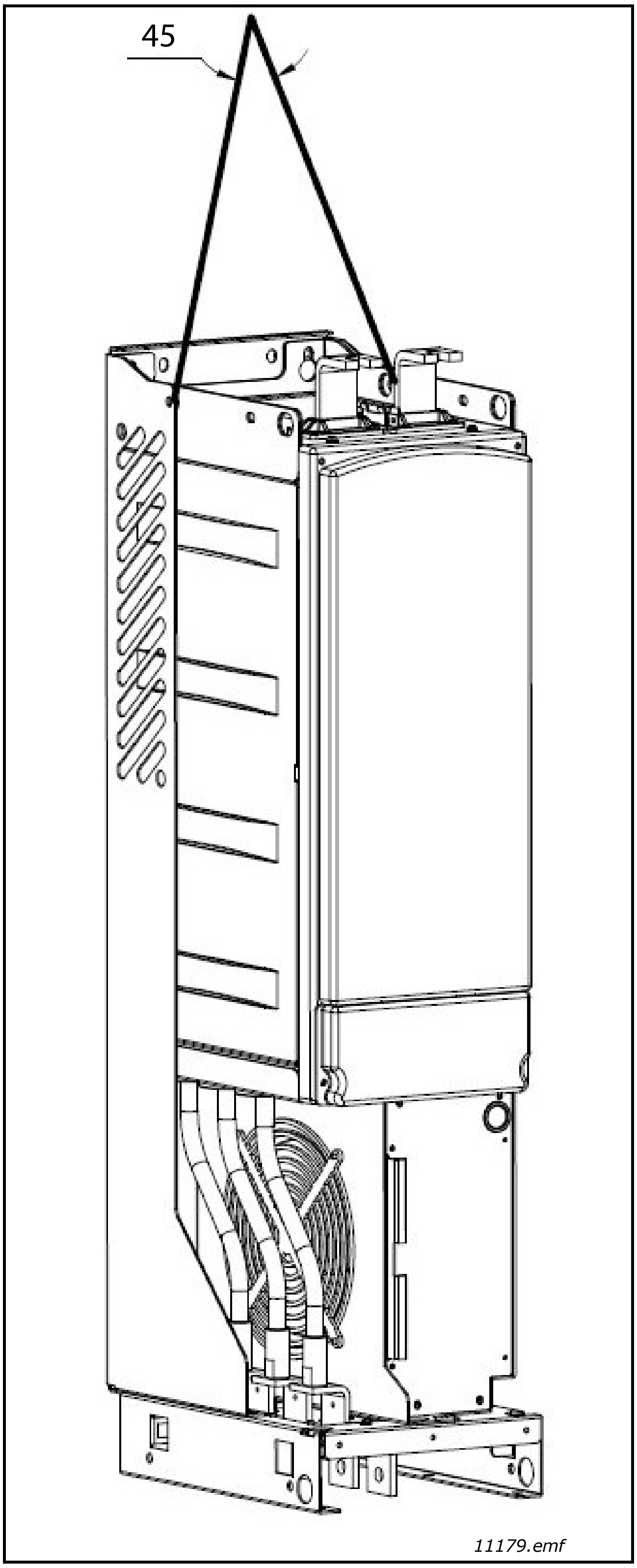


Figure 2. Lifting points for FI9 and FI10 modules

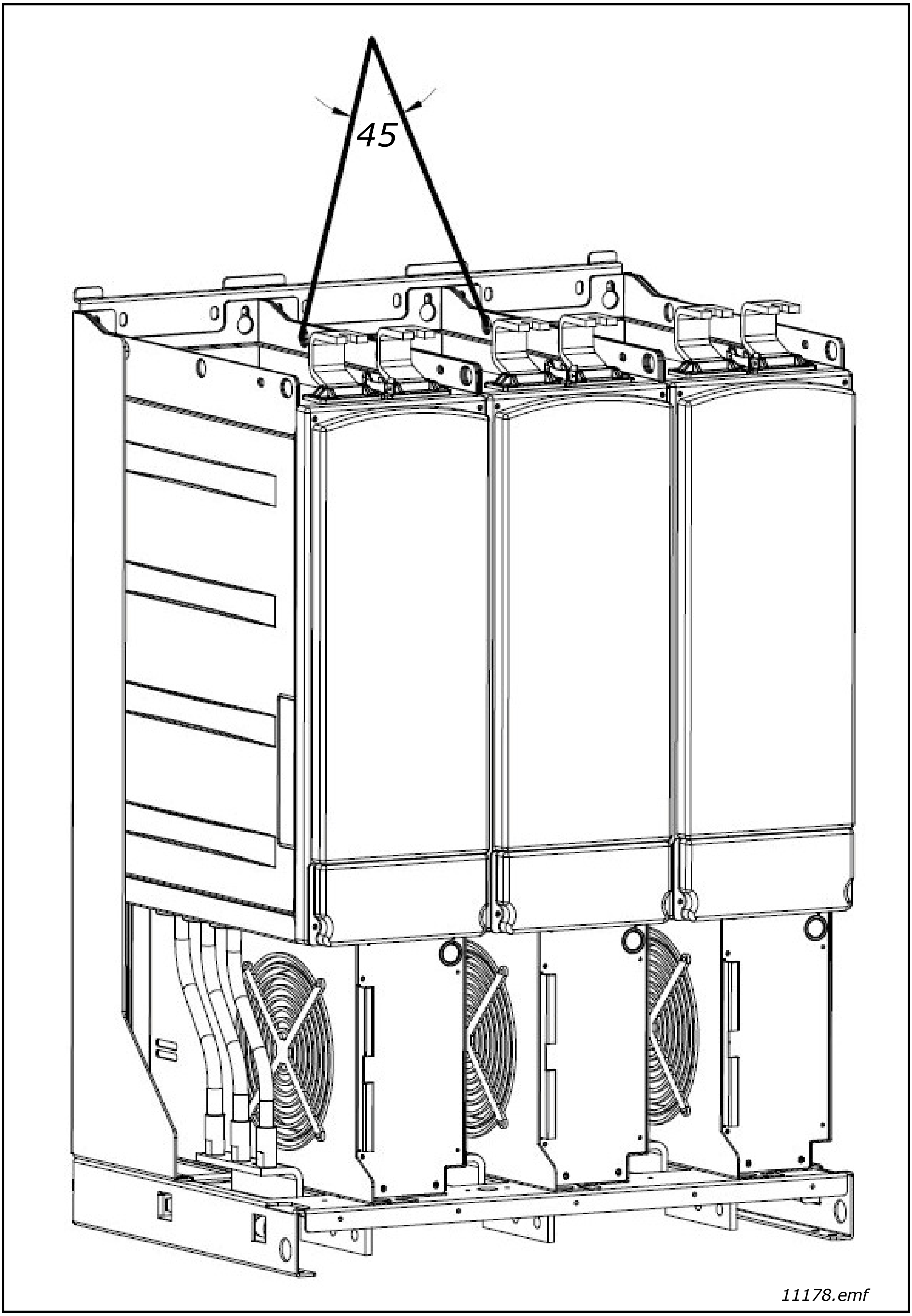


Figure 3. Lifting points for FI13 modules

3.7 Lifting the LCL filters

The modules can be lifted by the holes on top. Place the lifting hooks symmetrically in two holes in the FI9 and FI10 LCL filters and four holes in the FI13 LCL filter. The maximum allowed lifting angle is 45º. For the FI9 and FI10 LCL filter, see Figure 4 and for the FI13 LCL filter, see Figure 5.

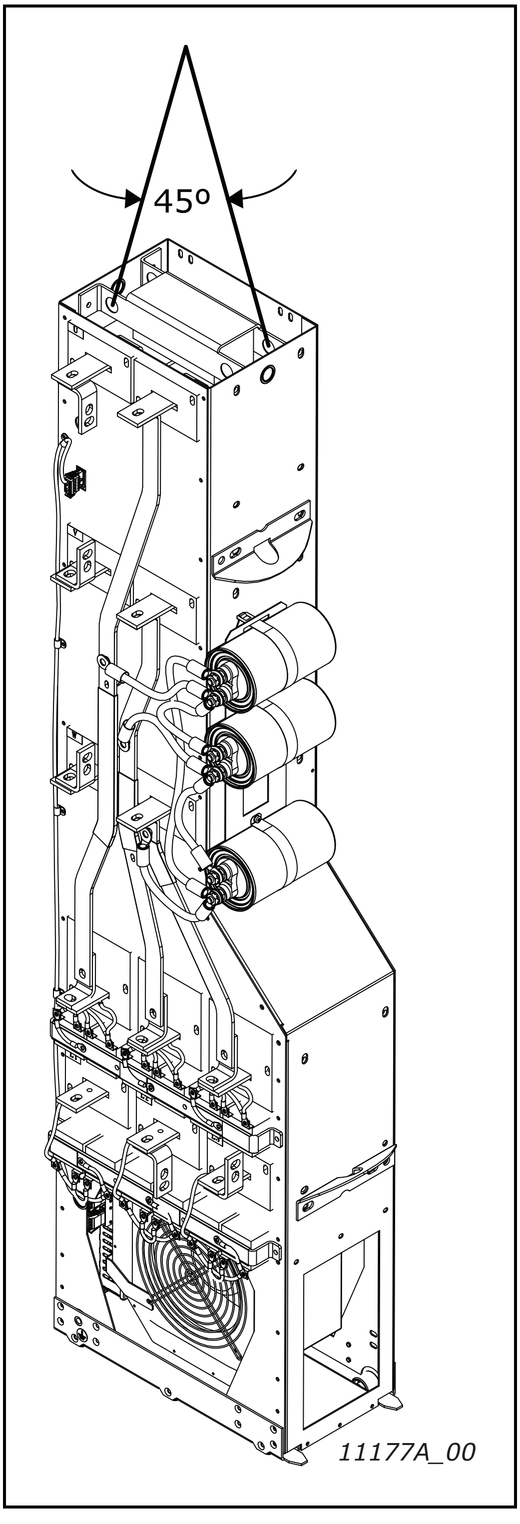


Figure 4. Lifting points for FI9 and FI10 LCL filter

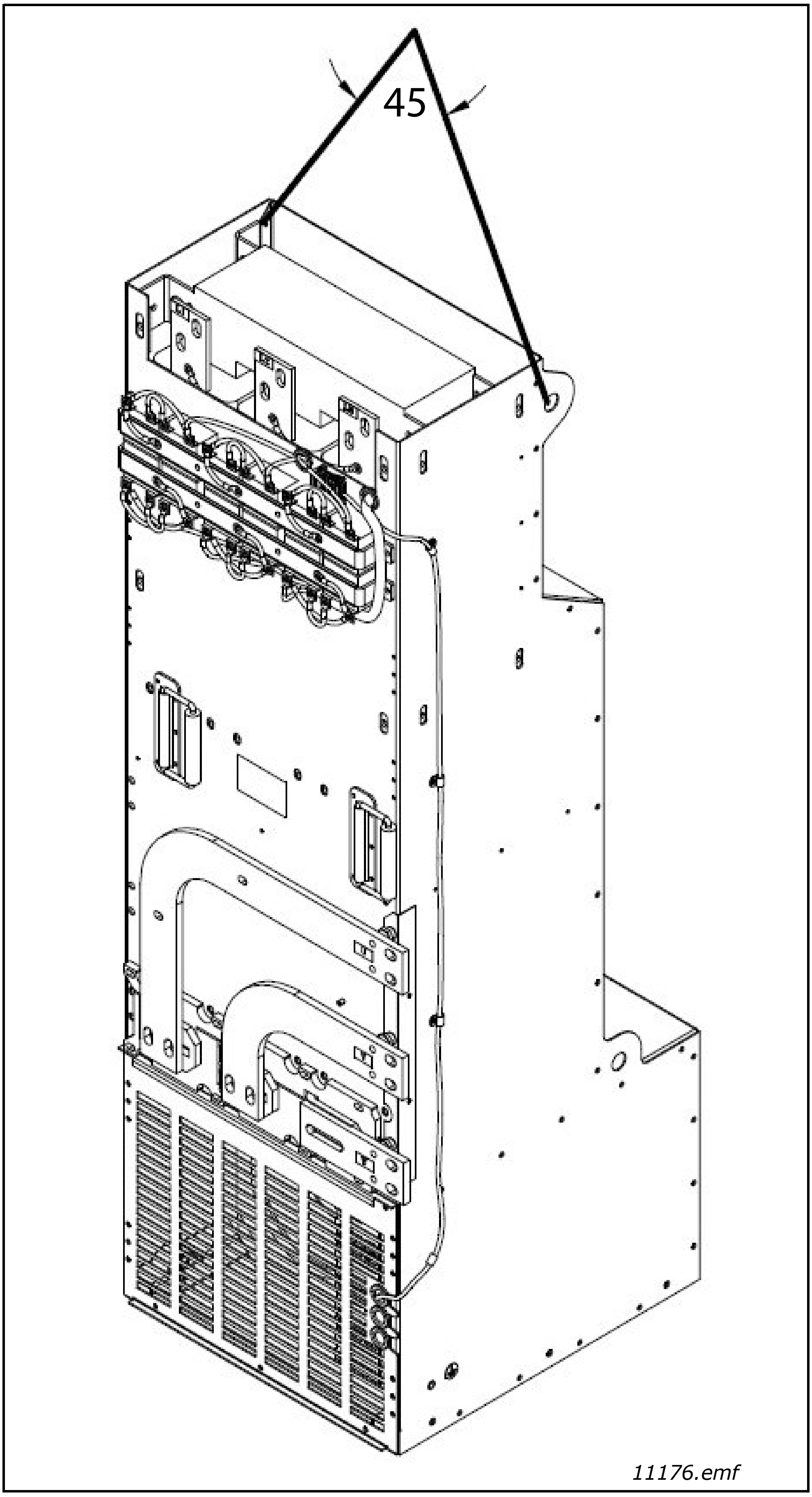
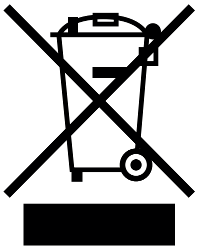


Figure 5. Lifting points for FI13 LCL filter

3.8 Disposal

	When the drive is at the end of its operation life, do not discard it as a part of municipal waste. You can recycle the primary components of the drive. You must disassemble some components before you can remove the different materials. Recycle the electrical and electronic components as waste. To make sure that the waste is recycled correctly, send the waste to a recycling centre. You can also send the waste back to the manufacturer. Obey the local and other applicable regulations.

4. Active Front End (AFE)

4.1 Introduction

The VACON® NX Active Front End is used to transfer power between the AC input and intermediate DC circuit. The VACON® NX Active Front End has a two-way function. This means that when power is transferred from the AC input to the intermediate DC circuit, the VACON® NX Active Front End rectifies the alternating current and voltage. When power is transferred from the intermediate DC circuit to the AC input, the VACON® NX Active Front End inverts the direct current and voltage.

The difference between VACON® NX Active Front End and other Front Ends is that the unit creates low current distortion (THDI). In a typical VACON® NX Active Front End configuration, the desired number of Inverters, Figure 6, are connected to the intermediate DC circuit.

The Active Front End configuration consists of the unit itself, LCL filter, pre-charging circuit, control unit, AC fuses, main contactor (or circuit-breaker) and DC fuses, Figure 7.

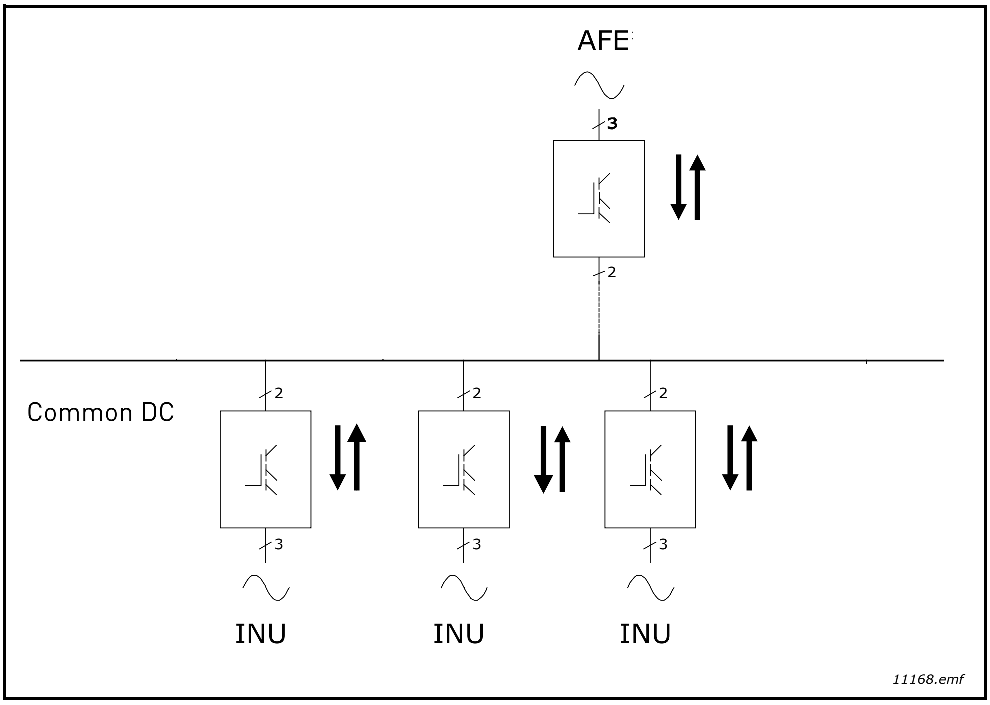


Figure 6. Typical Active Front End configuration

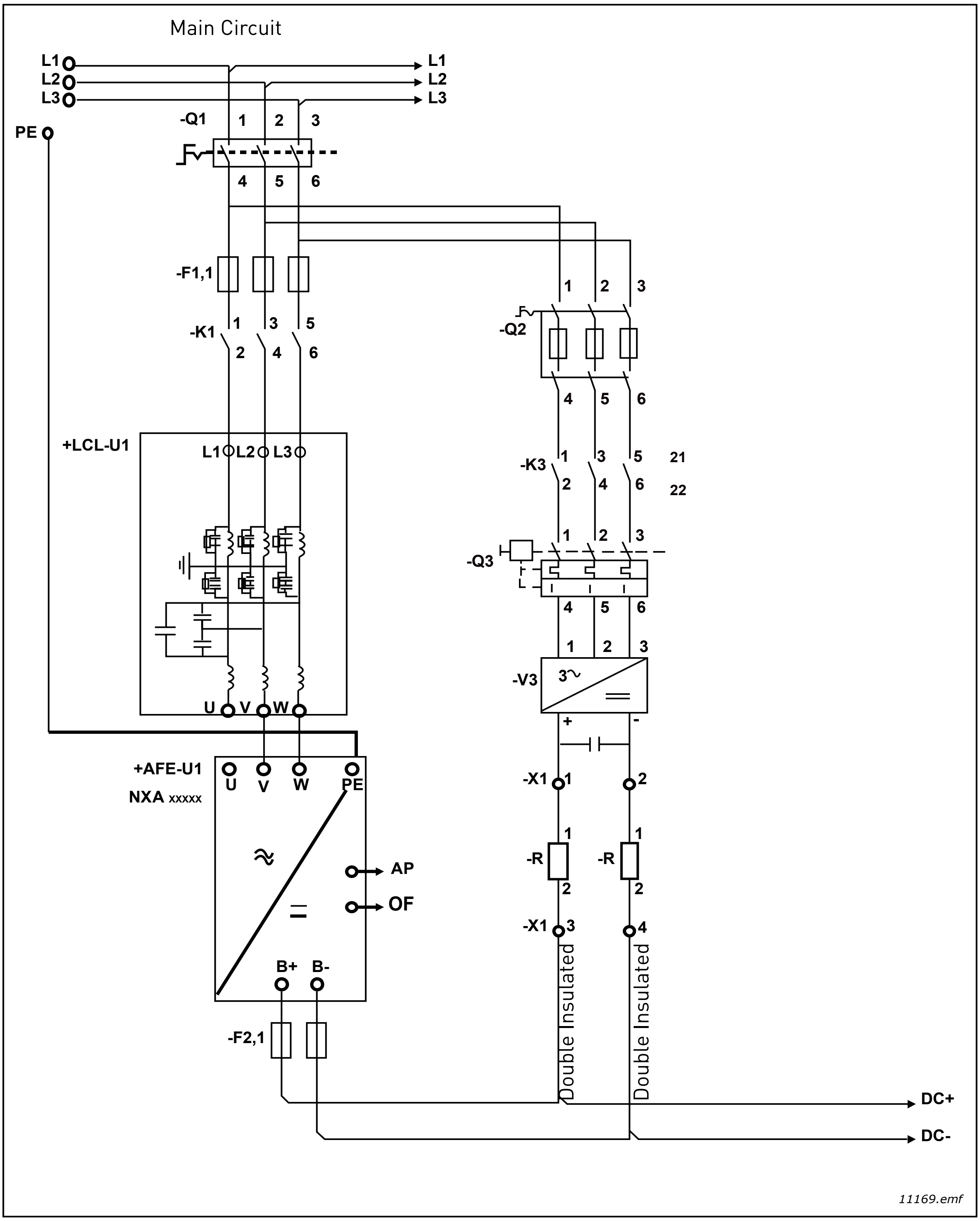


Figure 7. VACON® Active Front End Single Unit connections

4.2 Active Front End Unit block diagram

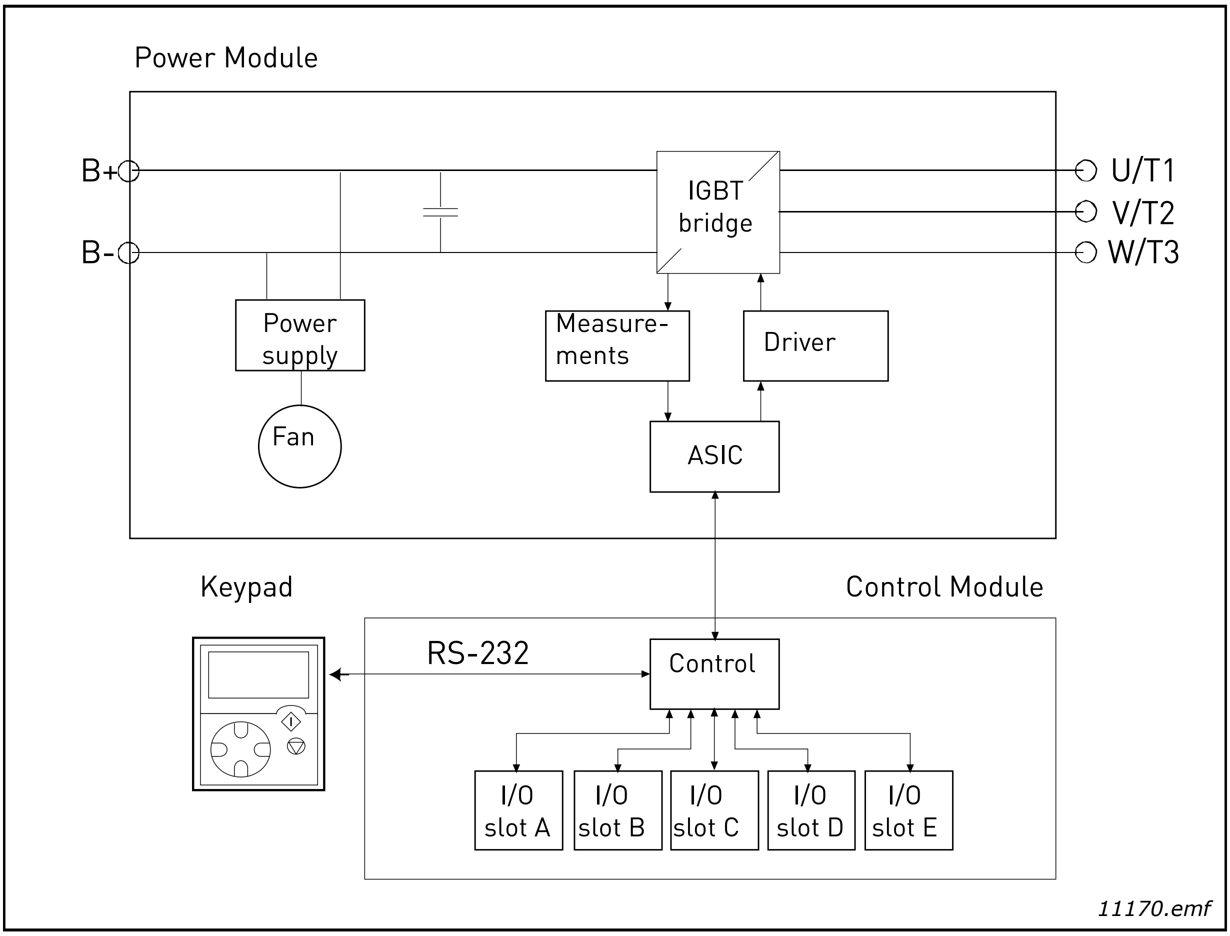


Figure 8. NXA block diagram

4.3 Active Front End enclosure sizes

Figure 9. VACON® NXA, FI9/FI10, Protection class IP00

Figure 10. VACON® NXA, FI13, Protection class IP00

4.4 Active Front End unit technical data

Table 7. Technical specification for VACON® NXA Active Front End unit

AC input connection	Voltage U_{in}	380…500 V AC; 525…690 V AC; UL rating up to 600 V, −10%…+10%
	Frequency f_{in}	45–66 Hz
	Starting delay	FI9–FI13: 5 s
	DC bank capacitance	FI9_5 : 4950 µF; FI9_6 : 3733 µF FI10_5: 9900 µF; FI10_6: 7467 µF FI13_5: 29700 µF; FI13_6: 22400 µF
DC output connection	Voltage	1.35 x U_{in} × 1.1 (default DC-link voltage boosting is 110%).
	Continuous output current	I_H: Ambient temperature +40 °C (104 °F), overloadability 1.5 × I_H (1 min/10 min). • For 40–50 °C (104–122 °F), the ambient temperatures use derating factor I_H × 1.5%/ 1 °C (°F). • For 50–55 °C (122–131 °F), the ambient temperatures use derating factor I_H × 2.5% / 1 °C (°F). I_L: Ambient temperature +40 °C (104 °F), overloadability 1.1 × I_L (1 min/10 min).
Control characteristics	Control system	Open Loop Vector Control
	Switching frequency	NXA_xxxx 5: 3.6 kHz NXA_xxxx 6: 3.6 kHz

Table 7. Technical specification for VACON® NXA Active Front End unit

Ambient conditions	Ambient temperature during operation	I_H/I_L: −10 °C (-14 °F) (no frost)...+40 °C (104 °F) Maximum temperature +55 °C (131 °F), see Power derating as a function of ambient temperature.
	Storage temperature	-40 °C (-104 °F)...+70 °C (158 °F)
	Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water.
	Air quality: - chemical vapors - mechanical particles	Designed according to • IEC 60721-3-3 Edition 2.2, AC drive in operation, class 3C3 • IEC 60721-3-3 Edition 2.2, AC drive in operation, class 3S2
	Elevation of place of operation	100% loadability (no derating) up to 1000 m. Maximum elevation 2000 m (525–690 V AC) and 4000 m (380–500 V AC), Relay I/O: max. 240 V: 3000 m; max. 120 V: 4000 m, see Power derating as a function of installation altitude. See Chapter 4.17.
	Vibration IEC/EN 61800-5-1/ EN 60068-2-6	5...150 Hz. FI9: • Vibration amplitude 1 mm (peak) in frequency range 5...15.8 Hz. • Max. acceleration 1 G in frequency range 15.8...150 Hz. FI10-13: • Vibration amplitude 0.25 mm (peak) in frequency range 5...31Hz. • Max. acceleration 1 G in frequency range 31...150 Hz.
	Impacts EN 50178, EN 60068-2-27	UPS drop test (with applicable UPS weights) Storage and transport: max. 15 G, 11 ms (packed).
	Enclosure class	IP00/Open type standard size in the kW/HP range.
EMC (using factory settings)	Immunity	IEC/EN 61800-3:2004+A1:2012, second environment
Noise level	Average noise level (cooling fan) in dB(A)	FI9: 76 FI10: 76 FI13: 81
Safety standards		IEC/EN 61800-5-1, UL 508C, CSA C22.2 No.274 T-level, see chapter 2.2.3.
Approvals		CE, cULus, RCM, KC, EAC, UA. (See the nameplate of the drive for more approvals.) Marine approvals: LR, BV, DNV, GL, ABS, RMRS, CCS,KR.

Table 7. Technical specification for VACON® NXA Active Front End unit

Control connections	Analogue input voltage	0...+10 V, R_i = 200 kΩ. Resolution 0.1% (12-bit), 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
	Reference voltage, output	+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	Two programmable changeover relay outputs Switching capacity (resistive): 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: 461 V DC
	Earth fault protection	In case of 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.
	Overcurrent protection	Yes
	Unit over-temperature protection	Yes
	Short-circuit protection of +24 V and +10 V reference voltages	Yes

4.5 LCL filter technical data

Table 8. Technical specifications for VACON® LCL filter for Active Front End units

AC connections	Voltage U_{in}	Same as the unit
	Frequency f_{in}	50 or 60 Hz +2%
	Continuous output current	Same as the unit
	Switching frequency	LCLxxxx 5: 3.6 kHz LCLxxxx 6: 3.6 kHz
Cooling fan With integrated DC/DC-power supply	Input voltage U_{in}	333...911 V DC; 460...1200 V DC
	Power consumption	220 W
	Losses	20...30 W
	Short-circuit protection	DC fuses on the input side
Cooling fan with external DC-power supply	Input voltage U_{in}	48 V DC; -10...+10%
	Current	5 A
	Short-circuit protection	AC fuses on the input side of the external power supply.
EMC (using factory settings)	Immunity	Same as the unit
Safety		Same as the unit
Ambient conditions	Ambient temperature during operation	Same as the unit
	Storage temperature	Same as the unit
	Relative humidity	Same as the unit
	Air quality: - Chemical fumes - Solid particles	Same as the unit
	Elevation of place of operation	Same as the unit
	Vibration EN 50178/EN 60068-2-6	Same as the unit
	Impacts EN 50178, EN 60068-2-27	Same as the unit
	Dissipation power	Approximately 1%
Protection	Cooling fan rotation monitoring	Yes (with integrated DC/DC power supply)
	Over-temperature monitoring	Yes

4.6 Application

The VACON® NX Active Front End needs special application software, which is delivered with the NX AFE unit. More information on the application can be found in VACON® NX AFE Application Manual.

4.7 Connection between control unit and power unit

The communication connections between the Active Front End power unit and the control unit is established using optical cable, Figure 11. The standard cable length of the optical cable is 1.5 m. For optional the optical cables can get different lengths. The maximum length of the optical cable is 10 m. The adapter board is located back side of the control unit, see Figure 12. ASIC board terminals located in the unit under the black cover, Figure 13. To open black cover two screws at left and right side should be opened.

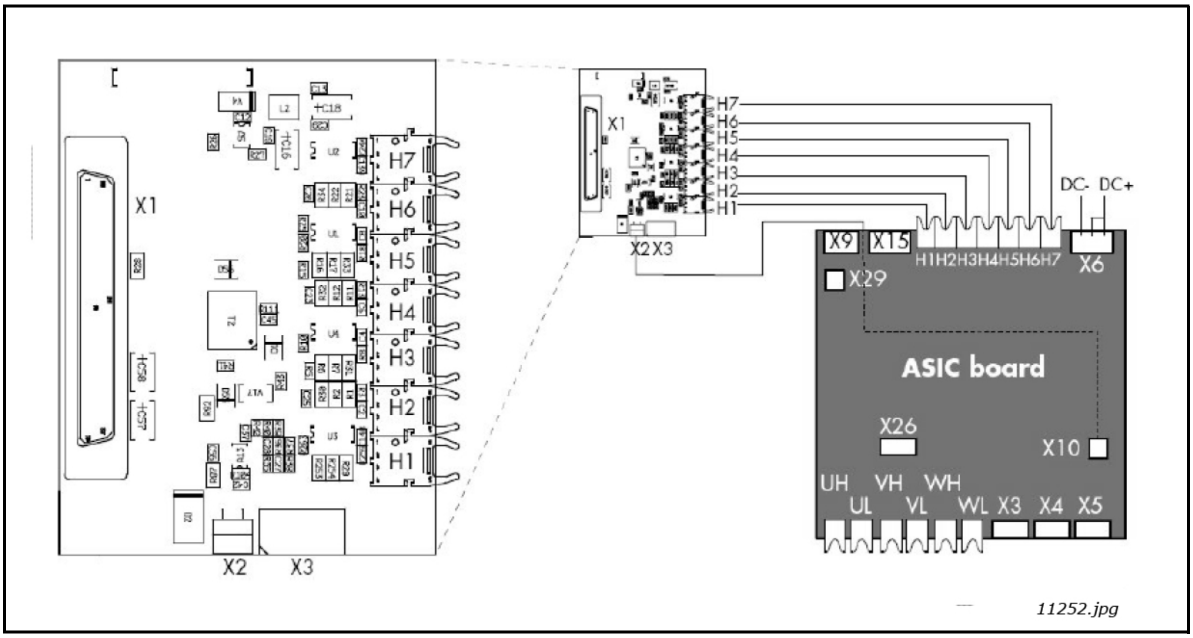


Figure 11. Optical cable adapter board

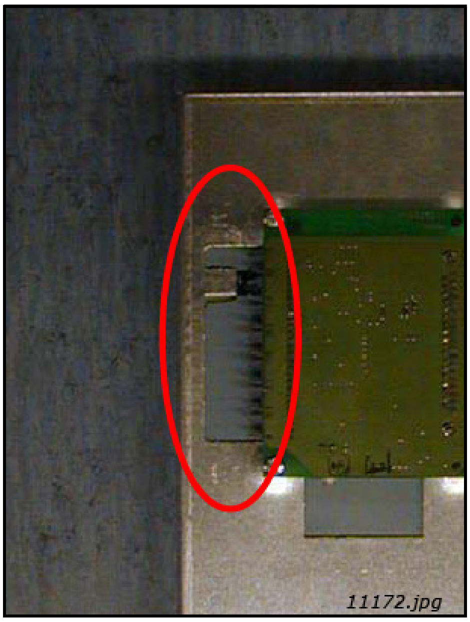


Figure 12. Optical cable adapter board

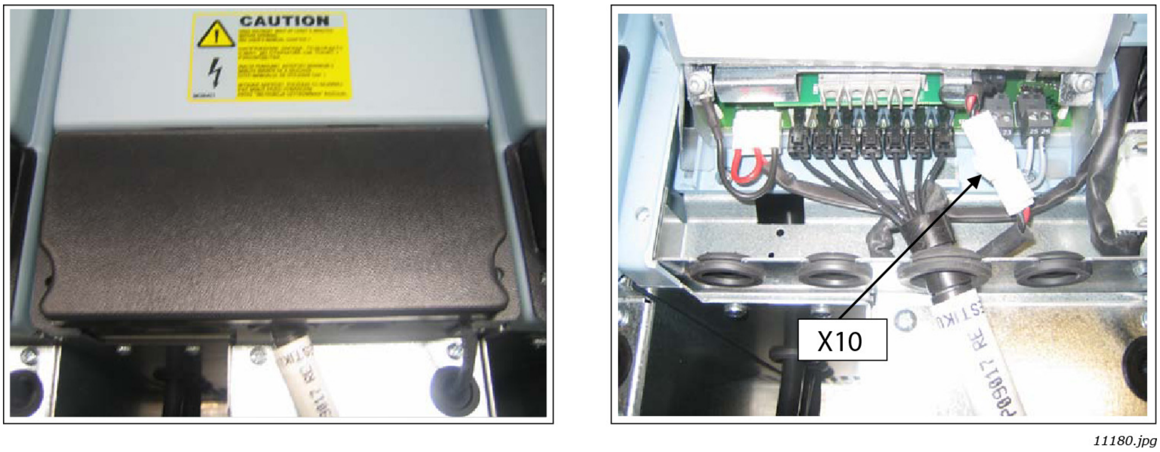


Figure 13. Optical cable terminals in the unit (FI13 example)

Optical terminals on adapter board	
H1	Gate control enable
H2	Phase U control
H3	Phase V control
H4	Phase W control
H5	ADC synchronization
H6	VaconBus data from control board to ASIC
H7	VaconBus data from ASIC to control board

Other terminals on adapter board	
X1	Control board connection
X2	Supply voltage 24 V_{in} (from power unit ASIC)
X3	Supply voltage 24 V_{in} (customer); • Max. current 1A • Terminal #1: + • Terminal #2: –

NOTE! The minimum fibre cable bending radius is 50 mm.

NOTE! Terminals X2 and X3 can be in use simultaneously. However, if the +24 V supply from the control I/O terminals (e.g. from board OPT-A1) is used, this terminal must be protected with a diode.

4.8 Guidelines for the use of high frequency capacitors in grid converter applications

NOTE! Please note that the instructions given here are guidelines. It is the responsibility of the system designer to ensure that common-mode currents and subsequent EMI are sufficiently mitigated, in line with all applicable regulations.

It is assumed that the reader of the section is competent and aware of the relevant cabinet design of the installation including, but not limited to, the grounding system plan, insulation monitoring equipment at hand, the EMC plan and installation of third-party AC drives, and aware of concepts of EMC and common-mode currents. If in doubt, please contact your Danfoss Drives representative or the relevant system designer.

4.8.1 Common-mode currents

Switching power supplies and variable speed motor drives produce large noise current which are conducted out to the load as well as conducted back to the power source. These are called common-mode noise currents, which cause low frequency conducted emissions and high frequency radiated emissions. Power line filters in combination with proper load side filtering, grounding, and/or shielding will usually solve most common-mode emission problems. High Frequency Capacitors (HF) capacitors can be installed to handle these common mode currents.

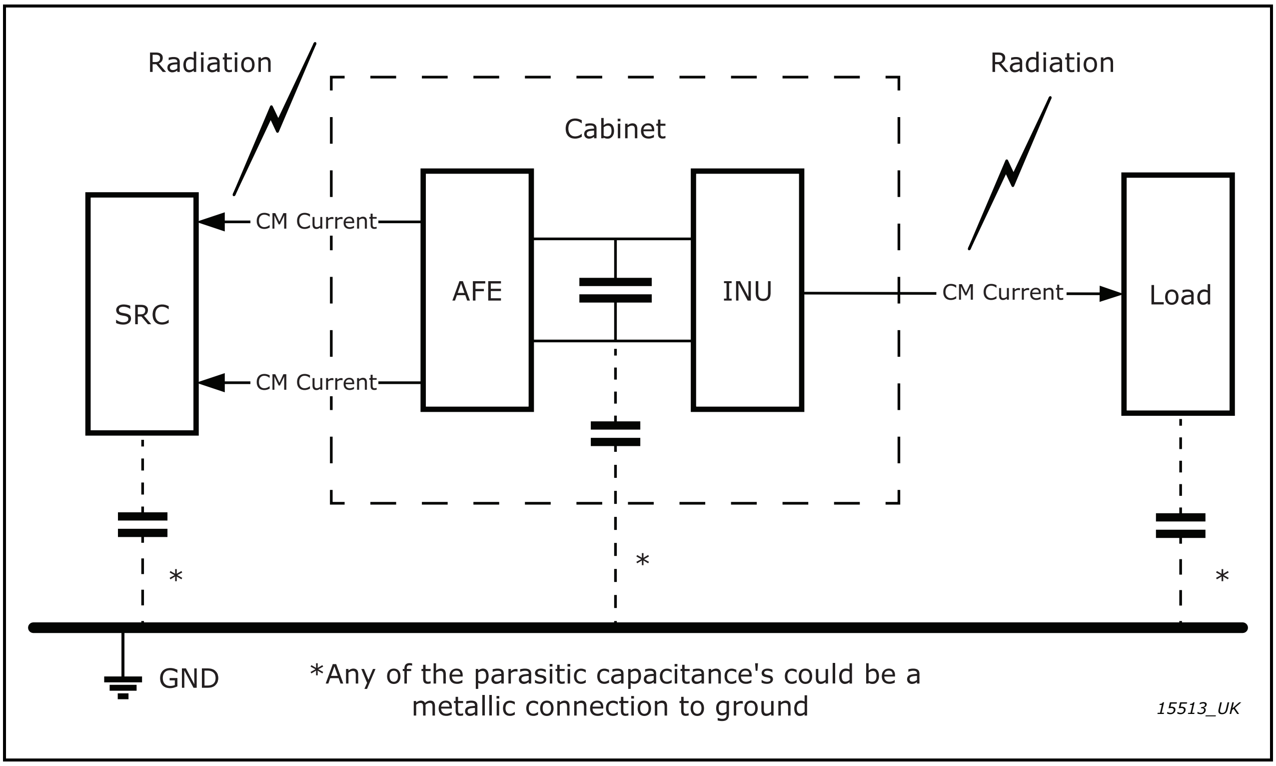


Figure 14. Common-mode current principle

4.8.2 HF capacitor installation recommendations

Table 9. HF capacitor installation recommendations

Network	Recommended to have HF capacitors installed	Recommended NOT to have HF capacitors
TN-C, TN-C-S	Yes	If the transformer is dedicated to this drive only.
IT - Land	Yes, and evaluate: • Ground fault currents. • Total capacitance. • Insulation resistance. monitoring. • Installation of other AFE.	If the transformer is dedicated to this drive only.
IT - Marine	Yes, and evaluate: • Ground fault currents. • Total capacitance. • Insulation resistance monitoring. • Installation of other AFE.	If the transformer is dedicated to this drive only.
DC grid	Yes, on DC link. Remember: • "System approach" is required.	No (Stray capacitance of cable can act as HC capacitors)
Grid converter + battery	Yes, on DC link. Evaluate: • Cable length to transformer. • Requirement from battery supplier.	If battery can handle common-mode voltage

4.8.3 Determining the impedance value of the HF capacitors

A fundamental design rule in deciding the impedance values is that $C_{HF} >> C_{stray}$.

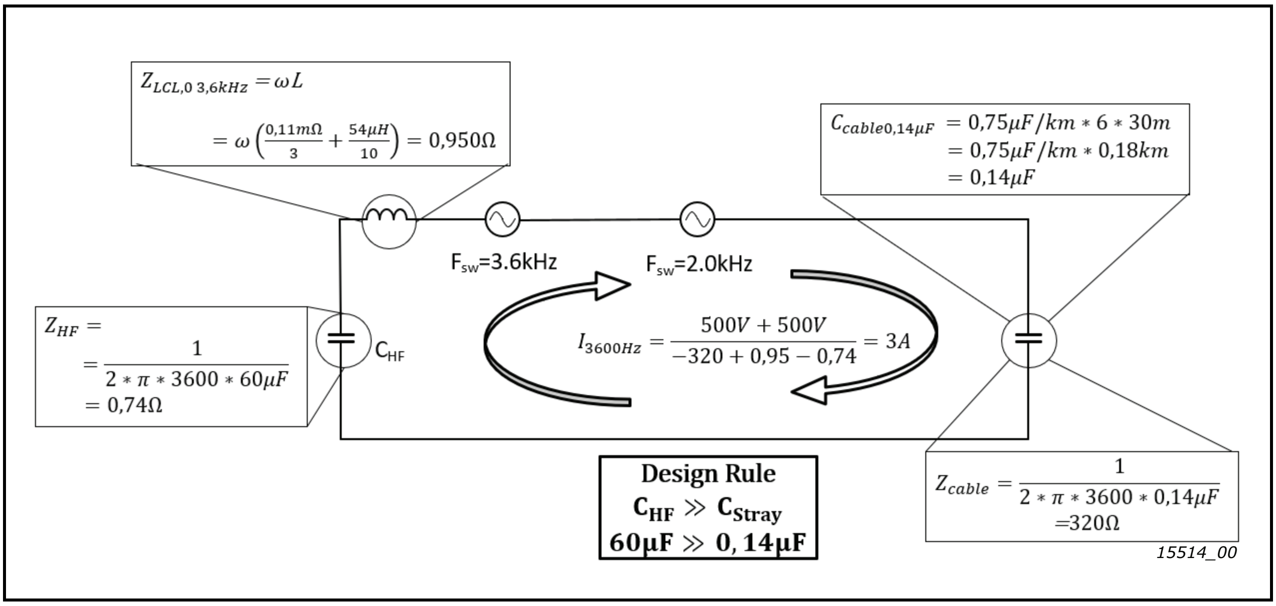


Figure 15. Sample calculation for 1 kA rated at 690 V and switching at 3.6 kHz on grid side

4.8.4 Installation location of the HF capacitors

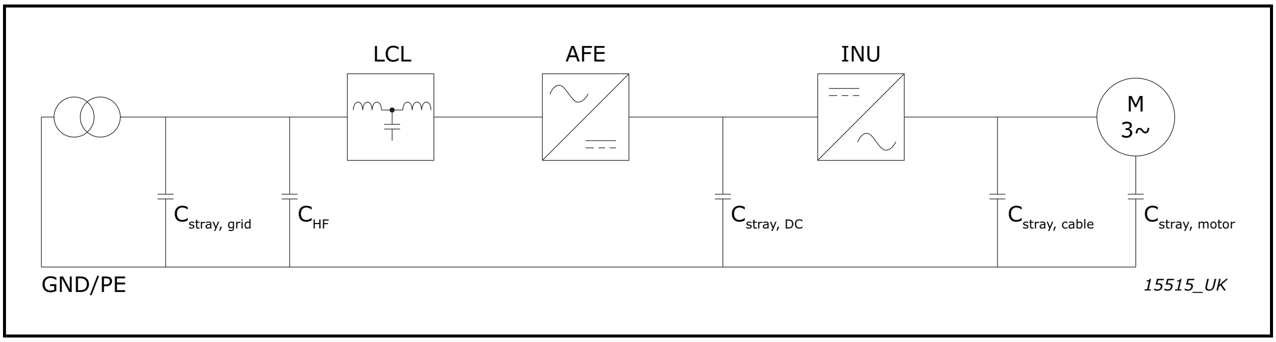


Figure 16. TN-C, TN-C-S, and IT land based networks

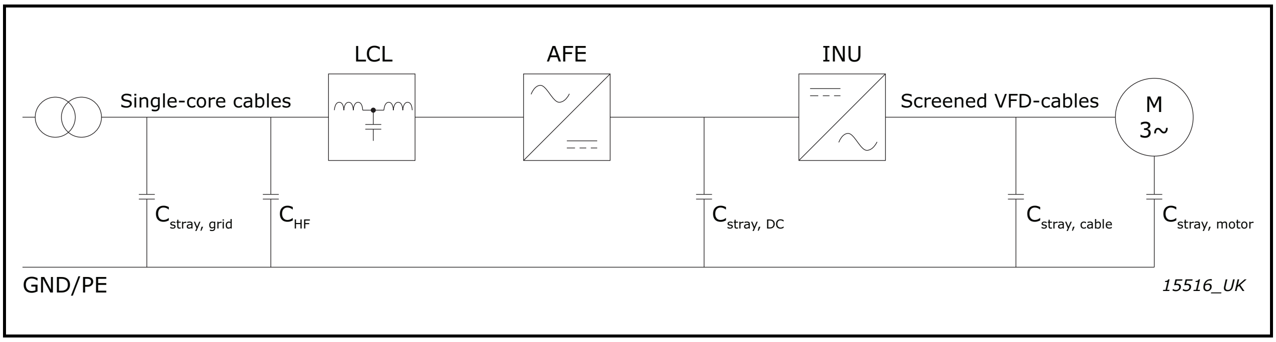


Figure 17. IT marine based networks

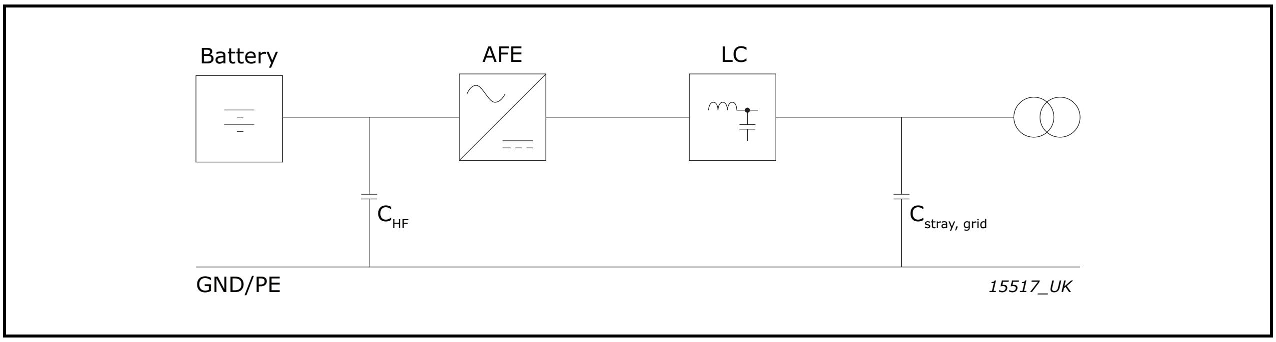


Figure 18. Batteries on DC

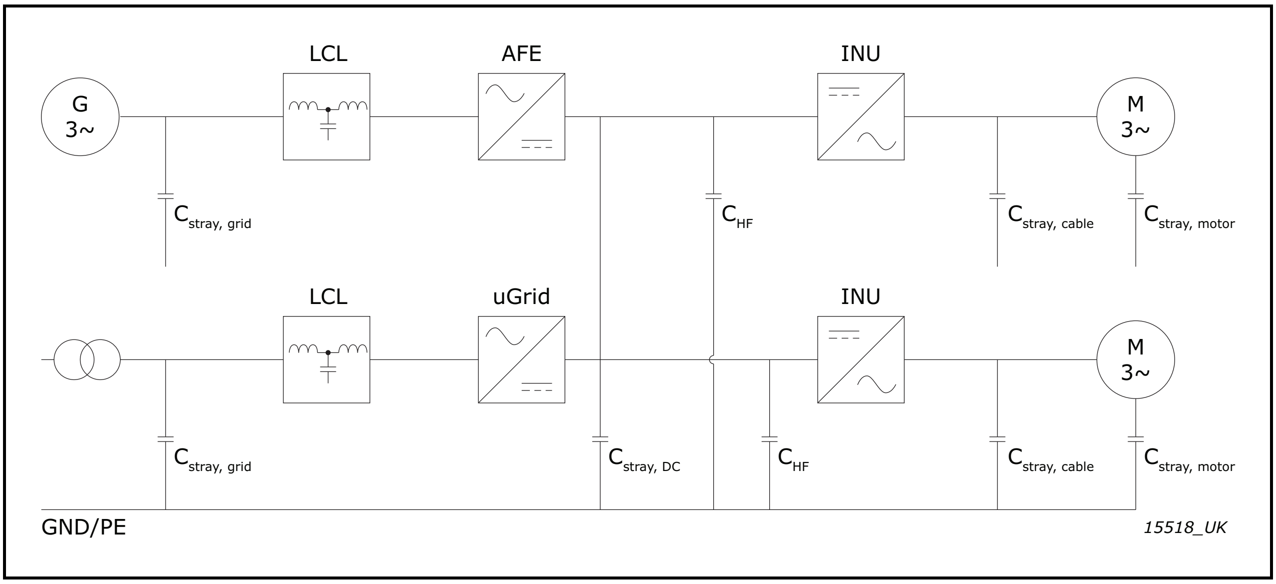


Figure 19. DC grid on common-DC link

4.8.5 LCL filter wiring and modifications

The LCL filter contains a choke (L1) on the mains side, and capacitors (C1–3) and a choke (L2) on the AFE side (see Figure 20). The LCL filter also includes HF capacitors (C1.1–2, C2.1–2, C3.1–2, C4.1–2, C5.1–2 and C6.1–2) connected against ground potential. There are discharging resistors (R1–6) connected across the capacitors for discharging the capacitors when the LCL filter is disconnected from the input power. The discharging resistors are 10 MΩ, 500 V and 0.5 W.

Depending on the grid type and if energy storage or other manufacturer's AFE units are used on the same transformer, the LCL may require modifications.

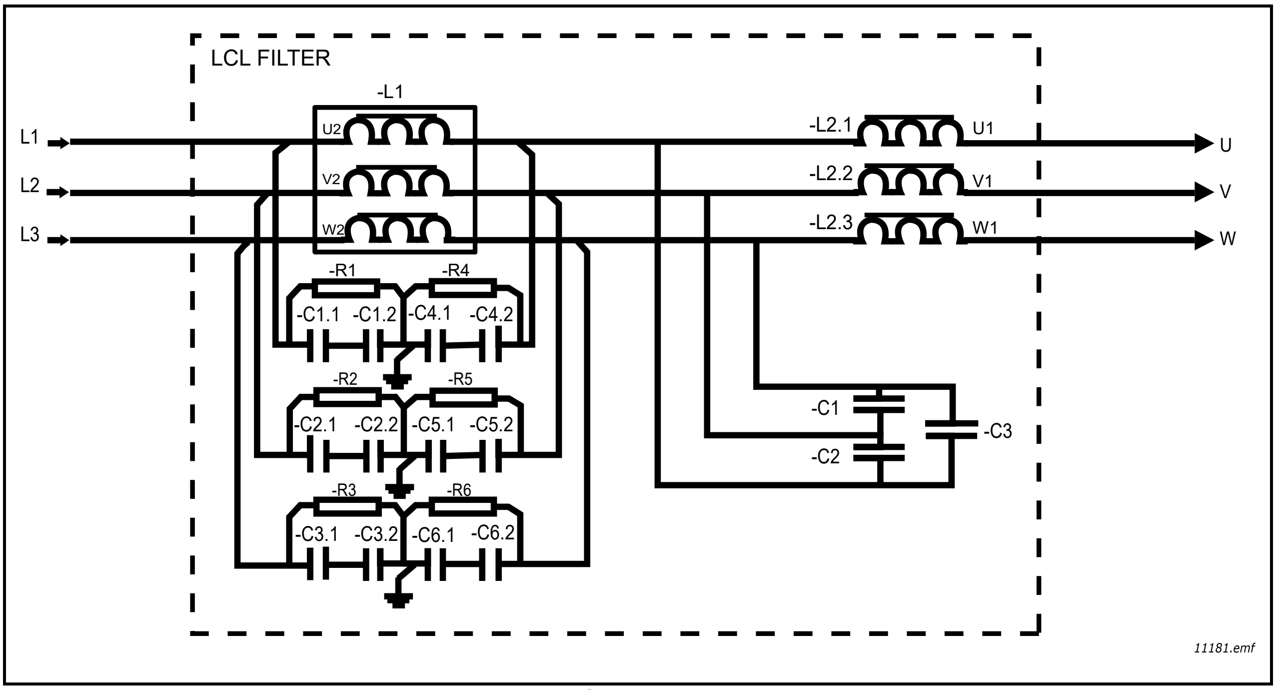


Figure 20. VACON® LCL filter wiring diagram

4.8.5.1 Relocating the discharging resistors

If the LCL filter is used in a network fitted with an earth fault protection relay, the discharging resistors of the LCL filter should be relocated. If the discharging resistors are not relocated, the earth fault monitoring device might indicate a very low leakage resistance. Figure 21 shows the default wiring of the LCL filter. The wiring diagram of the discharging circuit after the relocation of the resistors can be seen in Figure 22. The new discharging resistors, shown in Figure 22, should be 100 kΩ, 500 V and 2 W.

The resistors must be connected so that the capacitors are discharged when disconnecting from the input power. Failure to ensure the discharging of capacitors results in a risk of electric shock! Without the discharge resistors, the capacitors take a very long time to discharge. Figure 24 (for FI9 and FI10) and Figure 25 (for FI13) show the leads that have to be removed from each capacitor if the discharging resistors are not to be used.

WARNING! If you do not allow a total discharge of the system before starting the modification, it is likely that you will get an electric shock in spite of the fact the system is disconnected from the power supply.

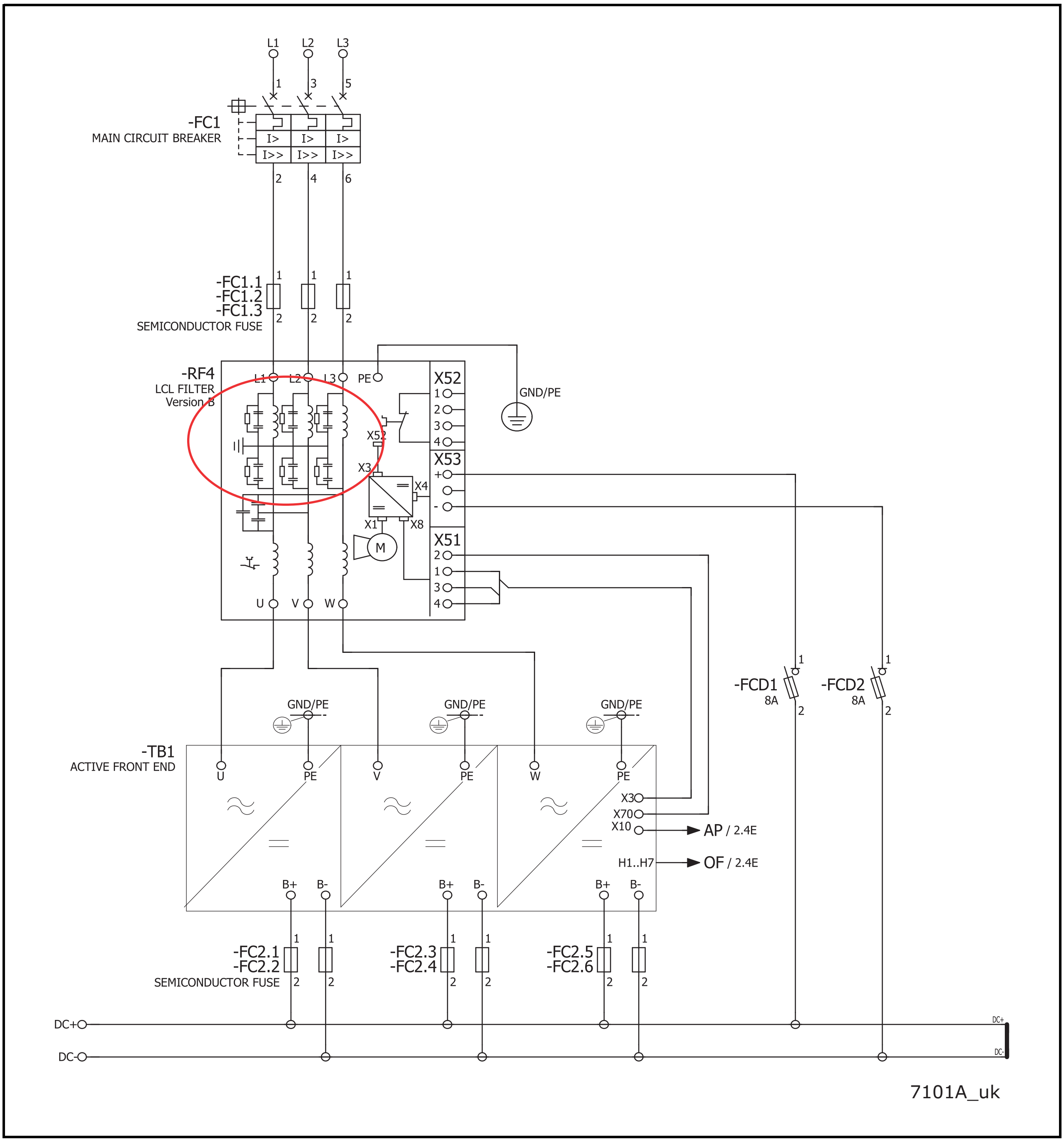


Figure 21. Default wiring diagram of the FI13 AFE and the location of the LCL filter (-RF4)

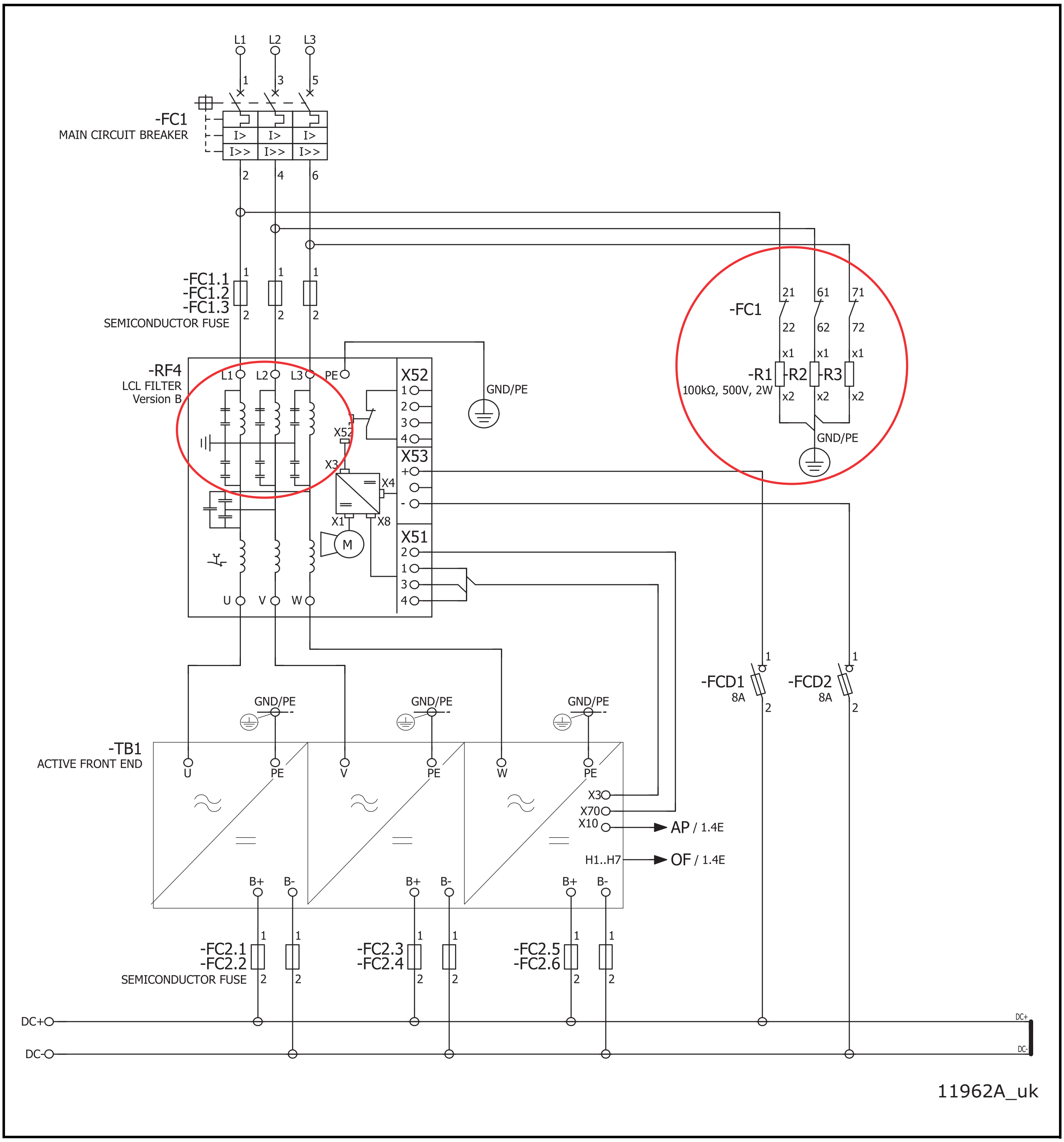


Figure 22. Wiring diagram of LCL and AFE circuit when used in installations which have earth fault protection relay or when used in IT network

4.8.5.2 Disconnecting the HF capacitors

When a unit supplies PWM to its output, it results in leakage current to ground. The HF capacitors give this current a fixed path back to the DC link. Therefore, there must always be HF capacitors in a system where PWM is present, either in the LCL filter or from the DC link to ground.

In case there is an energy storage connected to the DC link, it is recommended to always have a dedicated transformer and move the HF capacitors from the LCL filter to the DC link (DC+ to PE and DC- to PE).

Figure 24 (for FI9 and FI10) and Figure 25 (for FI13) show the leads that have to be removed from each capacitor if the HF capacitors are not to be used. Removing the leads disconnects the capacitors from ground potential.

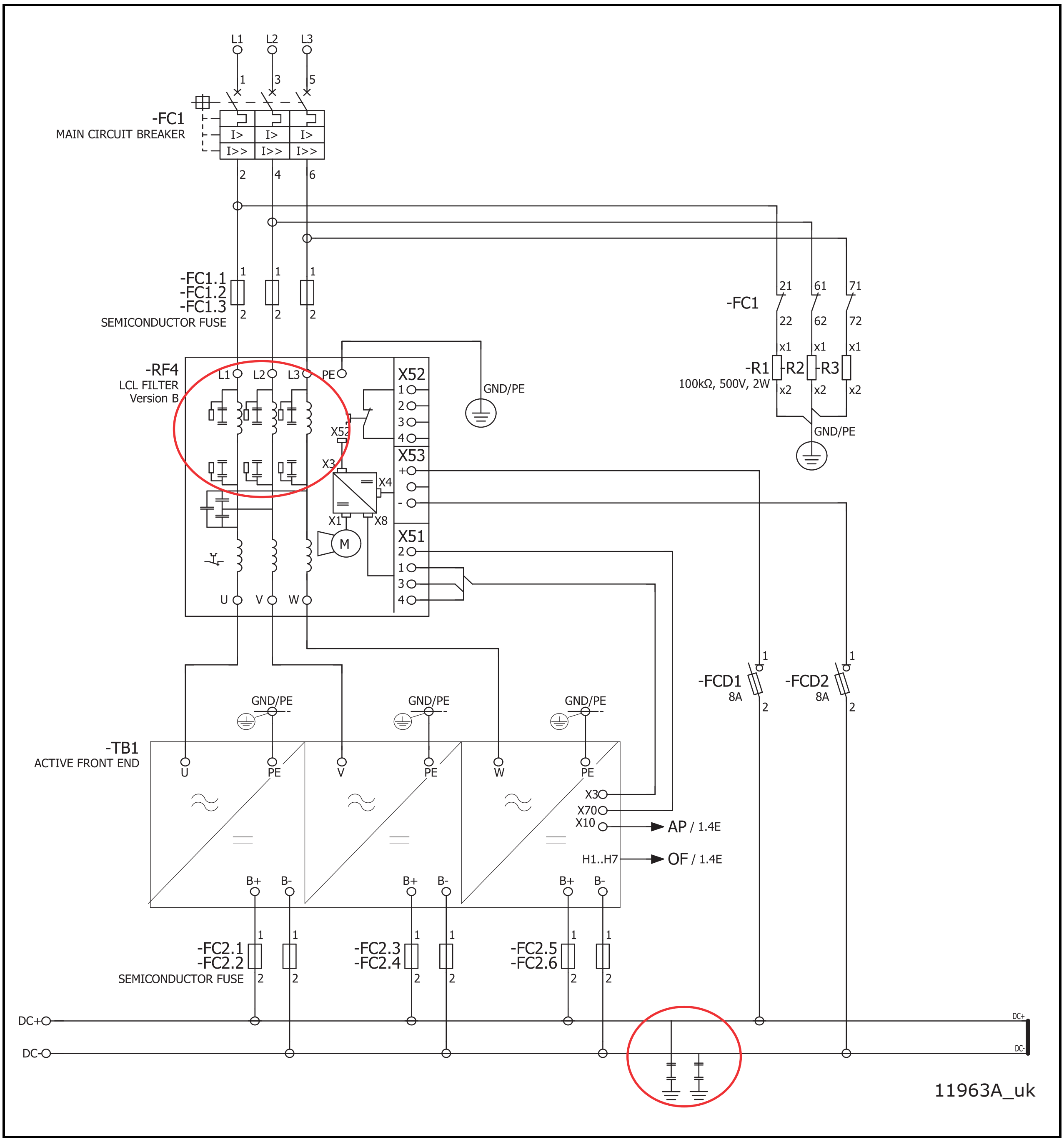


Figure 23. Wiring diagram of LCL and AFE circuit when AFE of other manufacturer is connected to same transformer secondary supply

4.8.5.3 LCL filter modification - FI9 and FI10

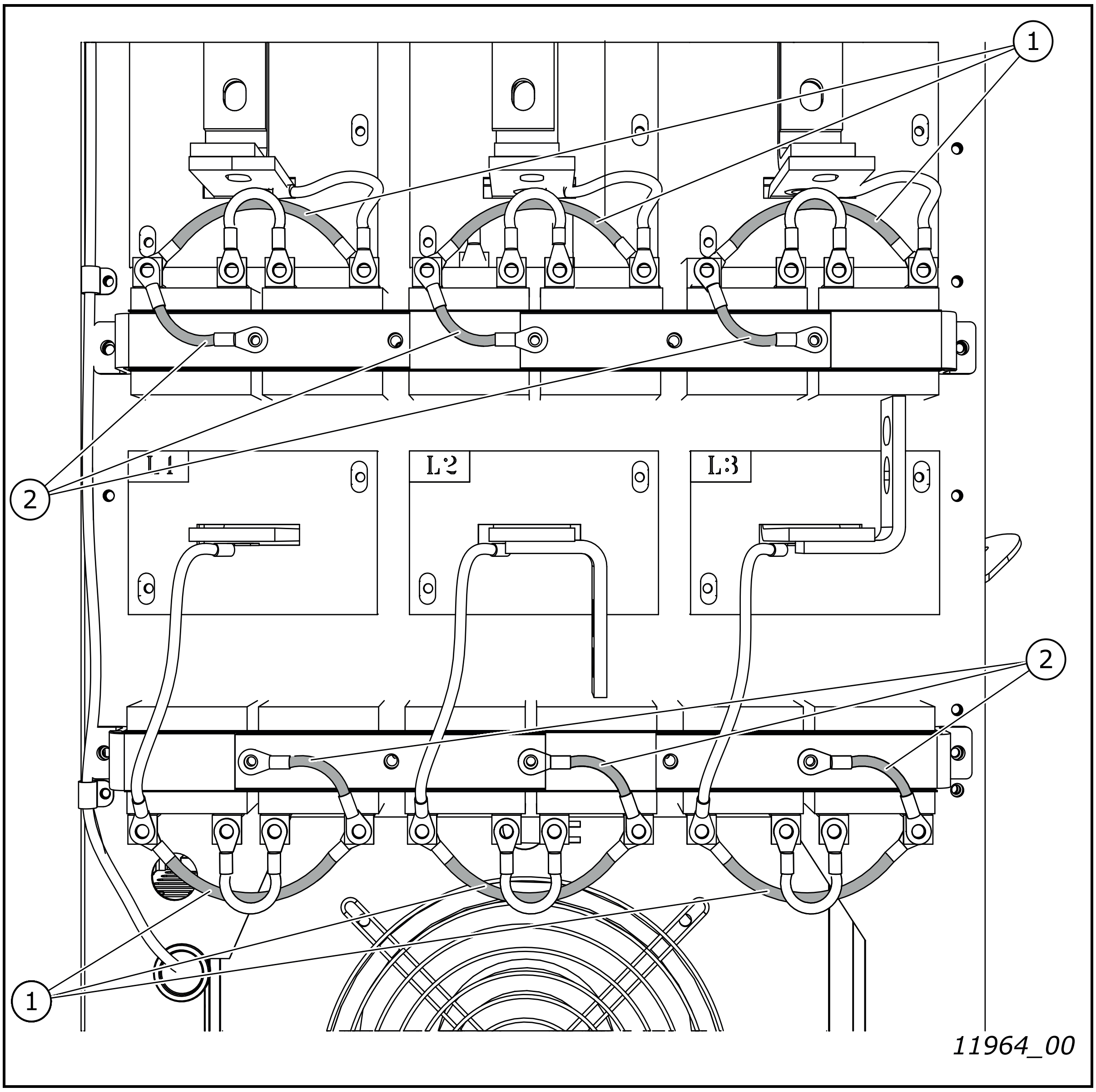


Figure 24. HF capacitor and discharging resistor leads in FI9 and FI10 LCL filter

1. Leads that must be removed if the discharging resistors are not used.
2. Leads that must be removed if the HF capacitors are not used.

4.8.5.4 LCL filter modification - FI13

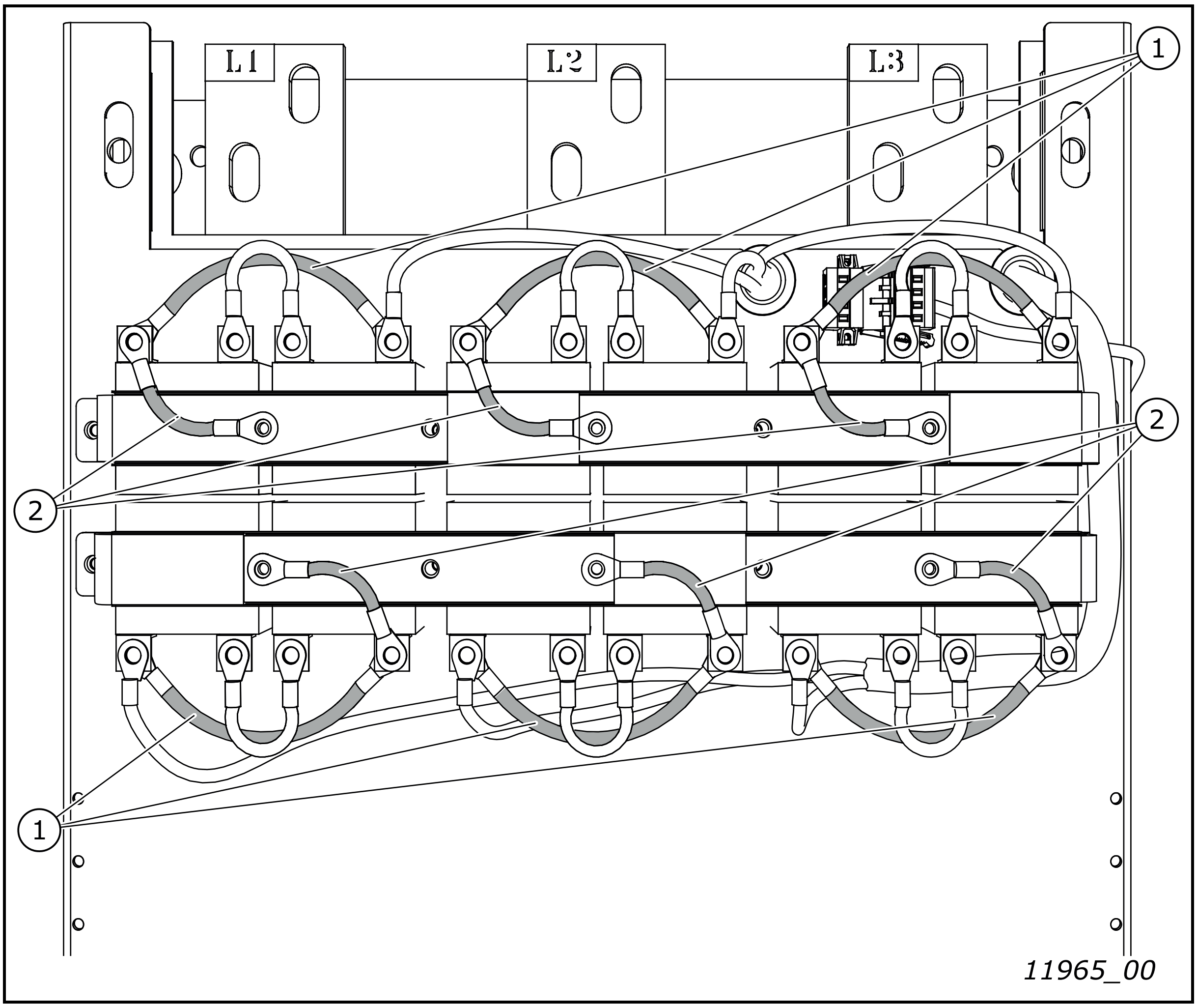


Figure 25. HF capacitor and discharging resistor leads in FI13 LCL filter

1. Leads that must be removed if the discharging resistors are not used.
2. Leads that must be removed if the HF capacitors are not used.

4.9 Active Front End power ratings

4.9.1 VACON® NXA; AC voltage 380–500 V

Table 10. Power ratings of VACON® NXA, supply voltage 380–500 V AC

Type	Unit		Low overload (AC current)		High overload (AC current)		DC Power (continuous)	
	Code	Enclosure size	$I_{L\text{-}cont}$ [A]	I_{1min} [A]	$I_{H\text{-}cont}$ [A]	I_{1min} [A]	400 V mains P [kW]	500 V mains P [kW]
AFE	NXA_0168 5	FI9	170	187	140	210	114	143
	NXA_0205 5	FI9	205	226	170	255	138	172
	NXA_0261 5	FI9	261	287	205	308	175	220
	NXA_0385 5	FI10	385	424	300	450	259	323
	NXA_0460 5	FI10	460	506	385	578	309	387
	NXA_1150 5	FI13	1150	1265	1030	1545	773	966
	NXA_1300 5	FI13	1300	1430	1150	1725	874	1092

For dimensions of NXA units, see Table 12 and LCL filters Table 13.

NOTE! The rated currents in a given ambient (+40°C) temperature are achieved only when the switching frequency is equal to the factory default.

NOTE! The motor output power: $P_{out}=P_{dc} \times (\eta_{INU} \times \eta_{Motor})$.

P_{dc} = DC power of AFE

η_{INU} = efficiency of the inverter

η_{Motor} = efficiency of the motor

4.9.2 VACON® NXA; AC voltage 525–690 V

Table 11. Power ratings of VACON® NXA, supply voltage 525–690 V AC (UL 525-600V)

Type	Unit		Low overload (AC current)		High overload (AC current)		DC Power (continuous)
	Code	Enclosure size	$I_{L\text{-}cont}$ [A]	I_{1min} [A]	$I_{H\text{-}cont}$ [A]	I_{1min} [A]	690 V mains P [kW]
AFE	NXA_0125 6	FI9	125	138	100	150	145
	NXA_0144 6	FI9	144	158	125	188	167
	NXA_0170 6	FI9	170	187	144	216	197
	NXA_0261 6	FI10	261	287	208	312	303
	NXA_0325 6	FI10	325	358	261	392	377
	NXA_0920 6	FI13	920	1012	820	1230	1067
	NXA_1030 6	FI13	1030	1133	920	1380	1194

For dimensions of NXA units, see Table 12 and LCL filters Table 13.

NOTE! The rated currents in a given ambient (+40 °C) temperature are achieved only when the switching frequency is equal to the factory default.

NOTE! The motor output power: $P_{out}=P_{dc} x (\eta_{INU} x \eta_{Motor})$.

P_{dc} = DC power of AFE

η_{INU} = efficiency of the inverter

η_{Motor} = efficiency of the motor

4.10 Active Front End unit – Dimensions

Table 12. The NXA unit dimensions

Module		Module Dimension			
Type	**Enclosure size**	**Height [mm]**	**Width [mm]**	**Depth [mm]**	**Weight [kg]**
AFE	FI9	1030	239	372	67
	FI10	1032	239	552	100
	FI13	1032	708	553	306

NOTE! More detailed dimensions can be found in Chapter 8.2.

4.11 LCL filter – Dimensions

Table 13. LCL filter dimensions

Module		Module Dimension			
Type	**Enclosure size**	**Height [mm]**	**Width [mm]**	**Depth [mm]**	**Weight [kg]**
LCL	FI9	1775	291	515	241/245
	FI10	1775	291	515	263/304
	FI13	1442	494	525	477/473

NOTE! Weight is different for 500 V/690 V other dimensions are same for both voltage classes.

NOTE! More detailed dimensions can be found in Chapter 8.2.

4.12 Active Front End unit – Fuse selection

4.12.1 Introduction

AC fuses are used to protect the input network in case the Active Front End unit or the LCL filter is faulty. DC fuses are used to protect the Active Front End unit and the LCL filter in case there is a short circuit in the DC buses. If DC fuses are not used, short-circuit in the DC buses will cause a loading of the Active Front End unit. The manufacturer will not assume any responsibility for damages caused by insufficient protection.

To ensure fuse performance, make sure that the available supply short circuit current is sufficient. See the minimum required short circuit current ($I_{cp,mr}$) in the fuse tables.

4.12.2 Fuses, mains voltage 380–500 V

4.12.2.1 AC fuses

Table 14. Mersen AC fuse selection, mains voltage 380–500 V AC (UL 380–480 V)

Module			Min. short circuit current $I_{cp,mr}$ [A]	AC fuses				
Type	Code	Enclosure size		Mersen type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0168 5	FI9	2250	PC32UD69V400TF	690	400	32	3
	NXA_0205 5	FI9	2250	PC32UD69V400TF	690	400	32	3
	NXA_0261 5	FI9	2250	PC32UD69V400TF	690	400	32	3
	NXA_0385 5	FI10	4400	PC33UD69V700TF	690	700	33	3
	NXA_0460 5	FI10	4400	PC33UD69V700TF	690	700	33	3
	NXA_1150 5	FI13	12500	PC44UD75V18CTQ	750	1800	44	3
	NXA_1300 5	FI13	12500	PC44UD75V18CTQ	750	1800	44	3

*** NOTE!** All fuses are flush-end type. If some other type is needed, contact your distributor.

Table 15. Bussman AC fuse selection, mains voltage 380–500 V AC (UL 380–480 V)

Module			Min. short circuit current $I_{cp,mr}$ [A]	AC fuses				
Type	Code	Enclosure size		Bussman type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0168 5	FI9	4200	170M8602	1000	400	3BKN/75	3
	NXA_0205 5	FI9	4200	170M8602	1000	400	3BKN/75	3
	NXA_0261 5	FI9	4400	170M8604	1000	500	3BKN/75	3
	NXA_0385 5	FI10	6000	170M8607	1000	700	3BKN/75	3
	NXA_0460 5	FI10	7000	170M8608	1000	800	3BKN/75	3
	NXA_1150 5	FI13	10500	170M7082	690	2000	4BKN/65	3
	NXA_1300 5	FI13	10500	170M7082	690	2000	4BKN/65	3

*** NOTE!** Fuses for FI9 and FI10 are blade type and for FI13 flush-end type. If some other type is needed, contact your distributor.

4.12.2.2 DC fuses

Table 16. Mersen DC fuse selection, mains voltage 465–800 V DC

Module			DC fuses				
Type	Code	Enclosure size	Mersen type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0168 5	FI9	PC73UD13C400TF	1250	400	73	2
	NXA_0205 5	FI9	PC73UD13C400TF	1250	400	73	2
	NXA_0261 5	FI9	PC73UD13C500TF	1250	500	73	2
	NXA_0385 5	FI10	PC73UD13C800TF	1250	800	73	2
	NXA_0460 5	FI10	PC73UD95V11CTF	950	1100	73	2
	NXA_1150 5	FI13	PC84UD11C22CTQ	1100	2200	84	2
	NXA_1300 5	FI13	PC84UD11C24CTQ	1100	2400	84	2

* **NOTE!** All fuses are flush-end type. If some other type is needed, contact your distributor.

Table 17. Bussman DC fuse selection, mains voltage 465–800 V DC

Module			DC fuses				
Type	Code	Enclosure size	Bussman type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0168 5	FI9	170M6458	690	500	3BKN/50	2
	NXA_0205 5	FI9	170M6458	690	500	3BKN/50	2
	NXA_0261 5	FI9	170M6462	690	800	3BKN/50	2
	NXA_0385 5	FI10	170M6466	690	1250	3BKN/50	2
	NXA_0460 5	FI10	170M6466	690	1250	3BKN/50	2
	NXA_1150 5	FI13	170M7084	690	3000	4BKN/65	2
	NXA_1300 5	FI13	170M7084	690	3000	4BKN/65	2

* **NOTE!** All fuses are flush-end type. If some other type is needed, contact your distributor.

Table 18. Bussman DC fuse selection, mains voltage 465–800 V DC, North-America

Module			DC fuses				
Type	Code	Enclosure size	Bussman type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0168 5	FI9	170M1777	800	400	FU/70	2
	NXA_0205 5	FI9	170M1777	800	400	FU/70	2
	NXA_0261 5	FI9	170M1781	800	630	FU/70	2
	NXA_0385 5	FI10	170M6499	1200	1100	3BKN/90	2
	NXA_0460 5	FI10	170M6499	1200	1100	3BKN/90	2
	NXA_1150 5	FI13	170M6499	1200	1100	3BKN/90	3x2
	NXA_1300 5	FI13	170M6499	1200	1100	3BKN/90	3x2

*** NOTE!** Fuses for FI9 is fuse links type and for FI10 and FI13 are flush-end type. If some other type is needed, contact your distributor.

4.12.3 Fuses, mains voltage 525–690 V

4.12.3.1 AC fuses

Table 19. Mersen AC fuse selection, mains voltage 525–690 V AC (UL 525–600 V)

Module			Min. short circuit current $I_{cp,mr}$ [A]	AC fuses				
Type	Code	Enclosure size		Mersen type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0125 6	FI9	1750	PC71UD13C250TF	1250	250	71	3
	NXA_0144 6	FI9	1750	PC71UD13C250TF	1250	250	71	3
	NXA_0170 6	FI9	1750	PC71UD13C250TF	1250	250	71	3
	NXA_0261 6	FI10	3400	PC73UD13C450TF	1250	450	73	3
	NXA_0325 6	FI10	3400	PC73UD13C450TF	1250	450	73	3
	NXA_0920 6	FI13	10000	PC44UD75V16CTQ	750	1600	44	3
	NXA_1030 6	FI13	10000	PC44UD75V16CTQ	750	1600	44	3

*** NOTE!** All fuses are flush-end type. If some other type is needed, contact your distributor.

Table 20. Bussman AC fuse selection, mains voltage 525–690 V AC (UL 525–600 V)

Module			Min. short circuit current $I_{cp,mr}$ [A]	AC fuses				
Type	Code	Enclosure size		Bussman type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0125 6	FI9	3400	170M4954	1000	315	1BKN/75	3
	NXA_0144 6	FI9	3400	170M4954	1000	315	1BKN/75	3
	NXA_0170 6	FI9	3400	170M4954	1000	315	1BKN/75	3
	NXA_0261 6	FI10	4400	170M8604	1000	500	3BKN/75	3
	NXA_0325 6	FI10	6000	170M8607	1000	700	3BKN/75	3
	NXA_0920 6	FI13	9500	170M7081	690	1600	4BKN/65	3
	NXA_1030 6	FI13	9500	170M7081	690	1600	4BKN/65	3

*** NOTE!** All fuses are flush-end type. If some other type is needed, contact your distributor.

4.12.3.2 DC fuses

Table 21. Mersen DC fuse selection, mains voltage 640–1100 V DC

Module			DC fuses				
Type	Code	Enclosure size	Mersen type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0125 6	FI9	PC71UD13C315TF	1250	315	71	2
	NXA_0144 6	FI9	PC71UD13C315TF	1250	315	71	2
	NXA_0170 6	FI9	PC71UD13C400TF	1250	400	71	2
	NXA_0261 6	FI10	PC73UD13C500TF	1250	500	73	2
	NXA_0325 6	FI10	PC73UD13C630TF	1250	630	73	2
	NXA_0920 6	FI13	PC84UD12C18CTQ	1150	1800	84	2
	NXA_1030 6	FI13	PC84UD11C20CTQ	1100	2000	84	2

* **NOTE!** All fuses are flush-end type. If some other type is needed, contact your distributor.

Table 22. Bussman DC fuse selection, mains voltage 640–1100 V DC

Module			DC fuses				
Type	Code	Enclosure size	Bussman type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0125 6	FI9	170M4956	1250	400	1BKN/75	2
	NXA_0144 6	FI9	170M4956	1250	400	1BKN/75	2
	NXA_0170 6	FI9	170M4956	1250	400	1BKN/75	2
	NXA_0261 6	FI10	170M8607	1250	700	3BKN/75	2
	NXA_0325 6	FI10	170M8607	1250	700	3BKN/75	2
	NXA_0920 6	FI13	170M7640	1000	2500	4BKN/95	2
	NXA_1030 6	FI13	170M7658	1000	2700	4BKN/95	2

* **NOTE!** All fuses are flush-end type. If some other type is needed, contact your distributor.

Table 23. Bussman DC fuse selection, mains voltage 640–1100 V DC, North-America

Module			DC fuses				
Type	**Code**	**Enclosure size**	**Bussman type [aR]***	**U_N [V]**	**I_N [A]**	**Size**	**Q'ty**
AFE	NXA_0125 6	FI9	170M1831	1000	400	FU/90	2
	NXA_0144 6	FI9	170M1831	1000	400	FU/90	2
	NXA_0170 6	FI9	170M1831	1000	400	FU/90	2
	NXA_0261 6	FI10	170M6496	1200	800	3BKN/90	2
	NXA_0325 6	FI10	170M6496	1200	800	3BKN/90	2
	NXA_0920 6	FI13	170M6496	1200	800	3BKN/90	3x2
	NXA_1030 6	FI13	170M6498	1200	1000	3BKN/90	3x2

* **NOTE!** Fuses for FI9 is fuse links type and for FI10 and FI13 are flush-end type. If some other type is needed, contact your distributor.

4.13 Active Front End unit – Circuit breaker selection

The Active Front End can also be protected by a circuit-breaker. The recommended types of circuit-breakers are shown in the following tables. If a circuit-breaker from another manufacturer is used, it must be equivalent to the listed circuit-breakers. Further information on the listed circuit-breakers is available from the manufacturer. Circuit-breakers do not provide the same level of protection as fuses, therefore, fuses are always recommended to be used. A circuit-breaker can be used without a main contactor. In this case, the Active Front End unit controls the circuit-breaker instead of the contactor.

Table 24. Circuit breaker for VACON® NXA 380-500 V

Type	XT5H 400 Ekip Dip LS/I In=400 3p F F		Circuit breaker manufacturer part codes
FI9	XT5H 400 Ekip Dip LS/I In=400 3p F F	MCCB	1SDA100490R1
	YU-C XT5-XT6 F/P 220...240Vac-220...250Vdc	Undervoltage rel. (cabled)	1SDA104958R1
	AUX-C 3Q+1SY 250Vac/dc XT2...XT6 F/P	Aux./trip cont. (cabled)	1SDA066434R1
	AUX-SA-C 1S51 250Vac/dc XT2-XT4...XT6F/P	S51 NC	1SDA066429R1
	MOE XT5 220...250V AC/DC	Motor operator	1SDA104885R1
	KIT ES XT5 3pcs	Extended spread front terminals and phase separators	1SDA104738R1
	KIT ES XT5 3pcs	Extended spread front terminals and phase separators	1SDA104738R1
Type	**XT5H 630 Ekip Dip LS/I In=630 3p F F**		**Circuit breaker manufacturer part codes**
FI10	XT5H 630 Ekip Dip LS/I In=630 3p F F	MCCB	1SDA100491R1
	YU-C XT5-XT6 F/P 220...240Vac-220...250Vdc	Undervoltage rel. (cabled)	1SDA104958R1
	AUX-C 3Q+1SY 250Vac/dc XT2...XT6 F/P	Aux./trip cont. (cabled)	1SDA066434R1
	AUX-SA-C 1S51 250Vac/dc XT2-XT4...XT6F/P	S51 NC	1SDA066429R1
	MOE XT5 220...250V AC/DC	Motor operator	1SDA104885R1
	KIT ES XT5 3pcs	Extended spread front terminals and phase separators	1SDA104738R1
	KIT ES XT5 3pcs	Extended spread front terminals and phase separators	1SDA104738R1
Type	**E1.2N 1600 Ekip Dip LI 3p F F**		**Circuit breaker manufacturer part codes**
FI13	E1.2N 1600A Ekip Dip LI 3p F-F	MCCB	1SDA070881R1
	M E1.2 220-250V AC/DC	Spring charging motor	1SDA073711R1
	YR 250Vac/dc E1.2	Reset coil	1SDA073746R1
	RTC 250V E1.2	Ready to close auxiliary contact	1SDA073770R1
	YO E1.2 220-240Vac/dc	Opening coil	1SDA073674R1
	YC E1.2 220-240V AC/DC	Closing coil	1SDA073687R1
	YU E1.2 220-240V AC/DC	Undervoltage coil	1SDA073700R1
	PB H=200mm/7.87" 4pcs E1.2 3P	Phase separators	1SDA073879R1

Table 25. Circuit breaker for VACON® NXA 525-690 V

Type	XT5H 400 Ekip Dip LS/I In=320 3p F F		Circuit breaker manufacturer part codes
FI9	XT5H 400 Ekip Dip LS/I In=320 3p F F	MCCB	1SDA100489R1
	YU-C XT5-XT6 F/P 220...240Vac-220...250Vdc	Undervoltage rel. (cabled)	1SDA104958R1
	AUX-C 3Q+1SY 250Vac/dc XT2...XT6 F/P	Aux./trip cont. (cabled)	1SDA066434R1
	AUX-SA-C 1S51 250Vac/dc XT2-XT4...XT6F/P	S51 NC	1SDA066429R1
	MOE XT5 220...250V AC/DC	Motor operator	1SDA104885R1
	KIT ES XT5 3pcs	Extended spread front terminals and phase separators	1SDA104738R1
	KIT ES XT5 3pcs	Extended spread front terminals and phase separators	1SDA104738R1
Type	**XT5H 400 Ekip Dip LS/I In=400 3p F F**		**Circuit breaker manufacturer part codes**
FI10 NXA_0261 6 NXA_0325 6	XT5H 400 Ekip Dip LS/I In=400 3p F F	MCCB	1SDA100490R1
	YU-C XT5-XT6 F/P 220...240Vac-220...250Vdc	Undervoltage rel. (cabled)	1SDA104958R1
	AUX-C 3Q+1SY 250Vac/dc XT2...XT6 F/P	Aux./trip cont. (cabled)	1SDA066434R1
	AUX-SA-C 1S51 250Vac/dc XT2-XT4...XT6F/P	S51 NC	1SDA066429R1
	MOE XT5 220...250V AC/DC	Motor operator	1SDA104885R1
	KIT ES XT5 3pcs	Extended spread front terminals and phase separators	1SDA104738R1
	KIT ES XT5 3pcs	Extended spread front terminals and phase separators	1SDA104738R1

Table 25. Circuit breaker for VACON® NXA 525-690 V

Type	XT5H 630 Ekip Dip LS/I In=630 3p F F		Circuit breaker manufacturer part codes
FI10 NXA_0385 6 NXA_0416 6	XT5H 630 Ekip Dip LS/I In=630 3p F F	MCCB	1SDA100491R1
	YU-C XT5-XT6 F/P 220...240Vac-220...250Vdc	Undervoltage rel. (cabled)	1SDA104958R1
	AUX-C 3Q+1SY 250Vac/dc XT2...XT6 F/P	Aux./trip cont. (cabled)	1SDA066434R1
	AUX-SA-C 1S51 250Vac/dc XT2-XT4...XT6F/P	S51 NC	1SDA066429R1
	MOE XT5 220...250V AC/DC	Motor operator	1SDA104885R1
	KIT ES XT5 3pcs	Extended spread front terminals and phase separators	1SDA104738R1
	KIT ES XT5 3pcs	Extended spread front terminals and phase separators	1SDA104738R1
Type	**E1.2N 1600 Ekip Dip LI 3p F F**		**Circuit breaker manufacturer part codes**
FI13	E1.2N 1600A Ekip Dip LI 3p F-F	MCCB	1SDA070881R1
	M E1.2 220-250V AC/DC	Spring charging motor	1SDA073711R1
	YR 250Vac/dc E1.2	Reset coil	1SDA073746R1
	RTC 250V E1.2	Ready to close auxiliary contact	1SDA073770R1
	YO E1.2 220-240Vac/dc	Opening coil	1SDA073674R1
	YC E1.2 220-240V AC/DC	Closing coil	1SDA073687R1
	YU E1.2 220-240V AC/DC	Undervoltage coil	1SDA073700R1
	PB H=200mm/7.87" 4pcs E1.2 3P	Phase separators	1SDA073879R1

4.14 Main contactor

If a main contactor is to be used, the types shown in Table 26 are recommended. If a contactor from another manufacturer is used, it must be equivalent to the types shown. Further information on the contactors shown is available from the manufacturer.

Table 26. Recommended main contactor types

Type	FI9 Contactor / 500 V	
FI9	A210-30-11-80	Contactor, 350 A/690 V, AC3 110 KW/400 V, 230 VAC-Coil
Type	FI9 Contactor / 690 V	
FI9	A185-30-11-80	Contactor, 275 A/690 V, AC3 132 KW/690V, 230 VAC-Coil
Type	FI10 Contactor / 500 V	
FI10	AF400-30-11-70	Contactor, 600 A/500 V, AC3 200KW/400V, 100-250 V AC/DC coil
Type	FI10 Contactor / 690 V	
FI10	AF300-30-11-70	Contactor, 500 A/690 V, AC3 250 KW/690 V, 100-250 V AC/DC coil
Type	FI13 Contactor / 500 V	
FI13	AF1650-30-11-70	Contactor, 1650 A/500 V, AC3 560 KW/400 V, 100-250 V AC/DC coil
Type	FI13 Contactor / 690 V	
FI13	AF1350-30-11-70	Contactor, 1350 A/690 V, AC3 --- KW/400 V, 100-250 V AC/DC coil

4.15 Pre-charging circuit

The Active Front End unit requires an external pre-charging circuit. The purpose of the pre-charging unit is to charge the voltage in the intermediate circuit to a level sufficient for connecting the Active Front End unit to the mains. The charging time depends on the capacitance of the intermediate circuit and the resistance of the charging resistors. The technical specifications of our standard pre-charging circuits are shown in Table 27. Pre-charging circuits are suitable for 380-500 V AC and 525-690 V AC.

The Active Front End unit must not be connected to mains without pre-charging. In order to ensure the correct operation of the pre-charging circuit, the input circuit-breaker or contactor, as well as the pre-charging circuit contactor, must be controlled by the Active Front End unit. The input circuit-breaker or contactor as well as the pre-charging circuit contactor must be connected as shown in Figure 85 on page 137.

Table 27. Capacitance Min and Max value for Pre-charging circuit

Enclosure size	Resistance	Capacitance	
		Min	Max
FI9	2x47R	4950 μF	30000 μF
FI10	2x20R	9900 μF	70000 μF
FI13	2x11R	29700 μF	128000 μF

If the capacitance of the intermediate circuit in the system exceeds the values shown, contact your nearest distributor.

The example shown in Figure 85 on page 137 uses a spring-return switch. The switch has positions 0-1-START. The spring returns the switch from position START to position 1. To start the pre-charging, the switch is turned from position 0 via 1 to START. When pre-charging starts, the switch can be released and it returns to position 1. No other control measures are required. The Active Front End application controls the main contactor of the system with Relay Output RO2, see Figure 87 on page 139. When pre-charging of the intermediate circuit is ready the main contactor will be closed. The status of the main contactor is monitored via digital input (Default is DIN4). As a default the main contactor monitoring is ON but it can be set OFF with parameter. The main contactor should not be possible close without pre-charging.

To open the main contactor, simply turn the switch to 0. The contactor should not be opened under load. Opening the contactor under load will shorten its service life.

NOTE! Wirings that are used for connecting the pre-charging circuit to the intermediate circuit has to be double-insulated (example: NSGAFÖU 1.8/3kV (IEC), NSHXAFÖ 3kV (IEC Halogen free), MULTI-STANDARD SC 2.2 (UL)).

NOTE! Enough space must be reserved around the resistors to ensure sufficient cooling. Don't place any heat sensitive components near the resistors.

4.16 Paralleling

The power of the input group can be increased by connecting several Active Front End units in parallel. Paralleling refers to Active Front End units connected in the same input transformer. Active Front End units of different power ratings can also be connected in parallel. No communication between the units is required; they work independently. Our standard LCL filters must be used for paralleling. If filters other than our standard LCL filters are used in Active Front End units connected in parallel, too large circulation currents may be generated between the Active Front End units. Parameter P2.1.4 Parallel AFE must be set to "1/yes" for all parallel AFE units. This parameter will also set DC Drooping to 4%. The value of DC Drooping can be also modified manually with parameter P2.2.2.

Each Active Front End unit connected in parallel must have its own short-circuit protection on AC and DC sides. The fuses are selected in accordance with Section 4.12. When paralleling, attention must be paid to the sufficient short-circuit capacity of the system.

The derating of Active Front End units connected in parallel is 5% of the DC power; this should be taken into account when selecting the input unit.

If a device is to be isolated from the AC and DC voltages, and other Active Front End units connected in parallel are also to be used, separate isolators are required in the AC input and DC output. The AC input can be isolated using a compact circuit-breaker, an ordinary circuit-breaker or a fuse switch. Contactors are not suitable for isolating the AC input because they cannot be locked in the safe position. The DC output can be isolated using a fuse switch. The pre-charging circuit must also be isolated from the AC input. A load isolation switch or safety isolation switch can be used for this. The device can also be connected to mains even when the other devices connected in parallel are already connected and running. In such a case, the isolated device must first be pre-charged. When that is done, the AC input can be switched on. After this, the device can be connected to the intermediate DC circuit.

4.16.1 Common pre-charging circuit

In case of paralleled Active Front End units, one common pre-charging circuit can be used, see Figure 26. Standard pre-charging circuits can be used if the capacitance of the intermediate circuit not exceeds maximum value. For example if three FI10 Active Front End units are connected parallel, the pre-charging circuit for FI13 Active Front End unit can be used. If all paralleled Active Front End units have a common circuit breaker, the breaker can be controlled by one of the Active Front End units. If each paralleled Active Front End unit has its own circuit-breaker, each Active Front End controls it's own circuit. The circuit diagram for control, see Figure 85 on page 137 and Figure 87 on page 139.

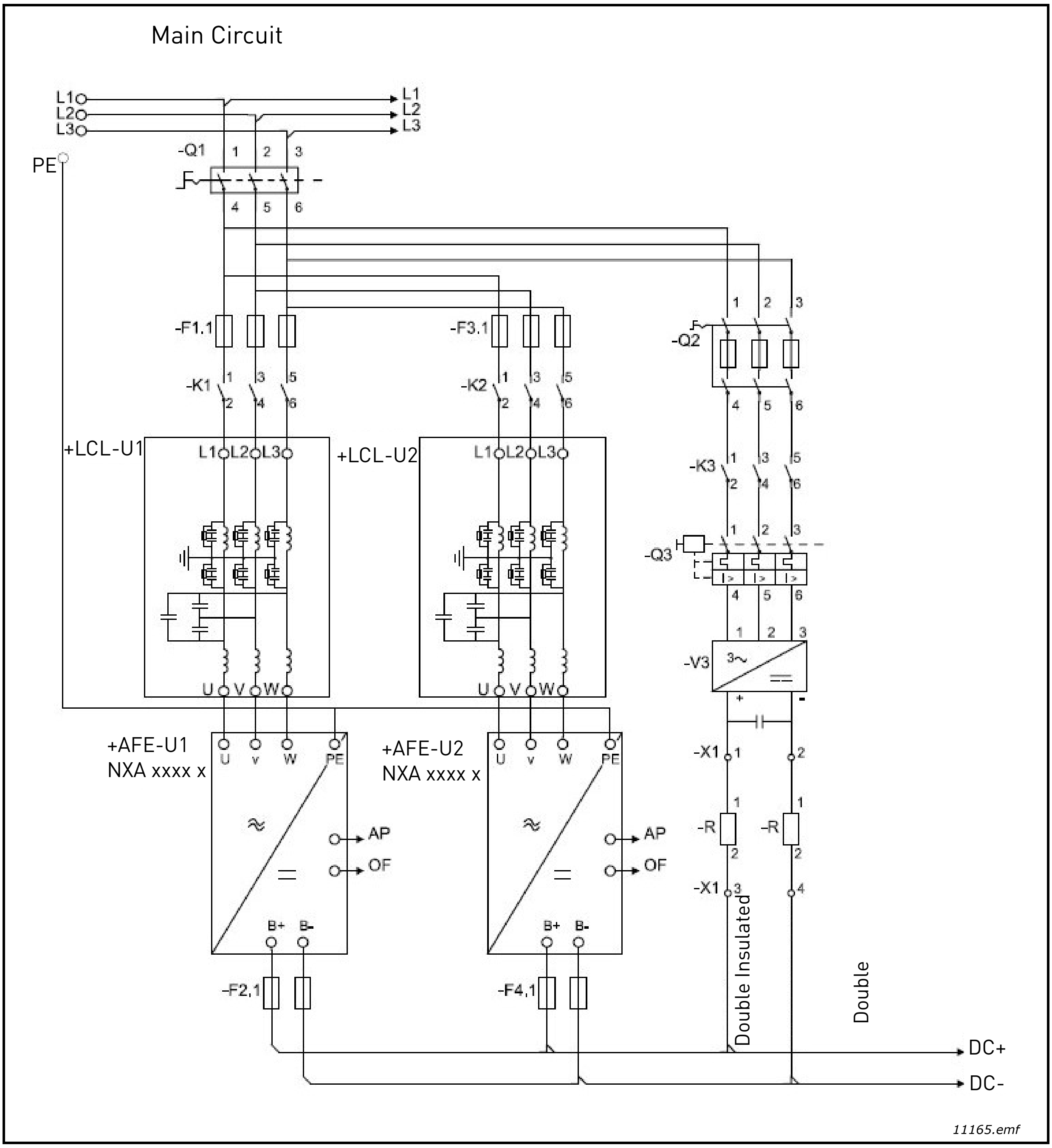


Figure 26. Active Front End units parallel connection with one common pre-charging circuit

4.16.2 Each Active Front End unit has the pre-charging circuit

Each Active Front End can have its own pre-charging circuit. Each unit controls its own pre-charging and main contactor. See Figure 27. One control switch can be used, but if an Active Front End unit needs to be controlled independently, separate switches are needed. With this the system is more redundant than with a common pre-charging circuit. The circuit diagram for control, see Figure 85 on page 137 and Figure 87 on page 139.

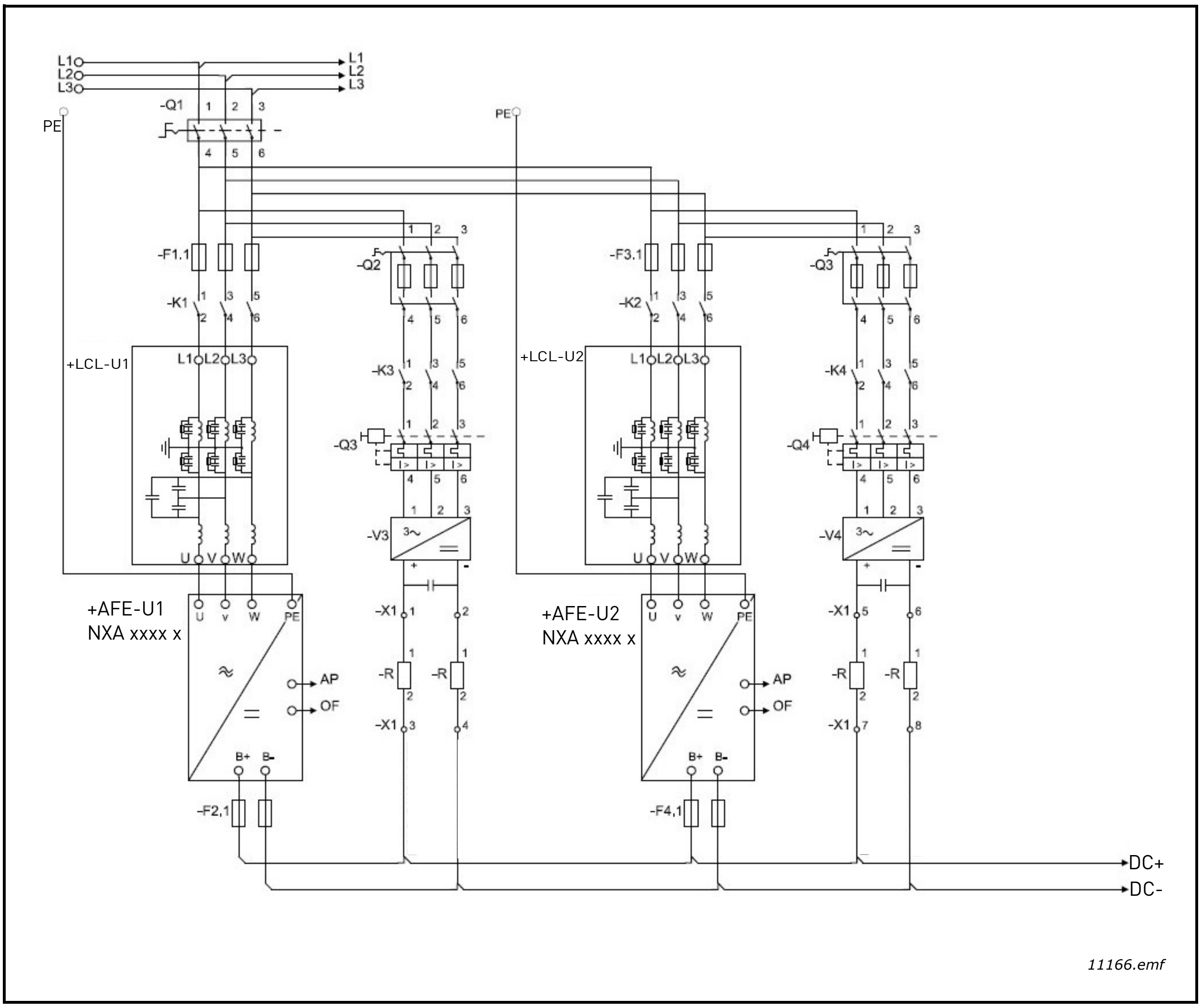


Figure 27. Active Front End units parallel connection with own pre-charging circuits

4.17 Derating

The output power has to be derated if one of following cases:

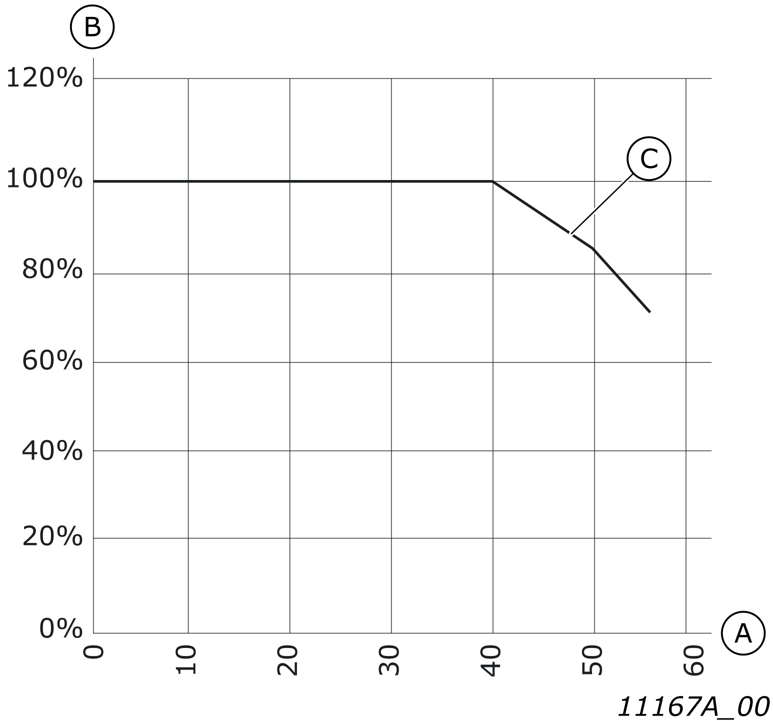
- Ambient temperature is more than 40 °C (104 °F).
- Installation altitude is more than 1000 m.

4.17.1 Ambient Temperature

The power rating of the Active Front End unit is valid for an ambient temperature of 40 °C (104 °F). If the device is to be used in higher ambient temperatures, its power rating must be subjected to derating. The derating coefficient from 40 °C to 50 °C, use derating factor 1.5%/1 °C, and from 50 °C to 55 °C, use derating factor 2.5%/1 °C, for ambient temperatures not exceeding 55 °C (131 °F). The reduced power is calculated using the formula:

$$P_{de} = P_n *((100\% - (t - 40°C)*X)/100)$$

P_n = nominal power of the unit
t = ambient temperature
x = derating coefficient



A	Ambient temperature, °C
B	Loadability, %
C	Loadability %

Figure 28. Derating as the ambient temperature

4.17.2 High altitude installation

The density of air decreases when the altitude increases and the pressure decreases. When the air density decreases, the thermal capacity decreases (i.e. less air removes less heat) and the resistance to electric field (breakdown voltage / distance) decreases.

The full thermal performance of VACON® NX AC drives is designed for installation up to 1000 m altitude and the electric insulation is designed for installations up to 2000 m altitude. Higher installation locations are possible, when you obey the derating guidelines in this chapter.

NOTE! 690 V units maximum installation altitude is 2000 m.

Above 1000 m, you must decrease the limited maximum load current by 1% for each 100 m. Thus, for example, at 2500 m altitude, you must decrease the load current down to 85% of the rated output current (100% – (2500 m – 1000 m) / 100 m x 1% = 85%).

When you use fuses at high altitudes, the cooling effect of the fuse decreases as the density of the atmosphere decreases.

When you use fuses above 2000 m, the continuous rating of the fuse:

$$I = I_n*(1- (h-2000)/100*0.5/100)$$

I = Current rating at high altitude
I_n = Rated current of a fuse
h = Altitude in meters

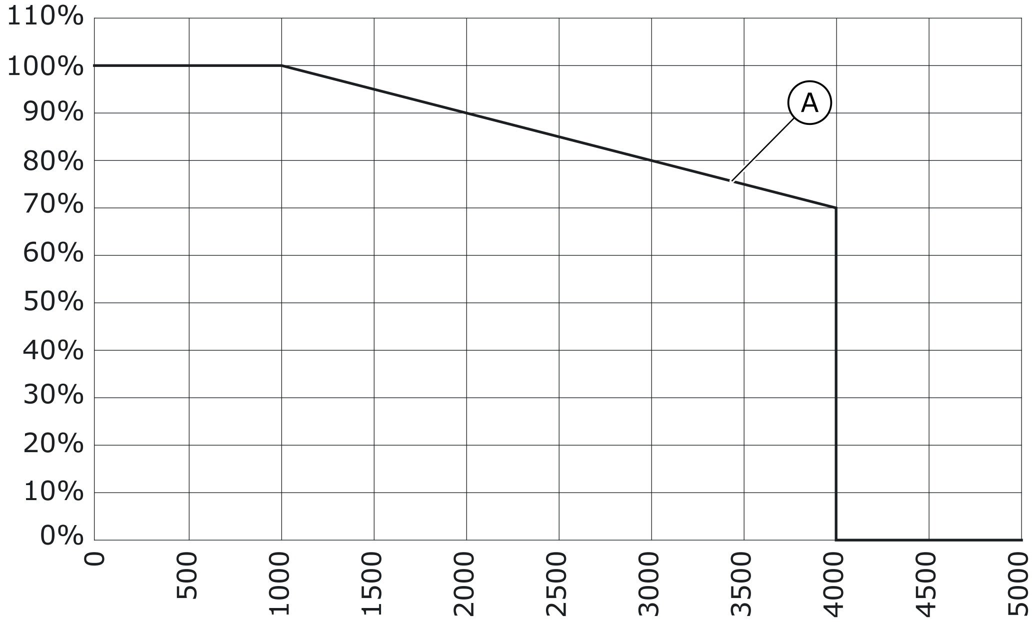


Figure 29. Loadability in high altitudes

For permitted maximum altitudes, see Table 7.

For information on option boards and I/O signals and relay outputs, see VACON® NX I/O Boards User Manual.

5. Installation

5.1 Mounting

The Active Front End modules have enclosure class IP00 and they must be installed in a cabinet with a suitable IP-rating based on the end user installation location and requirements.

The equipment mounting must be sturdy enough to carry the weight of the equipment. The enclosure class of the equipment will depend on the mounting and solutions to be used. The equipment mounting must provide sufficient shielding for contact of the live parts (IPXXB). The installation and mounting must comply with local laws and regulations.

5.1.1 Active Front End Unit

The Active Front End can be mounted in a vertical position on the back plane of a cubicle. Enough space must be reserved around the Active Front End to ensure sufficient cooling, see Figure 37. Follow the minimum dimensions for installation, see Table 28. Required cooling air capacity and minimum air holes on the switchgear, see Table 29. Also make sure that the mounting plane is relatively even. The Active Front End is fixed with four bolts, Figure 30, Figure 31 and Figure 32.

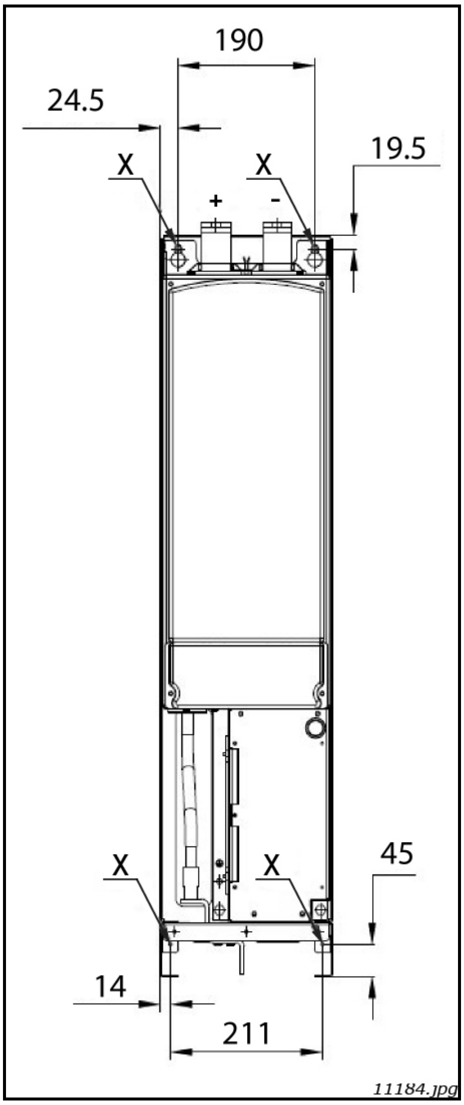


Figure 30. Mounting points of FI9 AFE unit

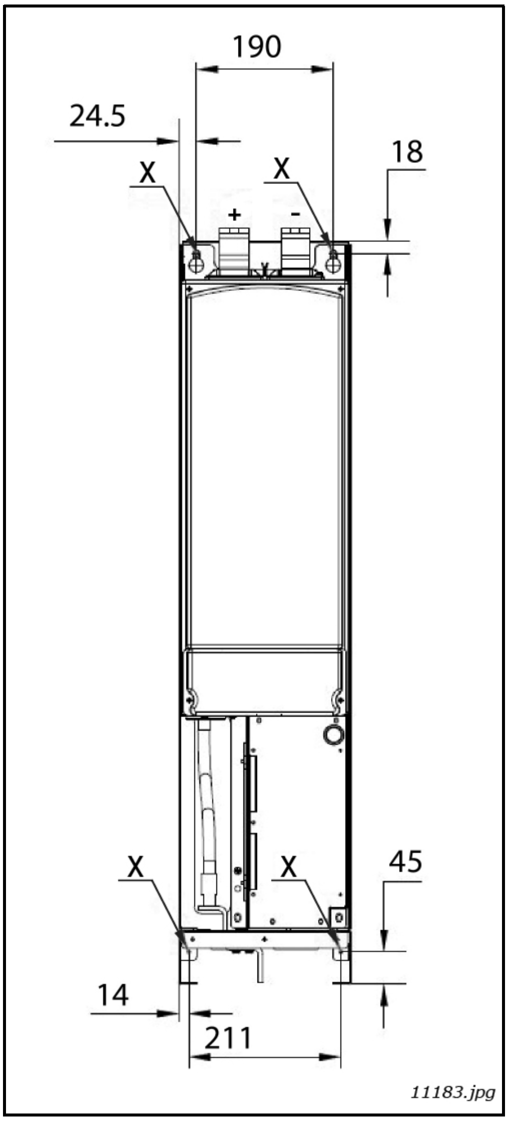


Figure 31. Mounting points of FI10 AFE unit

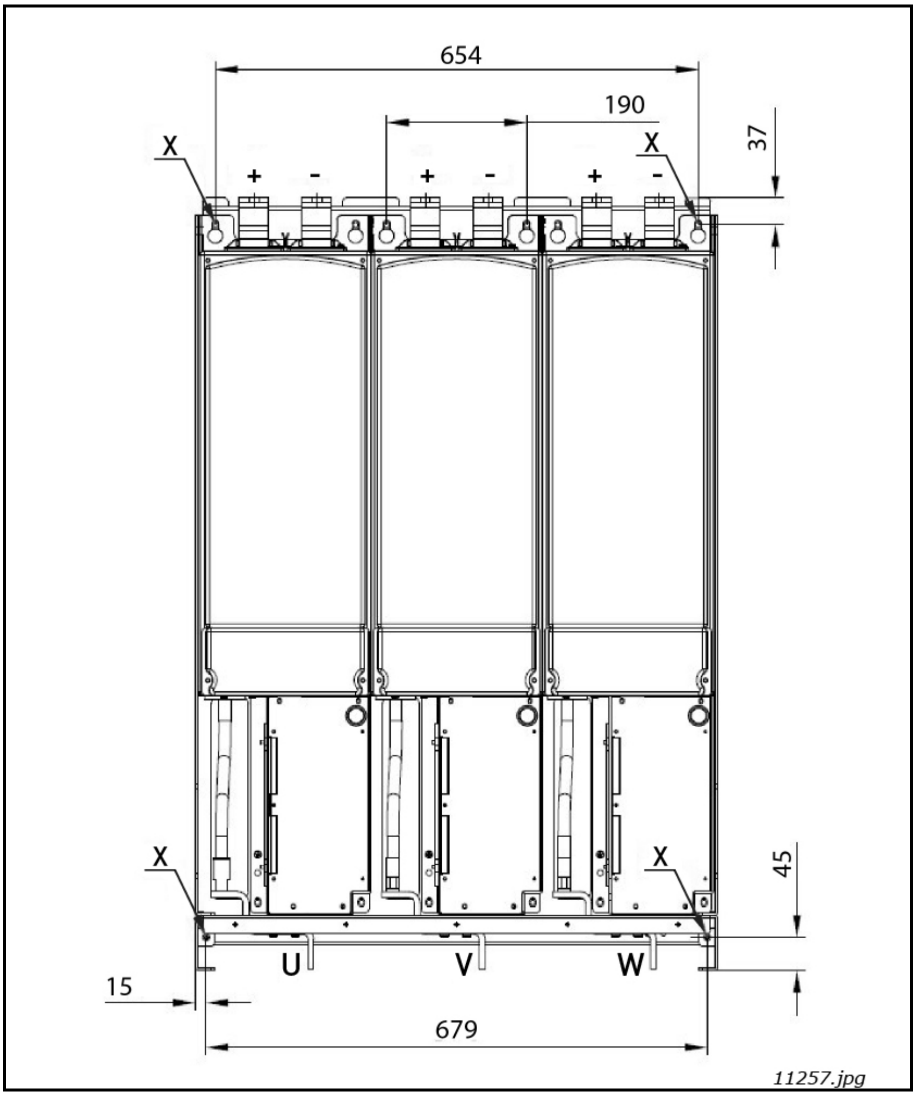


Figure 32. Mounting points of FI13 AFE unit

5.1.2 LCL filter

The LCL filter can only be mounted in a vertical position on the floor of a cubicle. Enough space must be reserved around the LCL filter to ensure sufficient cooling, see Figure 40. Follow the minimum dimensions for installation, see Table 30. Required cooling air capacity and minimum air holes on the switchgear, see Table 31. LCL filters cooling air airflow is present in Figure 41 and Figure 42. Also make sure that the floor is relatively even. The LCL filter must be attached properly so it can not move.

In the LCL filter for the FI13 Active Front End unit, the connection direction can change from right to left, see Figure 95 and Figure 96. Follow the instruction below:

1. Open fastenings numbered by 1 in Figure 33.
2. Open fastenings numbered by 2 in Figure 33.
3. Remove busbars.
4. Remove the insulator (dark grey) from the right side and place it in same place to the left.
5. Place the busbars like in Figure 34.
6. Close fastenings numbered by 2 in Figure 34.
7. Close fastenings numbered by 1 in Figure 34.

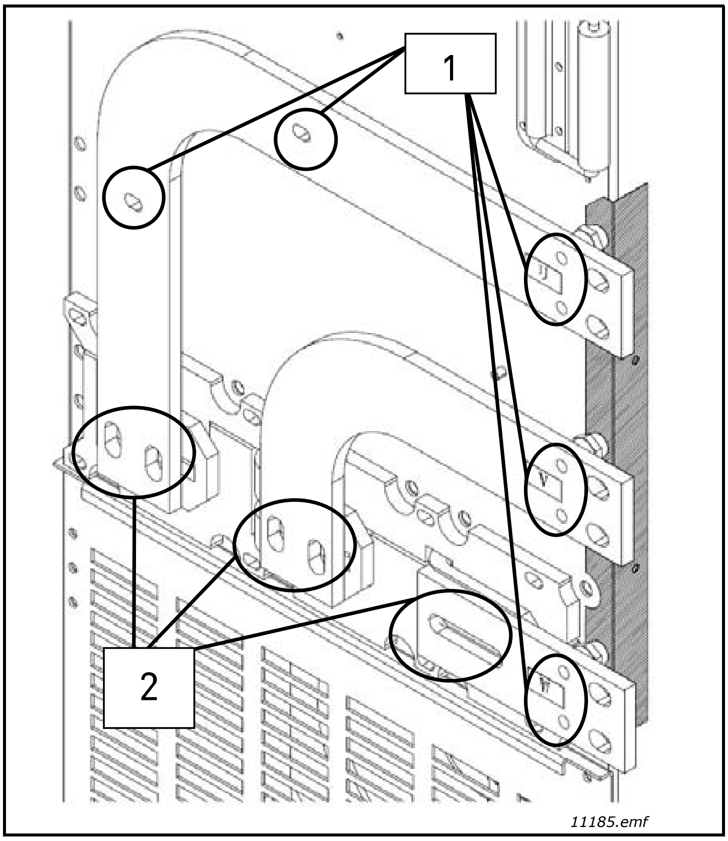


Figure 33. Right-side connection

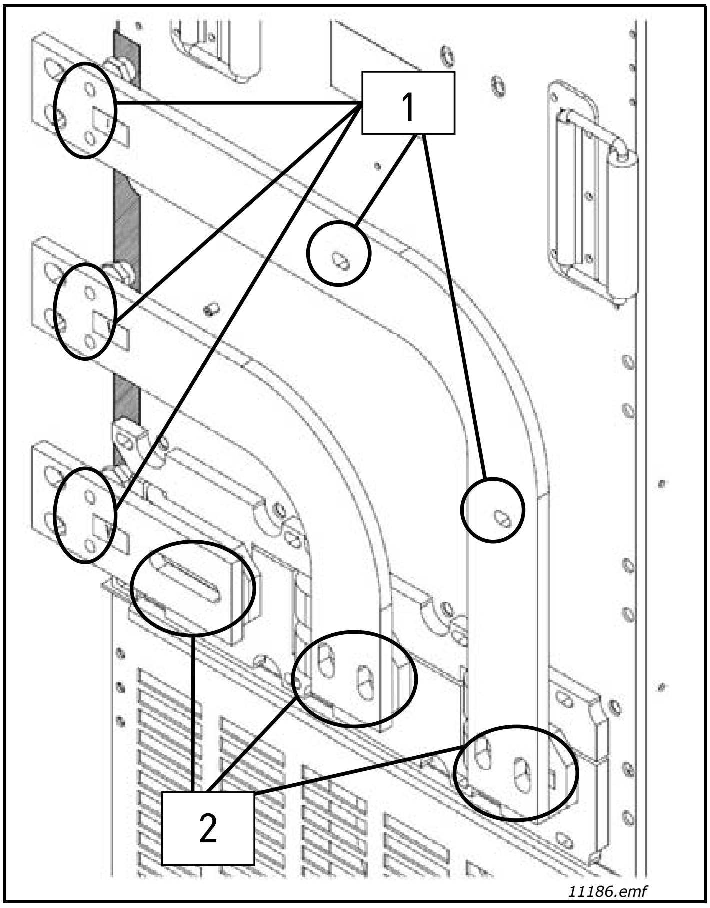


Figure 34. Left-side connection

5.1.3 Control Box

The control unit of the Active Front End unit is mounted into a mounting rack which then can be placed inside the enclosure, Figure 35 and Figure 36. The control unit should be placed so that it is easy to access. VACON® alpha-numeric or graphical keypad can be used to control the Active Front End unit. The keypad is connected to the control unit. The keypad can be mounted on the enclosure door with optional door mounting kit, see Figure 97 on page 149. In that case the keypad connects to the control unit with an RS232 cable. Pay special attention to the grounding of the cable, see the instructions below.

Figure 35. Control unit installed into the mounting box; Left: front; Right: back

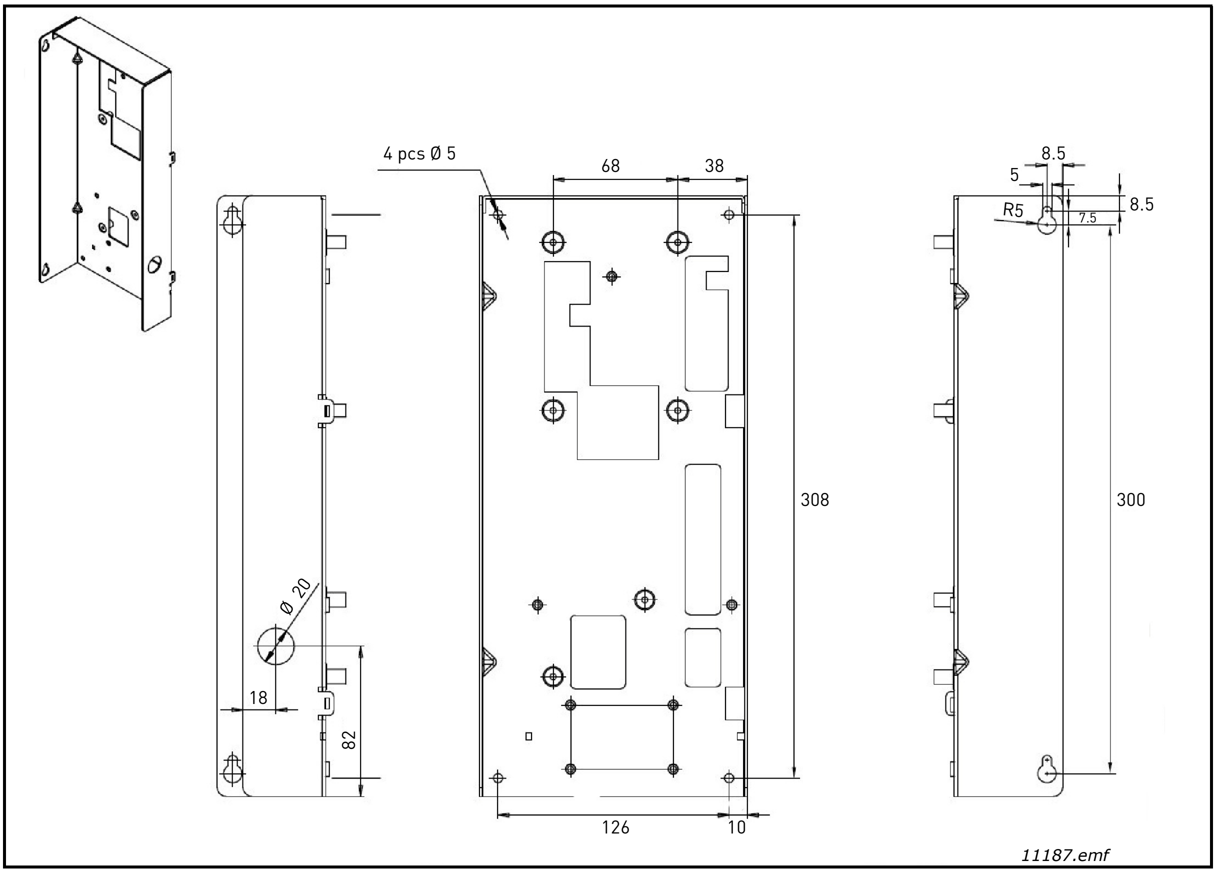


Figure 36. Mounting points of Control Box

1. If the keypad sits in its place on the control unit, remove the keypad.
2. Connect the male end of the keypad cable to the D-connector of the control unit. Use the RS232 cable included in the delivery. Figure 1.
3. Run the cable over the top of the box and secure with plastic band on the backside. Figure 2.
4. Grounding of keypad cable: Ground the keypad cable in the mounting box frame by fixing the branch cable with a screw underneath the control unit. See Figures 3–4.
5. Mount the control unit mounting box in the front-left corner of the enclosure using two screws as shown in Figure 5. **NOTE!** Do not install the mounting box floating (with e.g. plastic screws).
6. Connect the optical cables (or the flat cable) to the power unit. See Chapter 4.7 Connection between control unit and power unit and Figures 1–7.
7. Connect the female end of the keypad cable to keypad on the enclosure door, Figure 8. Use a cable channel for the cable run, Figure 9.

Figure 1.


Figure 2.

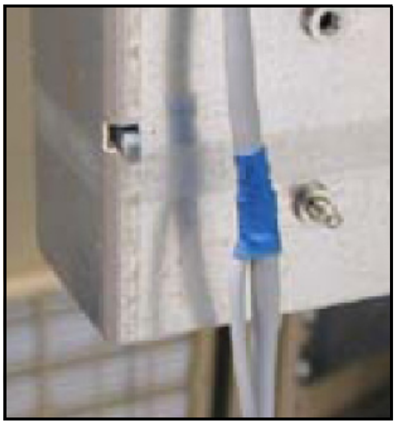


Figure 3.

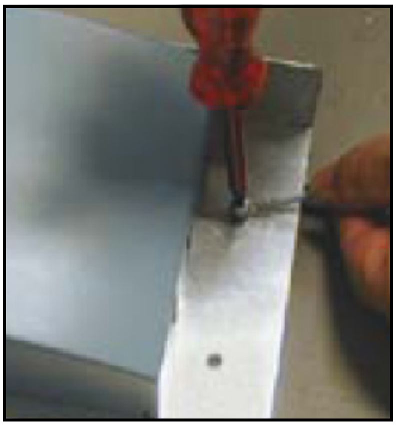


Figure 4.


Figure 5.


Figure 6.


Figure 7.


Figure 8.


Figure 9.

5.2 Cooling

5.2.1 Active Front End unit

Enough free space must be left around the Active Front End unit to ensure sufficient air circulation and cooling. You will find the required dimensions for free space in the Table 28. You will find the required cooling air, minimum air holes and heat dissipation in the Table 29.

When planning the cooling for the space, take into consideration that the Active Front End unit heat loss is approximately 2% of the nominal capacity. Air flow, see Figure 38 and Figure 39.

Table 28. Mounting space dimensions

Type	Dimensions [mm]			
	A	B	B_2	C
NXA_0168 - 0261 5 NXA_0125 - 0170 6	200	0	0	100
NXA_0385 - 0460 5 NXA_0261 - 0325 6	200	0	0	100
NXA_1150 - 1300 5 NXA_0920 - 1030 6	200	0	0	100

A = free space above the unit

B = distance between inverter and cabinet wall

B2 = distance between two units

C = free space underneath of the units

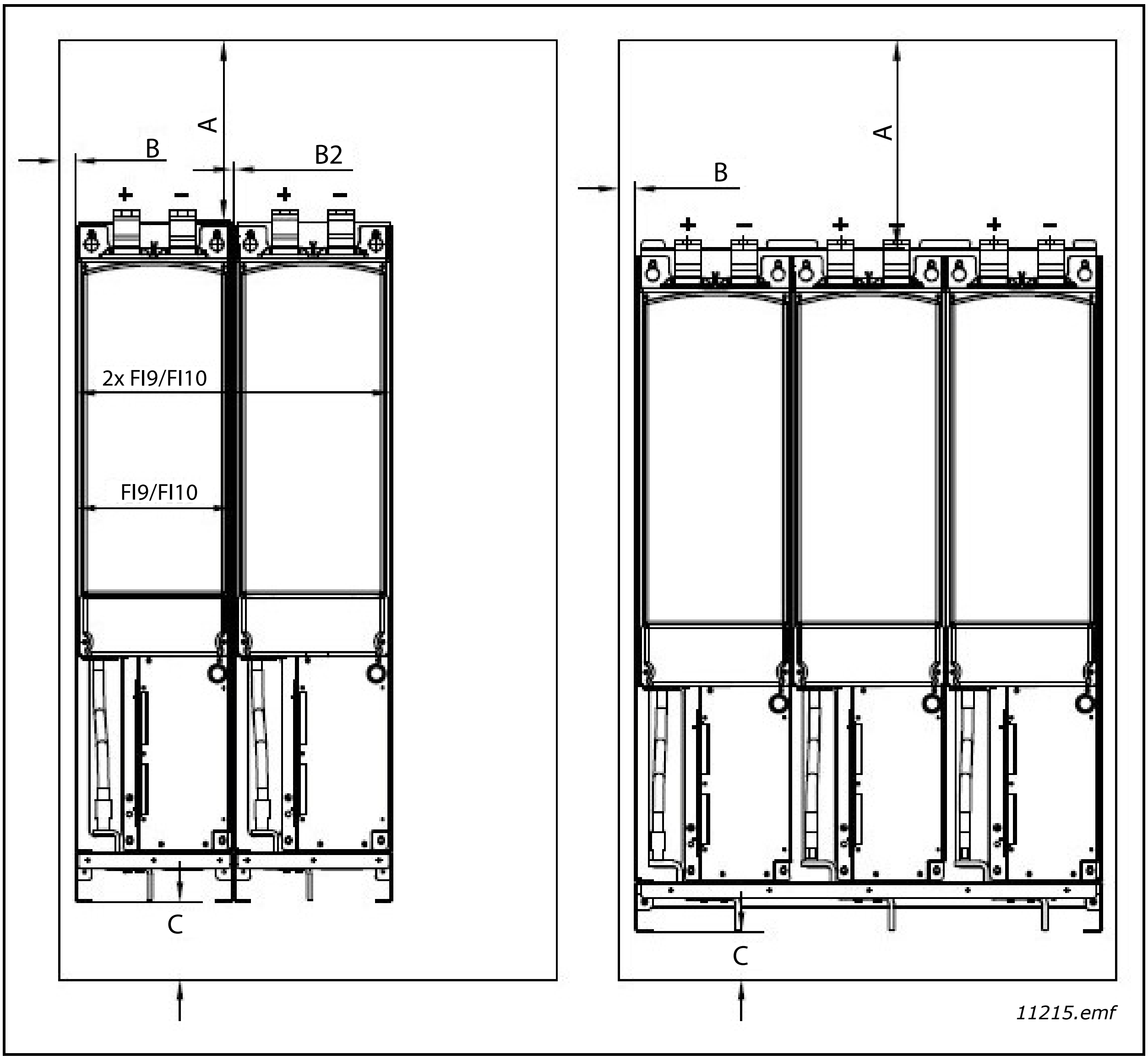


Figure 37. Installation space for FI9, FI10 and FI13

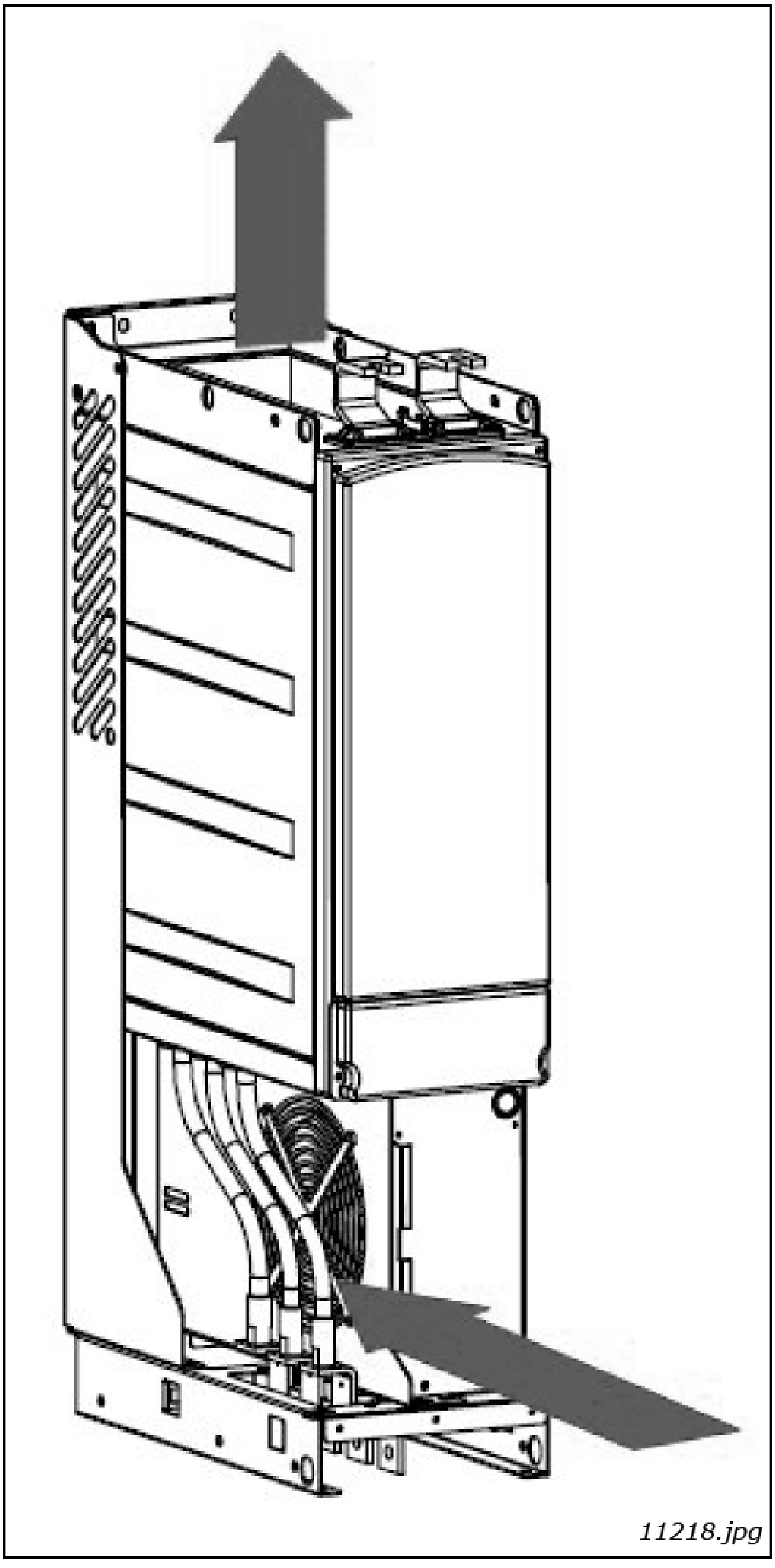


Figure 38. Cooling airflow for FI9 and FI10 units

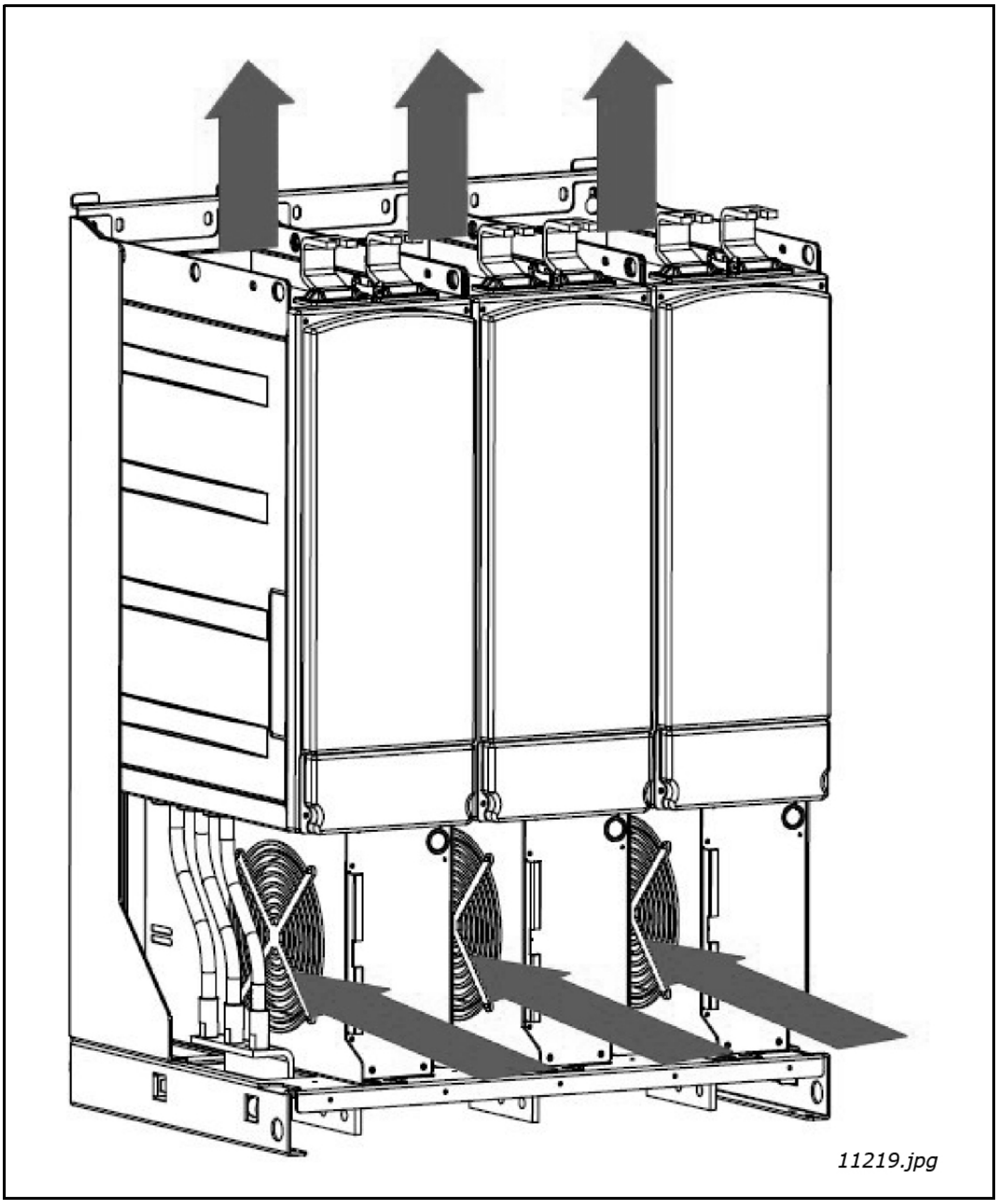


Figure 39. Cooling airflow for the FI13 unit

Table 29. Power losses and required cooling air for the Active Front End units

Type	Enclosure size	Heat dissipation (W)	Cooling air required (m^3/h)	Minimum air holes on switchgear (mm^2)
NXA_0168 - 0261 5 NXA_0125 - 0170 6	FI9	3540 3320	1150	Inlet: 55000 Outlet: 30000
NXA_0385 - 0460 5 NXA_0261 - 0325 6	FI10	6160 6070	1400	Inlet: 65000 OUtlet: 40000
NXA_1150 - 1300 5 NXA_0920 - 1030 6	FI13	17920 19050	4200	Inlet: 195000 OUtlet 105000

5.2.2 LCL filter

Enough free space must be left around the LCL filter to ensure sufficient air circulation and cooling. See the required dimensions for free space in Table 30. See the required cooling air, minimum air holes, and heat dissipation in Table 31.

When planning the cooling for the space, take into consideration that the LCL filter heat loss is approx. 1% of the nominal capacity. Air flow, see Figure 41 and Figure 42.

Table 30. Mounting space dimensions

Type	Dimensions [mm]			
	A	B	B_2	C
LCL0261 5 LCL0170 6	350	0	20	0
LCL0460 5 LCL0325 6	350	0	20	0
LCL1300 5 LCL1030 6	350	0	20	0

A = Free space above the LCL filter

B = Distance between LCL filter and cabinet wall

B_2 = Distance between LCL filter terminals and cabinet wall

C = Free space below the LCL filter

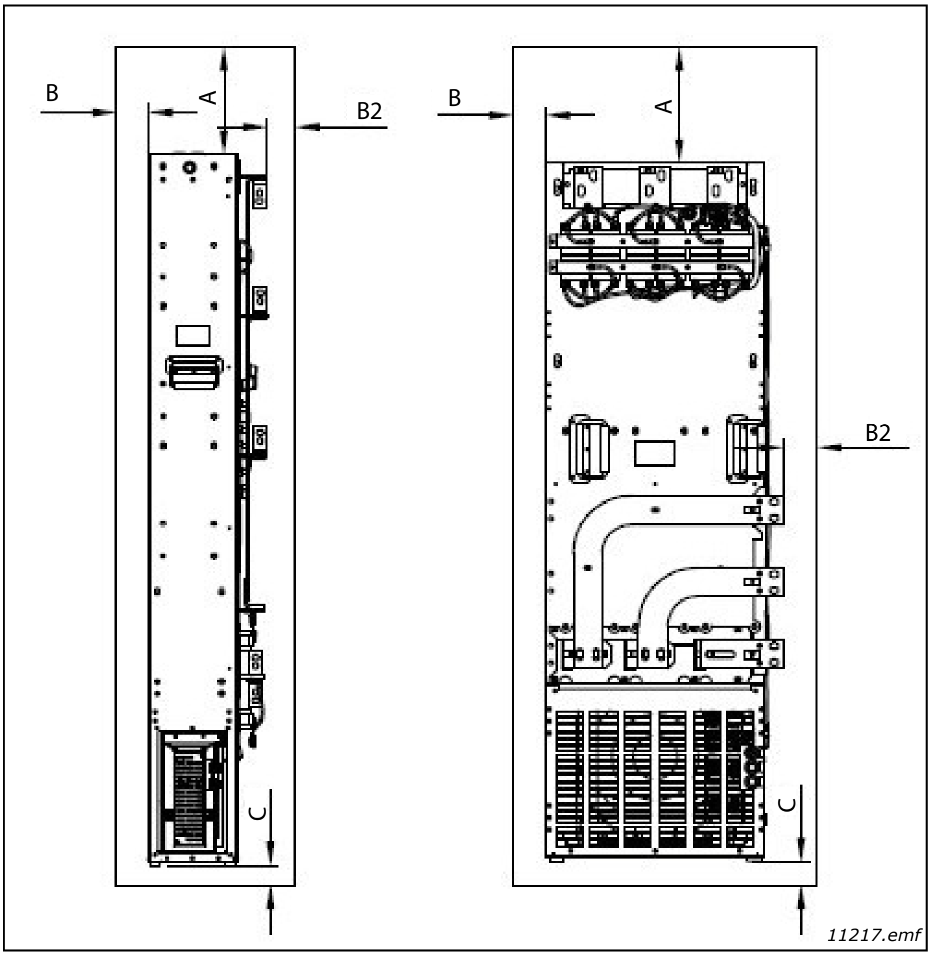


Figure 40. Installation space

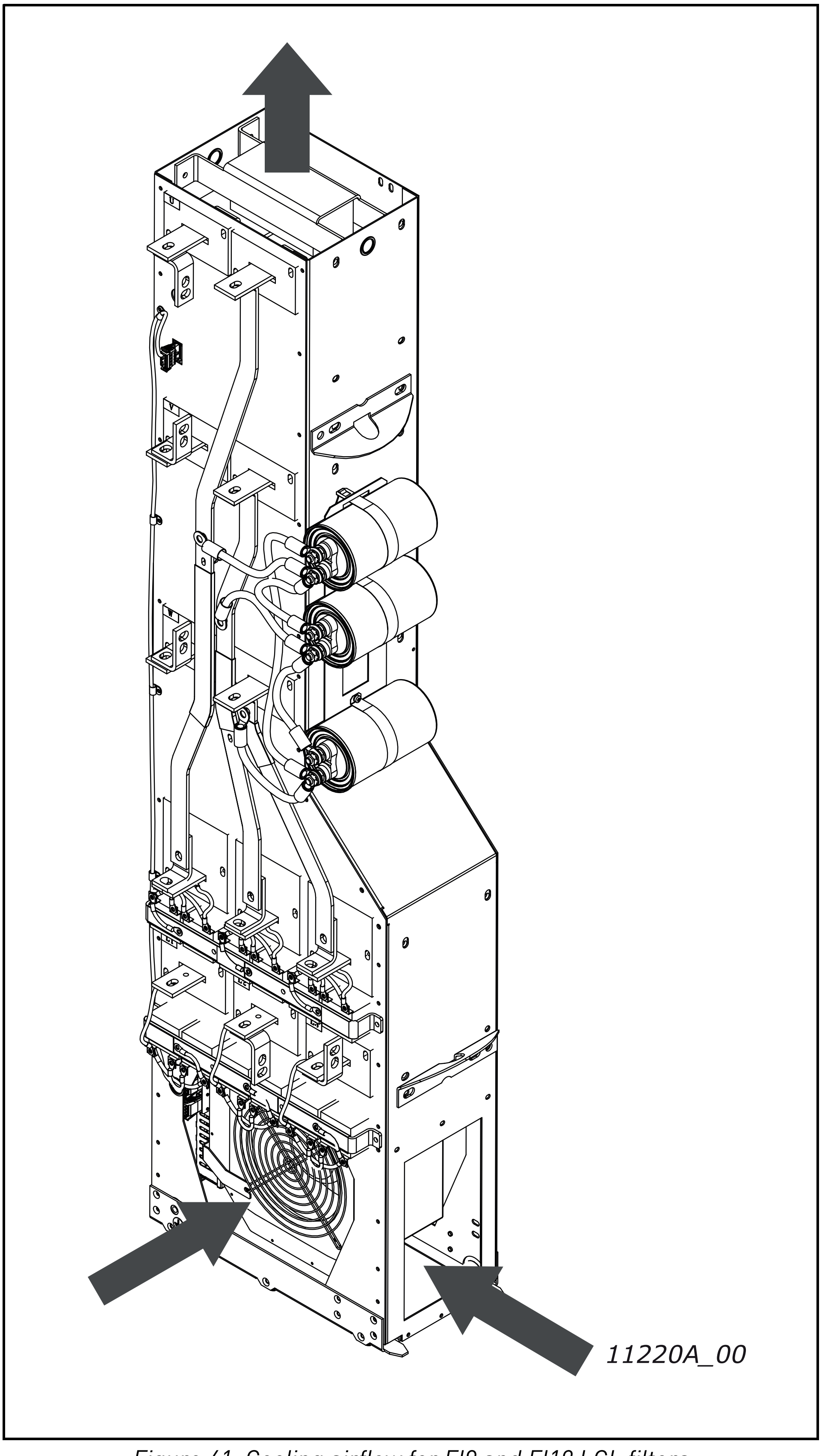


Figure 41. Cooling airflow for FI9 and FI10 LCL filters

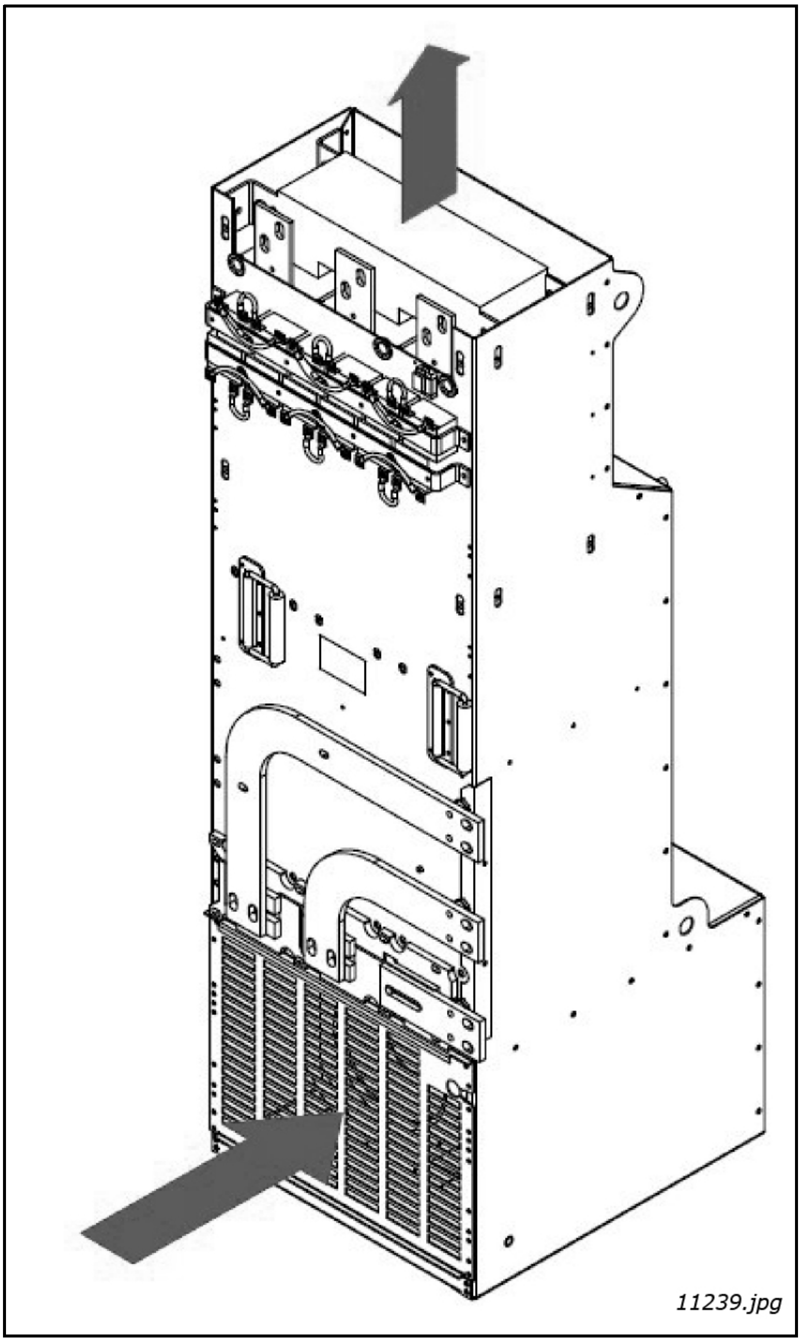


Figure 42. Cooling airflow guides for FI13 LCL filter

Table 31. Power losses and required cooling air for the LCL filters

Type	Heat dissipation (W)	Cooling air required (m^3/h)	Minimum air holes on switchgear (input and output) (mm^2)
LCL0261 5 LCL0170 6	2350 2050	1100	30000
LCL0460 5 LCL0325 6	3180 3290	1100	30000
LCL1300 5 LCL1030 6	6330 8680	1300	42000

5.2.3 Arranging ventilation of the enclosure

The enclosure door must be provided with air gaps for air intake. To achieve sufficient cooling inside the cabinet, the dimensions for the total area of free openings for incoming air given in Table 29 and Table 31 must be followed. For instance, there could be two screened gaps as presented in Figure 43 (our recommendation). This layout ensures a sufficient air flow to the module fans as well as cooling of the additional components.

Air outlet gaps must be situated on top of the cabinet. The minimum effective air outlet area per unit frame is given in Table 29 and Table 31. The cooling arrangements inside the cabinet must be such that they prevent hot output air from mixing with the incoming fresh air (see Chapter 5.2.4).

The ventilation gaps must fulfil the requirements set by the selected IP class. The examples in this manual apply to protection class IP21.

During operation, air is sucked in and circulated by a fan blower at the bottom of the power unit. If the power unit is placed in the upper part of the cabinet, the fan blower will be in the mid of the cabinet, at the height of the upper ventilation grid. In case of LCL filter air inlet 1.1 in Figure 43 cannot be used.

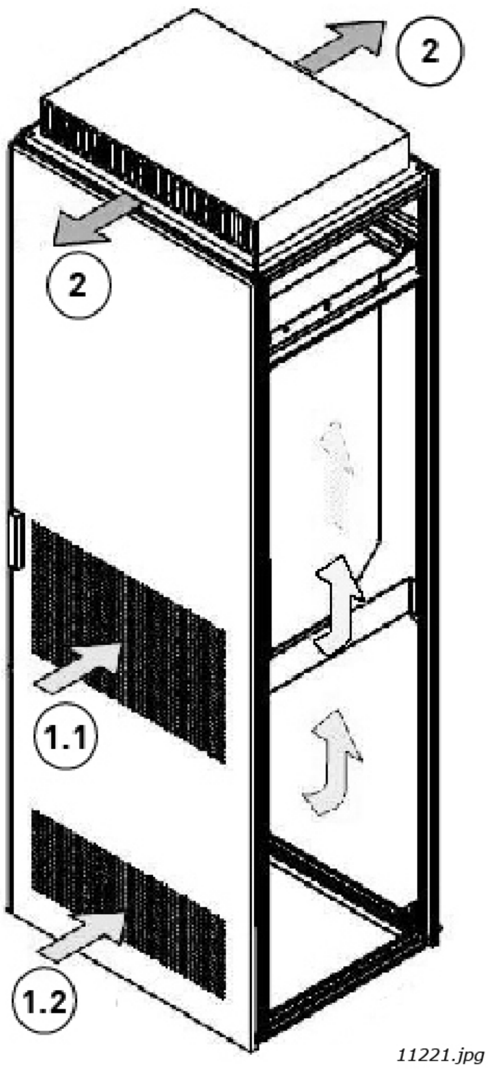


Figure 43. Cabinet openings for cooling

1. Cooling air inlets
2. Hot air exhaust

5.2.4 Steering air flow

Cooling air must be taken in through the ventilation gaps on the door and blown out at the top of the enclosure. To steer the hot air from the power unit to the outlet at the top of the enclosure and prevent it from circulating back to the fan blower, use either of the following arrangements:

A. Install a closed air duct from the power unit to the outlet on top of the enclosure (A in Figure 44).
B. Install shields in the gaps between the power unit and the cabinet walls (B in Figure 44). Place the shields above the air outlet gaps at the sides of the module.

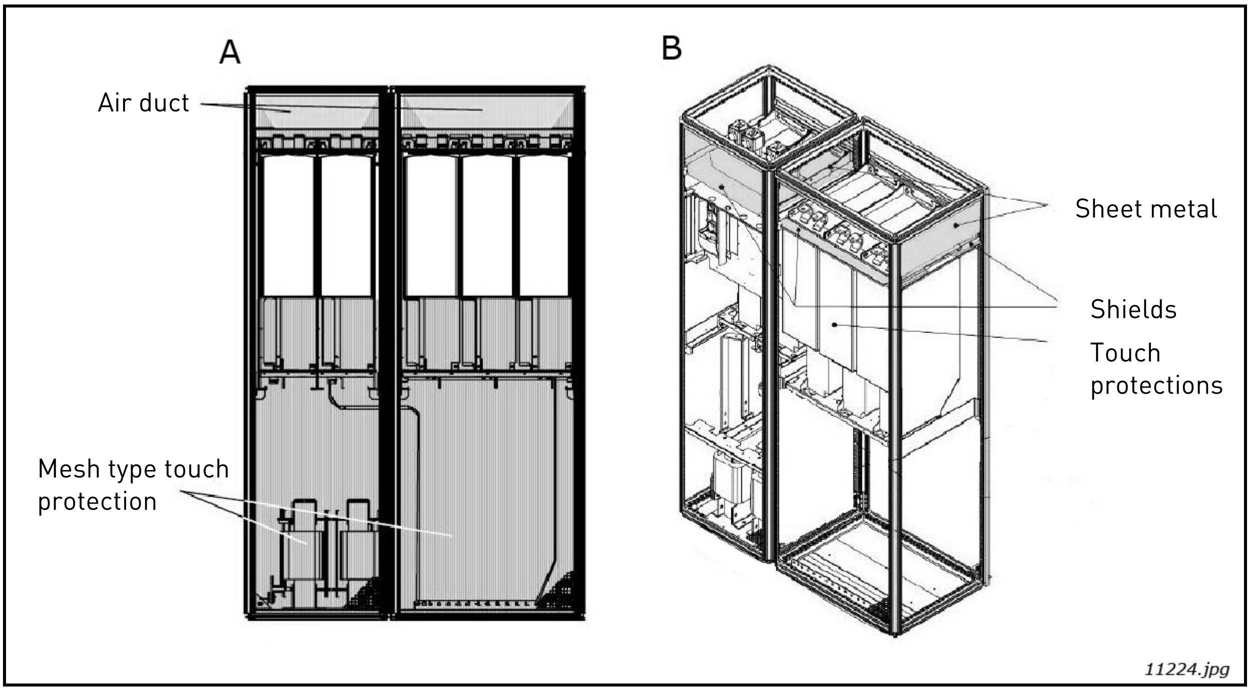


Figure 44. Cabinet cooling airflow guides

NOTE! If a flat roof is used, mount a V-shaped air guide on the underside of the roof to direct the air flow horizontally. See Figure 45.

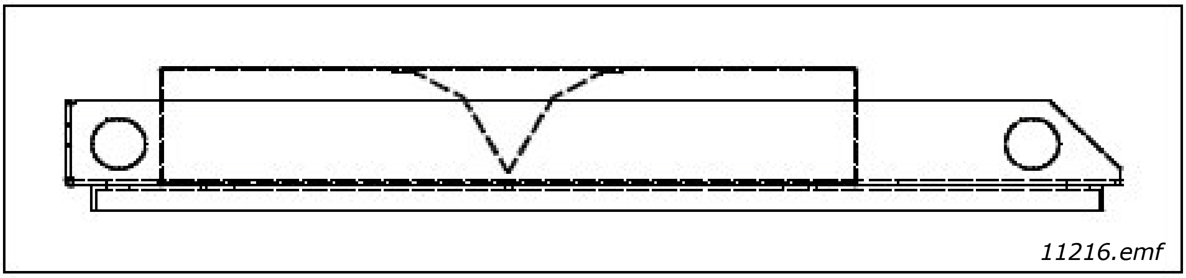


Figure 45. Roof structure seen from the side

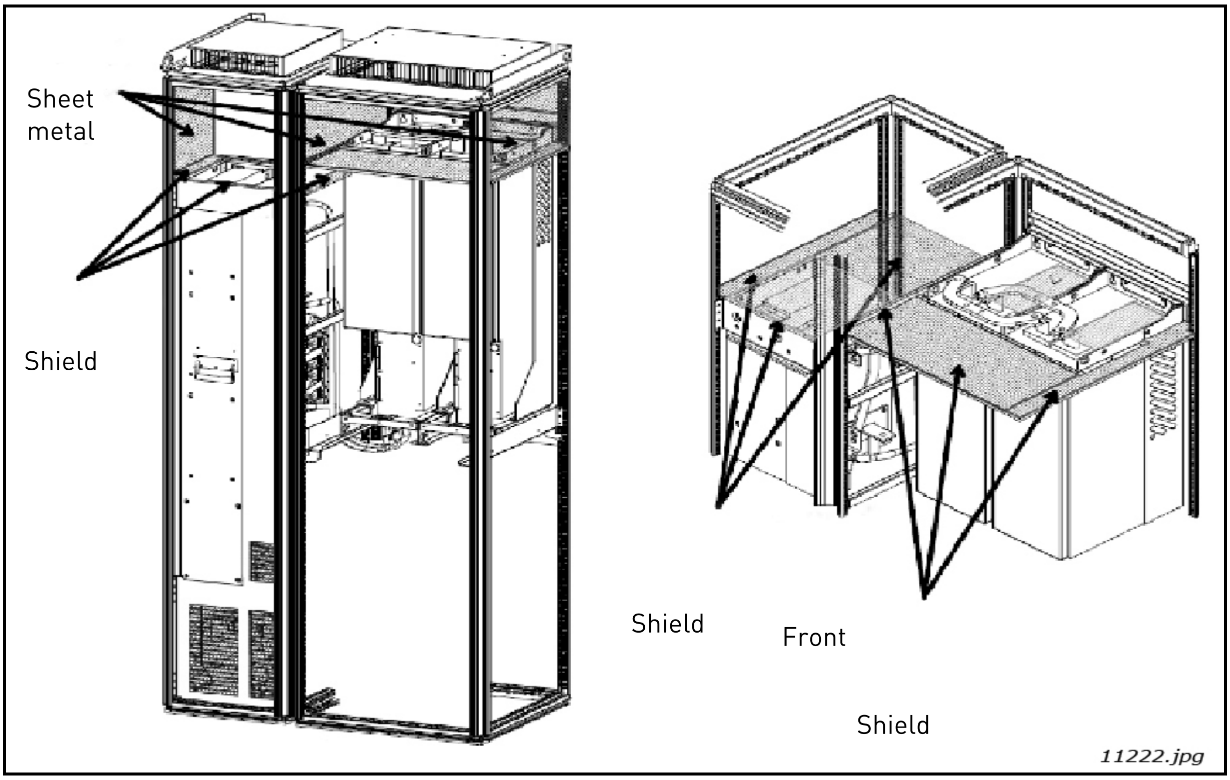


Figure 46. Cabinet cooling airflow guides for FI9 and FI10 AFE unit and LCL filter

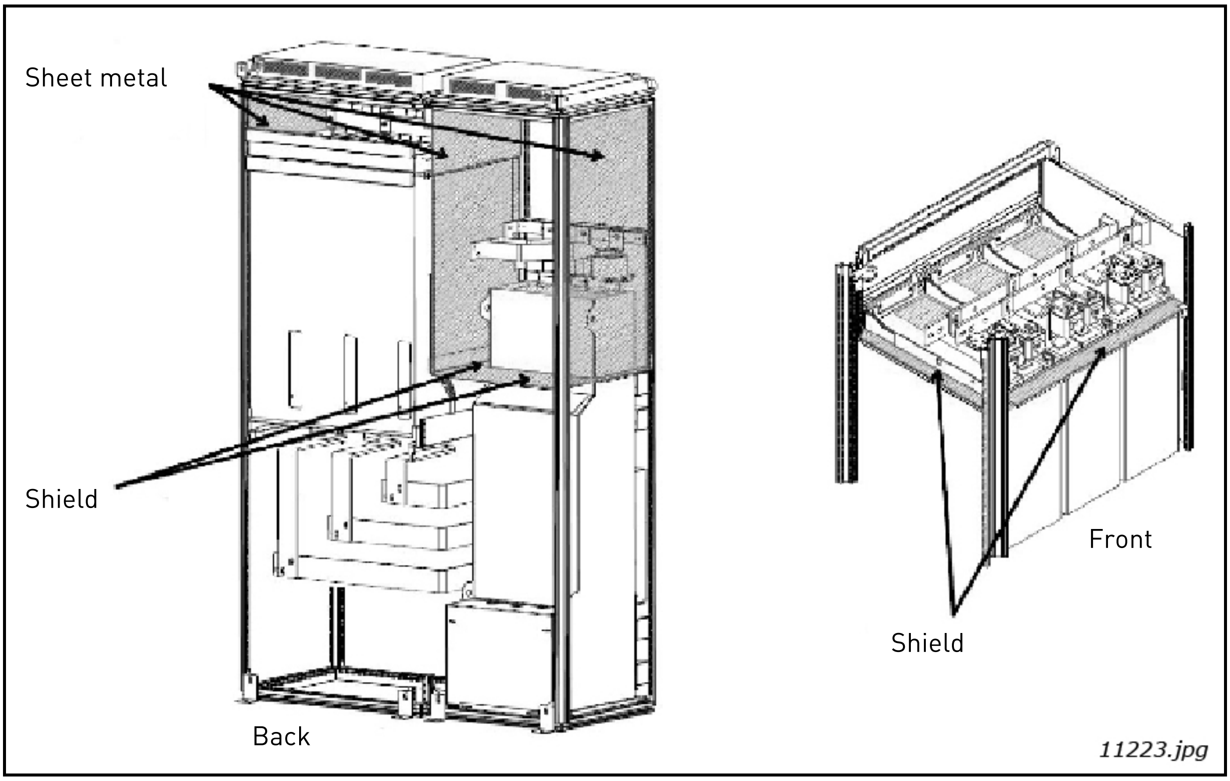


Figure 47. Cabinet cooling airflow guides for FI13 AFE unit and LCL filter

The sheet metal air flow guides (deflectors) prevent air circulation between different sections of the equipment. The shield guides prevent air circulation inside a section. The exhaust air holes must not be covered, nor must anything be placed above them to stop the free exit of warm air from inside the equipment. The cooling air intake holes must not be blocked in any way.

The materials used for preventing the circulation of air inside the equipment must be fire-restraining. The edges must be sealed to prevent the formation of gaps. When the deflectors are made according to the instructions, no separate cooling fan is required.

5.3 Power connection

5.3.1 AC connection

The 3-phase input is connected to the input terminals of the LCL filter (L1, L2 and L3). The output terminals of the LCL filter (U, V, and W) are connected to the input terminals of the AFE unit (U, V, and W), Figure 7. The AC input of the AFE input group must be protected against short circuit. The fuses suitable for protection are shown in Chapter 4.12. A circuit breaker can also be used for protection, see Chapter 4.13. The best short-circuit protection is achieved by using fuses. The short-circuit protection must be on the input side when seen from the LCL filter, Figure 7.

A cable or busbar designed for the purpose must be used to make the connection. The connection must be dimensioned according to the nominal current rating of the Active Front End unit. The necessary overloading allowance must also be used. The connection must also have the same short-circuit capacity as the whole system. The connecting cable or busbar may be of copper or aluminium. When aluminium is used, steps must be taken to prevent corrosion. The dimensions of the terminals in the unit are indicated in Figure 98 and their locations are shown in Figure 91, Figure 92 and Figure 93. Locations of terminals in the LCL filter are shown in Figure 94 and Figure 95.

For more details about the connections and terminals of FI9, FI10, and FI13 units, see the VACON® NXI Inverters FI9-FI14 Operating Guide.

5.3.2 DC connection

The DC connection of the Active Front End unit is connected to the terminals at the top. The terminals are marked as B+ for connection to DC+ and B- for connection to DC-. The DC connection must be protected using DC fuses, see Chapter 4.12. The terminal dimensions are shown in Figure 98.

5.3.3 Cable installation and the UL standards

To meet the UL (Underwriters Laboratories) regulations, a UL-approved copper cable with a minimum heat-resistance of 90 C must be used.

Use Class 1 wire only.

The units are suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes, 600 V maximum, or equivalent when protected by class J, T or Semiconductor fuses.

5.3.4 LCL filter Fan power supply

Two types of power supplies are available for the LCL filter cooling fan. The cooling fan can be supplied from an external power supply or an integrated DC/DC power supply.

5.3.4.1 LCL filter with integrated DC/DC power supply for fan

The DC/DC power supply is integrated in the structure of the LCL filter. See Figure 48 and Figure 49. The integrated DC/DC power supply takes its input voltage from the intermediate circuit. See Figure 88. The input of the DC/DC power supply must be protected against short circuit using DC fuses type Ferraz Shawmut ATQ8 (8 A) if the length of the supply cable does not exceed 2 m. The fuses can be installed in holders type Ferraz Shawmut US102I (2-pole), to allow the easy disconnection of the DC/DC power supply from the supply. If the length of the supply cable exceeds 2 m, fuses type Ferraz Shawmut D100gRB008VI (8 A) must be used. The fuses should be installed in holders.

The DC- power supply should be wired from the AFE power module DC connectors. Wires should be connected between the main DC- fuses and AFE module (see Figure 50). With FI13, the power supply can be taken from the V- phase.

The high DC voltage must be taken into account when wiring the supply; suitable cables/leads must be used.

The DC/DC power supply is monitored and controlled by the Active Front End unit. The DC/DC power supply connections are shown in Figures 48 - 49 and Figure 88 and Figure 89.

The control connection has to be taken from the Active Front End unit. The control cable has to be connected to the terminal X51 on the LCL filter, see Figure 48 and Figure 49. The control cable has to be connected to the terminal X3 on the Active Front End unit, see Figure 51. The terminal X3 can be found under the black cover. In the FI13, the terminal X3 is located in the left-most unit (phase U). The delivery includes the cable for the control connection. The length of the standard cable is 1.6 m.

The overtemperature protection can be wired directly to the control unit or to the DC/DC power supply. The overtemperature protection must be connected to protect the filter for protect the filter in case of over-temperature.

NOTE! By default, the overtemperature protection is not activated. If it is not activated, the LCL can be damaged in case of overtemperature.

If the over-temperature protection is connected to a digital input, the wires have to be removed from the terminal X52. The I/O wiring has to be connected to the terminals 1 and 4 on the terminal X52, see Figure 89. If the overtemperature protection is connected to the I/O of the Active Front End unit, it can be programmed. The parameter P2.2.1.3 has to be set to choose the digital input to which the overtemperature monitoring is connected. The parameter P2.7.3 allows one to select the response to an over-temperature alarm as wanted.

If the over-temperature protection is connected to the DC/DC power supply, the jumper has to be removed from the terminal X3. The cable from the terminal X52 should be connected to the terminal X3. By default, the jumper is connected to the terminal X3, see Figure 49. The delivery includes the cable for connecting the terminals X52 and X3. The wiring diagram can be seen in Figure 89. If overtemperature monitoring is connected to the DC/DC power supply, the Active Front End unit will monitor over-temperature. The response to an overtemperature alarm cannot be selected. In this case, the over-temperature fault message will be same as the fan fault of the unit. On the keypad, the fault “32 Fan Cooling” is shown.

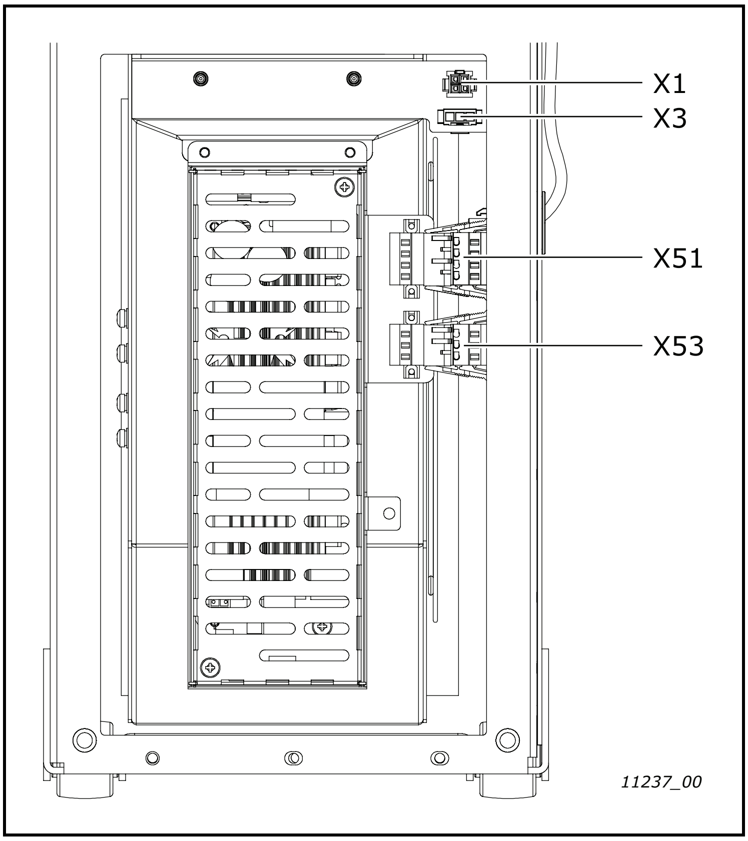


Figure 48. Integrated DC/DC-power in the FI9 and FI10 LCL filter

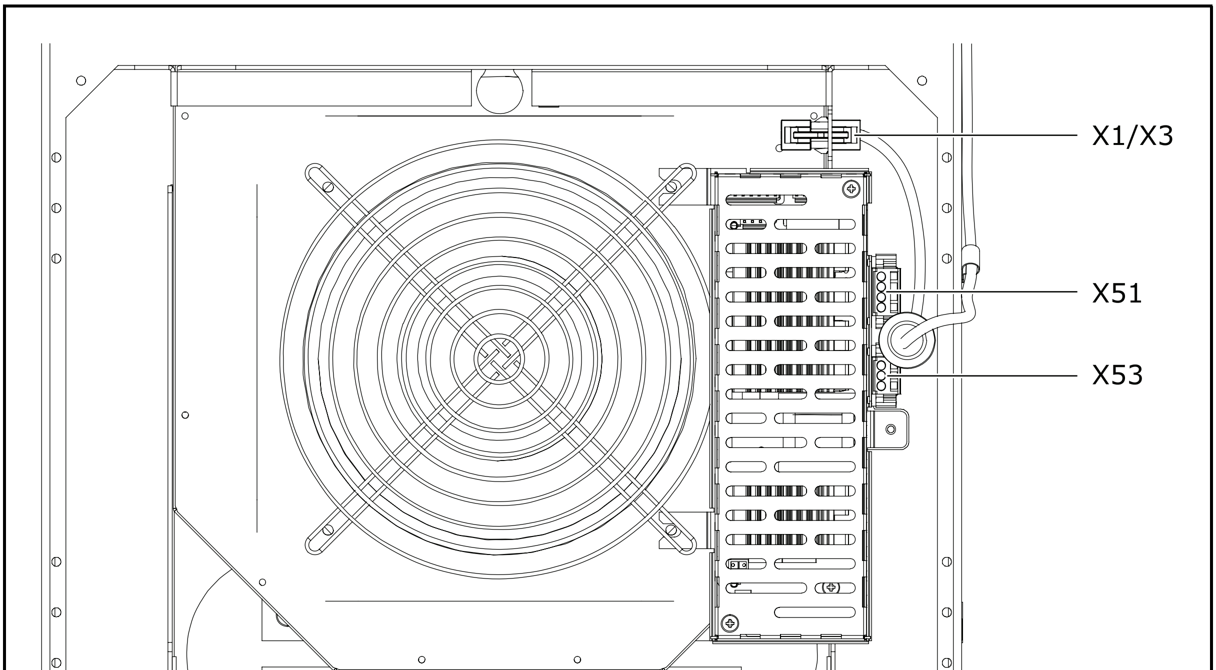


Figure 49. Integrated DC/DC power in the FI13 LCL filter

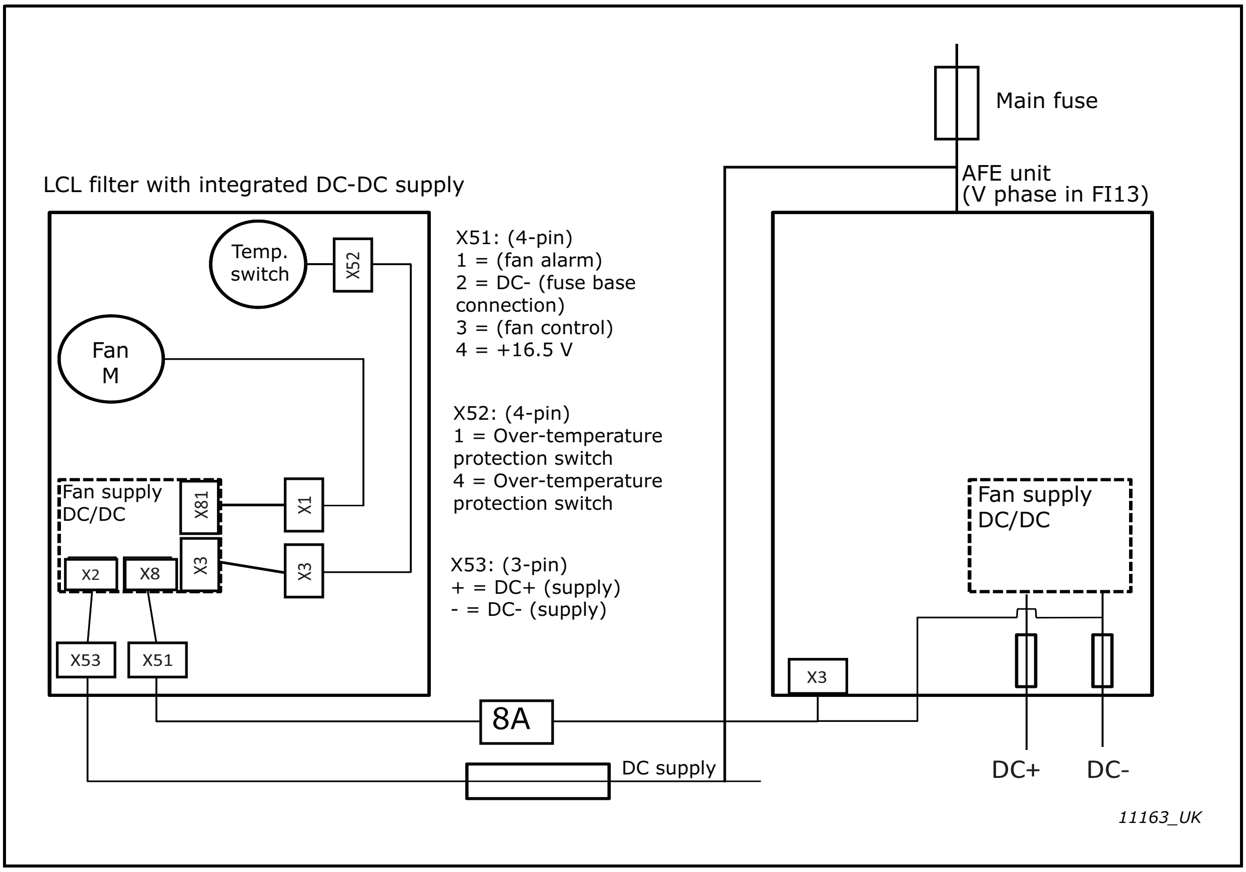


Figure 50. Wiring diagram of integrated DC/DC power

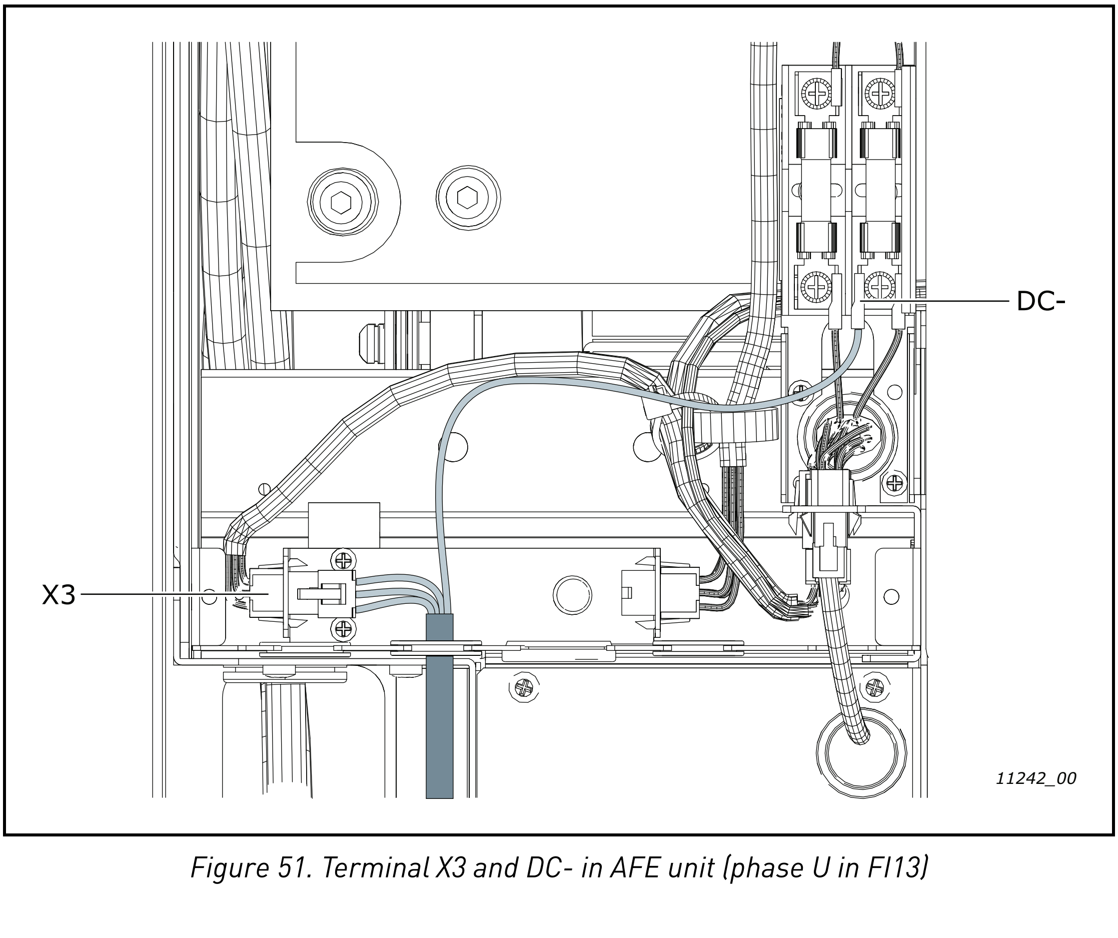


Figure 51. Terminal X3 and DC- in AFE unit (phase U in FI13)

5.3.4.2 LCL filter without DC/DC power supply for fan

The LCL filter is supplied without an integrated DC/DC power supply. In this case, the customer must procure the power supply separately. The requirements for the DC power supply are shown in Table 5. Short-circuit protection is implemented by protecting the input of the DC power with fuses. When required, the cooling fan can be controlled on/off by installing a contactor in the DC power supply input and controlling that depending on whether the main switch is open or closed. The over-temperature protection of the LCL filter must always be wired from contacts 1 and 4 of terminal X52 to a digital input of the control unit (see Figure 90) and from contacts 1 and 2 of terminal X51 to a digital input of the control unit. The wiring of the circuit is shown in Figure 52.

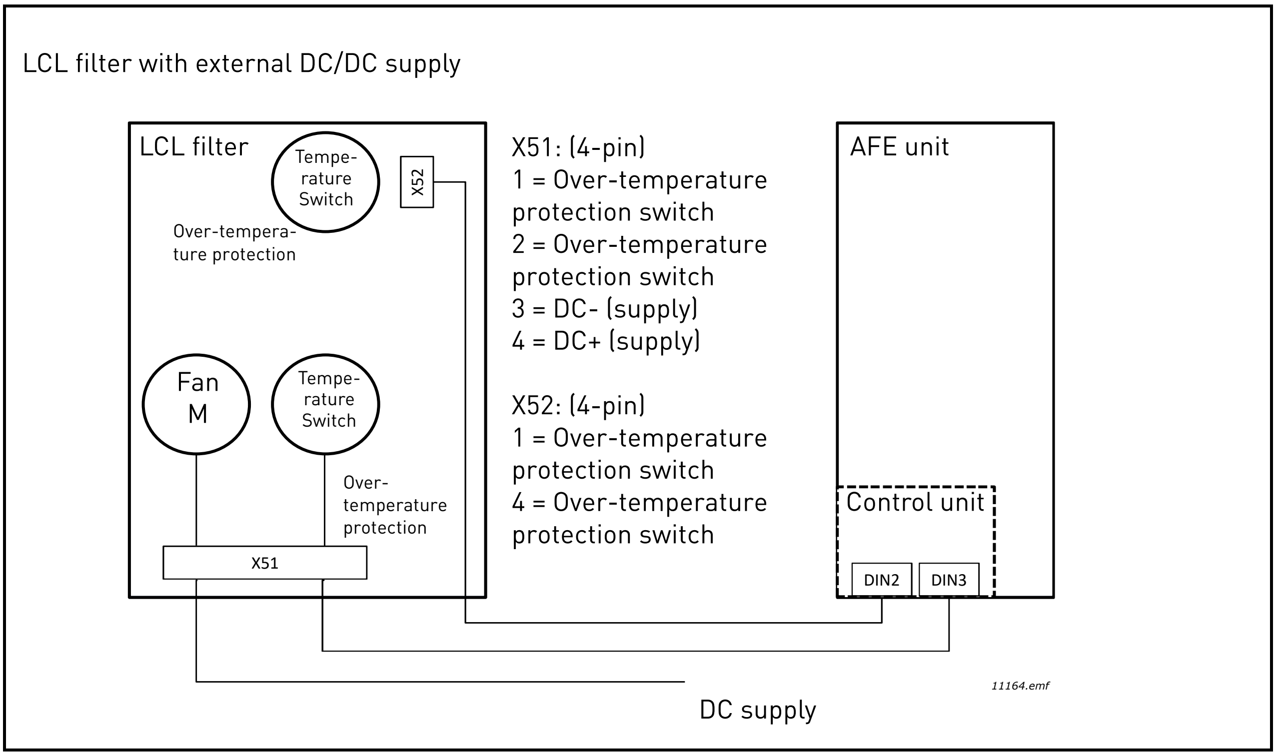


Figure 52. Wiring diagram of external DC-power

5.4 Control unit

5.4.1 Control unit components

The control unit of the VACON® NX Active Front End contains the control board and additional boards (see the figure below) connected to the 5 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.

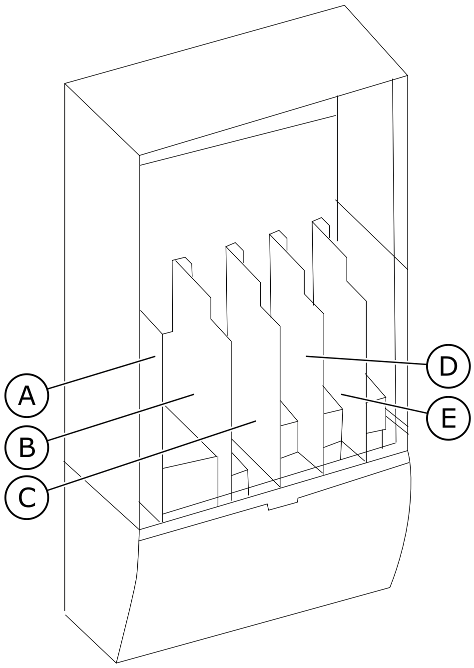


Figure 53. Basic and option board connections on the control board

When you receive the VACON® NX Active Front End, the control unit contains the standard control interface. If you included special options in your order, the VACON® NX Active Front End is as in your order. On the next pages, you can find information on the terminals and general wiring examples. The type code shows the I/O boards that are installed at the factory. For more information on the option boards, see VACON® NX I/O Boards User manual.

For instructions on how to install the control unit that is not attached to the power unit, see VACON® NXP IP00 Drives Installation Manual.

5.4.2 Control voltage (+24 V/EXT +24 V)

It is possible to use the drive with an external power source with these properties: +24 V DC ±10%, minimum 1000 mA. You can use it to externally power-up the control board, and the basic and expander boards.

Connect the external power source to one of the 2 bidirectional terminals (#6 or #12), see Figure 55. With this voltage, the control unit stays on and you can set the parameters. The measurements of the main circuit (for example, the DC-link voltage, and the unit temperature) are not available when the drive is not connected to mains.

NOTE! If you supply the AC drive with external 24 V DC power, you must use a diode in terminal #6 (or #12) to prevent the current to flow in opposite direction. Put a 1 A fuse in 24 V DC line for each AC drive. The maximum current consumption of each drive is 1 A from the external power supply.

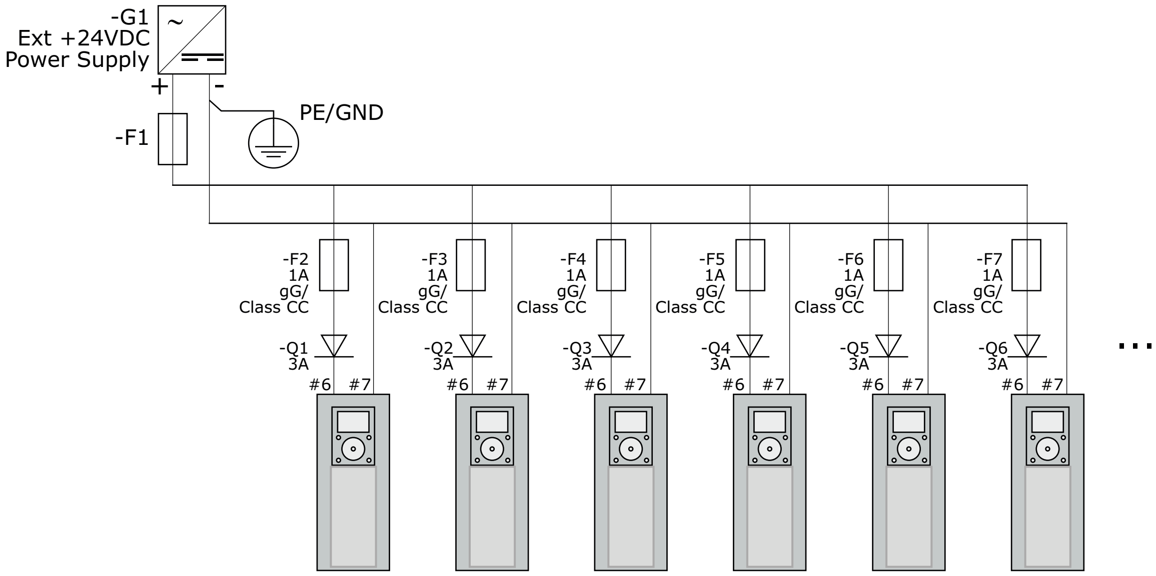


Figure 54. Parallel connection of 24 V inputs with many AC drives

NOTE! The control unit I/O ground is not isolated from the chassis ground / protective earth. In the installation, take into account the potential differences between the grounding points. We recommend that you use galvanic isolation in the I/O and 24 V circuitry.

NOTE! Analogue outputs and inputs do not work with only +24 V supplied to the control unit.

If there is a +24 V/EXT+24 V output on the board, it is locally short-circuit protected. If one of the +24 V/ EXT+24 V outputs short-circuits, the others remain powered because of the local protection.

5.4.3 CONTROL UNIT CABLING

The OPTA1 basic board has 20 control terminals, and the relay board has 6 or 7. You can see the standard connections of the control unit and the descriptions of signals in Figure 55.

5.4.3.1 Selection of the control cables

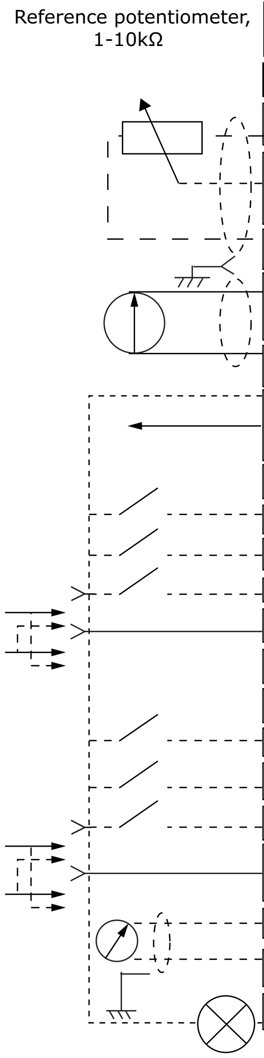
The control cables must be a minimum of 0.5 mm^2 (20 AWG) screened multi-core cables. The terminal wires must be a maximum of 2.5 mm^2 (14 AWG) for the terminals of the relay board and 1.5 mm^2 (16 AWG) for other terminals.

Table 32. The tightening torques of the control cables

The terminal	The terminal screw	The tightening torque	
		Nm	in-lb
Relay and thermistor terminals	M3	0.5	4.5
Other terminals	M2.6	0.2	1.8

5.4.3.2 Control terminals on OPTA1

Here you see the basic description of the terminals of the I/O board and the relay board. For more information, see Jumper selections on the OPTA1 basic board. For more information on control terminals, see VACON® All in One Application manual.



Standard I/O board

Terminal		Signal	Description
1	+10V$_{ref}$	Reference voltage	Maximum current 10 mA
2	AI1+	Analogue input, voltage or current	Selection V/mA with jumper block X1 (*) 0...+10 V (Ri = 200 kΩ) (-10V...+10V Joystick ctrl, sel. with jumper) 0-20 mA (Ri =250 Ω)
3	GND/AI1-	Analogue input common	Differential input if not connected to ground Allows ±20 V common mode voltage to GND
4	AI2+	Analogue input, voltage or current	Selection V/mA with jumper block X1 (*) 0...+10 V (Ri = 200 kΩ) (-10V...+10V Joystick ctrl, sel. with jumper) 0-20 mA (Ri =250 Ω)
5	GND/AI2-	Analogue input common	Differential input if not connected to ground Allows ±20 V common mode voltage to GND
6	+24V	24 V aux. voltage	±15%, max. 250 mA (all boards total) 150 mA (from single board) Can also be used as external power backup for the control unit (and fieldbus)
7	GND	I/O ground	Ground for reference and controls
8	DIN1	Digital input 1	Ri = min. 5 kΩ 18-30 V = 1
9	DIN2	Digital input 2	
10	DIN3	Digital input 3	
11	CMA	Common A for DIN1—DIN3	Digital inputs can be disconnected from ground (*)
12	+24V	Control voltage output	Same as terminal #6
13	GND	I/O ground	Same as terminal #7
14	DIN4	Digital input 4	Ri = min. 5 kΩ 18-30 V = 1
15	DIN5	Digital input 5	
16	DIN6	Digital input 6	
17	CMB	Common B for DIN4-DIN6	Must be connected to GND or 24 V of I/O term. or to ext.24 V or GND Selection with jumper block X3 (*)
18	AO1+	Analogue signal (+output)	Output signal range: Current 0(4)-20 mA, RL max 500 Ω or Voltage 0-10 V, RL >1kΩ Selection with jumper block X6 (*)
19	AO1-	Analogue output common	
20	DO1	Open collector output	Maximum Uin = 48 VDC Maximum current = 50 mA

Figure 55. The control terminal signals in OPTA1

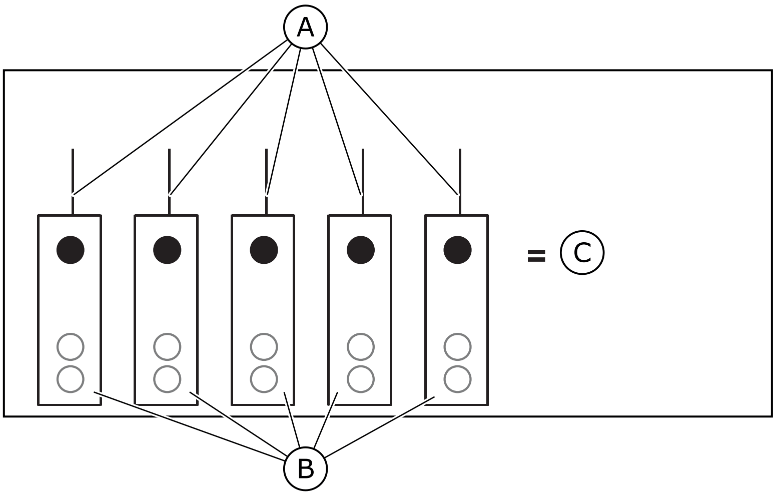
*) See Fig. 26 Jumper blocks on OPTA1.

Parameter references for I/O on keypad and NCDrive are: An.IN:A.1, An.IN:A.2, DigIN:A.1, DigIN:A.2, DigIN:A.3, DigIN:A.4, DigIN:A.5, DigIN:A.6, AnOUT:A.1 and DigOUT:A.1.

To use the control voltage output +24 V/EXT+24 V:

- You can wire the +24 V control voltage to digital inputs through an external switch.
- You can use the control voltage to power up external equipment, such as encoders and auxiliary relays.

Note that the specified total load on all available +24 V/EXT+24 V output terminals must not exceed 250 mA. The maximum load on the +24 V/EXT+24 V output per board is 150 mA.

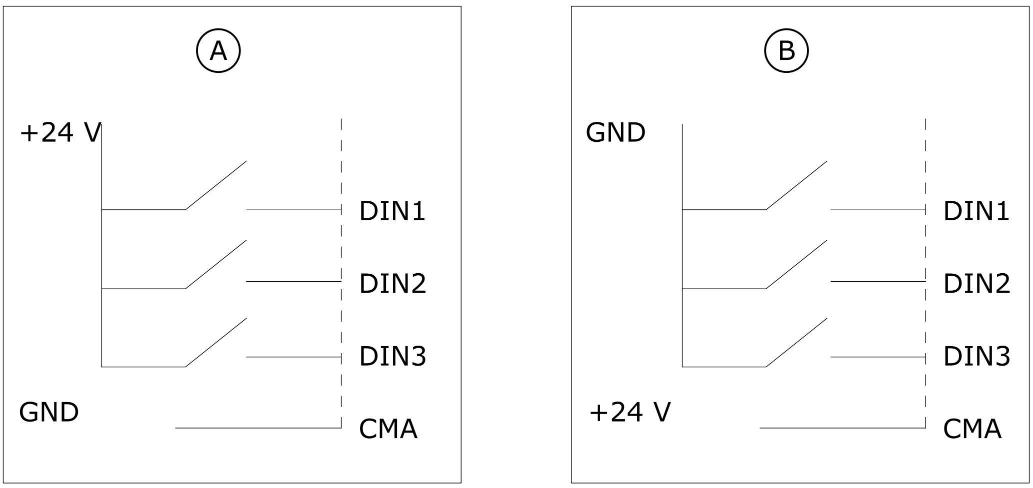


#	Reference	#	Reference
A	Max. 150 mA	C	Max. 250 mA
B	+24 V out		

Figure 56. Maximum loads on +24V/EXT+24V output

Digital input signal inversions

The active signal level is different when the common inputs CMA and CMB (terminals 11 and 17) are connected to +24 V or to ground (0 V). See Fig. 25. The 24 V control voltage and the ground for the digital inputs and the common inputs (CMA, CMB) can be internal or external.



#	Reference	#	Reference
A	Positive logic (+24 V is the active signal) = the input is active when the switch is closed.	B	Negative logic (0 V is the active signal) = the input is active when the switch is closed. You must set the jumper X3 to the position 'CMA/CMB isolated from ground'.

Figure 57. The Positive/Negative logic

Jumper selections on the OPTA1 basic board

You can change the functions of the AC drive to make them better agree with your requirements. To do this, change some positions for the jumpers on the OPTA1 board. The positions of the jumpers set the signal type of analogue and digital inputs.

On the A1 basic board, there are 4 jumper blocks: X1, X2, X3 and X6. Each jumper block contains 8 pins and 2 jumpers. See the possible jumper selections in the figure below.

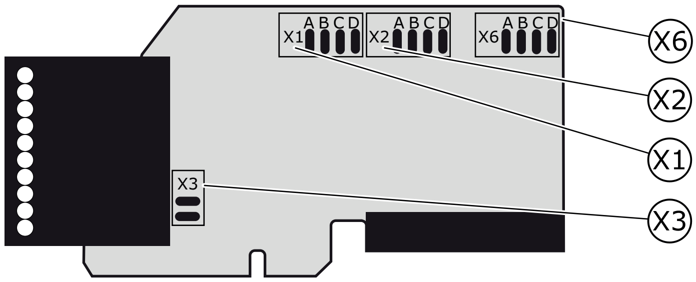


Figure 58. Jumper blocks on OPTA1

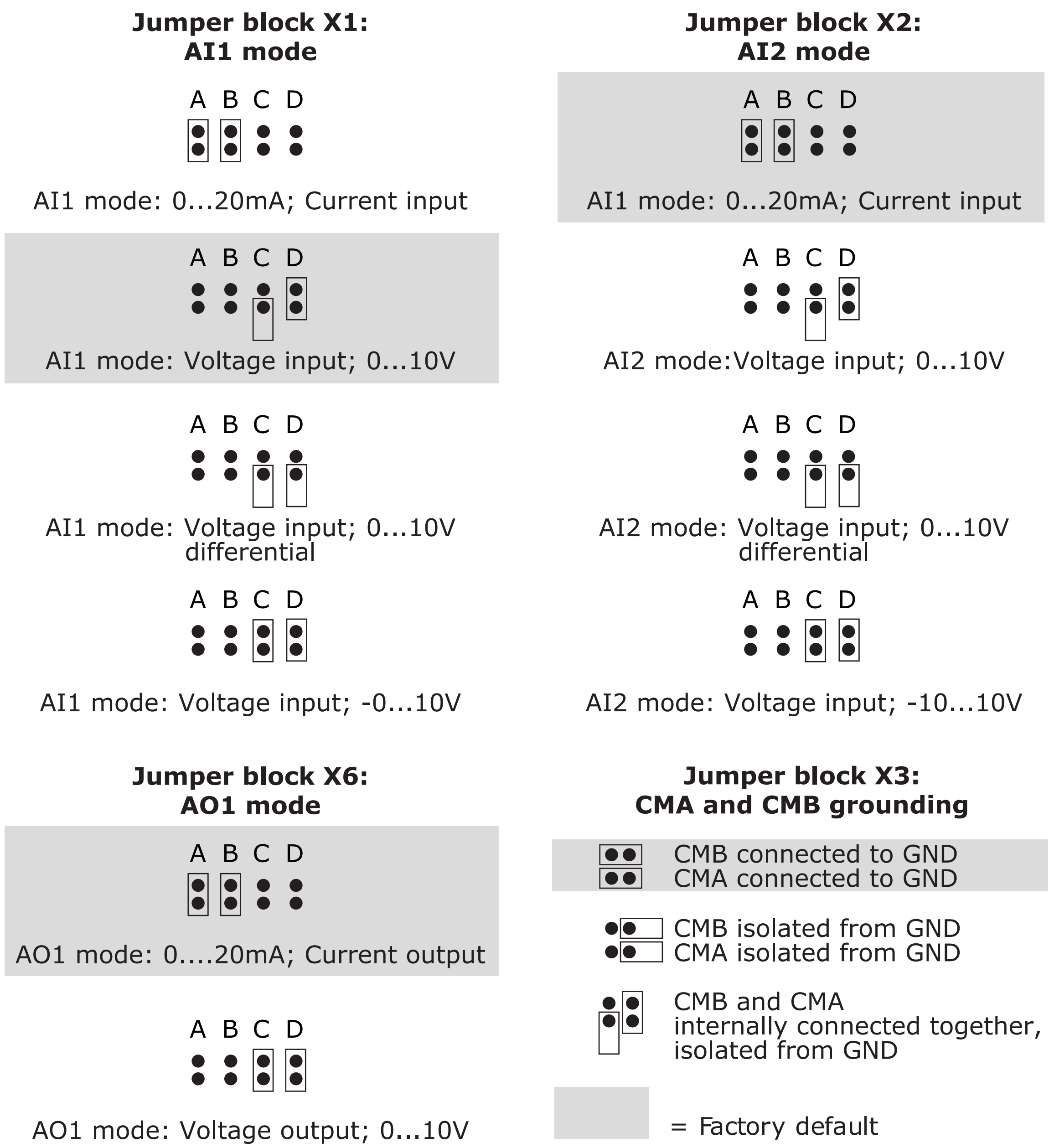


Figure 59. Jumper selections for OPTA1

NOTE! If you change the AI/AO signal contents, also change the related board parameter in menu M7.

5.4.3.3 Control terminals on OPTA2

OPTA2			
21	RO1/1	Relay output 1 DigOUT:B.1 *)	Switching capacity • 24 VDC/8 A • 250 VAC/8 A • 125 VDC/0.4 A Minimum switching load • 5 V/10 mA
22	RO1/2		
23	RO1/3		
24	RO2/1	Relay output 2 DigOUT:B.2 *)	Switching capacity • 24 VDC/8 A • 250 VAC/8 A • 125 VDC/0.4 A Minimum switching load • 5 V/10 mA
25	RO2/2		
26	RO2/3		

Figure 60. The control terminal signals on relay boards OPTA2

*) Parameter reference on keypad and NCDrive.

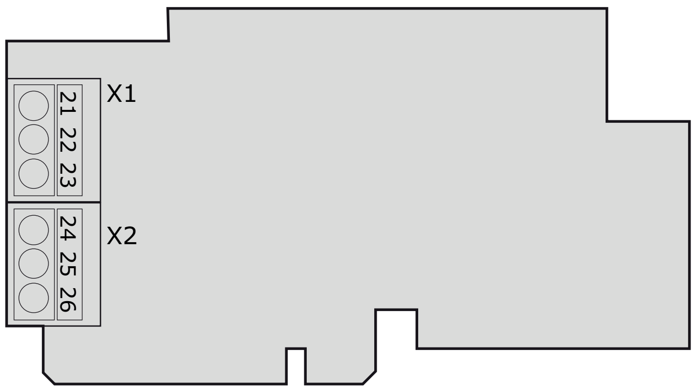


Figure 61. OPTA2

5.5 Galvanic isolation barriers

The control connections are isolated from the mains potential and the GND terminals are permanently connected to ground. See Figure 62.

The digital inputs are galvanically isolated from the I/O ground. The relay outputs are additionally double-isolated from each other at 300 V AC (EN-50178). See Figure 62.

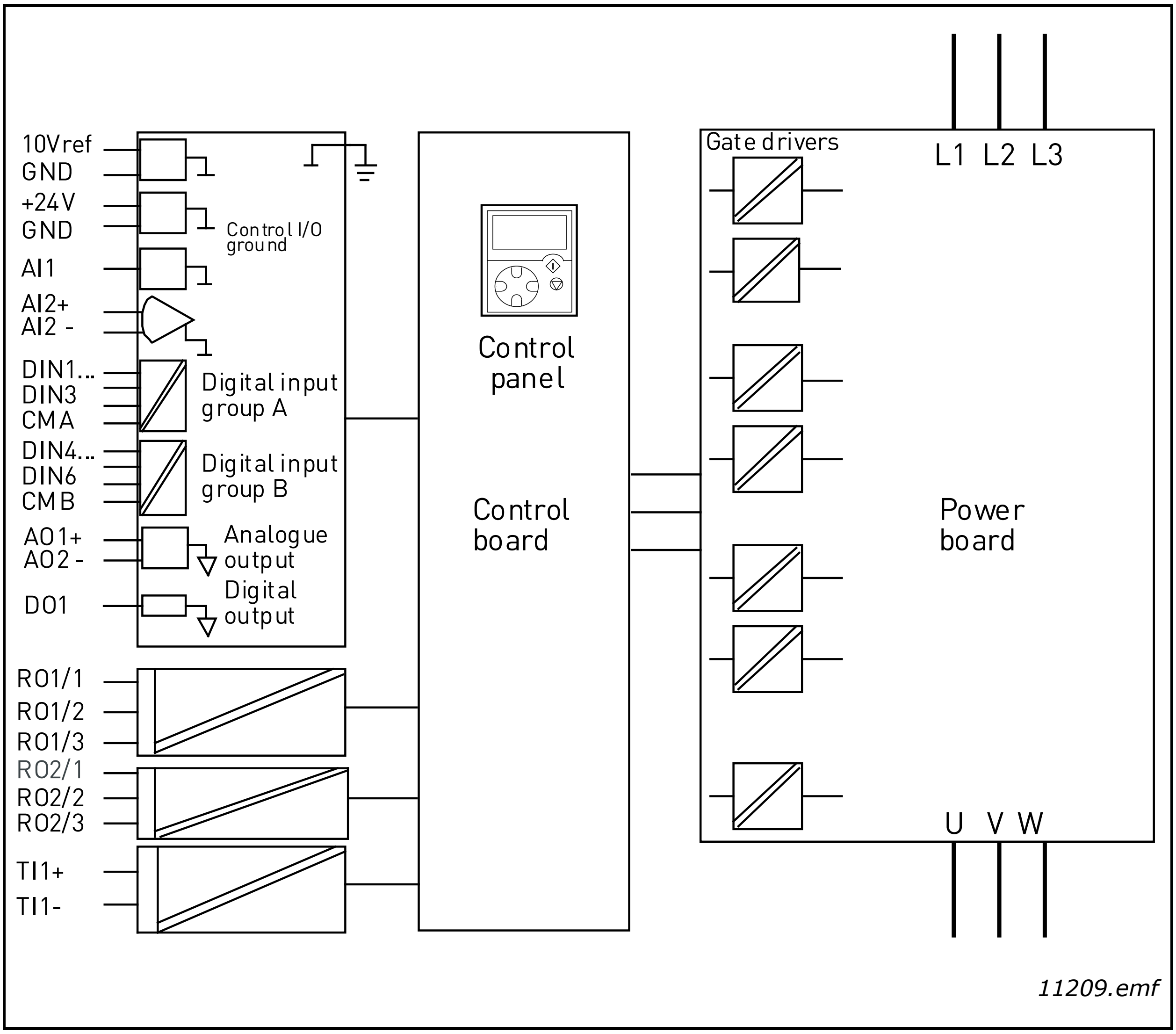


Figure 62. Galvanic isolation barriers

6. CONTROL KEYPAD

The control keypad is the link between VACON®NX Active Front End and the user. The VACON® NX control keypad features an alphanumeric display with seven indicators for the Run status (RUN, ⟲ ⟳, READY, STOP, ALARM, FAULT) and three indicators for the control place (I/O term/ Keypad/ BusComm). There are also three Status Indicator LED's (green – green – red), see Chapter 6.1.2.

The control information, i.e. the menu number, description of the menu or the displayed value and the numeric information are presented on three text lines.

The VACON® NX Active Front End is operable through the nine push-buttons of the control keypad. Furthermore, the buttons can be used in setting parameters and monitoring values.

The keypad is detachable and isolated from the input line potential.

6.1 INDICATORS ON THE KEYPAD DISPLAY

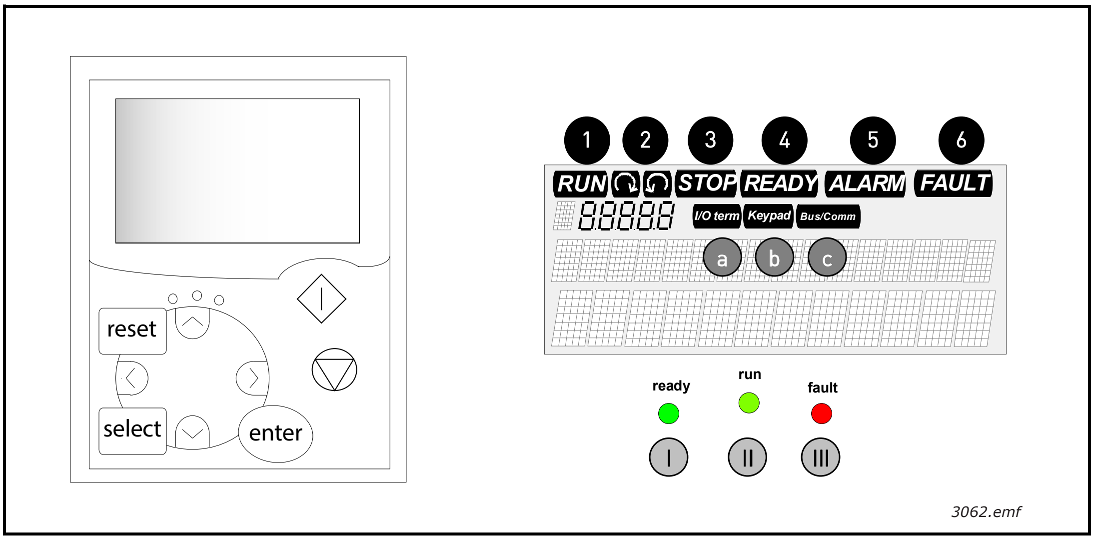


Figure 63. VACON® control keypad and drive status indications

6.1.1 DRIVE STATUS INDICATIONS

The drive status symbols tell the user the status of the brake chopper. In addition, they tell about possible irregularities detected by the brake chopper control software in brake chopper functions.

1	RUN	=	Indicates that the drive is running.
2	STOP	=	Indicates that the drive is not running.
3	READY	=	Lights up when AC power is on. In case of a trip, the symbol will not light up.
4	ALARM	=	Indicates that the drive is running outside a certain limit and a warning is given.
5	FAULT	=	Indicates that unsafe operating conditions were encountered due to which the drive was stopped.

6.1.2 STATUS LEDS (GREEN – GREEN – RED)

The status LEDs light up in connection with the READY, RUN and FAULT drive status indicators.

I	● (green)	=	Lights up with the AC power connected to the drive. Simultaneously, the drive status indicator READY is lit up.
II	● (green)	=	Lights up when the drive is running (modulating).
III	● (red)	=	Lights up when unsafe operating conditions were encountered due to which the drive was stopped (Fault Trip). Simultaneously, the drive status indicator FAULT blinks on the display and the fault description can be seen.

6.1.3 Text Lines

The three text lines (•, ••, •••) provide the users with information on their present location in the keypad menu structure as well as with information related to the operation of the drive.

●	=	Location indicator; displays the symbol and number of the menu, parameter, etc. Example: M2 = Menu 2 (Parameters); P2.1.3 = Acceleration time.
●●	=	Description line; Displays the description of the menu, value or fault.
●●●	=	Value line; Displays the numerical and textual values of references, parameters, etc. and the number of submenus available in each menu.

6.2 Keypad push-buttons

The VACON® NX alphanumeric control keypad has 9 push-buttons that are used for controlling VACON® NX Active Front End, setting parameters, and monitoring values.

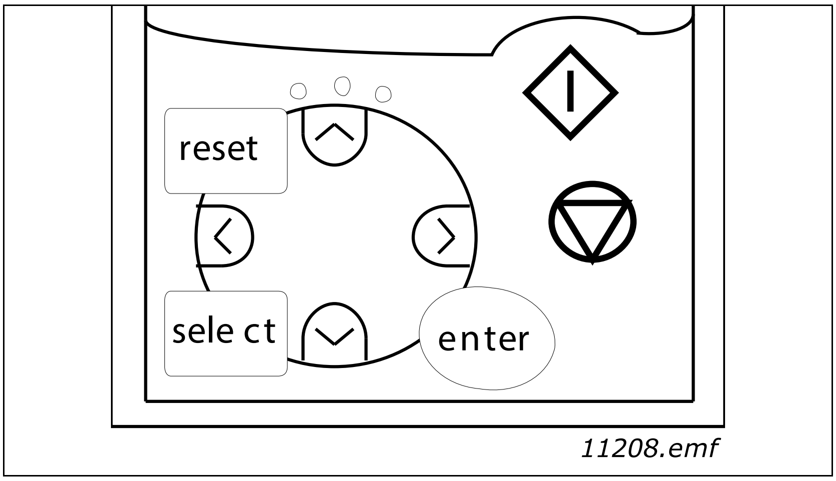
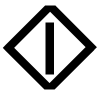
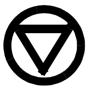


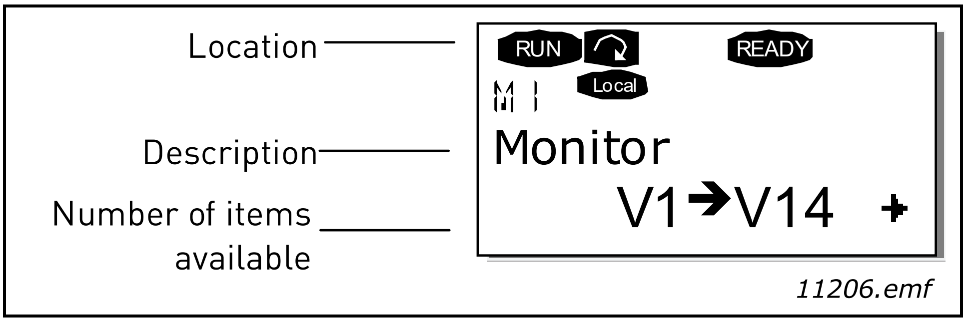
Figure 64. Keypad push-buttons

6.2.1 BUTTON DESCRIPTIONS

reset	=	This button is used to reset active faults. See Chapter 6.3.4.
select	=	This button is used to switch between the two latest displays. This may be useful when you want to see how the changed new value influences some other value.
enter	=	The enter button is used for: 1) Confirmation of selections. 2) Fault history reset (2–3 seconds).
▲ +	=	Browser button up. Browse the main menu and the pages of different submenus. Edit values.
- ▼	=	Browser button down. Browse the main menu and the pages of different submenus. Edit values.
◀	=	Menu button left Move backward in menu. Move cursor left (in parameter menu). Exit edit mode.
▶	=	Menu button right Move forward in menu. Move cursor right (in parameter menu). Enter edit mode.
	=	Start button Pressing this button starts VACON® NX Active Front End (modulation) if the keypad is the active control place. See Chapter 6.3.3.
	=	Stop button Pressing this button stops VACON® NX Active Front End (unless disabled by parameter R3.4/R3.6). See Chapter 6.3.3.

6.3 Navigation on the control keypad

The data on the control keypad is arranged in menus and submenus. The menus are used for the display and editing of measurement and control signals, parameter settings (see Chapter 6.3.2) and reference value and fault displays (see Chapter 6.3.4). Through the menus, you can also adjust the contrast of the display (see Chapter 6.3.8.5).



The first menu level consists of menus **M1** to **M7** and is called the Main menu. The user can navigate in the Main menu with the Browser buttons up and down. The desired submenu can be entered from the Main menu with the Menu buttons. When there still are pages to enter under the currently displayed menu or page, you can see an arrow (➧) in the lower right corner of the display and can reach the next menu level by pressing Menu button right.

The control keypad navigation chart is shown on the next page. Note that menu **M1** is located in the lower left corner. From there you will be able to navigate your way up to the desired menu using the menu and browser buttons.

You will find more detailed descriptions of the menus later in this chapter.

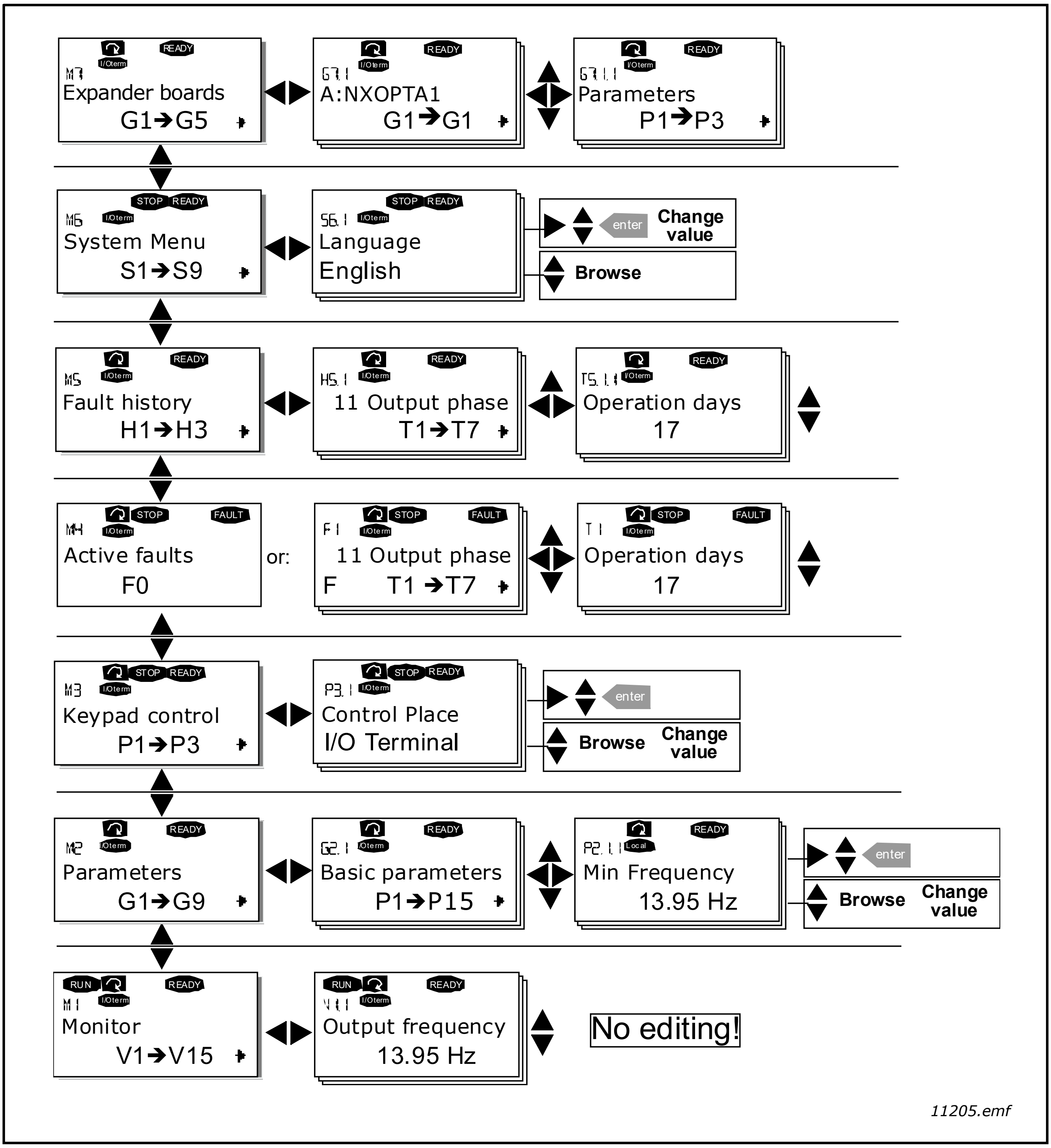


Figure 65. Keypad navigation chart

6.3.1 Monitoring menu (M1)

You can enter the Monitoring menu from the Main menu by pressing Menu button right when the location indication **M1** is visible on the first line of the display. Figure 66 shows how to browse through the monitored values.

The monitored signals carry the indication V#.# and they are listed in Table 33. The values are updated once every 0.3 seconds.

This menu is meant only for signal checking. The values cannot be altered here. For changing values of parameters, see Chapter 6.3.2.

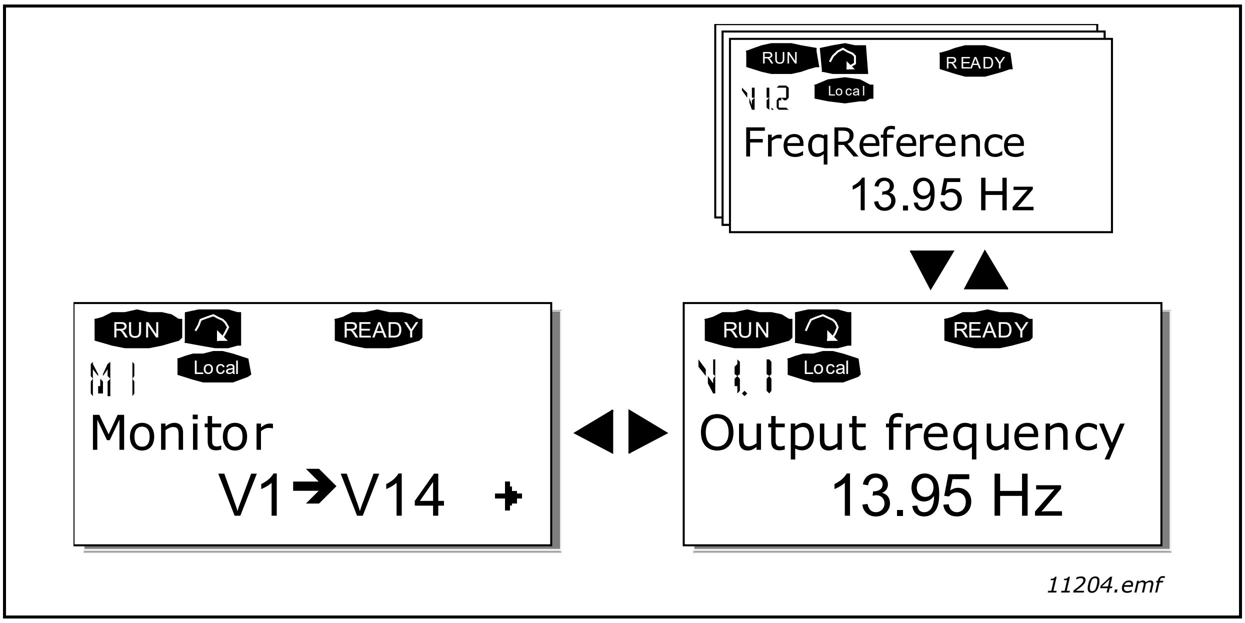


Figure 66. Monitoring menu

Table 33. Monitored signals

Code	Signal name	Unit	Description
V1.1	Frequency reference	Hz	
V1.2	DC-link voltage	V	Measured DC-link voltage
V1.3	Unit temperature	ºC	Heat sink temperature
V1.4	Voltage input	V	AI1
V1.5	Current input	mA	AI2
V1.6	DIN1, DIN2, DIN3		Digital input statuses
V1.7	DIN4, DIN5, DIN6		Digital input statuses
V1.8	DO1, RO1, RO2		Digital and relay output statuses
V1.9	Analogue output current	mA	AO1
M1.17	Multimonitoring items		Displays three selectable monitoring values. See Chapter 6.3.8.4, Multimonitoring items (P6.5.4).

6.3.2 PARAMETER MENU (M2)

Parameters are the way of conveying the commands of the user to VACON® NX Active Front End. Parameter values can be edited by entering the Parameter Menu from the Main Menu when the location indication **M2** is visible on the first line of the display. The value editing procedure is presented in Figure 67.

Pressing Menu button right once takes you to the Parameter Group Menu (G#). Locate the desired parameter group by using the Browser buttons and press Menu button right again to see the group and it's parameters. Use the Browser buttons to find the parameter (P#) you want to edit. Pressing

Menu button right takes you to the edit mode. As a sign of this, the parameter value starts to blink. You can now change the value in two different ways:

- Set the desired value with the Browser buttons and confirm the change with the Enter button. Consequently, the blinking stops and the new value are visible in the value field.

- Press Menu button right once more. Now you will be able to edit the value digit by digit. This may come in handy, when a relatively greater or smaller value than that on the display is desired. Confirm the change with the Enter button.

The value will not change unless the Enter button is pressed. Pressing Menu button left takes you back to the previous menu.

Several parameters are locked, i.e. cannot be edited, when VACON® NX Active Front End is in RUN status. If you try to change the value of such a parameter the text *Locked* will appear on the display. The Active Front End must be stopped to edit these parameters.

The parameter values can also be locked using the function in menu **M6** (see Chapter 6.3.8.4, Parameter lock (P6.5.2)).

You can return to the Main menu any time by pressing Menu button left for 1 to 2 seconds.

You will find the parameter lists from the VACON® NX Active Front End Application manual.

Once in the last parameter of a parameter group, you can move directly to the first parameter of that group by pressing Browser button up.

See the diagram for parameter value change procedure in Figure 67.

NOTE! You can connect power to the control board by connecting the external power source to the bidirectional terminal #6 on the NXOPTA1 board (see Chapter 5.4). The external power source can also be connected to the corresponding +24 V terminal on any option board. This voltage is sufficient for parameter setting and for keeping the fieldbus active.

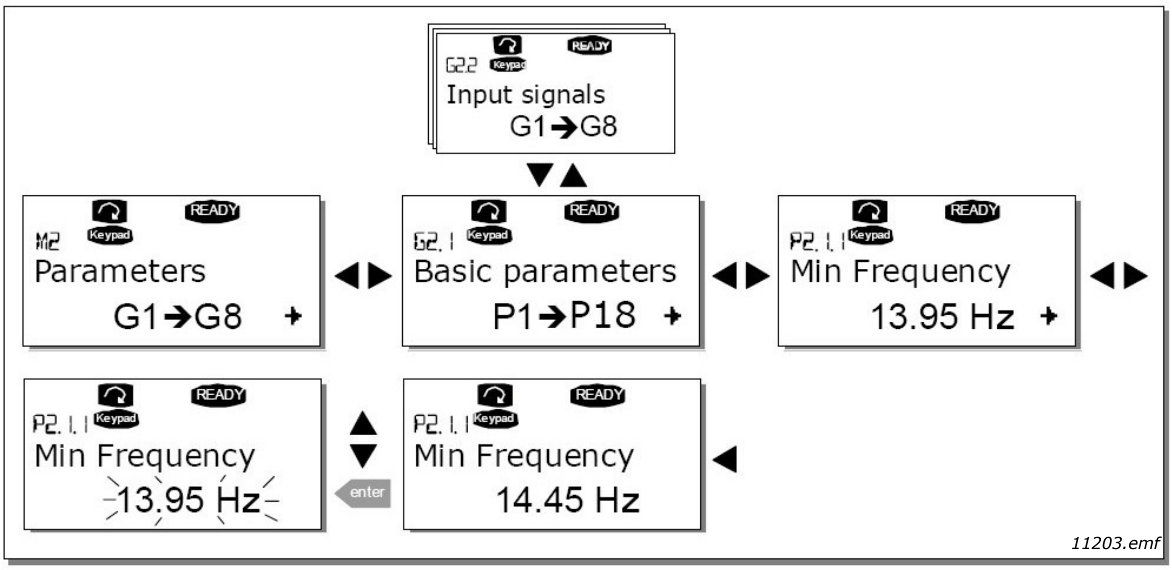
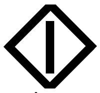


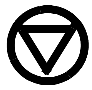
Figure 67. Parameter value change procedure

6.3.3 Keypad control menu (M3)

In the Keypad Control Menu, you can choose the control place. You can enter the submenu level by pressing Menu button right.

NOTE! There are some special functions that can be performed in menu M3:

Select the keypad as the active control place by pressing  for 3 seconds when the Active Front End is running (modulating). The keypad will become the active control place.

Select the keypad as the active control place by pressing  for 3 seconds when the Active Front End is stopped (modulating). The keypad will become the active control place.

NOTE! that if you are in any other than menu **M3** these functions will not work.
If you are in some other than menu **M3** and try to start the Active Front End by pressing the START button when the keypad is not selected as the active control place, you will get an error message: Keypad Control NOT ACTIVE.

6.3.3.1 Selection of control place

There are three different places (sources) where the Active Front End can be controlled from. For each control place, a different symbol will appear on the alphanumeric display:

Control place	Symbol
I/O terminals	I/O term
Keypad (panel)	Keypad
Fieldbus	Bus/Comm

You can change the control place by entering the edit mode with Menu button right. The options can then be browsed with the Browser buttons. Select the desired control place with the Enter button. See the diagram on the next page. See also Chapter 6.3.3 above.

6.3.4 Active fault menu (M4)

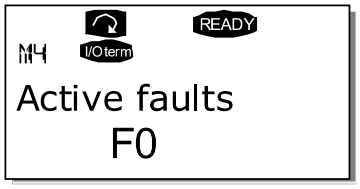
You can enter the Active faults menu from the Main menu by pressing Menu button right when the location indication **M4** is visible on the first line of the keypad display.

When a fault brings the brake chopper to a stop, the location indication F1, the fault code, a short description of the fault, and the fault type symbol (see Chapter 6.3.5) will appear on the display. In addition, the indication FAULT or ALARM (see Figure 67 or Chapter 6.1.1) is displayed and, in case of a FAULT, the red LED on the keypad starts to blink. If several faults occur simultaneously, the list of active faults can be browsed with the Browser buttons.

The memory of active faults can store a maximum of 10 faults in the order of appearance. The display can be cleared with the Reset button and the read-out will return to the same state it was in before the fault trip. The fault remains active until it is cleared with the Reset button or with a reset signal from the I/O terminal.

NOTE! Remove external Start signal before resetting the fault to prevent unintentional restart of the drive.

Normal state, no faults



11201.emf

6.3.5 FAULT TYPES

VACON® NX Active Front End has four types of faults. These types differ from each other on the basis of the subsequent behaviour of the drive. See Table 34.

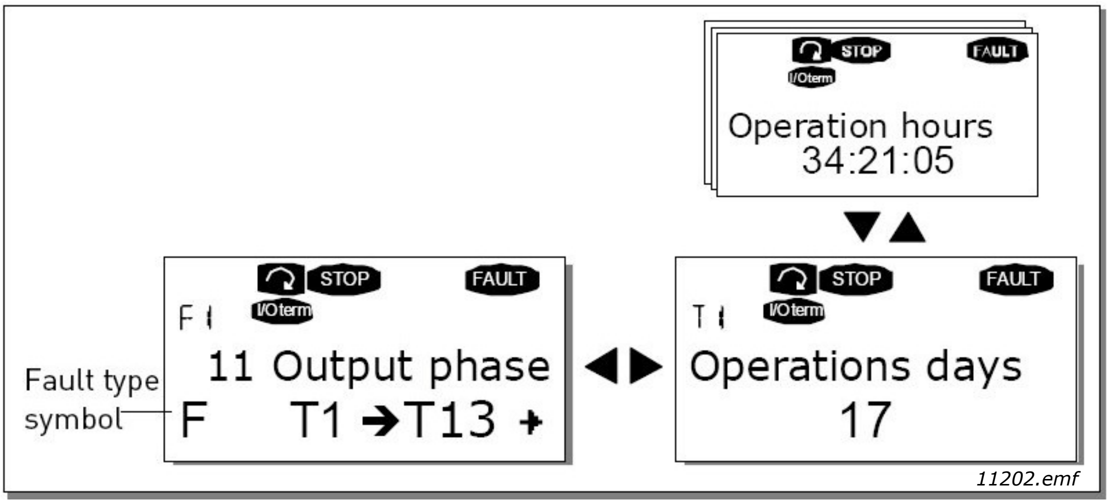


Figure 68. Fault display

Table 34. Fault types

Fault type symbol	Meaning
A (Alarm)	This type of fault is a sign of an unusual operating condition. It does not cause the drive to stop, nor does it require any special actions. The 'A fault' remains in the display for about 30 seconds.
F (Fault)	An 'F fault' makes the drive stop. Actions need to be taken to restart the drive.
AR (Fault Autoreset)	If an 'AR fault' occurs the drive will stop immediately. The fault is reset automatically and the drive tries to restart the motor. Finally, if the restart is not successful, a fault trip (FT, see below) occurs.
FT (Fault Trip)	If the drive is unable to restart the motor after an AR fault an FT fault occurs. The 'FT fault' has basically the same effect as the F fault: the drive is stopped.

6.3.6 Fault codes

The fault codes, their causes and correcting actions are presented in the Table 35. The shadowed faults are A faults only. The items in white on black background are faults for which you can program different responses in the application. See parameter group Protections.

NOTE! When contacting the distributor or factory because of a fault condition, always write down all texts and codes visible on the keypad display.

Table 35. Fault codes

Fault code	Fault	Possible cause	Correcting measures
1	Overcurrent	AFE has detected too high current (>4*IH) in the resistor cables.	- Check cables. - Check resistors.
2	Overvoltage	The DC-link voltage has exceeded the limit: 911 V for 500 V AFE 1200 V for 690 V AFE	
7	Saturation trip	Various causes: - Defective component. - Brake resistor short-circuit or overload.	- Cannot be reset from the keypad. - Switch off power. - DO NOT RE-CONNECT POWER! - Contact your local distributor.
8	System fault	- Component failure - Faulty operation Note exceptional fault data record Subcode in T.14: S1 = Reserved S2 = Reserved S3 = Reserved S4 = Reserved S5 = Reserved S6 = Reserved S7 = Charging switch S8 = No power to driver card S9 = Power unit communication (TX) S10 = Power unit communication (Trip) S11 = Power unit communication (Measurement)	Reset the fault and restart. Should the fault re-occur, contact your local distributor.
9	Undervoltage	DC-link voltage is under the AFE fault voltage limit: 333 VDC for 500 V AFE 460 VDC for 690 V AFE - Most probable cause: too low supply voltage in the system. - AFE internal fault.	- In case of temporary supply voltage break, reset the fault and restart the AC drive. - Check the supply voltage. - If it is adequate, an internal failure has occurred. - Contact your local distributor.
13	AFE undertemperature	Heat sink temperature is under –10 °C	
14	AFE overtemperature	Heat sink temperature is over 90 °C. Overtemperature warning is issued when the heat sink temperature exceeds 85 °C.	- Check the correct amount and flow of cooling air. - Check the heat sink for dust. - Check the ambient temperature.

Table 35. Fault codes

Fault code	Fault	Possible cause	Correcting measures
18	Unbalance (Warning only)	Unbalance between power modules in paralleled units. Subcode in T.14: S1 = Current unbalance S2 = DC-Voltage unbalance	Should the fault re-occur, contact your local distributor.
29	Thermistor fault	The thermistor input of option board has detected too high resistor temperature.	Check resistors. Check thermistor connection (If thermistor input of the option board is not in use it has to be short circuited).
31	IGBT temperature (hardware)	IGBT Inverter Bridge overtemperature protection has detected too high a short term overload current	
35	Application	Problem in application software	Contact your distributor. If you are application programmer check the application program.
37	Device changed (same type)	Option board or control unit changed. Same type of board or same power rating of drive.	Reset. Device is ready for use. Old parameter settings will be used.
38	Device added (same type)	Option board or drive added. Drive of same power rating or same type of board added.	Reset. Device is ready for use. Old board settings will be used.
39	Device removed	Option board removed. Drive removed.	Reset. Device no longer available.
40	Device unknown	Unknown option board or drive. Subcode in T.14: S1 = Unknown device S2 = Power1 not same type as Power2	Contact the distributor near to you.
41	IGBT temperature	IGBT Inverter Bridge overtemperature protection has detected too high a short term overload current	
44	Device changed (different type)	Option board or control unit changed. Option board of different type or different power rating of drive.	Reset. Set the option board parameters again if option bard changed. Set converter parameters again if power unit changed.
45	Device added (different type)	Option board or drive added. Option board of different type or drive of different power rating added.	Reset. Set the option board parameters again.
51	External fault	Digital input fault.	Remove fault situation from external device.
54	Slot fault	Defective option board or slot	Check board and slot. Contact your nearest distributor.
56	PT100 fault	Temperature limit values set for the PT100 have been exceeded.	Find the cause of temperature rise.
60	Cooling fault	The cooling circulation of the liquid cooled drive has failed.	Check the reason for the cooling failure from the external system.

6.3.6.1 Fault time data record

When a fault occurs, the information described in Chapter 6.3.4 is displayed. By pressing Menu button right, you will enter the Fault time data record menu indicated by T.1→T.#. In this menu, some selected important data valid at the time of the fault are recorded. This feature will help the user or the service person in determining the cause of the fault.

The data available are;

Table 36. Fault time recorded data

T.1	Counted operation days (Fault 43: Additional code)	(d)
T.2	Counted operation hours (Fault 43: Counted operation days)	(hh:mm:ss) (d)
T.3	Output frequency (Fault 43: Counted operation hours)	Hz (hh:mm:ss)
T.8	DC voltage	V
T.9	Unit temperature	°C
T.10	Run status	
T.11	Direction	
T.12	Warnings	

Real time record

If real time is set to run, the data items T1 and T2 will appear as follows:

T.1	Counted operation days	yyyy-mm-dd
T.2	Counted operation hours	hh:mm:ss,sss

6.3.6.2 Error message on control panel display

The alphanumerical keypad memory has been upgraded from 32 kbit to 64 kbit in VACON® NX AC drives. This allows the applications with larger parameter sets to be copied to keypad memory.

If an application with larger parameter sets is uploaded into 32 kbit control panel, it shows an error message "Failed". A new control panel version with 64 kbit must be used to avoid the error message.

6.3.7 Fault history menu (M5)

You can enter the Fault history menu from the Main menu by pressing Menu button right when the location indication **M5** is visible on the first line of the keypad display.

All faults are stored in the Fault history menu where you can browse them with the Browser buttons. Additionally, the Fault time data record pages (see Chapter 6.3.6.1) are accessible for each fault. You can return to the previous menu any time by pressing Menu button left. The memory of the Active Front End can store a maximum of 30 faults in order of appearance. The number of faults currently in the fault history is shown on the value line of the main page (H1→H#). The order of the faults is indicated by the location indication in the upper left corner of the display. The latest fault is indicated by F5.1, the one before that by F5.2 and so on. If there are 30 uncleared faults in the memory, the next fault will erase the oldest fault from the memory.

Pressing the Enter button for about 2 to 3 seconds resets the whole fault history. The symbol H# will change to 0.

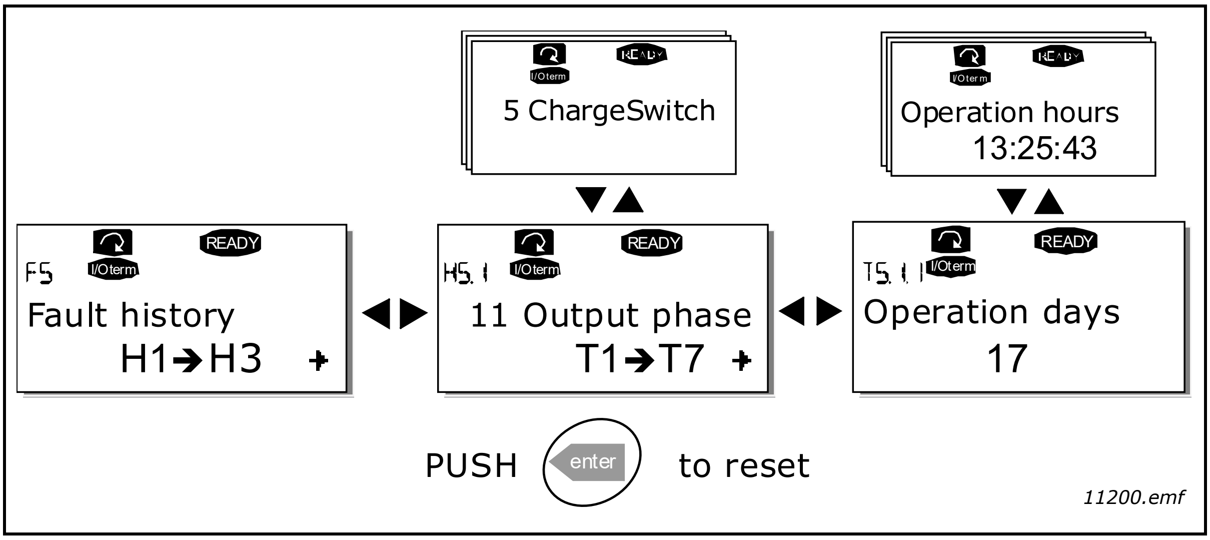


Figure 69. Fault history menu

6.3.8 SYSTEM MENU (M6)

You can enter the System menu from the Main menu by pressing Menu button right when the location indication **M6** is visible on the first line of the keypad display.

The controls associated with the general use of the Active Front End, such as application selection, customised parameter sets or information about the hardware and software are located under the System menu. The number of submenus and subpages is shown with the symbol S (or P) on the value line.

The System menu functions are presented in the Table 37.

System menu functions

Table 37. System menu functions

Code	Function	Min	Max	Unit	Default	Selections
S6.1	Selection of language				English	English Deutsch Suomi Svenska Italiano
S6.2	Application selection				Active Front End application	
S6.3	Copy parameters					

Table 37. System menu functions

Code	Function	Min	Max	Unit	Default	Selections
S6.3.1	Parameter sets					Load factory defaults Store set 1 Load set 1 Store set 2 Load set 2
S6.3.2	Up to keypad					All parameters
S6.3.3	Down from keypad					All parameters All but motor parameters Application parameters
P6.3.4	Autom. BackUp				Yes	No Yes
S6.4	Parameter comparison					
S6.5	Security					
S6.5.1	Password				Not used	0 = Not used
P6.5.2	Parameter locking				Change Enabled	Change Enabled Change Disabled
S6.5.3	Start-up wizard					No Yes
S6.5.4	Multimonitoring items				Change Enabled	Change Enabled Change Disabled
P6.5.5	OPTAF Remove					
S6.6	Keypad settings					
P6.6.1	Default page					
P6.6.2	Default page/OM					
P6.6.3	Timeout time	0	65535	s	30	
P6.6.4	Contrast	0	31		18	
P6.6.5	Backlight time	Always	65535	min	10	
S6.7	Hardware settings					
P6.7.1	Internal brake resistor				Connected	Not connected Connected
P6.7.2	Fan control function				Continuous	Continuous Temperature First Start Calc temp
P6.7.3	HMI acknowledgment	200	5000	ms	200	
P6.7.4	HMI: no. of retries	1	10		5	
P2.6.7.5	Sine Filter					Not connected Connected
P2.7.6	Pre-Charge Mode					Normal FC Ext. ChSwitch
S6.8	System information					
S6.8.1	Total counters					
T6.8.1.1.	MWh counter			kWh		
T6.8.1.2.	PwOn Day Counter					

Table 37. System menu functions

Code	Function	Min	Max	Unit	Default	Selections
T6.8.1.3.	PwOn Hour Count.					
S6.8.2	Trip counters					
T6.8.2.1	MWh counter					
T6.8.2.2	Clr MWh Counter					Not Reset Reset
T6.8.2.3	PwOn Day Counter					
T6.8.2.4	PwOn Hour Count.					
T6.8.2.5	Clr Optime cntr					Not Reset Reset
S6.8.3	Software					
I6.8.3.1	Software package					
I6.8.3.2	SystemSw version					
I6.8.3.3	Firmware interf.					
I6.8.3.4	System load					
S3.8.4	Applications					
S6.8.5	Hardware					
S6.8.5.1	Power unit					
S6.8.5.2	Unit Voltage					
S6.8.5.3	Brake Chopper					
S6.8.5.4	Brake Resistor					
S6.8.5.5	Serial number					
S6.8.6	Expander boards					A: B: C: D: E:
S6.8.7	Debug					
I6.8.7.1	System Load					
I6.8.7.2	Parameter Log					
S6.9	Power Monitor					IU filtered IV filtered IW filtered
S6.11	Power multimon.					

6.3.8.1 Selection of language

The VACON® NX control keypad offers you the possibility to control the inverter through the keypad in the language of your choice.

Locate the language selection page under the System menu. It´s location indication is S6.1. Press Menu button right once to enter the edit mode. As the name of the language starts to blink you can select another language for the keypad texts. Confirm with the Enter button. The blinking stops and all text information on the keypad are presented in the selected language.

You can return to the previous menu any time by pressing Menu button left.

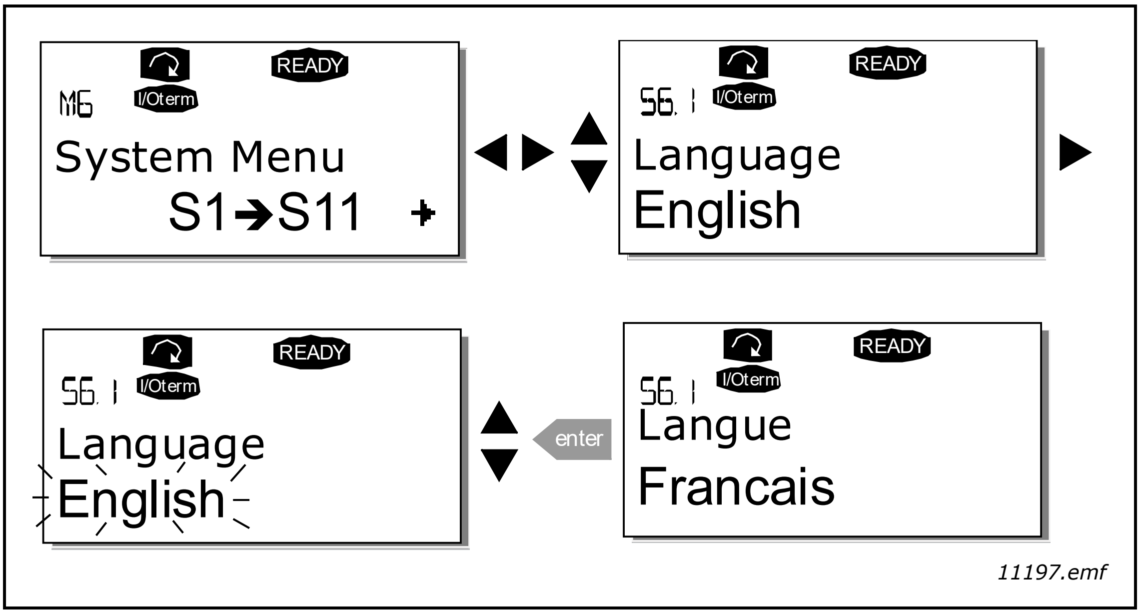


Figure 70. Selection of language

6.3.8.2 Copy parameters

The parameter copy function is used when the operator wants to copy one or all parameter groups from one drive to another. All the parameter groups are first uploaded to the keypad, then the keypad is connected to another drive and then the parameter groups are downloaded to it (or possibly back to the same drive). For more information, see on Page 113.

Before any parameters can be successfully copied from one drive to another, the Active Front End has to be stopped when the parameters are downloaded to it:

The parameter copy menu (S6.3) contains four functions:

Parameter sets (S6.3.1)

The user can reload the factory default parameter values and store and load two customised parameter sets (all parameters included in the application).

On the Parameter sets page (S6.3.1), press Menu button right to enter the edit mode. The text LoadFactDef begins to blink and you can confirm the loading of factory defaults by pressing the Enter button. The drive resets automatically.

Alternatively, you can choose any other storing or loading functions with the Browser buttons. Confirm with the Enter button. Wait until 'OK' appears on the display.

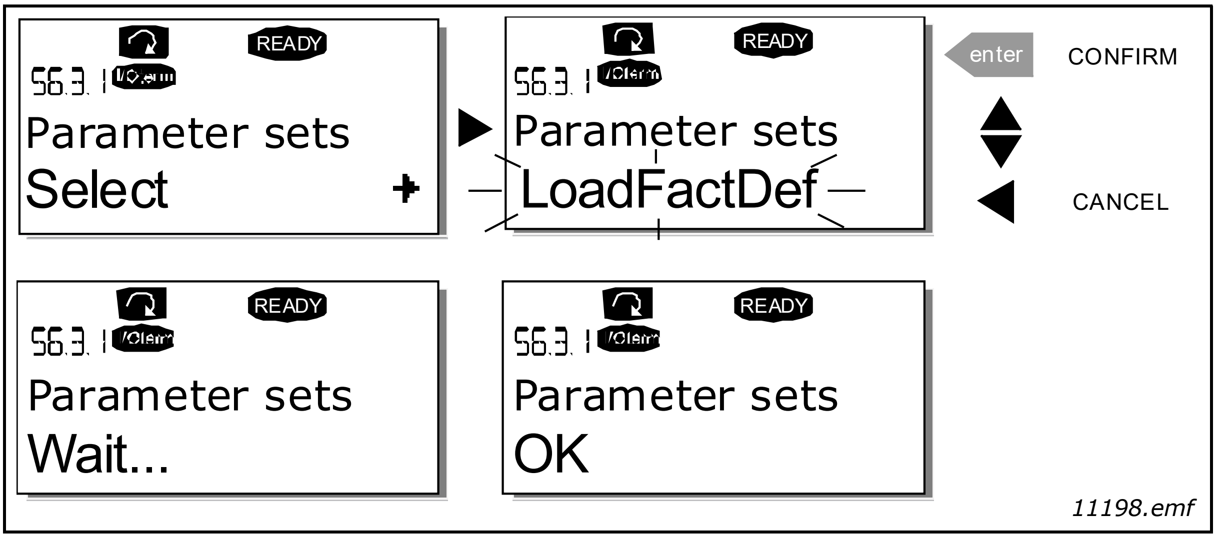


Figure 71. Storing and loading of parameter sets

Upload parameters to keypad (To keypad, S6.3.2)

This function uploads all existing parameter groups to the keypad provided that the drive is stopped.

Enter the To keypad page (S6.3.2) from the Parameter copy menu. Pressing Menu button right takes you to the edit mode. Use the Browser buttons to select the option All parameters and press the Enter button. Wait until 'OK' appears on the display.

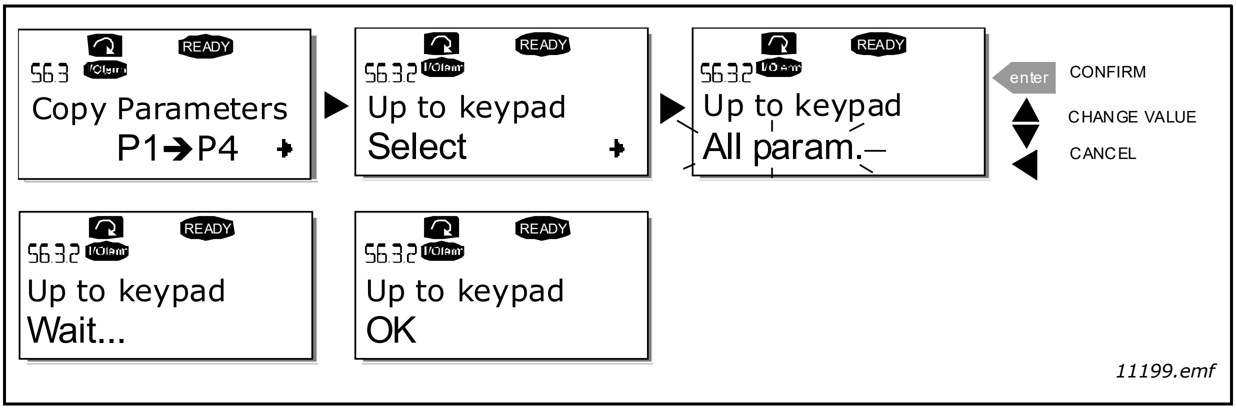


Figure 72. Parameter copy to keypad

Download parameters to drive (From keypad, S6.3.3)

This function downloads one or all parameter groups uploaded to the keypad to a drive provided that the drive is in STOP status.

Enter the To keypad page (S6.3.2) from the Parameter copy menu. Pressing the Menu button right takes you to the edit mode. Use the Browser buttons to select either All parameters, All but motor parameters or Application parameters and press the Enter button. Wait until 'OK' appears on the display.

The procedure to download the parameters from keypad to Active Front End is similar to that of from Active Front End to keypad. See Figure 71.

Automatic parameter backup (P6.3.4)

On this page you can activate or inactivate the parameter backup function. Enter the edit mode by pressing Menu button right. Select Yes or No with the Browser buttons.

When the Parameter backup function is activated VACON® NX control keypad makes a copy of the parameters of the presently used application. When applications are changed, you will be asked if you wish the parameters of the new application to be uploaded to the keypad. If you want to do this, press the Enter button. If you wish to keep the copy of the parameters of the previously used application saved in the keypad, press any other button. Now you will be able to download these parameters to the Active Front End following the instructions given in Chapter 6.3.8.2.

If you want the parameters of the new application to be automatically uploaded to the keypad you have to do this for the parameters of the new application once on page the Upload parameters to keypad (To keypad, S6.3.2) as instructed. Otherwise the panel will always ask for the permission to upload the parameters.

NOTE! Parameters saved in the parameter settings on page the Parameter sets (S6.3.1) will be deleted when applications are changed. If you want to transfer the parameters from one application to another, you have to upload them first to the keypad.

6.3.8.3 Parameter comparison

In the Parameter comparison submenu (S6.4), you can compare the actual parameter values to the values of your customised parameter sets and those loaded to the control keypad.

You can compare the parameter by pressing Menu button right in the Compare parameters submenu. The actual parameter values are first compared to those of the customised parameter Set1. If no differences are detected, '0' is displayed on the lowermost line. If any of the parameter values differ from those of Set1, the number of the deviations is displayed together with symbol P (for example, P1→P5 = five deviating values). By pressing Menu button right once more, you can enter pages where you can see both the actual value and the value it was compared to. In this display, the value on the description line (in the middle) is the default value and the one on the value line (lowermost) is the edited value. Furthermore, you can also edit the actual value with the Browser buttons in the edit mode which you can enter by pressing Menu button right once.

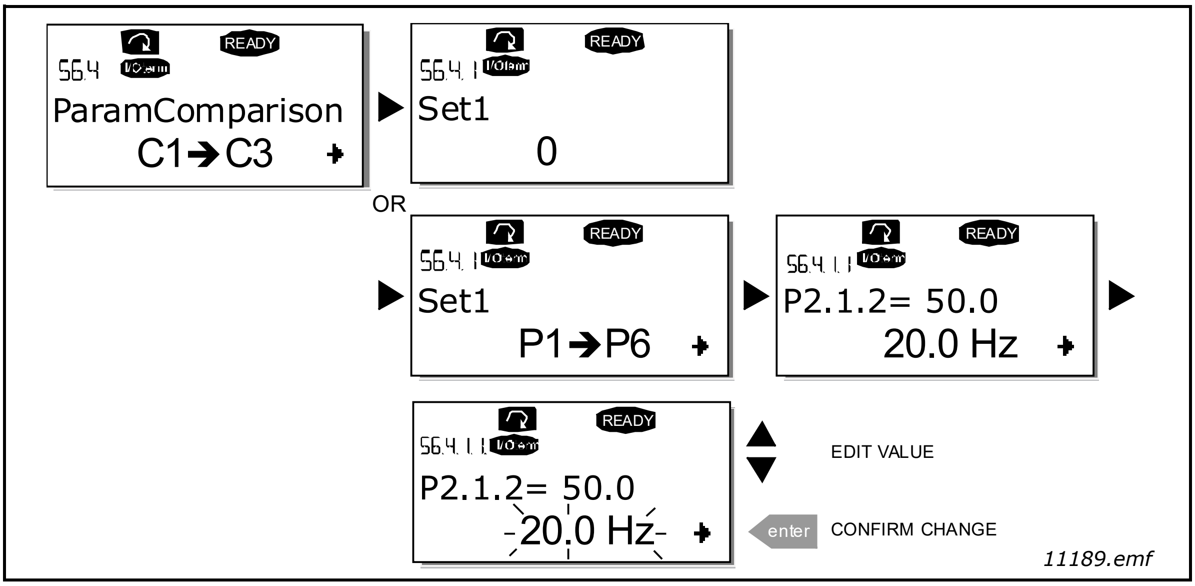


Figure 73. Parameter comparison

6.3.8.4 Safety

NOTE! The Security submenu (S6.5) is protected with a password. Store the password in a safe place!

Password (S6.5.1)

The application selection can be protected against unauthorised changes with the Password function (S6.5.1).

By default, the password function is not in use. If you want to activate the function, enter the edit mode by pressing Menu button right. A blinking zero appears in the display and you can set a password with the Browser buttons. The password can be any number between 1 and 65535.

NOTE! that you can also set the password by digits. In the edit mode, push Menu button right again and Timeout time (P6.6.3) another zero appears on the display. Set ones first. To set the tens, press Menu button right, and so on. Confirm the password with the Enter button. After this, you have to wait until the Timeout time (P6.6.3) (see Timeout time (P6.6.3) has expired before the password function is activated.

If you try to change applications or the password itself, you will be prompted for the current password. Enter the password with the Browser buttons.

You can deactivate the password function by entering the value 0.

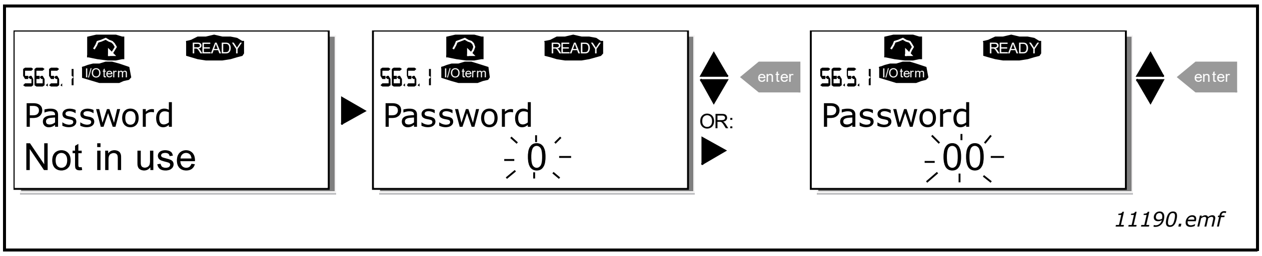


Figure 74. Password setting

NOTE! Store the password in a safe place! No changes can be made unless a valid password is entered.

Parameter lock (P6.5.2)

This function allows the user to prohibit changes to the parameters.
If the parameter lock is activated, the text *locked* will appear on the display if you try to edit a parameter value.

NOTE! This function does not prevent unauthorised editing of parameter values.

Enter the edit mode by pressing Menu button right. Use the Browser buttons to change the parameter lock status. Confirm the change with the Enter button or go back to the previous level by pressing Menu button left.

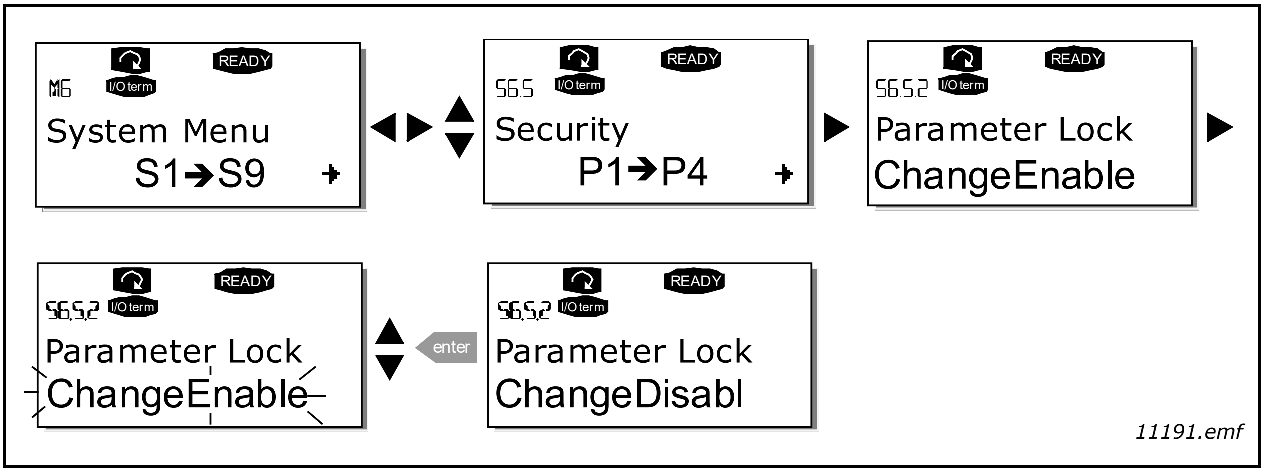


Figure 75. Parameter locking

Start-up wizard (P6.5.3)

The Start-up wizard facilitates the commissioning of VACON® NX Active Front End. If active, the Start-up wizard prompts the operator for the language and application of his/her choice and then displays the first menu or page.

Activating the Start-up wizard: In the System Menu, find page P6.5.3. Press Menu button right once to enter the edit mode. Use the Browser buttons to select Yes and confirm the selection with the Enter button. If you want to deactivate the function, follow the same procedure and give the parameter value No.

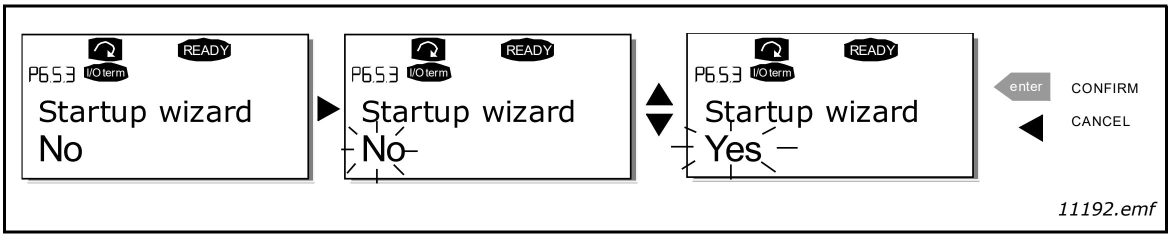


Figure 76. Activation of Start-up wizard

Multimonitoring items (P6.5.4)

VACON® NX alphanumeric keypad features a display where you can monitor up to three actual values at the same time (see Chapter 6.3.1 and Chapter Monitoring values in the manual of the application you are using). On page P6.5.4 of the System Menu, you can define whether the operator can replace the values monitored with other values. See Figure 77.

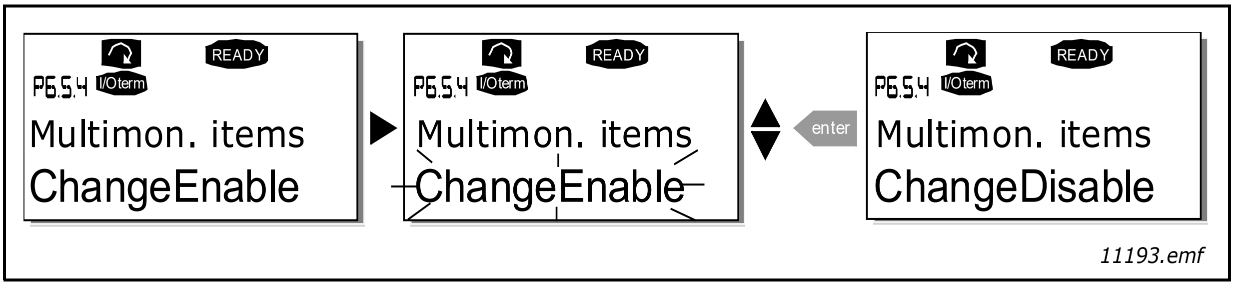


Figure 77. Disabling the change of multimonitoring items

6.3.8.5 Keypad settings

In the Keypad settings submenu under the System menu, you can further customise your Active Front End operator interface.

Locate the Keypad setting submenu (S6.6). Under the submenu, there are four pages (P#) associated with the keypad operation:

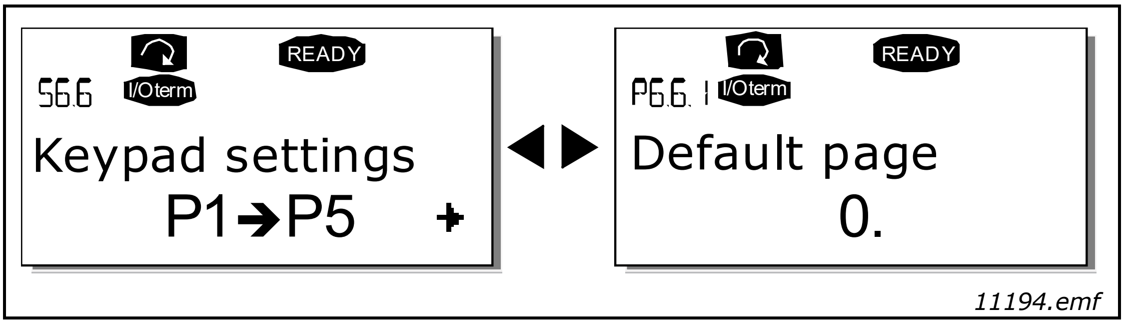


Figure 78. Keypad settings submenu

Default page (P6.6.1)

Here you can set the location (page) to which the display automatically moves when the Timeout time (P6.6.3) (see Timeout time (P6.6.3)) has expired or the power is switched on to the keypad.

If the Default page is 0, the function is not activated i.e. the latest displayed page remains on the keypad display. Pressing Menu button right takes you to the edit mode. Change the number of the Main menu with the Browser buttons. To edit the number of the submenu/page, press Menu button right. If the page you want to move to by default is at the third level, repeat the procedure. Confirm the new default page with the Enter button. You can return to the previous menu at any time by pressing Menu button left.

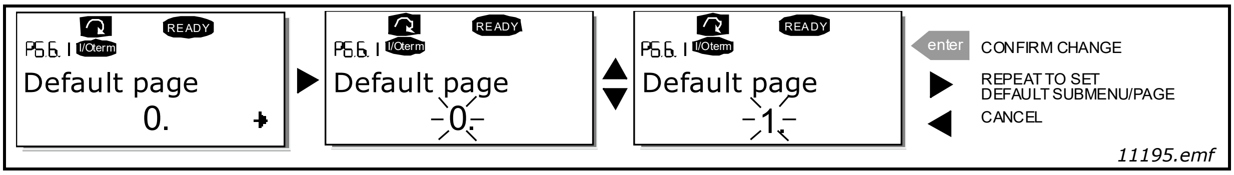


Figure 79. Default page function

Default page in the operating menu (P6.6.2)

Here you can set the location (page) in the Operating menu (in special applications only) to which the display automatically moves to when the set Timeout time (P6.6.3) (see Timeout time (P6.6.3)) has expired or the power is switched on to the keypad.

See how to set the Default page (Figure 79).

Timeout time (P6.6.3)

The Timeout time setting defines the time after which the keypad display returns to the Default page (P6.6.1). (See Default page (P6.6.1))

Enter the edit mode by pressing Menu button right. Set the desired timeout time and confirm it with the Enter button. You can return to the previous menu at any time by pressing Menu button left.

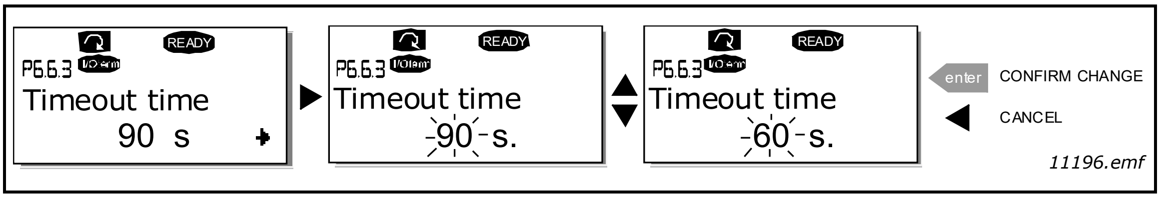


Figure 80. Timeout time setting

NOTE! If the Default page value is 0 the Timeout time setting has no effect.

Contrast adjustment (P6.6.4)

In case the display is unclear, you can adjust it´s contrast through the same procedure as for the timeout time setting, see Timeout time (P6.6.3).

Backlight time (P6.6.5)

By giving a value for the Backlight time, you can determine how long the backlight stays on before going out. You can select any time between 1 and 65535 minutes or 'Forever'. For the value setting procedure, see Timeout time (P6.6.3).

7. Grid converter/Utility interactive inverter

7.1 Safety

To be connected only to a dedicated branch circuit protection.

The output of the inverter can be connected with up to 4 parallel combination of modules.

Surge protection device shall be installed.

WARNING

Risk of electric shock from energy stored in capacitor. Both AC and DC voltage sources are terminated inside this equipment. Each circuit must be individually disconnected and the service person must wait 5 minutes before servicing or accessing or removing the cover.

WARNING

Hazardous Voltage remains for 5 minutes after disconnecting the main power supply.

WARNING

When the photovoltaic array is exposed to light, it supplies a DC voltage to this equipment.

WARNING

For continued protection against risk of fire, use fuses as mentioned in the user manual.

WARNING

The inverter unit is not provided with a GFDI (ground fault detector/interrupter) device. The inverter must be used with an external GFDI device as required by the Article 690 of the National Electric Code for the installation location.

Ground fault detector/interrupter shall be installed at the inverter or at the array, if the inverter is connected to direct photovoltaic inputs from a grounded photovoltaic array.

WARNING

Hot surface - Risk of Burn. Resistors, heaters, chokes, dU/dt filters, LCL filters, sine-wave filter are examples of hot surfaces and not limited to these.

CAUTION

Wear protective gloves when you do installation, cabling or maintenance operations. There can be sharp edges in the AC drive/frequency converter that can cause cuts.

Read the user manual, drawings and all other related documentation.

7.2 Used symbols and markings

Table 38. Symbols and Markings

B+	The terminal for the DC+ connection
B-	The terminal for the DC- connection
U/T1	The terminal for the L1 connection
V/T2	The terminal for the L2 connection
W/T3	The terminal for the L3 connection
⏚	The grounding terminal

7.3 Conditions of acceptability

1. The power converter shall be installed in compliance with the enclosure, mounting, spacing, casualty, and segregation requirements of the ultimate application.
2. The equipment is intended to be installed within a suitable enclosure for the end product and operating environment.
3. The need for external equipment disconnect devices shall be evaluated in the end product.
4. The suitability of the module chassis in combination with the end product enclosure, including accessibility of live parts through openings in the enclosure, impact tests for reduced enclosure thicknesses, reliable retention of guards or barrier for prevention of shock hazards, etc., shall be considered in the end product evaluation.
5. The power supply bulk capacitors store hazardous energy for 5 minutes after disconnecting all sources of power.

This inverter is intended for operation in an environment having a maximum ambient temperature of 40 °C (104 °F).

7.3.1 Conditions of acceptability and engineering considerations for UL1741

1. Inverter can be connected only to Delta winding of transformer.
2. Communication cables shall be routed via grounded metallic conduits for field wiring.
3. UL listed Surge protection shall be installed in enclosure. For UL1741 certification, Mersen STXR600D05 was used.
4. Additional relay shall be included in end installation for detection of Open phase.
5. VACON® pre-charging circuit shall be used.
6. Only semiconductor fuses which are in UL1741 files shall be used for modules protection. Please refer to Table 45 and Table 48.
7. UL listed branch circuit protection current rating shall be as per ratings mentioned in Table 40.
8. UL1741 Utility Interactive inverters and Stand-alone inverters shall be loaded with System software NXP2V200.
9. UL1741 Utility Interactive inverters shall be loaded with Application software ARFIF106V103.

7.4 Required tools

No special tools apart from a torque wrench and screwdrivers are needed for the installation of the device. The bolt and screw sizes and tightening torques are stated in this manual.

7.5 Mounting

For mounting instructions, see Chapter 5.1.

7.5.1 Dimensions - Drive unit

Find the dimensions for the grid converter unit in Chapter 4.10 and the dimensional drawings in Chapter 8.2.

7.5.2 Dimensions - LCL filter

Find the dimensions for the LCL filter in Chapter 4.11 and the dimensional drawings in Chapter 8.2.

7.5.3 Enclosure sizes for UL1741 inverters installation

All applicable tests from UL1741, IEEE 1547, or UL 1741 SA, with the exception of the enclosure tests have been conducted on the UL1741 recognized component version of the product.

Enclosure tests must be conducted in the end product application, at the appropriate levels and in the conditions for end product use.

The Inverters were tested for UL1741, IEEE 1547, and UL1741SA when installed in enclosures. Enclosure tests such as temperature tests, ventilation tests, or fooling failure tests must be considered. Some construction details which should be considered are as follows:

- The size of enclosure in which the Inverter is installed is smaller in volume than a similar unit which has already been tested.
- Ventilation openings are smaller in size.
- Enclosure cooling delivery is less than a similar unit which has already been tested.

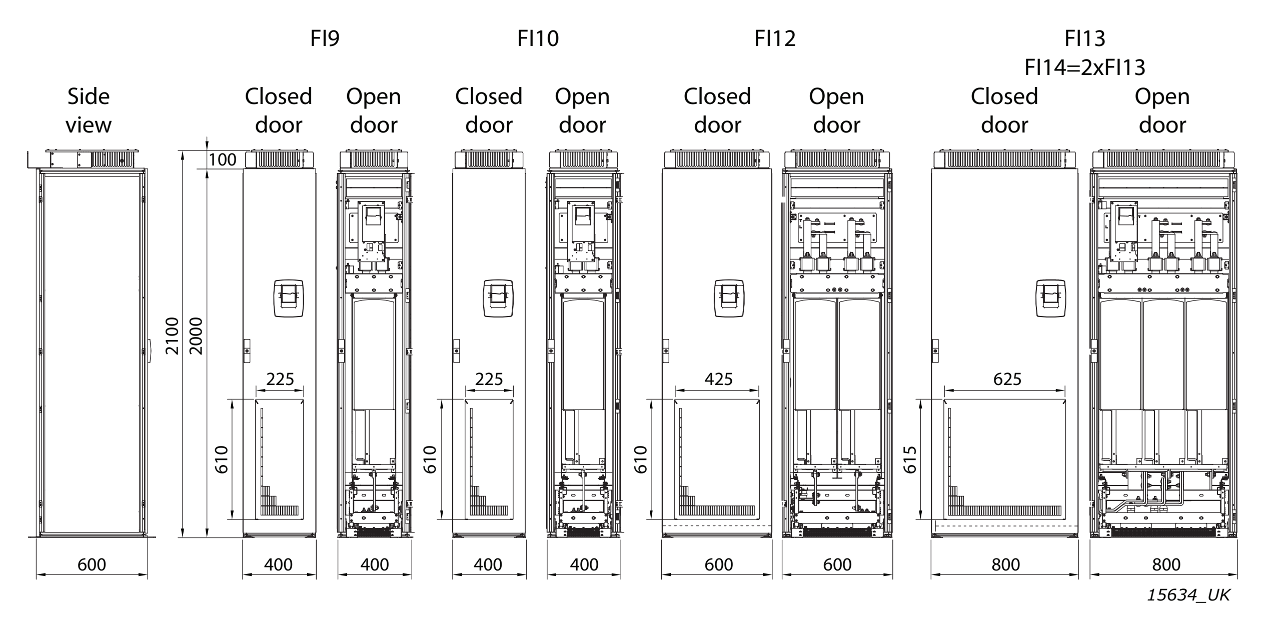


Figure 81. Layouts of inverters installed in enclosures

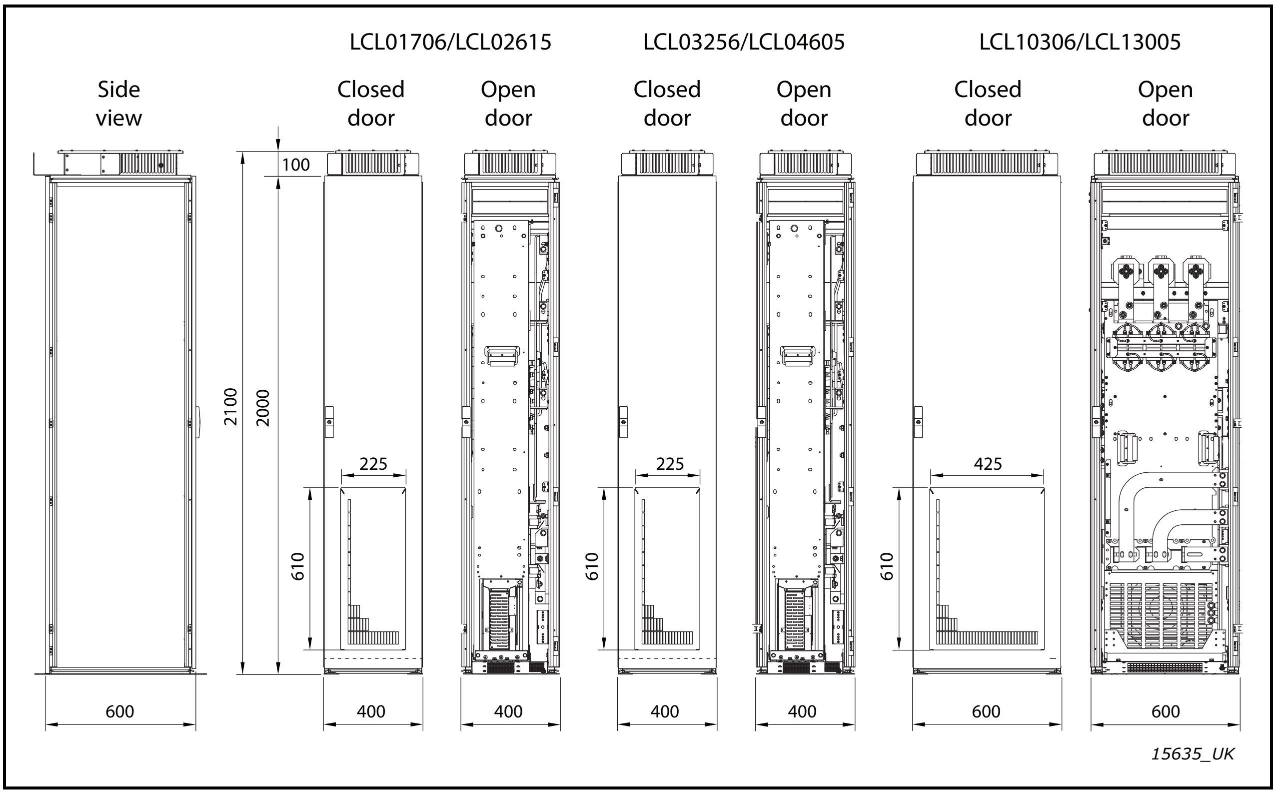


Figure 82. Layouts of LCL filters installed in enclosures

7.6 Cooling

See the cooling instructions for the power unit and the LCL filter in Chapter 5.2.

7.7 Power cabling

The AC input and AC output circuits are isolated from the enclosure. The system grounding, if required by Section 250 of the National Electrical Code, ANSI/NFPA 70, is the responsibility of the installer.

Use the wiring methods described in National Electrical Code, ANSI/NFPA 70.

CAUTION!

To reduce the risk of fire, connect only to a circuit provided with branch-circuit overcurrent protection in accordance with the National Electrical Code, ANSI/NFPA 70. See the maximum branch circuit overcurrent protection values in Table 40.

7.7.1 Cable installation and the UL standards

To meet the UL (Underwriters Laboratories) regulations, a UL-approved copper cable with a minimum heat-resistance of +60/75 °C must be used.

Use Class 1 wire only.

Use shielded cables.

7.7.2 Cable sizes - European grid codes

Table 39. Cable sizes for 640–1100 V DC (525–690 V AC)

Enclosure size (1)	Drive type	I_L (A)	DC supply cable, Cu (mm^2)	AC cable (mm^2) (2)
FI9	NX_0125 6	125	2×(1×24) (3)	Cu: 3×95+50 Al: 3×120+70
	NX_0144 6	144	2×(1×24) (3)	Cu: 3×95+50 Al: 3×120+70
	NX_0170 6	170	2×(1×24) (3)	Cu: 3×95+50 Al: 3×120+70
	NX_0208 6	208	2×(1×24) (3)	Cu: 3×150+70 Al: 3×240Al+72Cu
FI10	NX_0261 6	261	3×(1×24) (3)	Cu: 3×185+95 Al: 2×(3×95Al+29Cu)
	NX_0325 6	325	5×40 (4)	Cu: 2×(3×95+50) Al: 2×(3×150Al+41Cu)
	NX_0385 6	385	5×40 (4)	Cu: 2×(3×120+70) Al: 2×(3×185Al+57Cu)
	NX_0416 6	416	5×40 (4)	Cu: 2×(3×150+70) Al: 2×(3×185Al+57Cu)
FI12 (5)	NX_0460 6	460	5×40 (4)	Cu: 2×(3×150+70) Al: 2×(3×240Al+72Cu)
	NX_0502 6	502	5×40 (4)	Cu: 2×(3×185+95) Al: 2×(3×300Al+88 Cu)
	NX_0590 6	590	5×40 (4)	Cu: 2×(3×240+120) Al: 4×(3×120Al+41Cu)
	NX_0650 6	650	5×40 (4)	Cu: 4×(3×95+50) Al: 4×(3×150Al+41Cu)
	NX_0750 6	750	5×40 (4)	Cu: 4×(3×120+70) Al: 4×(3×150Al+41Cu)
	NX_0820 6	820	5×40 (4)	Cu: 4×(3×150+70) Al: 4×(3×185Al+57Cu)
FI13	NX_0920 6	920	5×40 (4)	Cu: 4x(3x150+70) Al: 4x(3x240+72Cu)
	NX_1030 6	1030	5×40 (4)	Cu: 4x(3x185+95) Al: 5x(3x185+57Cu)
	NX_1180 6	1180	5×40 (4)	Cu: 5x(3x185+95) Al: 6x(3x185+72Cu)
FI14 (5)	NX_1500 6	1500	5×40 (4)	Cu: 2×4×(3×120+70) Al: 2×4×(3×150Al+41Cu)
	NX_1900 6	1900	5×40 (4)	Cu: 2×4x(3x185+95) Al: 2×5x(3x185+57Cu)
	NX_2250 6	2250	5×40 (4)	Cu: 2×5x(3x185+95) Al: 2×6x(3x185+72Cu)

(1) Table valid for protection rating IP20 cabinets.
(2) EN 60204-1, IEC 60364-5-2/2001; PVC insulation; 40 °C ambient temperature; 70 °C surface temperature.

(3) Flexible conductor. Min. temperature endurance for isolation 70 °C.
(4) Copper Busbar.
(5) The modules require symmetrical parallel cable with minimum length 40 m or dU/dt- or sine filter.

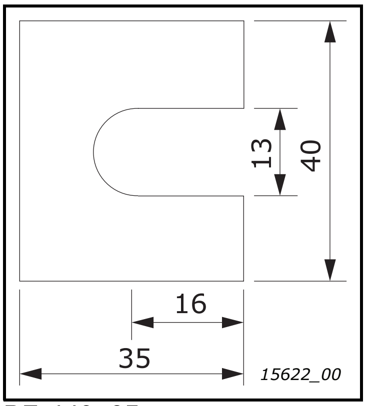
7.7.3 Cable sizes - UL1741

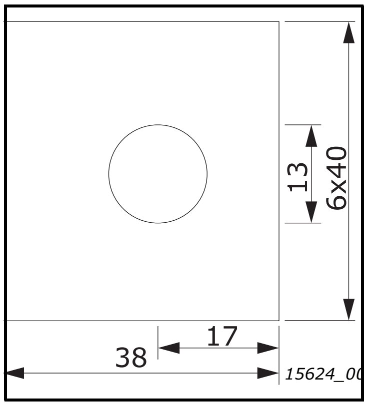
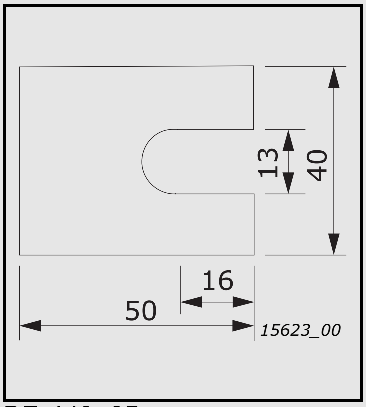
Table 40. Cable sizes for 640–1100 V DC (525–690 V AC)

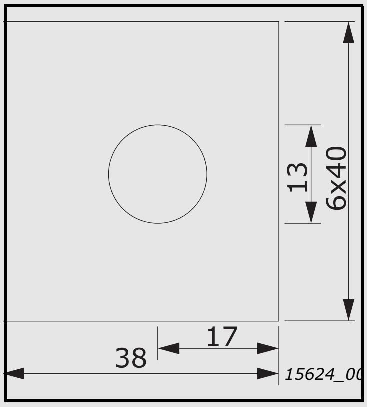
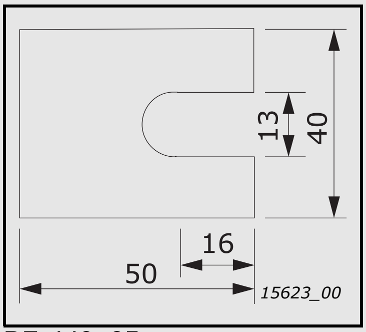
Enclosure size	Drive type	Maximum input DC overcurrent protection (A)	Max. branch circuit overcurrent protection (A)	DC supply cable	AC cable
FI9	NX_0125 6	400	200	3/0 AWG	2/0 AWG
	NX_0144 6	400	200	4/0 AWG	3/0 AWG
	NX_0170 6	400	250	250 kcmil	4/0 AWG
	NX_0208 6	400	250	350 kcmil	250 kcmil
FI10	NX_0261 6	700	400	2x3/0 AWG	400 kcmil
	NX_0325 6	800	400	2x250 kcmil	3/0 AWG
	NX_0385 6	1000	500	2x300 kcmil	2x250 kcmil
FI12	NX_0460 6	2x800	600	2x400 kcmil	2x300 kcmil
	NX_0502 6	2x800	600	2x500 kcmil	2x350 kcmil
	NX_0590 6	2x800	800	4x4/0 AWG	2x500 kcmil
	NX_0650 6	2x1000	800	4x250 kcmil	4x3/0 AWG
	NX_0750 6	2x1000	1000	4x300 kcmil	4x4/0 AWG
FI13	NX_0920 6	3x800	1200	6x4/0 AWG	4x4/0 AWG
	NX_1030 6	3x1000	1200	6x250 kcmil	4x400 kcmil
	NX_1180 6	3x1000	1600	6x300 kcmil	4x500 kcmil
FI14	NX_1500 6	2x3x800	2000	2x6x4/0 AWG	2x4x250 kcmil
	NX_1900 6	2x3x1000	2500	2x6x250 kcmil	2x4x350 kcmil
	NX_2250 6	2x3x1000	3000	2x6x300 kcmil	2x4x500 kcmil

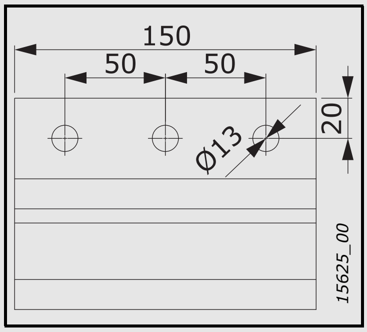
7.7.4 Terminal sizes

Table 41. Terminal sizes

<table>
<tr><th>Enclosure size</th><th>Drive type</th><th>DC terminal</th><th>AC terminal</th></tr>
<tr><td>FI9</td><td>NX_0168 5 - NX_0300 5
NX_0125 6 - NX_0208 6</td><td>

PE: M8×25</td><td>
</td></tr>
<tr><td>FI10</td><td>NX_0385 5 - NX_0520 5
NX_0261 6 - NX_0416 6</td><td rowspan="2">

PE: M8×25</td><td rowspan="2">
</td></tr>
<tr><td>FI12</td><td>NX_0590 5 - NX_1030 5
NX_0460 6 - NX_0820 6</td></tr>
<tr><td>FI13</td><td>NX_1150 5 - NX_1450 5
NX_0920 6 - NX_1180 6</td><td rowspan="2">

PE: M8×25</td><td rowspan="2">
</td></tr>
<tr><td>FI14</td><td>NX_1770 5 - NX_2700 5
NX_1500 6 - NX_2250 6</td></tr>
</table>

7.7.5 Bolt sizes and tightening torques

Table 42. Bolt sizes and tightening torques

Enclosure size	Drive type	DC terminal			AC terminal		
		Bolt	Torque (Nm)	Torque (in-lb)	Bolt	Torque (Nm)	Torque (in-lb)
FI9	NX_0168 5 - NX_0300 5 NX_0125 6 - NX_0208 6	M10	40	355	M10	40	355
FI10	NX_0385 5 - NX_0520 5 NX_0261 6 - NX_0416 6	M12	70	620	M10	40	355

Table 42. Bolt sizes and tightening torques

Enclosure size	Drive type	DC terminal			AC terminal		
		Bolt	Torque (Nm)	Torque (in-lb)	Bolt	Torque (Nm)	Torque (in-lb)
FI12	NX_0590 5 - NX_1030 5 NX_0460 6 - NX_0820 6	M10	40	355	2×M10	40	355
FI13	NX_1150 5 - NX_1450 5 NX_0920 6 - NX_1180 6	M12	70	620	3×M12	70	620
FI14	NX_1770 5 - NX_2700 5 NX_1500 6 - NX_2250 6	M12	70	620	6×M12	70	620

7.8 Grounding

Connect the cable shields of the mains cables to the grounding conductor of the switchgear enclosure.

For grounding of the drive itself, use the grounding terminal on the drive mounting plate.

7.8.1 Grounding terminal

Grounding conductor sizing shall follow NEC Article 250 and minimum conductor size requirements as per NEC Table 250.122.

Use copper, copper-clad aluminum, or aluminum conductors.

Wire type – rated 75/90 °C (167/194 °F).

Mounting: M8 bolt, tightening torque: 13.5 Nm (120 in-lb).

7.8.2 GFDI requirements for UL1741 compliant installations

Inverters or charge controllers with direct photovoltaic inputs from a grounded photovoltaic array or arrays must be provided with a ground-fault detector/interrupter (GFDI). The inverter or charge controller must be used with an external GFDI device as required by the Article 690 of the National Electrical Code for the installation location.

7.9 Protections

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes. See the maximum branch circuit overcurrent protection values in Table 40.

7.9.1 Overcurrent protection

The overcurrent protection fuses must be installed by the end user.

7.9.1.1 AC output circuit - European grid codes

Overcurrent protection for the AC output circuit must be provided in the field. See the fuse specifications in the tables below.

Table 43. AC fuse sizes for VACON® NX air-cooled AFE (380-500 V)

Enclosure size	Type	Fuses needed (pcs)	Mersen fuse (type code)
FI9	NX_0168 5	3	PC30UD69V400TF
	NX_0205 5	3	PC30UD69V400TF
	NX_0261 5	3	PC32UD69V400TF
FI10	NX_0385 5	3	PC33UD69V700TF
	NX_0460 5	3	PC33UD69V700TF
FI12	NX_0590 5	6	PC31UD69V500TF
	NX_0650 5	6	PC31UD69V700TF
	NX_0730 5	6	PC31UD69V700TF
	NX_0820 5	6	PC32UD69V800TF
	NX_0920 5	6	PC32UD69V800TF
	NX_1030 5	6	PC33UD69V1000TF
FI13	NX_1150 5	6	PC44UD75V18CTQ
	NX_1300 5	6	PC44UD75V18CTQ
FI14	NX_1770 5	6	PC44UD75V16CTQ
	NX_2150 5	6	PC44UD75V18CTQ
	NX_2700 5	6	PC44UD75V22CTQ

Table 44. AC fuse sizes for VACON® NX air-cooled AFE (525-690 V)

Enclosure size	Type	Fuses needed (pcs)	Mersen fuse (type code)
FI9	NX_0125 6	3	PC71UD13C250TF
	NX_0144 6	3	PC71UD13C250TF
	NX_0170 6	3	PC71UD13C250TF
FI10	NX_0261 6	3	PC73UD13C450TF
	NX_0325 6	3	PC73UD13C450TF
FI12	NX_0460 6	6	PC73UD13C500TF
	NX_0502 6	6	PC73UD13C500TF
	NX_0590 6	6	PC73UD13C630TF
	NX_0650 6	6	PC73UD13C630TF
	NX_0750 6	6	PC73UD13C630TF
	NX_0820 6	6	PC73UD13C700TF
FI13	NX_0920 6	6	PC44UD75V16CTQ
	NX_1030 6	6	PC44UD75V16CTQ

Table 44. AC fuse sizes for VACON® NX air-cooled AFE (525-690 V)

Enclosure size	Type	Fuses needed (pcs)	Mersen fuse (type code)
FI14	NX_1500 6	6	PC83UD11C13CTF
	NX_1900 6	6	PC83UD95V16CTF
	NX_2250 6	6	PC84UD11C20CTQ

7.9.1.2 AC output circuit - UL1741

Overcurrent protection for the AC output circuit must be provided in the field. See the fuse specifications in the tables below.

Table 45. AC fuse sizes for VACON® NX air-cooled AFE (525-690 V)

Enclosure size	Type	Fuses needed (pcs)	Mersen fuse (type code)
FI9	NX_0125 6	3	PC71UD13C250TF
	NX_0144 6	3	PC71UD13C250TF
	NX_0170 6	3	PC71UD13C250TF
	NX_0208 6	3	PC71UD13C400TF
FI10	NX_0261 6	3	PC73UD13C450TF
	NX_0325 6	3	PC73UD13C450TF
	NX_0385 6	3	PC73UD13C630TF
FI12	NX_0460 6	6	PC73UD13C500TF
	NX_0502 6	6	PC73UD13C500TF
	NX_0590 6	6	PC73UD13C630TF
	NX_0650 6	6	PC73UD13C630TF
	NX_0750 6	6	PC73UD13C630TF
FI13	NX_0920 6	3	PC44UD75V16CTQ
	NX_1030 6	3	PC44UD75V16CTQ
	NX_1180 6	3	PC84UD11C20CTQ
FI14	NX_1500 6	6	PC83UD11C13CTF
	NX_1900 6	6	PC83UD95V16CTF
	NX_2250 6	6	PC84UD11C20CTQ

7.9.1.3 DC source circuit - European grid codes

Overcurrent protection for the DC source circuit must be provided in the field. See the fuse specifications in the tables below.

Table 46. DC fuse sizes for VACON® NX air-cooled AFE (380-500 V)

Enclosure size	Type	Fuses needed (pcs)	Fuse for DC charging switch (type code)	Fuse for busbar installation (type code)
FI9	NX_0168 5	2	170M3819	170M1781
	NX_0205 5	2	170M3819	170M1781
	NX_0261 5	2	170M6812	170M1781

Table 46. DC fuse sizes for VACON® NX air-cooled AFE (380-500 V)

Enclosure size	Type	Fuses needed (pcs)	Fuse for DC charging switch (type code)	Fuse for busbar installation (type code)
FI10	NX_0385 5	2	170M8547	170M6499
	NX_0460 5	2	170M8547	170M6499
FI12	NX_0590 5	4	170M8547	170M6499
	NX_0650 5	4	170M8547	170M6499
	NX_0730 5	4	170M8547	170M6499
	NX_0820 5	4	170M8547	170M6499
	NX_0920 5	4	170M8547	170M6499
	NX_1030 5	4	170M8547	170M6499
FI13	NX_1150 5	6	170M8547	170M6499
	NX_1300 5	6	170M8547	170M6499
FI14	NX_1770 5	12	170M8547	170M6499
	NX_2150 5	12	170M8547	170M6499
	NX_2700 5	12	170M8547	170M6499

Table 47. DC fuse sizes for VACON® NX air-cooled AFE (525-690 V)

Enclosure size	Type	Fuses needed (pcs)	Fuse for DC charging switch (type code)	Fuse for busbar installation (type code)
FI9	NX_0125 6	2	170M4199	170M1831
	NX_0144 6	2	170M4199	170M1831
	NX_0170 6	2	170M4199	170M1831
FI10	NX_0261 6	2	170M6305	170M6496
	NX_0325 6	2	170M6305	170M6496
FI12	NX_0460 6	4	170M6305	170M6496
	NX_0502 6	4	170M6305	170M6496
	NX_0590 6	4	170M6305	170M6496
	NX_0650 6	4	170M6277	170M6498
	NX_0750 6	4	170M6277	170M6498
	NX_0820 6	4	170M6277	170M6498
FI13	NX_0920 6	6	170M6305	170M6498
	NX_1030 6	6	170M6277	170M6498
FI14	NX_1500 6	12	170M6305	170M6496
	NX_1900 6	12	170M6277	170M6498
	NX_2250 6	12	170M6277	170M6498

7.9.1.4 DC source circuit - UL1741

Overcurrent protection for the DC source circuit must be provided in the field. See the fuse specifications in the tables below.

Table 48. DC fuse sizes for VACON® NX air-cooled AFE (525-690 V)

Enclosure size	Type	Fuses needed (pcs)	Fuse for mounting type 1 (type code)	Fuse for alternate mounting type 2 (type code)
FI9	NX_0125 6	2	170M4199	170M1831
	NX_0144 6	2	170M4199	170M1831
	NX_0170 6	2	170M4199	170M1831
	NX_0208 6	2	170M4199	170M1831
FI10	NX_0261 6	2	170M6305	170M6496
	NX_0325 6	2	170M6305	170M6496
	NX_0385 6	2	170M6277	170M6198
FI12	NX_0460 6	4	170M6305	170M6496
	NX_0502 6	4	170M6305	170M6496
	NX_0590 6	4	170M6305	170M6496
	NX_0650 6	4	170M6277	170M6498
	NX_0750 6	4	170M6277	170M6498
FI13	NX_0920 6	6	170M6305	170M6498
	NX_1030 6	6	170M6277	170M6498
	NX_1180 6	6	170M6277	170M6498
FI14	NX_1500 6	12	170M6305	170M6496
	NX_1900 6	12	170M6277	170M6498
	NX_2250 6	12	170M6277	170M6498

7.9.2 Voltage/frequency trip limits

For field adjustable trip points for voltage and frequency, see the VACON® NXP Grid Converter Application Manual (ARFIF106).

7.10 Control cabling

For selection of the control cables, see Chapter 5.4.3.1.

Route the field communication cables through grounded metal conduits.

7.11 LCL filter

For LCL filter selections, see Table 49 below.

Table 49. LCL filters for UL1741 installations

Enclosure size	Type	LCL filter (type code)
FI9	NX_0125 6	LCL-0170-6
	NX_0144 6	LCL-0170-6
	NX_0170 6	LCL-0170-6
	NX_0208 6	LCL-0325-6
FI10	NX_0261 6	LCL-0325-6
	NX_0325 6	LCL-0325-6
	NX_0385 6	LCL-0325-6
FI12	NX_0460 6	2 x LCL-0325-6
	NX_0502 6	2 x LCL-0325-6
	NX_0590 6	2 x LCL-0325-6
	NX_0650 6	2 x LCL-0325-6
	NX_0750 6	2 x LCL-0325-6
FI13	NX_0920 6	LCL-1030-6
	NX_1030 6	LCL-1030-6
	NX_1180 6	LCL-1030-6
FI14	NX_1500 6	2 x LCL-1030-6
	NX_1900 6	2 x LCL-1030-6
	NX_2250 6	2 x LCL-1030-6

7.12 Specifications

7.12.1 Technical data

or the technical data of the LCL filters, see Chapter 4.5.

Table 50. Technical data for UL1741 Utility Interactive operating mode

DC Ratings - Input	Maximum input/output voltage	1100 V DC
	Range of input/output voltage	600-1100 V DC
	DC input start range	640 V DC
	Maximum input/output operating current	See Table 54
	Circuit combiner on input	NO
	Maximum input DC overcurrent protection	See Table 40
AC Ratings - Output	Output - Grid configurations allowed for product connection	Delta 3 wire
	Nominal (line to line) output/input voltage	400-600 V AC
	Nominal output frequency	60 Hz
	Maximum continuous output/input current	See Table 54
	Maximum continuous AC power (at 600 V)	See Table 54
	Maximum branch circuit overcurrent protection	See Table 40
	Limits of accuracy of voltage measurement	2.5%
	Limits of accuracy of frequency measurement	0.050 Hz
	Maximum full power operating ambient temperature	40 °C (104 °F)
	Maximum air ambient temperature	40 °C (104 °F)
	Enclosure ratings	UL 50 Open Type
	Shipping temperature range	-40 °C...+70 °C (-40 °F...+158 °F)
	Operating temperature range	-10 °C...+50 °C (+14 °F...+122 °F)

Table 51. Technical data for European grid codes

DC Ratings	Maximum input/output voltage	NX xxxx 5: 800 V DC NX xxxx 6: 1100 V DC
	Range of input/output voltage	NX xxxx 5: 334–800 V DC (wake-up voltage: 436 V DC; with additional software license 334 V DC) NX xxxx 6: 508–1100 V DC (wake-up voltage: 603 V DC)
	Maximum input DC overcurrent protection	See Table 46 and Table 47.
AC Ratings	Output - Grid configurations allowed for product connection	3 phase + PE
	Nominal (line to line) output/input voltage	NX xxxx 5: 180–500 V AC NX xxxx 6: 300–600 V AC
	Nominal output frequency	45–66 Hz
	Maximum continuous output/input current	See Table 52 and Table 53.
	Maximum overcurrent protection	See Table 43 and Table 44.

Table 51. Technical data for European grid codes

	Enclosure ratings	IP00
	Ambient operating temperature	See Table 7.
	Storage temperature	See Table 7.
	Installation temperature	See Table 7.

7.12.2 POWER RATINGS

7.12.2.1 Power ratings - European grid codes

Table 52. Power ratings for VACON® NX air-cooled AFE (380-500 V)

Enclosure size	Type	Apparent current @ pf 1.0 (A)	Active current rating (A) for grid code applications	Active power (kW) @ nominal AC voltage
FI9	NX_0168 5	170	140	97
	NX_0205 5	205	168	116
	NX_0261 5	261	205	142
	NX_0300 5	300	261	181
FI10	NX_0385 5	385	300	208
	NX_0460 5	460	385	267
	NX_0520 5	520	460	319
FI12	NX_0590 5	590	520	360
	NX_0650 5	650	590	409
	NX_0730 5	730	650	450
	NX_0820 5	820	730	506
	NX_0920 5	920	820	568
	NX_1030 5	1030	920	637
FI13	NX_1150 5	1150	1020	714
	NX_1300 5	1300	1150	797
	NX_1450 5	1450	1300	901
FI14	NX_1770 5	1770	1600	1109
	NX_2150 5	2150	1940	1344
	NX_2700 5	2700	2300	1593

Table 53. Power ratings for VACON® NX air-cooled AFE (525-690 V)

Enclosure size	Type	Apparent current @ pf 1.0 (A)	Active current rating (A) for grid code applications	Active power (kW) @ nominal AC voltage
FI9	NX_0125 6	125	100	104
	NX_0144 6	144	125	130
	NX_0170 6	170	144	150
	NX_0208 6	208	170	177

Table 53. Power ratings for VACON® NX air-cooled AFE (525-690 V)

Enclosure size	Type	Apparent current @ pf 1.0 (A)	Active current rating (A) for grid code applications	Active power (kW) @ nominal AC voltage
FI10	NX_0261 6	261	208	216
	NX_0325 6	325	261	271
	NX_0385 6	385	325	338
FI12	NX_0460 6	460	385	400
	NX_0502 6	502	460	478
	NX_0590 6	590	502	522
	NX_0650 6	650	590	613
	NX_0750 6	750	650	675
FI13	NX_0920 6	920	820	852
	NX_1030 6	1030	920	956
	NX_1180 6	1180	1030	1070
FI14	NX_1500 6	1500	1300	1351
	NX_1900 6	1900	1500	1559
	NX_2250 6	2250	1900	1975

7.12.2.2 Power ratings - UL1741

Table 54. Power ratings for VACON® NX air-cooled AFE (525-690 V)

Enclosure size	Type	Max. continuous output/input current (A AC) - Stand-alone inverter	Max. continuous output/ input current (A AC) - Utility interactive inverter	Max. continuous AC power (W) @600 V AC - Utility interactive inverter
FI9	NX_0125 6	125	100	103 923
	NX_0144 6	144	125	129 904
	NX_0170 6	170	144	149 649
	NX_0208 6	208	170	176 669
FI10	NX_0261 6	261	208	216 160
	NX_0325 6	325	261	271 239
	NX_0385 6	385	325	337 750
FI12	NX_0460 6	460	385	400 104
	NX_0502 6	502	460	478 046
	NX_0590 6	590	502	521 694
	NX_0650 6	650	590	613 146
	NX_0750 6	750	650	675 500
FI13	NX_0920 6	920	750	852 169
	NX_1030 6	1030	920	956 092
	NX_1180 6	1180	1030	1 070 407
FI14	NX_1500 6	1500	1300	1 351 000
	NX_1900 6	1900	1500	1 558 846
	NX_2250 6	2250	1900	1 974 538

7.12.3 CONFIGURATION CIRCUIT DIAGRAMS

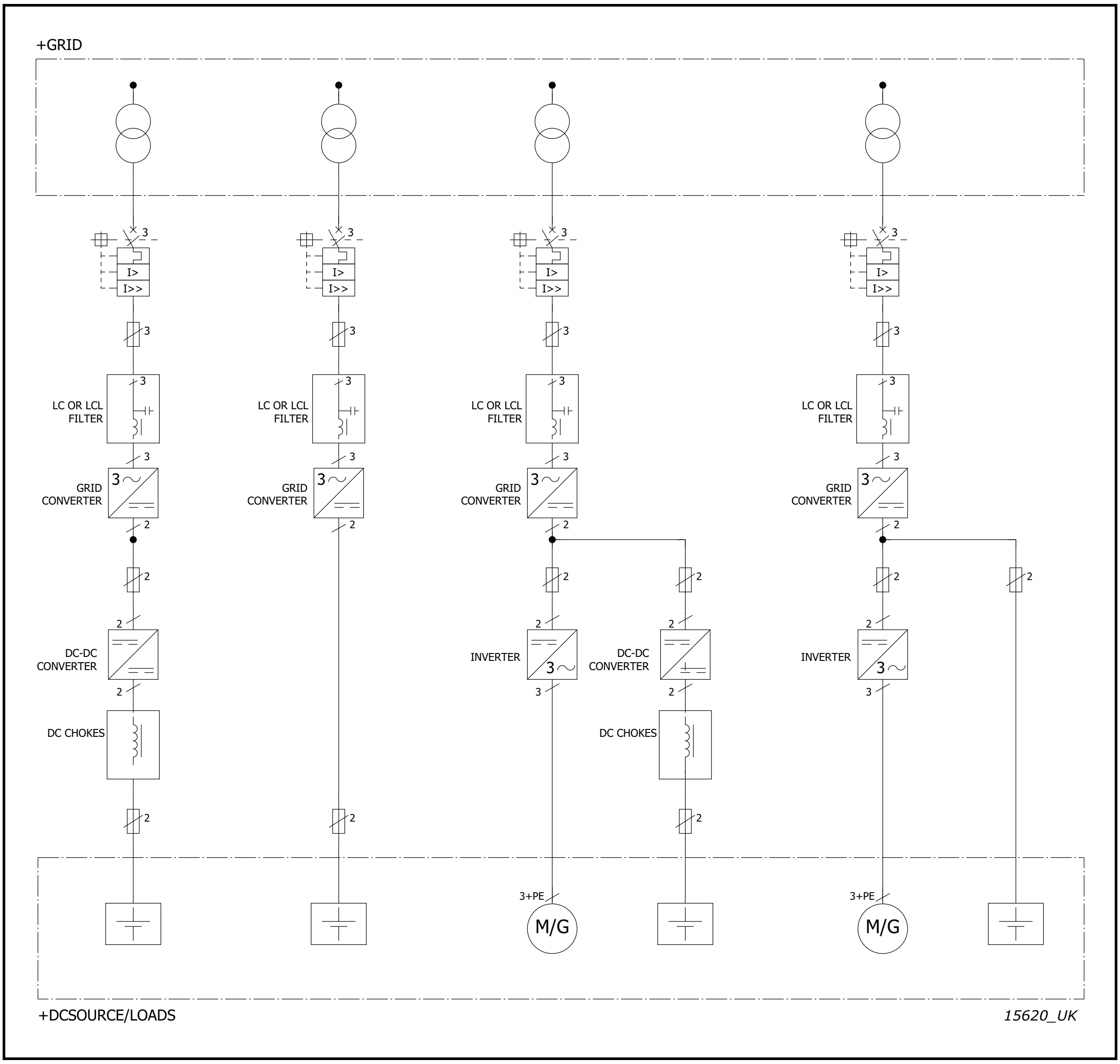


Figure 83. Single line diagrams of grid converter configurations for European grid codes

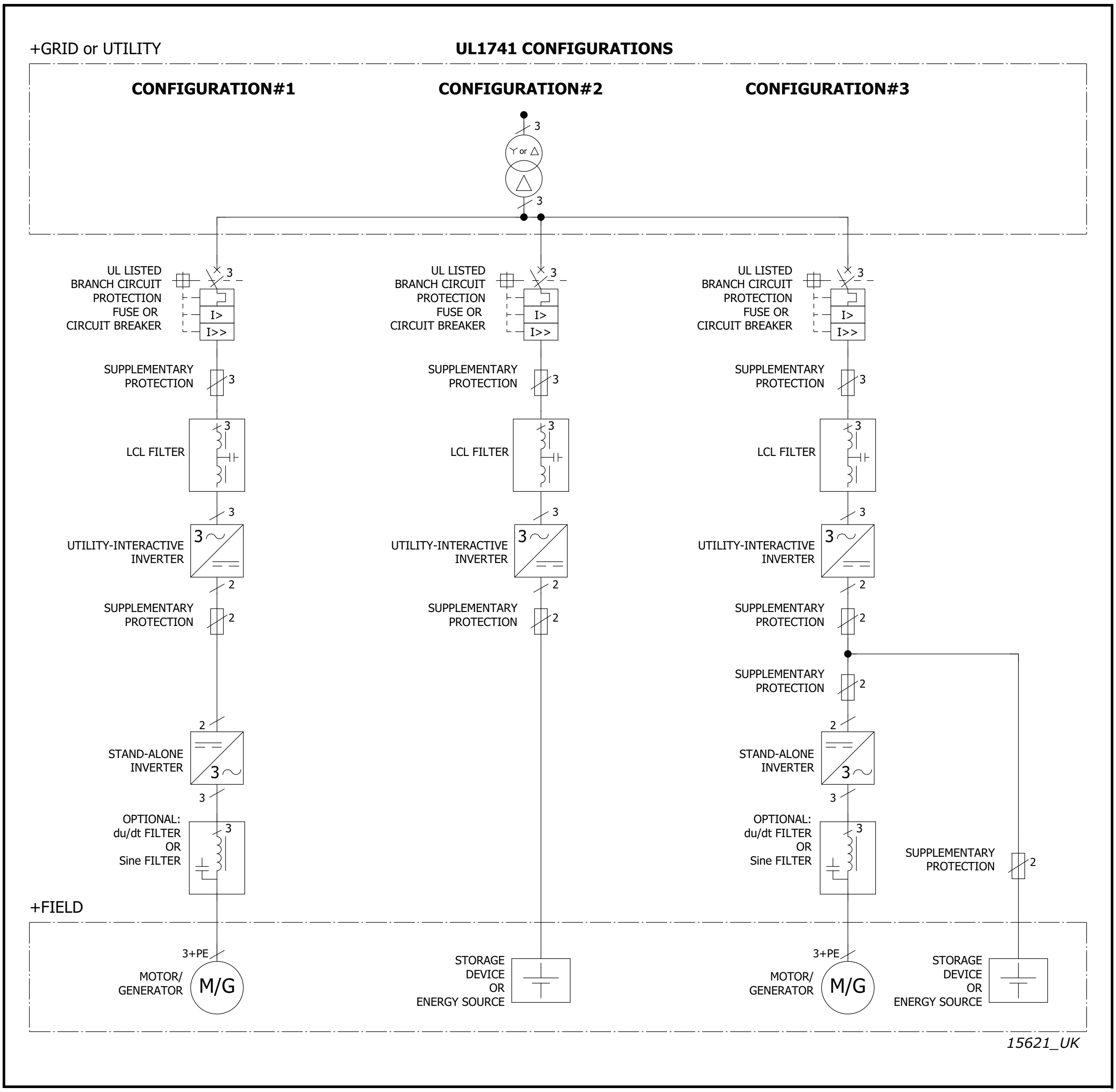


Figure 84. Single line diagrams of grid converter configurations for UL1741

8. APPENDIX

8.1 WIRING DIAGRAMS

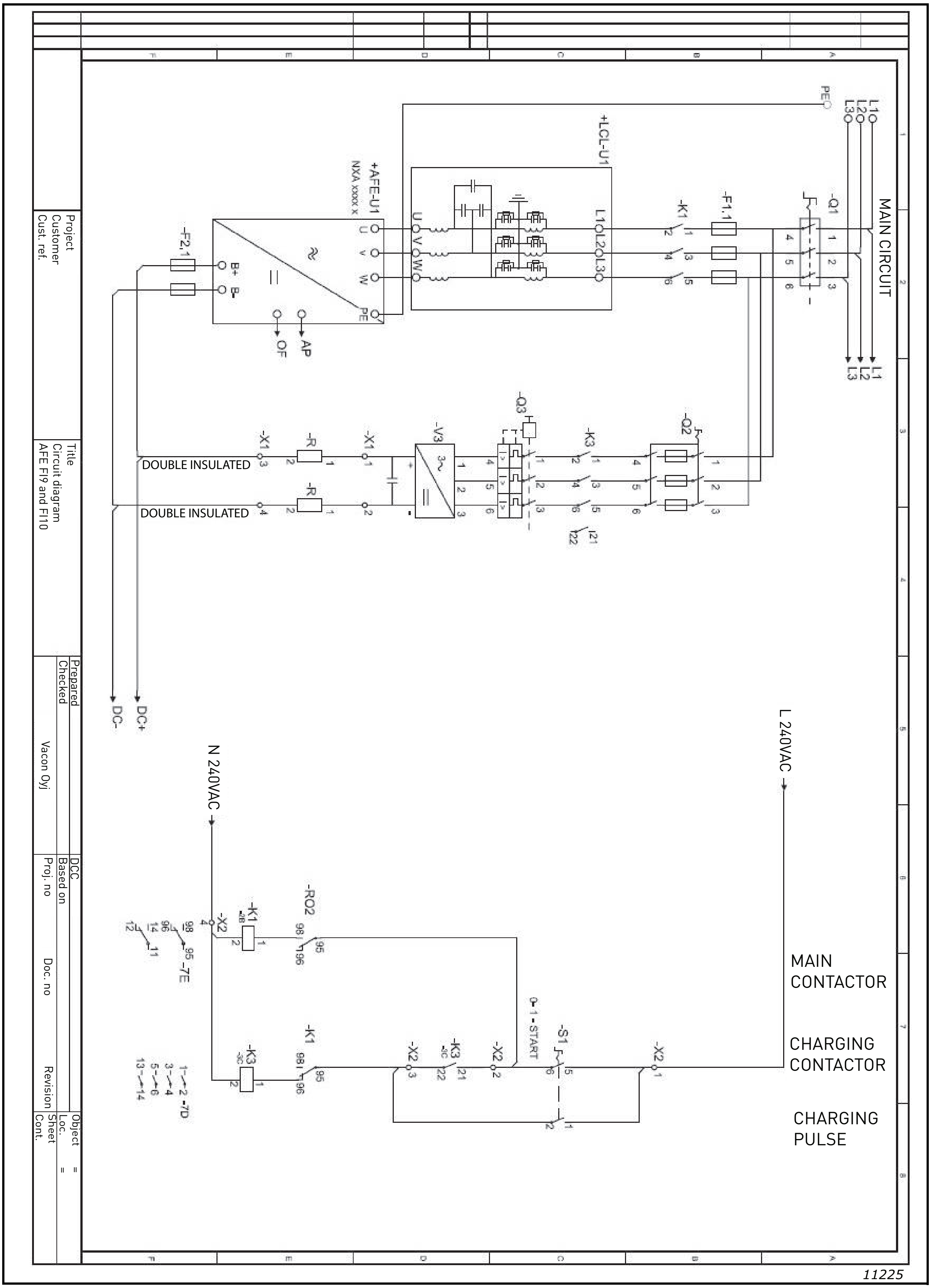


Figure 85. Wiring diagram for FI9 and FI10

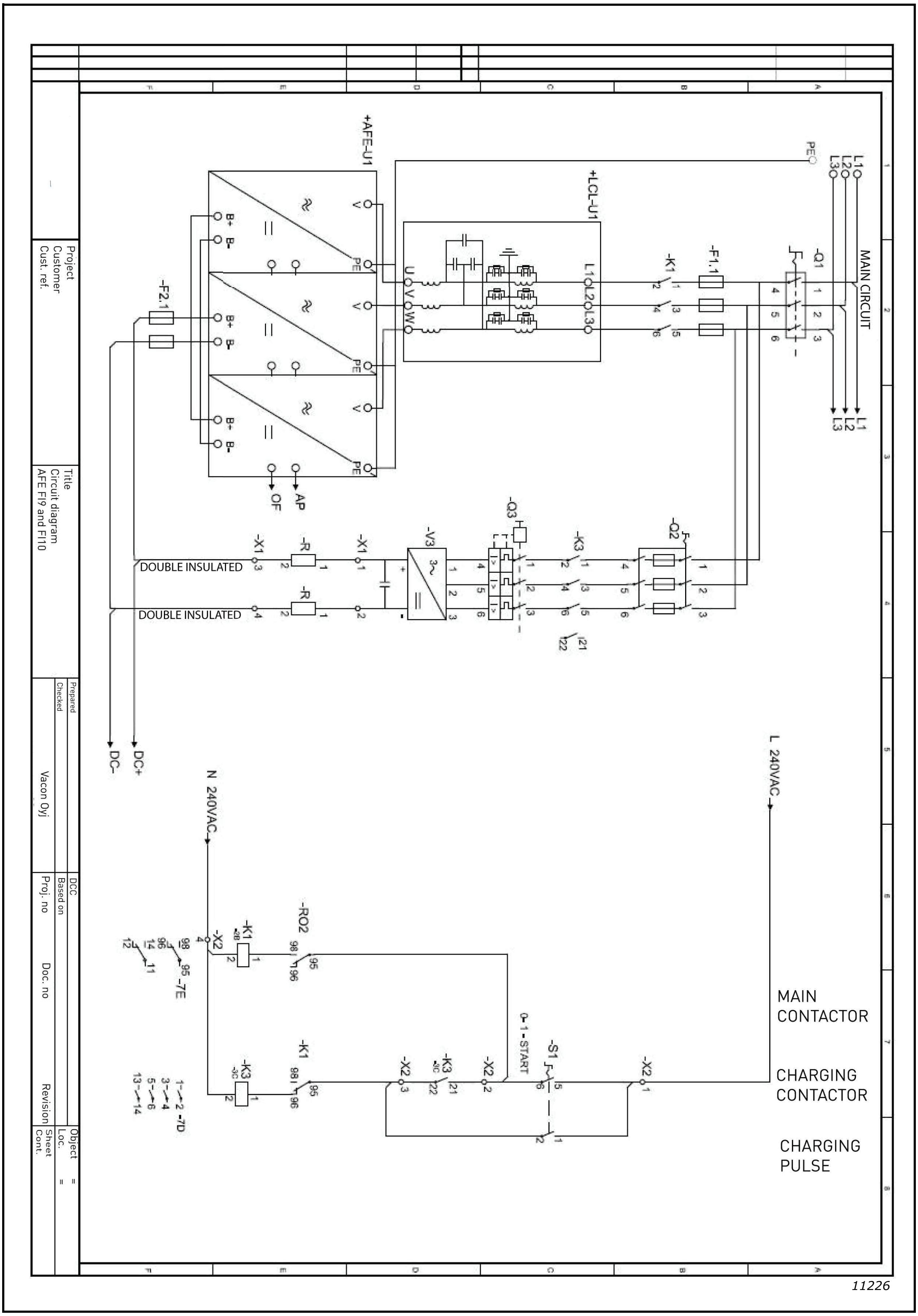


Figure 86. Wiring diagram for FI13

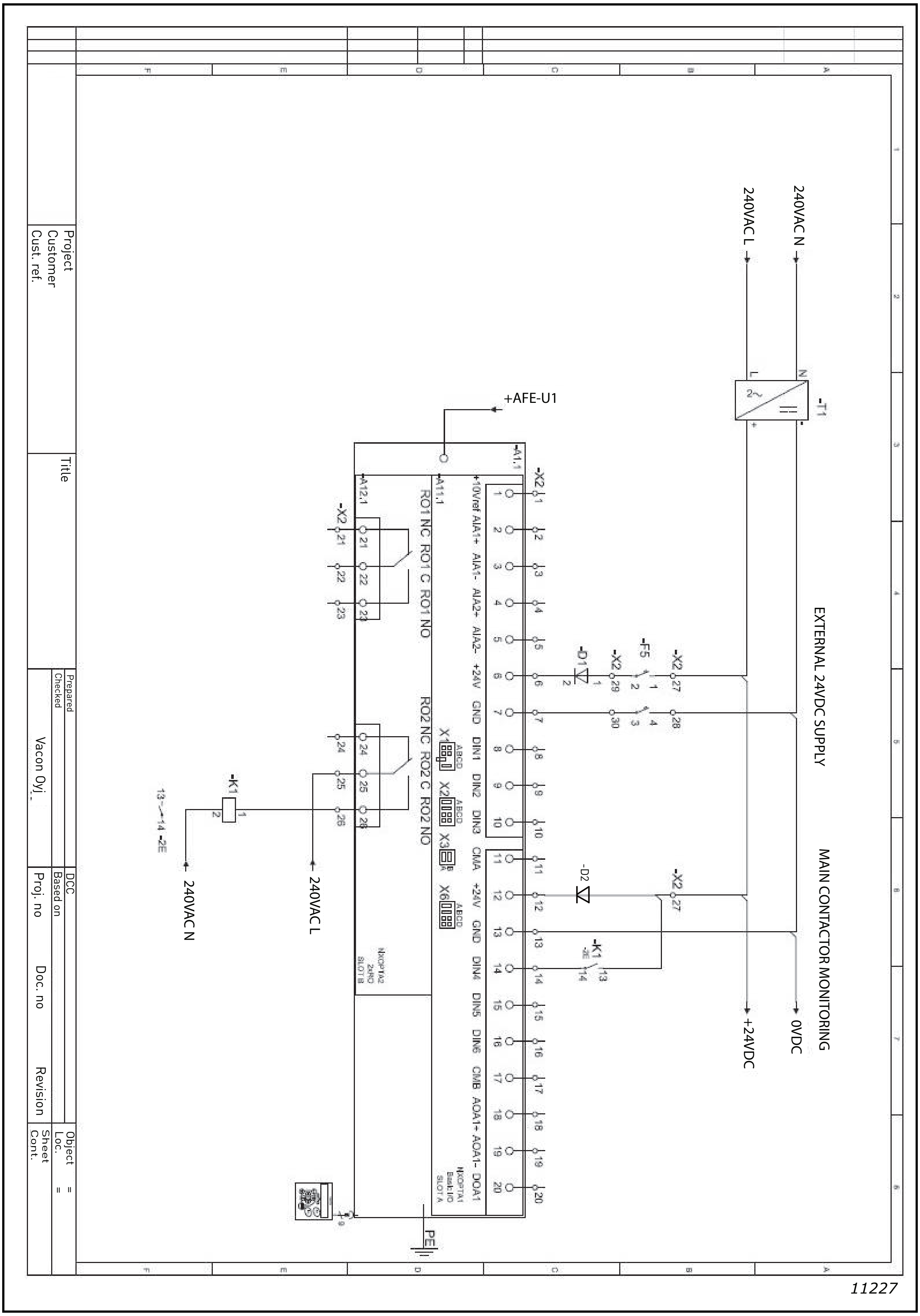


Figure 87. Wiring diagram for control circuit

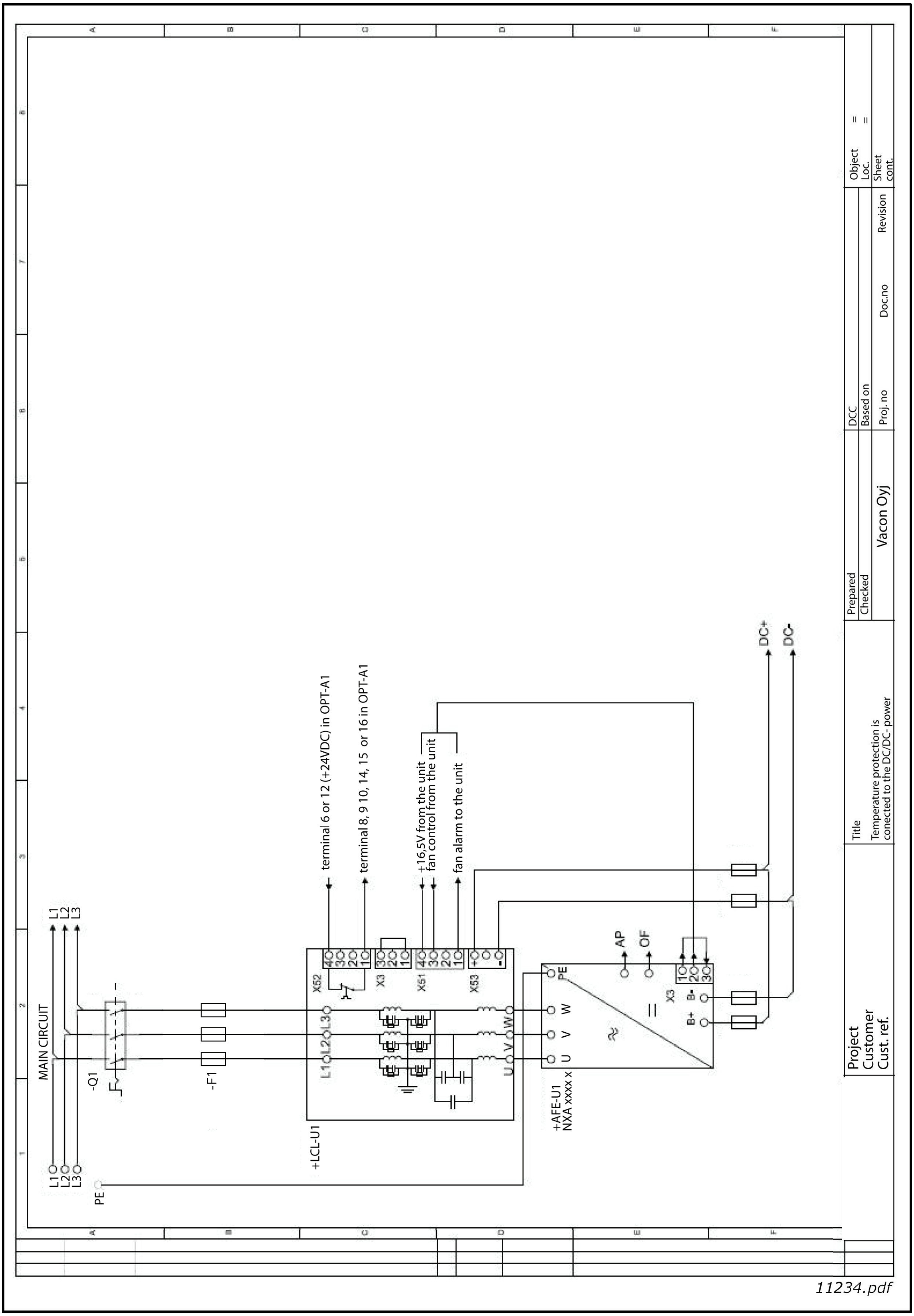
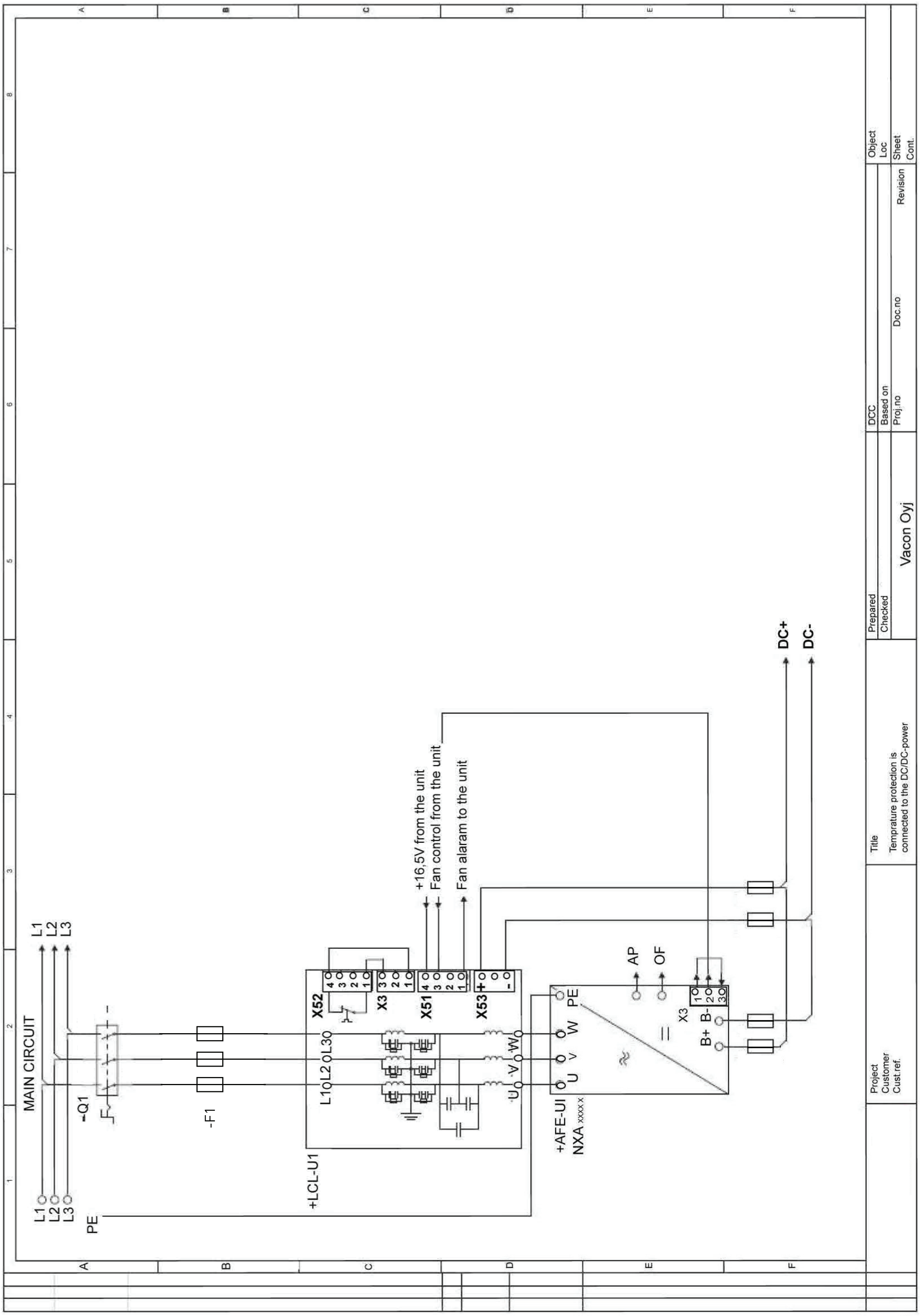


Figure 88. Circuit diagram for DC/DC-power supply if overtemperature protection is connected to the I/O



11235.pdf

Figure 89. Circuit diagram for DC/DC-power supply if overtemperature protection is connected to the DC/DC-power supply

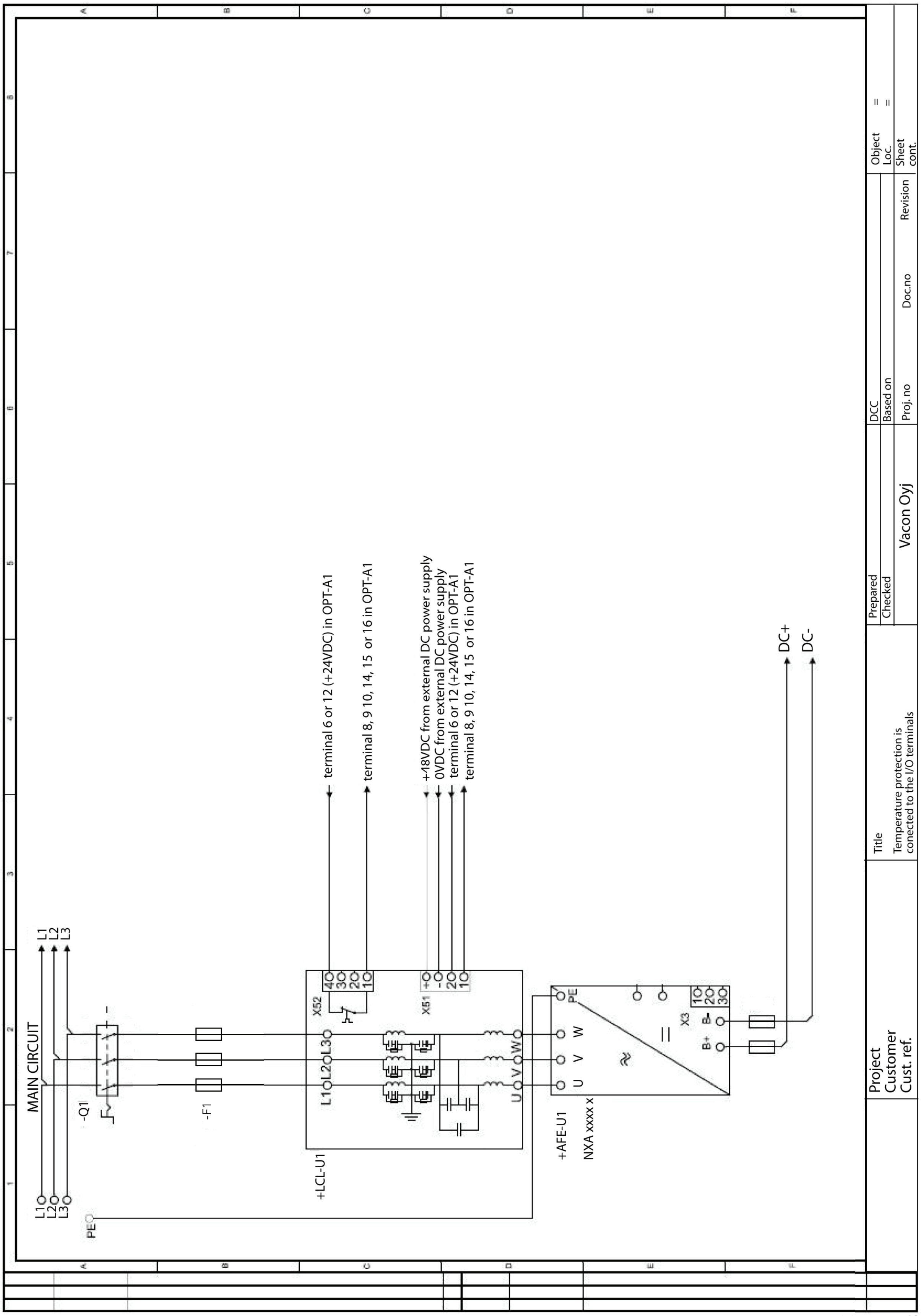


Figure 90. Circuit diagram for LCL filter without integrated DC/DC-power supply

8.2 Dimensions

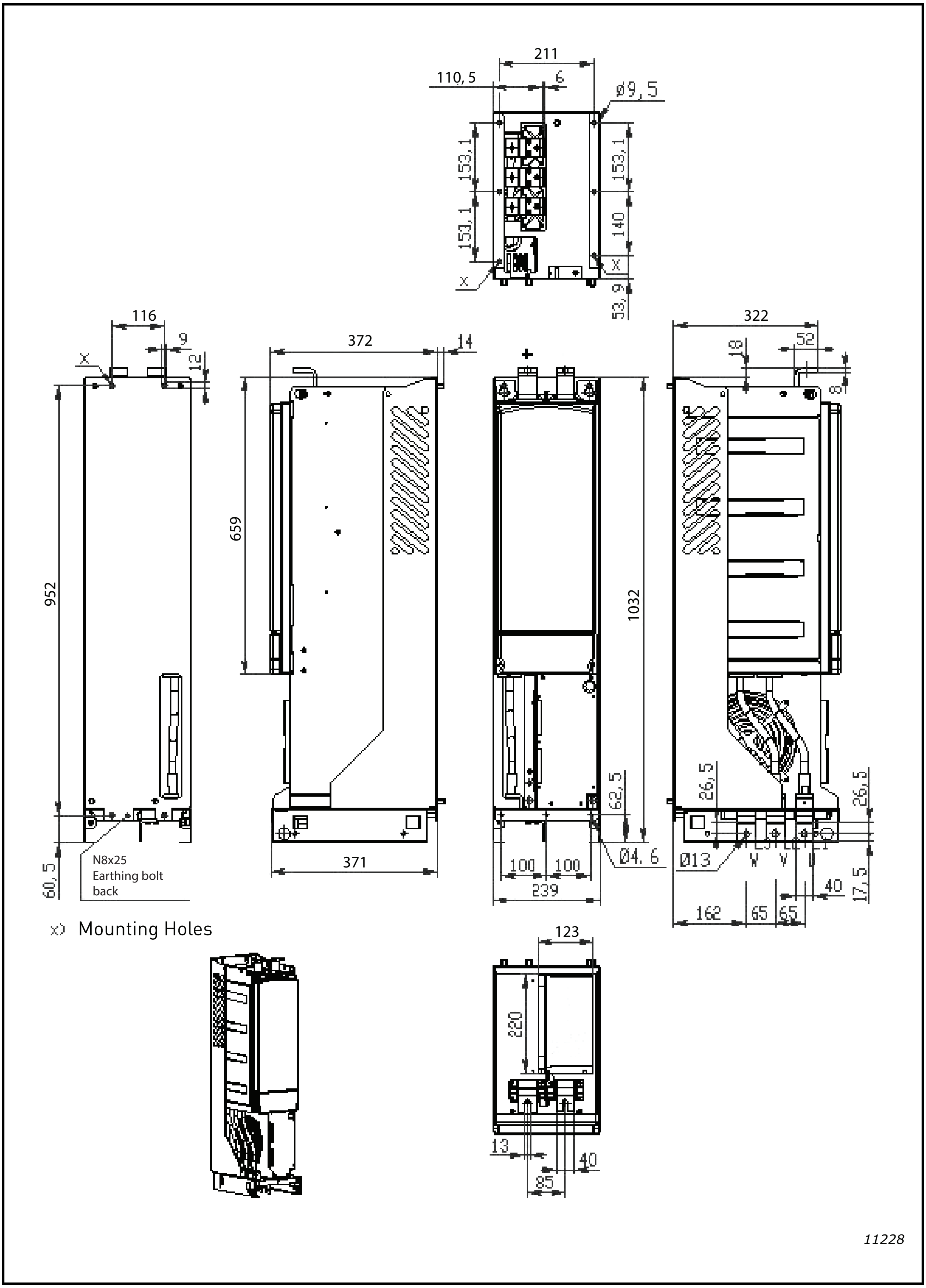


Figure 91. FI9 Dimensions

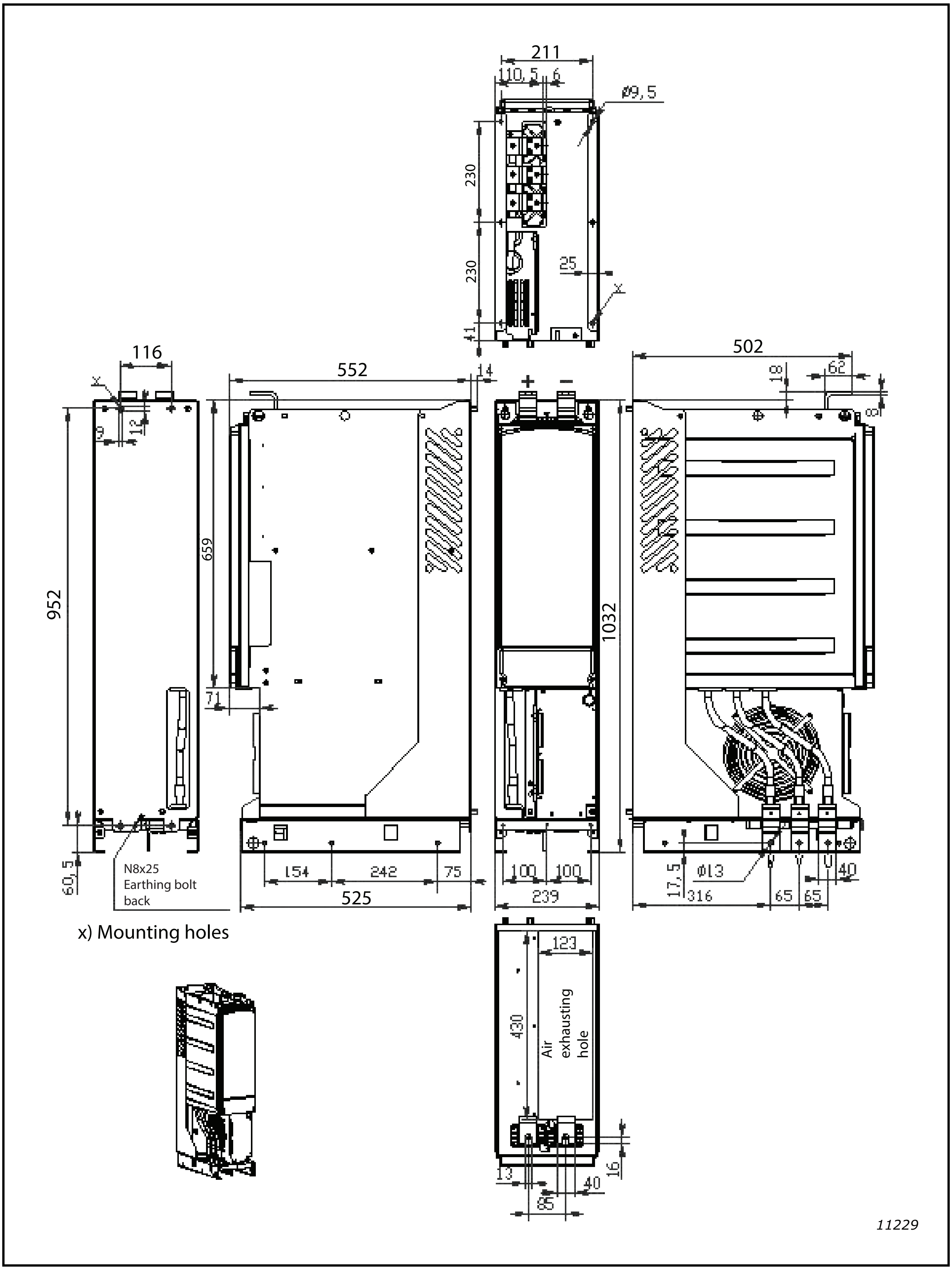


Figure 92. FI10 Dimensions

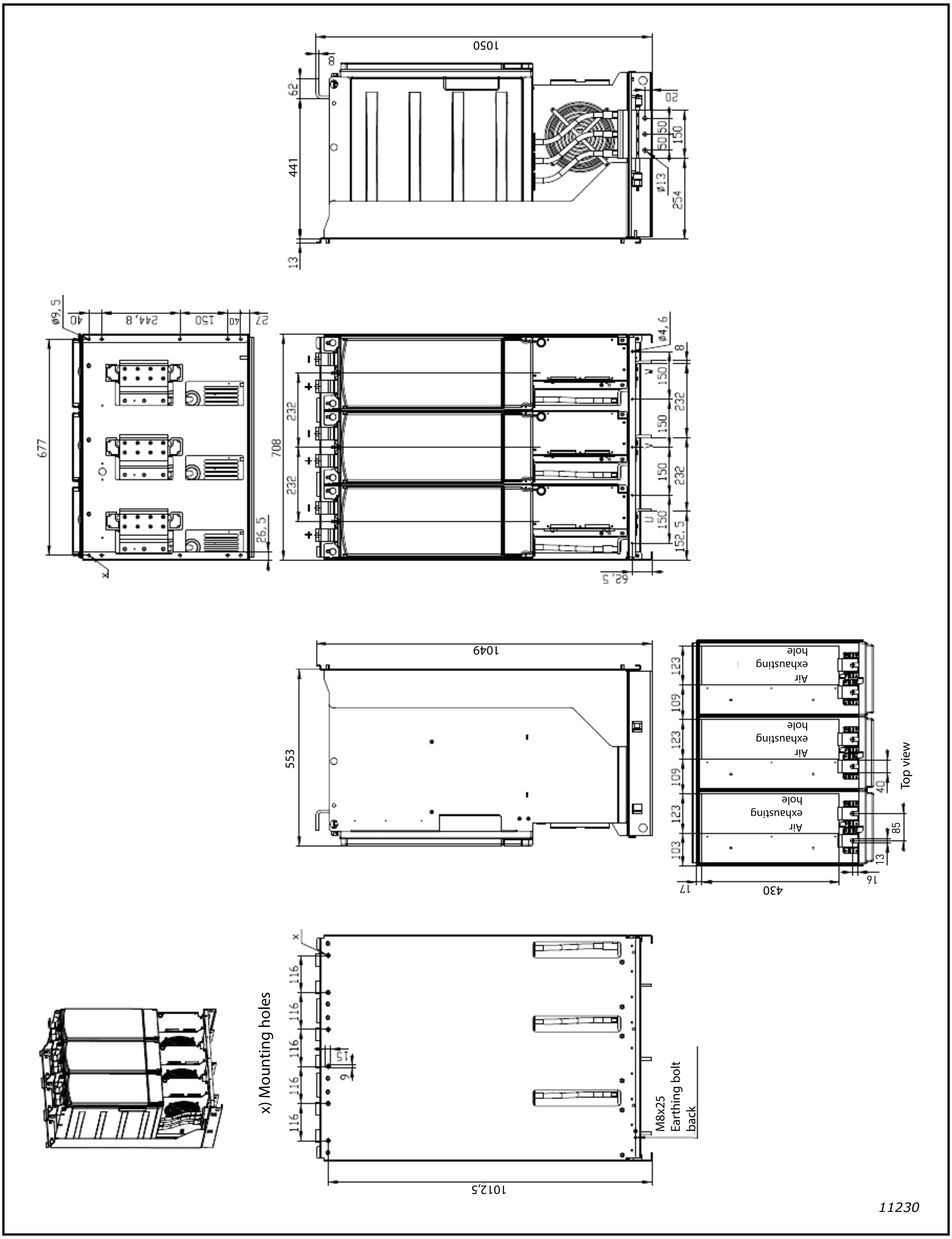


Figure 93. FI13 Dimensions

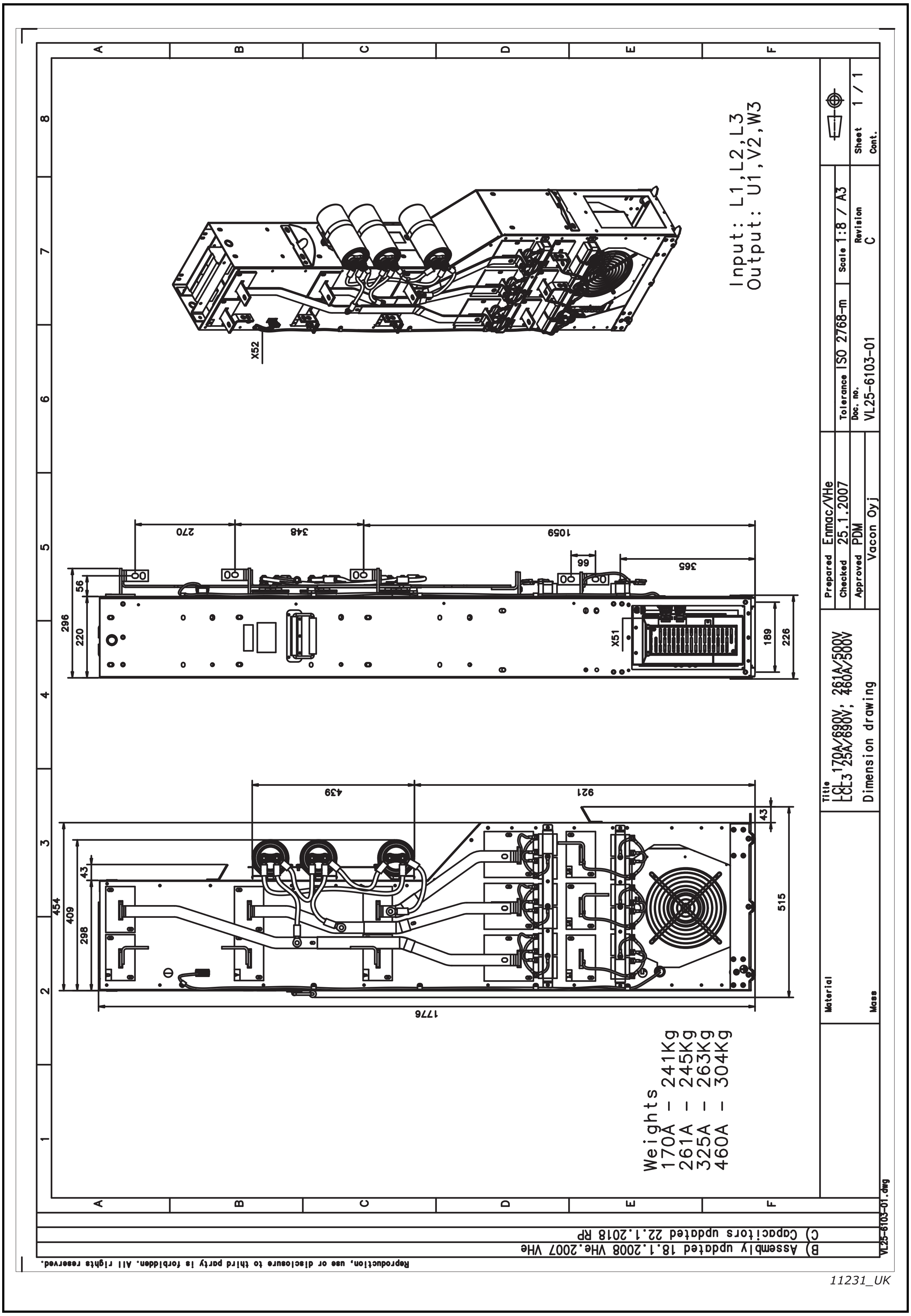


Figure 94. FI9 and FI10 LCL filter dimensions

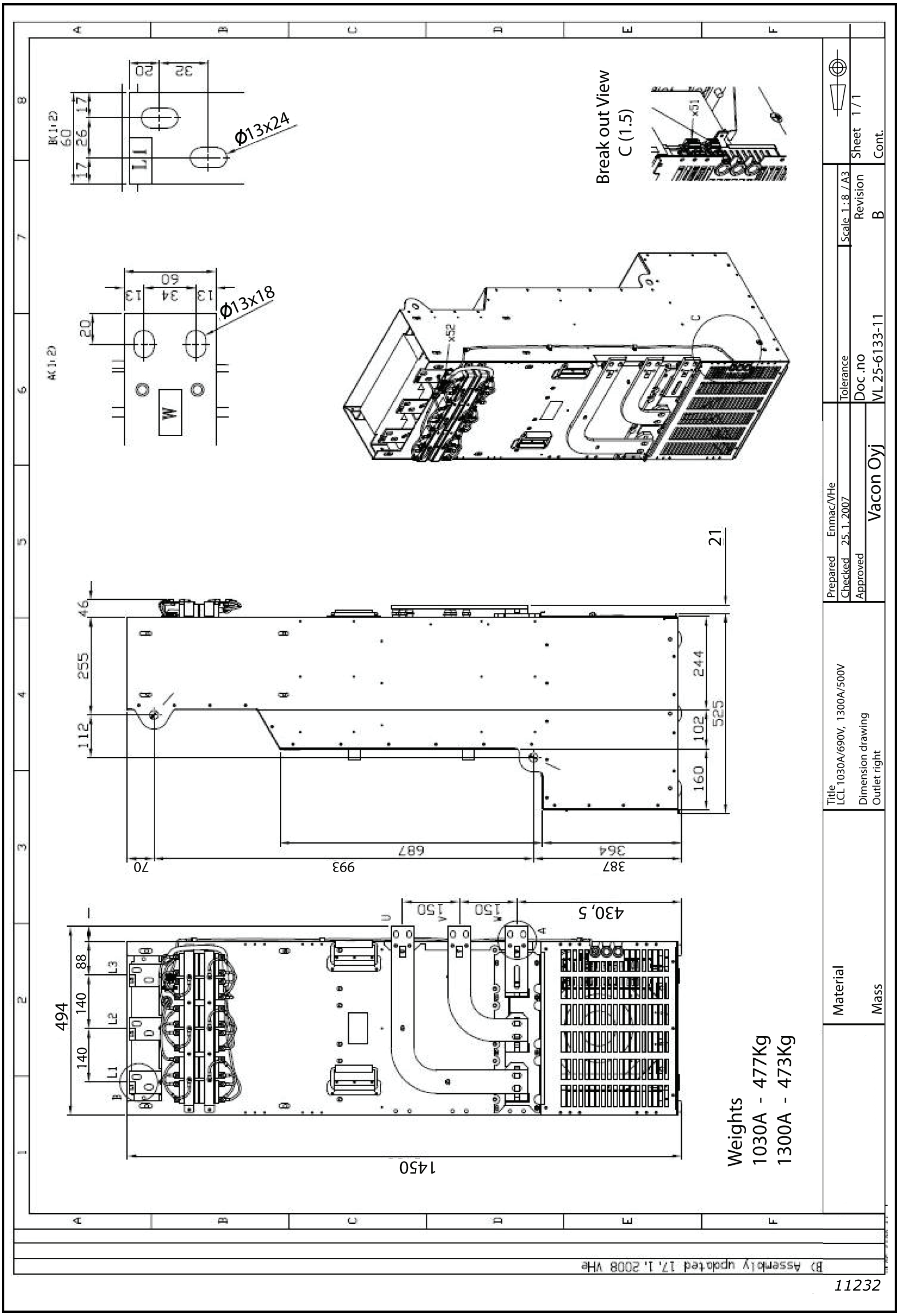


Figure 95. FI13 LCL filter dimensions, output connections right

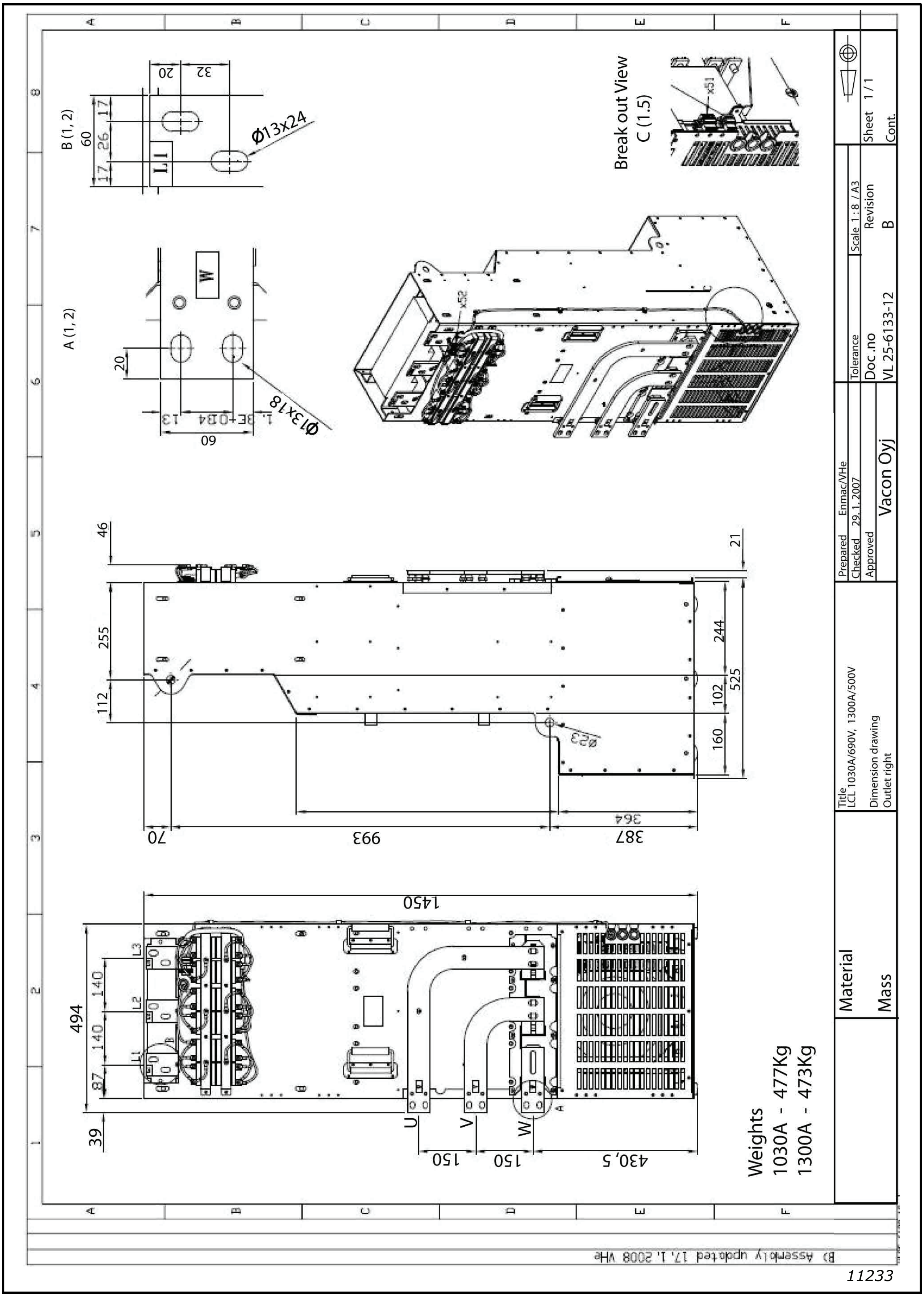


Figure 96. FI13 LCL filter dimensions, output connections left

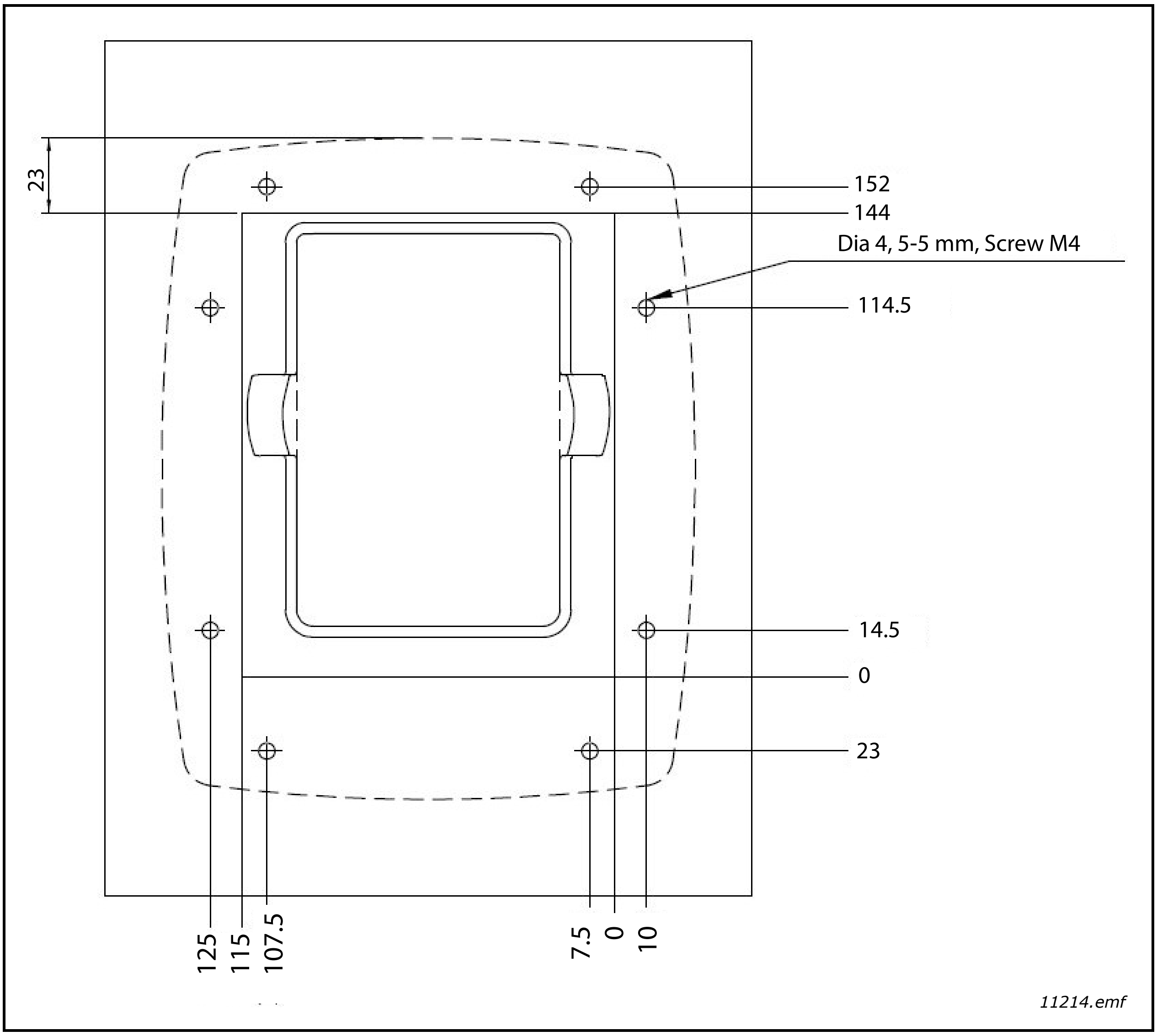


Figure 97. Dimensions of the door mounting kit

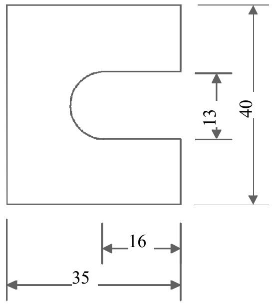
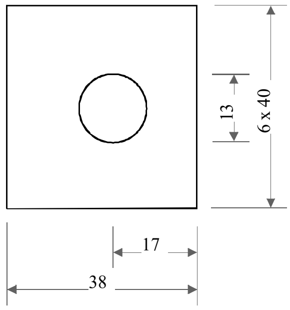
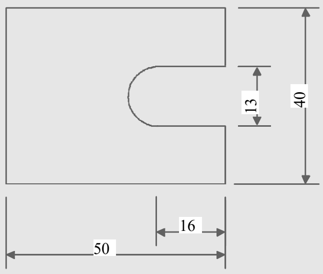
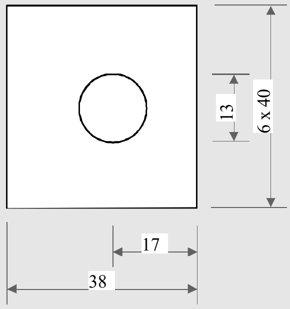
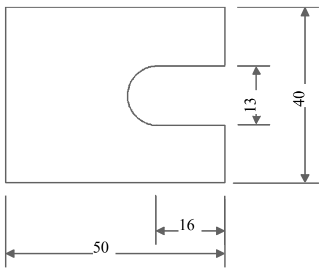
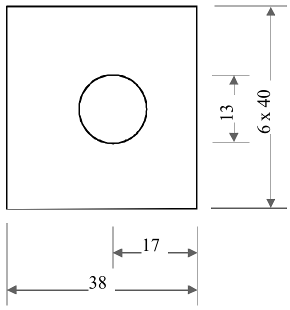
Frame	Type	IL [A]	DC terminal	AC Terminal
NXA_0261 5	FI9	261	 PE: M8×25	
NXA_0170 6		170		
NXA_0460 5	FI10	460	 PE: M8×25	
NXA_0325 6		325		
NXA_1300 5	FI13	1300	 PE: M8×25	
NXA_1030 6		1030		11213.emf

Figure 98. Terminal sizes for VACON® NX Active Front End units

8.3 Power conversion equipment

8.3.1 Technical data

Table 55. Additional technical specifications for VACON® Active Front End units used in grid converter applications

DC connection	Operating voltage	NXA_xxxx5: 465-800 V DC NXA_xxxx6: 640-1100 V DC
	Maximum operating DC current	See Chapter 8.3.2.
	I_{SC}	85 kA when fuses are used as per the fuse tables for grid converters with circuit breaker, busbar, busbar supports, enclosures, etc., which are sized for 85 kA based on relevant installation standards.
	Maximum inverter backfeed current to the DC load	Depends on the DC fuse rating. See Chapter 4.12.
	Minimum DC voltage for inverter to begin operation	The DC link must be charged up to 85% of nominal DC voltage (1.35 × grid nominal V AC)
AC connection	Nominal voltage	See Chapter 8.3.2.
	Current (maximum continuous)	See Chapter 8.3.2.
	Inrush current	Duration: < 10 ms Peak value: Depends on the short circuit capacity of the grid (grid impedance), grid voltage, LCL filter/LC filter, etc.
	Frequency	See Chapter 8.3.2.
	Power (maximum continuous)	See Chapter 8.3.2.
	Power factor range	-0.95...+0.95 with 100% active power. Other power factor values depend on the selected control mode. See the application manual for details.
	Maximum output fault current	The value depends on grid impedance and the fuse I^2t value. The maximum output current (from the inverter to the grid) is limited by the fast overcurrent protection, the software overcurrent protection, or the output current limit of the inverter. If the fault occurs upstream of the AC fuses, one of these limits the current from the inverter to the fault.
	Maximum output overcurrent protection	Depends on the AC fuse rating. See Chapter 4.12.

Table 55. Additional technical specifications for VACON® Active Front End units used in grid converter applications

External isolation transformer (not in the scope of Danfoss supply)	Configuration type	Delta-connection on the converter side is recommended. For other configurations, please contact local Danfoss representatives for further assistance.
	Electrical ratings *	• The transformer's secondary nominal voltage must be selected according to load DC voltage variation and/or grid code requirements. Refer to the design guide (DPD02146) or a local Danfoss representative for further assistance. • Rated Power of the transformer must be similar or higher than the maximum power of the inverter or group of inverters. • Frequency: 50/60 Hz • Transformer must indicate losses and SC current. • Transformer secondary winding impedance must be ≥ 4%, if LC filter is used
	Environmental ratings	Must be based on the installation location, end user requirements, compliance with applicable safety standards and directives, etc.
Ambient conditions	Enclosure class	IP00
	Pollution degree	2
Protection	Over voltage category	OVC III
	Protection class (IEC 61140)	Class I

* See the Grid converter application manuals (DPD01599 and DPD01978) and reference designs for more specific information.

8.3.2 Power ratings

Table 56. AC output/AC input ratings for VACON® Active Front End units used in grid converter applications

Code	Enclosure size	Voltage nominal* [V AC]	Current [A AC]	Frequency nominal [Hz]	Frequency range [Hz]	Power at pf 1.0 [kW]
NXA_0168 5	FI9	400	140	50	50/60	97
NXA_0205 5	FI9	400	170	50	50/60	118
NXA_0261 5	FI9	400	205	50	50/60	142
NXA_0385 5	FI10	400	300	50	50/60	208
NXA_0460 5	FI10	400	385	50	50/60	267
NXA_1150 5	FI13	400	1030	50	50/60	714
NXA_1300 5	FI13	400	1150	50	50/60	797
NXA_0125 6	FI9	600	100	50	50/60	104
NXA_0144 6	FI9	600	125	50	50/60	130
NXA_0170 6	FI9	600	144	50	50/60	150
NXA_0261 6	FI10	600	208	50	50/60	216
NXA_0325 6	FI10	600	261	50	50/60	271
NXA_0920 6	FI13	600	820	50	50/60	852
NXA_1030 6	FI13	600	920	50	50/60	956

* Voltage range: see the Design guide (DPD02146) and the VACON® Select web tool.

Table 57. DC input/DC output ratings for VACON® Active Front End units used in grid converter applications

Code	Enclosure size	Voltage nominal at nominal AC [V DC] *	Voltage range [V DC]	Current maximum continuous [A DC]
NXA_0168 5	FI9	630	465-800	154
NXA_0205 5	FI9	630	465-800	187
NXA_0261 5	FI9	630	465-800	225
NXA_0385 5	FI10	630	465-800	330
NXA_0460 5	FI10	630	465-800	423
NXA_1150 5	FI13	630	465-800	1133
NXA_1300 5	FI13	630	465-800	1265
NXA_0125 6	FI9	945	640-1100	110
NXA_0144 6	FI9	945	640-1100	137
NXA_0170 6	FI9	945	640-1100	158
NXA_0261 6	FI10	945	640-1100	229
NXA_0325 6	FI10	945	640-1100	287
NXA_0920 6	FI13	945	640-1100	902
NXA_1030 6	FI13	945	640-1100	1012

* 1.575 x nominal AC voltage. The value 1.575 comes from the ratio 1.5 (√2 + control margin) between the DC link and INU side, plus 5% filter losses.

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