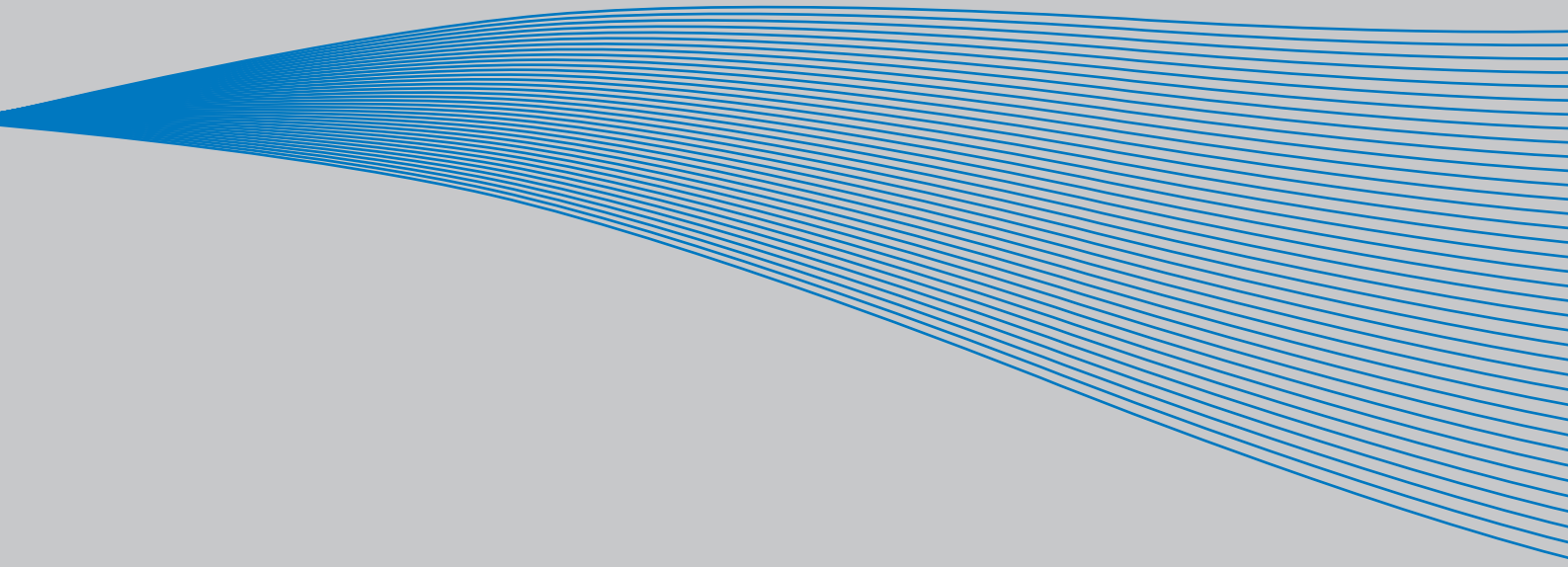
VACON® NX
AC DRIVES

ACTIVE FRONT END UNIT (AFE) USER MANUAL



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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, PLEASE 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/bus bar, and mains fuses, DC fuses and check the cable connections.
5. Follow the installation instructions, see Chapter 5.
6. The sizes and earthing 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 Active Front End (AFE) Application Manual.
10. Follow the commissioning instructions in the Active Front End Application Manual.
11. The Vacon® NX Active Front End is now ready for use.

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

ABOUT THE VACON NXA USER'S 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 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, please 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 hyperlinks 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 clearly marked cautions and warnings which are intended for your personal safety and to avoid unintentional damage to the product or connected appliances.

Please read the information included in cautions and warnings carefully.

The cautions and warnings are marked as follow:

Table 1. Warning signs

	**DANGER! Dangerous voltage**
	**WARNING! or CAUTION!**
	**CAUTION! Hot surface**

1.1 WARNINGS

The components of the power unit, LCL filter and pre-charging circuit are live when the Active Front End is connected to AC supply. Coming into contact with this voltage is extremely dangerous and may cause death or severe injury. The control unit is isolated from mains potential.

The control I/O-terminals are isolated from the mains potential. However, the relay outputs and other I/O-terminals may have dangerous control voltage present even when the Active Front End is disconnected from the AC supply.

1.2 SAFETY INSTRUCTIONS

Do not touch the components on the circuit boards. Static voltage discharge may damage the components.

The Active Front End, LCL filter and optional components are used for fixed installations only.

Do not perform any measurements when the Active Front End is connected to the AC supply.

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 perform any voltage withstand tests on any part of Active Front End. There is a certain procedure according to which the tests shall be performed. Ignoring this procedure may result in damaged product.

Before connecting the Active Front End to AC supply, make sure that the Active Front End front and cable covers are closed.

Before doing any work on Common DC bus, system shall be earthen.

1.3 EARTHING

The Active Front End unit and LCL filter must always be earthed with an earthing conductor connected to the earthing terminal.

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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. SGS FIMKO has acted as the Notified Body.

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 fulfills 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.

2.2.4 Manufacturer's declaration of conformity

The following page presents the photocopy of the Manufacturer's Declaration of Conformity assuring the compliance of Vacon® NX Active Front End with the EMC-directives.

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EC DECLARATION OF CONFORMITY

We

Manufacturer's name:	Vacon Oyj
Manufacturer's address:	P.O.Box 25 Runsorintie 7 FIN-65381 Vaasa Finland

hereby declare that the product

Product name:	Vacon NX Common DC bus Products
Model designation:	Vacon NXA 0004 5… to 2700 5 Vacon NXA 0004 6… to 2250 6

has been designed and manufactured in accordance with the following standards:

Safety:	EN 60204-1:2009 (as relevant) EN 61800-5-1:2007 Low Voltage Directive 2006/95/EC
EMC:	Factory delivered Vacon NX inverter modules comply with the requirements of category 4 equipment according to EN 61800-3:2004. EMC Directive 2004/108/EC

It is ensured through internal measures and quality control that the product conforms at all times to the requirements of the current Directive and the relevant standards.

In Vaasa, 25th of September, 2009

Vesa Laisi
President

The year the CE marking was affixed: 2005

11240.pdf

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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 designation of the product to the codes below, See Figure 1, Figure 2, Table 2).

Should the product have been damaged during the shipping, please 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 DESIGNATION CODE FOR THE AFE UNIT

In Vacon type designation 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.

VACON NX ACTIVE FRONT END - TYPE CODE

NX	A	AAAA	V	A	0	T	0	2	S	F	A1 A2 00 00 00

NX	**Product Generation**
A	**Module type** **A** = AFE Active Front End
AAAA	**Nominal current** (low overload) **eg.** 0261 = 261 A, 1030 = 1030 A, etc.
V	**Nominal supply voltage** **5** = 380-500 VAC / 465-800 VDC **6** = 525-690 VAC / 640-1100 VDC
A	**Control keypad** **A** = standard (alpha numeric)
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 **U** = Standard air cooled power unit - external supply for main fan
F	**Hardware modifications; module type - S Boards** **F** = Fiber connection, standard boards, FI9-FI13 **G** = Fiber connection, varnished boards, FI9-FI13
A1	**Option boards; each slot is represented by two characters:** **A** = Basic I/O board **B** = Expander I/O board **C** = Fieldbus board **D** = Special board
A2	
00	
00	
00	

Figure 1. Type designation code for the Active Front End

3.2 TYPE DESIGNATION 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, Figure 2.

VACON LCL FILTERS FOR AFE - TYPE CODE

VACON	LCL	AAAA	V	A	0	R	0	1	1	T

LCL → **Product range**
LCL = LCL filter for AFE

AAAA →

0261	**5**
0460	**5**
1300	**5**
0170	**6**
0325	**6**
1030	**6**

Nominal current (low overload)
eg. 0460 = 460 A, **1300** = 130 A, etc.

V → **Voltage class**
5 = 380-500 VAC
6 = 525-690 VAC

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

Figure 2. Type designation code for the LCL filters

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3.3 TYPE DESIGNATION 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 2. Each pre-charging circuit has maximum charging capacity, see Table 20.

Table 2. Type designation 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
Relative humidity	<95%, no condensation

When the Active Front End unit is stored without voltage being applied, the recharging of the capacitors should be done at least once a year by connecting voltage into the unit and keeping it powered at least for 1hour.

If the storing time is much longer than one year, the recharging of the capacitors has to be carried out so that the possible high leakage current through the capacitors is limited. The best alternative is to use DC-power supply with adjustable current limit. Current limit has to be set for example to 300...500 mA and DC-power supply has to be connected to the B+/B- terminals (DC supply terminals). DC-voltage must be adjusted up to nominal DC-voltage level of the unit (1.35*U_n AC) and shall be supplied at least for 1 hour.

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

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3.5 MAINTENANCE

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

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

Regular maintenance is recommended to ensure trouble free operation and long lifetime of Vacon® NX Active Front End. At least the following things should be included in the regular maintenance.

Table 3. Maintenance interval

Interval	Maintenance
12 months (if unit is stored)	Capacitor reforming, see seperate instructions.
6 - 24 months (depending on environment)	Check tightening torque of the input and output terminals and I/O terminals. Clean the cooling tunnel. Check operation of the cooling fan, check for corrosion on terminals, bus bars and other surfaces. Check the door filters.
5 - 7 years	Change the cooling fans. Main fan of the unit. Fan of the LCL filter.
5 - 10 years	Change the DC bus capacitors if DC voltage ripple is high.

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

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 frames FI9 and FI10, see Figure 3 and for the frame FI13, see Figure 4.

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

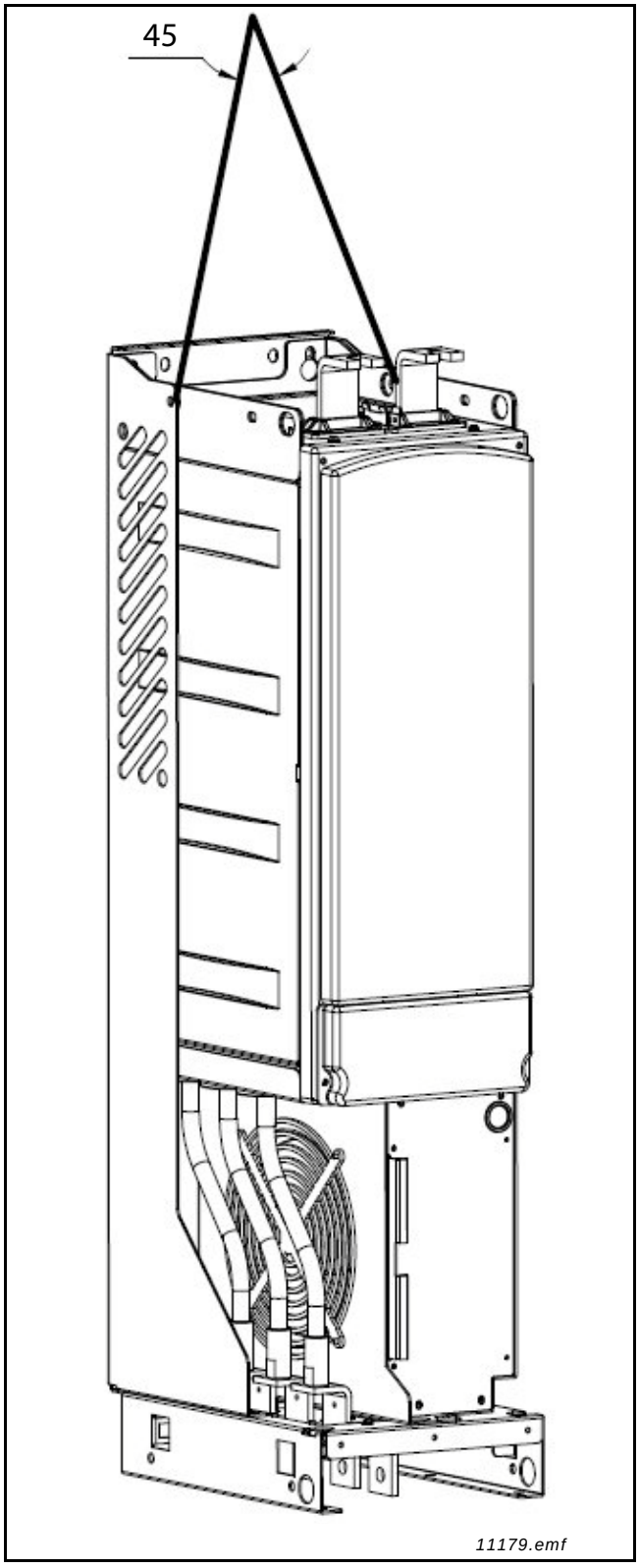

Figure 3. Lifting points for FI9 and FI10 modules

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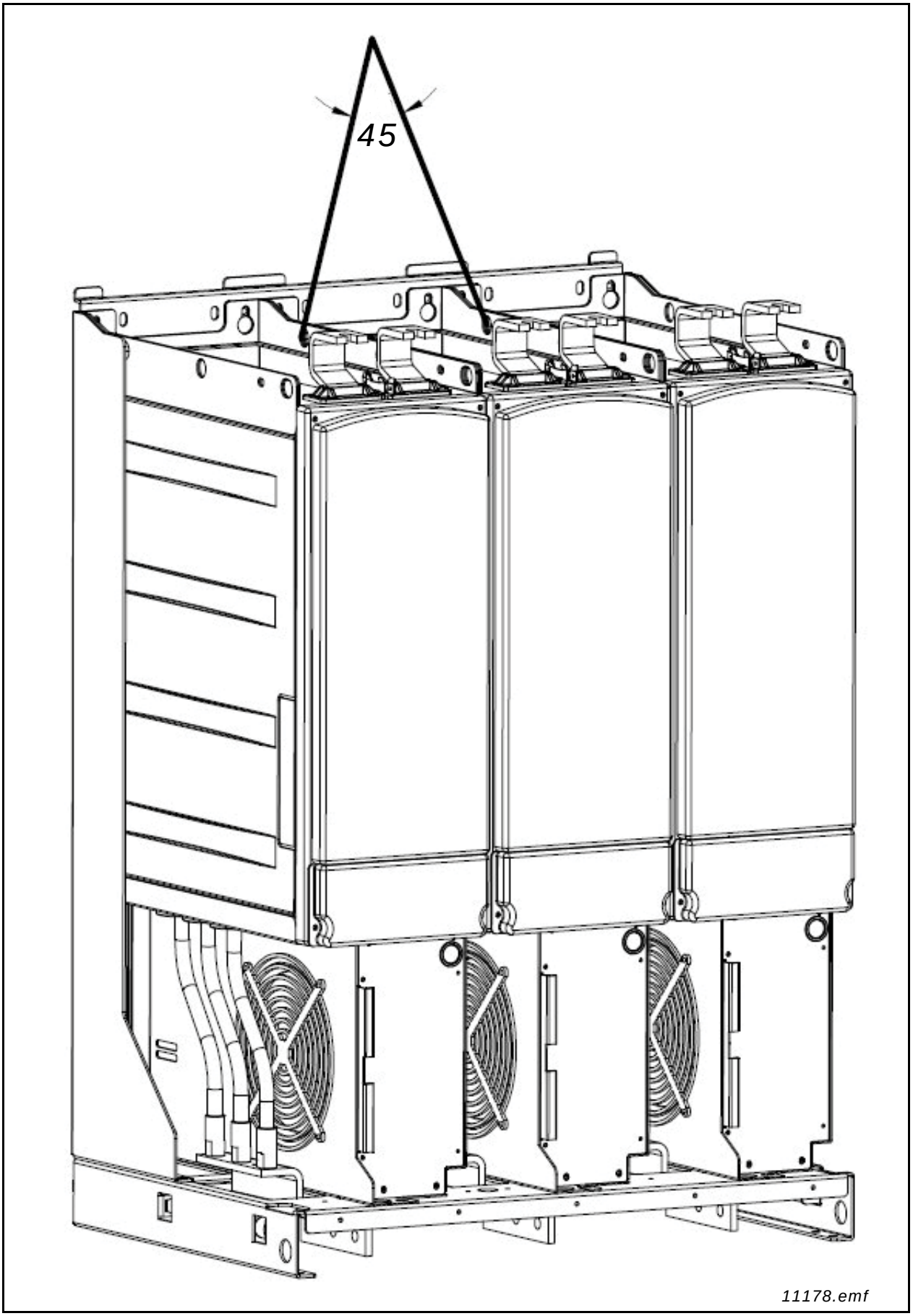

Figure 4. Lifting points for FI13 modules

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 5 and for the FI13 LCL filter, see Figure 6.

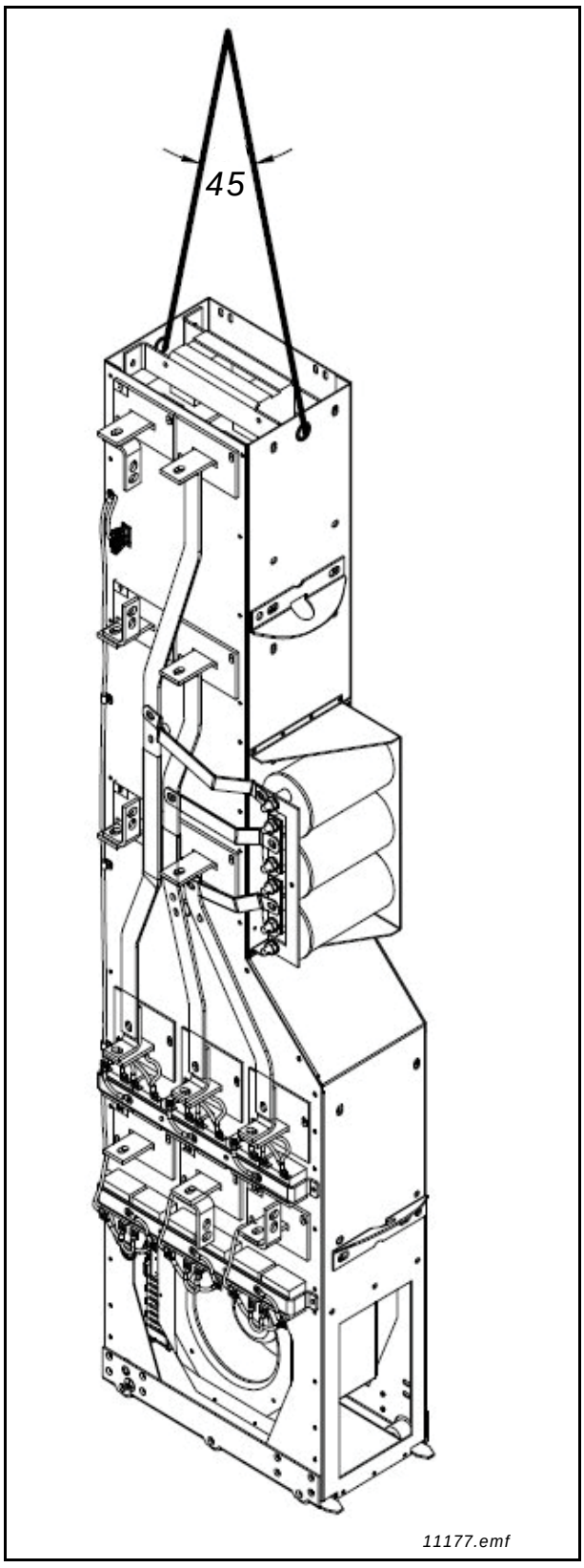

Figure 5. Lifting points for FI9 and FI10 LCL filter

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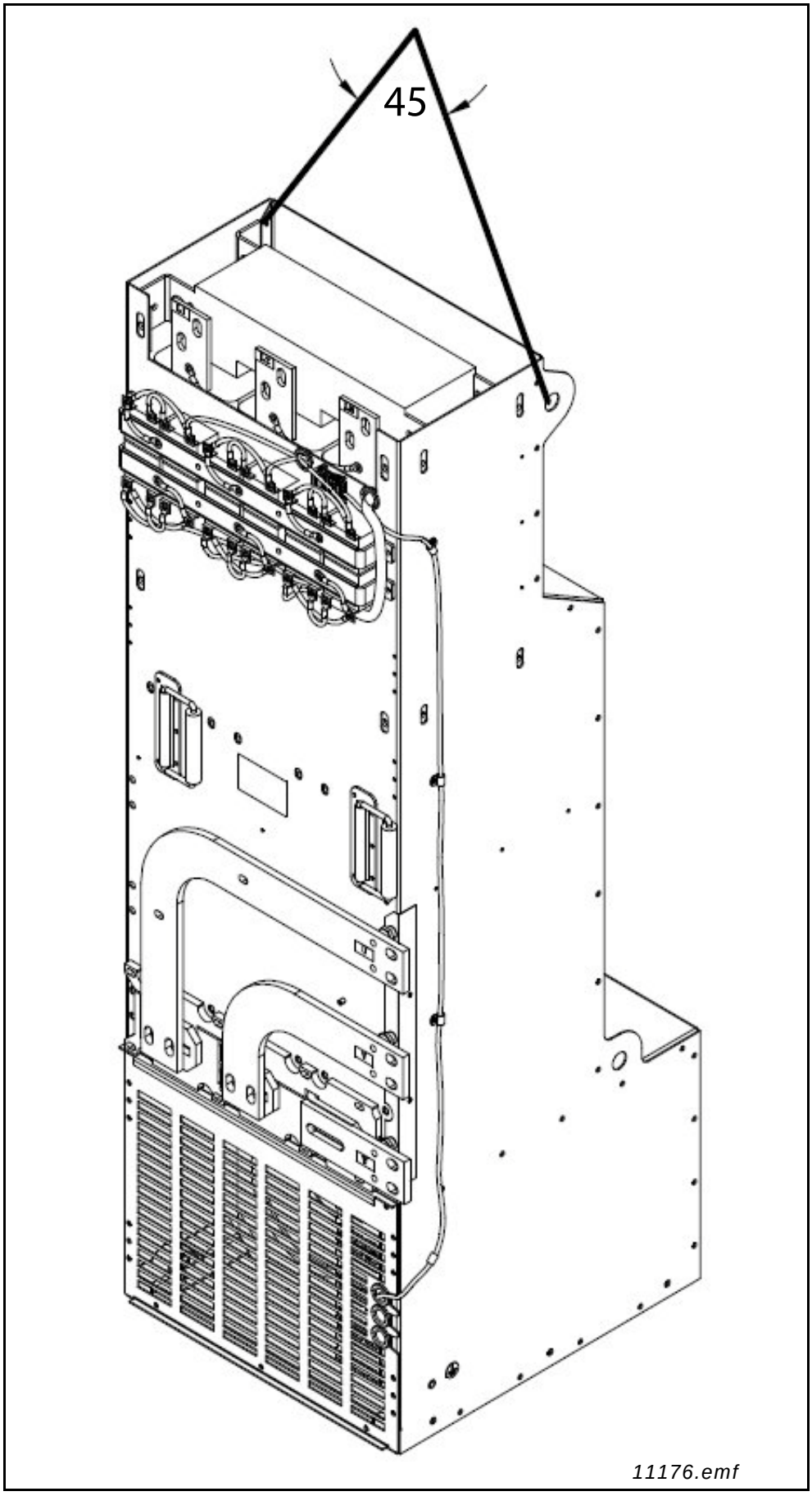

Figure 6. Lifting points for FI13 LCL filter

3.8 WARRANTY

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

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

Neither can the manufacturer be held responsible for consequential damages.

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

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

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

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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 7, 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 8.

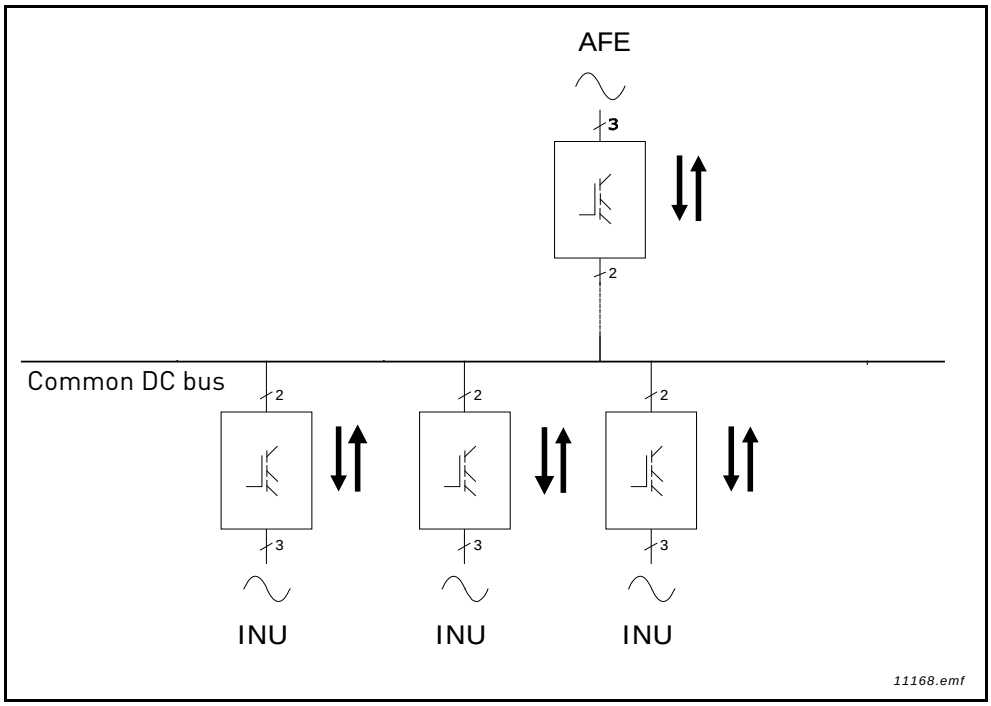

Figure 7. Typical Active Front End configuration

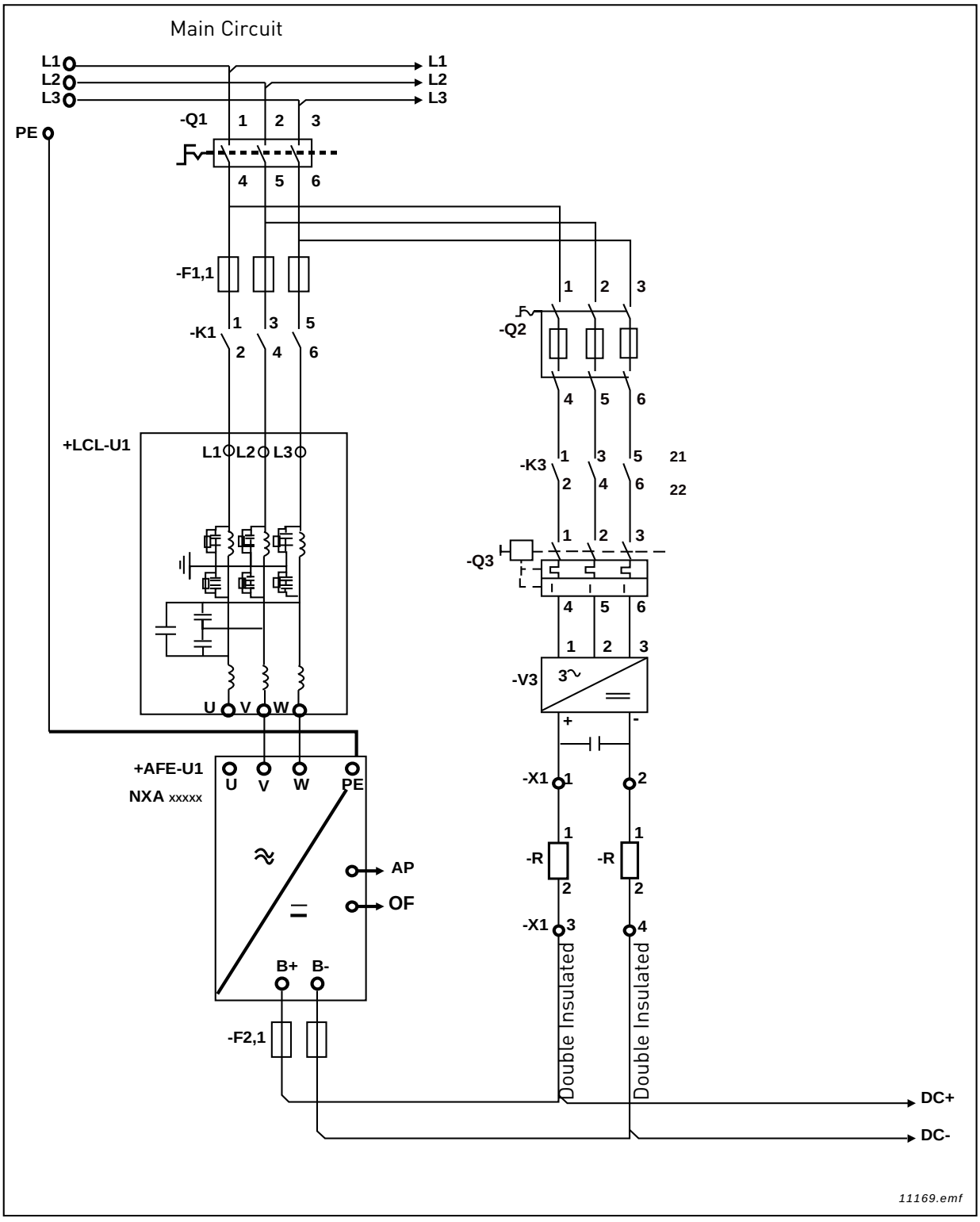

Figure 8. Vacon Active Front End Single Unit connections

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4.2 ACTIVE FRONT END UNIT BLOCK DIAGRAM

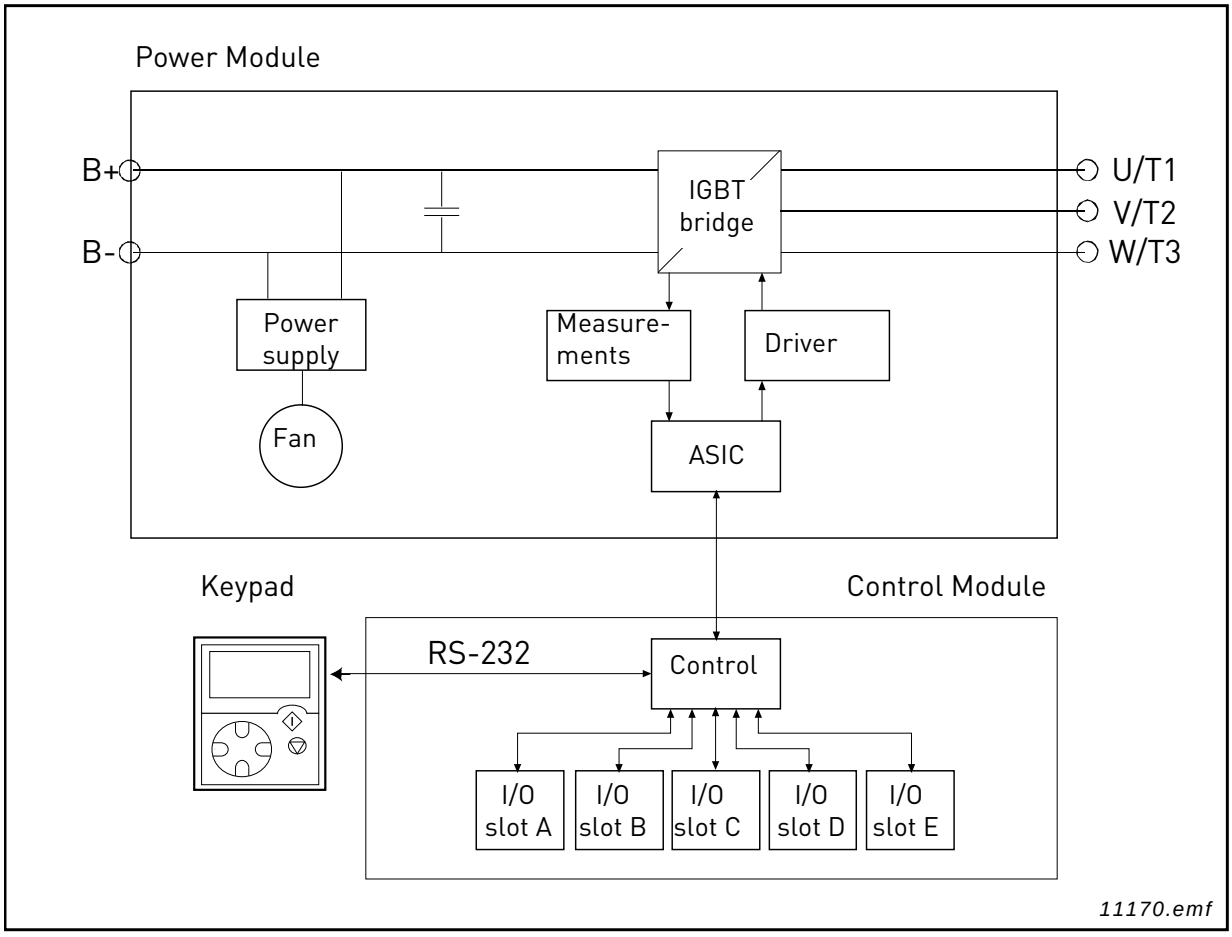

Figure 9. NXA block diagram

4.3 ACTIVE FRONT END FRAME SIZES

Figure 10. Vacon NXA, FI9. Protection class IP00

Figure 11. Vacon NXA, FI10. Protection class IP00

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Figure 12. Vacon NXA, FI13. Protection class IP00

4.4 ACTIVE FRONT END UNIT TECHNICAL DATA

Table 4. Technical specification for Vacon® NXA Active Front End unit

AC input connection	Voltage U_{in}	380...500 Vac; 525...690 Vac; –10%...+10%
	Frequency f_{in}	48–63 Hz
	Starting delay	FI9–FI13: 5 s
DC output connection	Voltage	1.35 x U_{in} x 1.1 (default DC link voltage boosting is 110%).
	Continuous output current	I_H: Ambient temperature +40 °C, overloadability 1.5 x I_H (1 min./10 min.). I_L: Ambient temperature +40 °C, overloadability 1.1 x 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
Ambient conditions	Ambient temperature during operation	–10 °C (no freezing)...+40 °C: I_H –10 °C (no freezing)...+40 °C: I_L Maximum temperature +50 °C, see Power derating as a function of ambient temperature.
	Storage temperature	–40 °C...+70 °C
	Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water.
	Air quality: - chemical fumes - solid particles	 EN 60721, equipment in operation, Class 3C3. IEC 721-3-3, equipment in operation, Class 3S2.
	Elevation of place of operation	100% loadability (no derating) up to 1000 m. Maximum elevation 2000 m (525-690 VAC) and 4000 m (380-500 VAC), Relay I/O: max. 240 V: 3000 m; max. 120 V: 4000 m, see Power derating as a function of installation altitude. See Chapter 4.16.
	Vibration EN50178/EN 60068-2-6	5...150 Hz. Vibration amplitude 1 mm (peak) in frequency range 3...15.8 Hz. Max. acceleration 1 G in frequency range 15.8...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/NEMA1 standard size in the kW/HP range.
EMC (using factory settings)	Immunity	EN 61800-3 (2nd edition 2004), second environment.
Safety		EN 50178 (1997), EN 60204-1 (1996-2009), EN 60950 (2000, 3. edition) (as relevant), CE, UL, cUL, FI, GOST R, IEC-EN 61800-5; (for approvals, see the unit nameplate).

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Table 4. Technical specification for Vacon® NXA Active Front End unit

Control connections	Analogue input voltage	0...+10 V, R_i = 200 kΩ. Resolution 0.1%, accuracy ±1%
	Analogue input current	0(4)...20 mA, R_i = 250 Ω differential
	Digital inputs (6)	Positive or negative logic; 18...30 VDC
	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	2 programmable changeover relay outputs Breaking capacity: 24 VDC / 8 A, 250 VAC / 8 A, 125 VDC / 0.4 A. Min. switching load: 5 V / 10 mA.
Protection	Overvoltage protection Undervoltage protection	NXA_5: 911 VDC; NXA_6: 1200 VDC NXA_5: 333 VDC; NXA_6: 460 VDC
	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 overheat protection	Yes
	Short-circuit protection of +24 V and +10 V reference voltages	Yes

4.5 LCL FILTER TECHNICAL DATA

Table 5. 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 Vdc; 460...1200 Vdc
	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 Vdc; -10...+10%
	Current	5 A
	Short-circuit protection	AC fuses on the input side of the external power supply.
EMC (using factory settings)	Immunity	EN 61800-3 (2nd edition 2004), second environment.
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

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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 Application User's Manual.

4.7 DIAGRAMS

4.7.1 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 13. 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 14. ASIC board terminals located in the unit under the black cover, Figure 15. To open black cover two screws at left and right side should be opened.

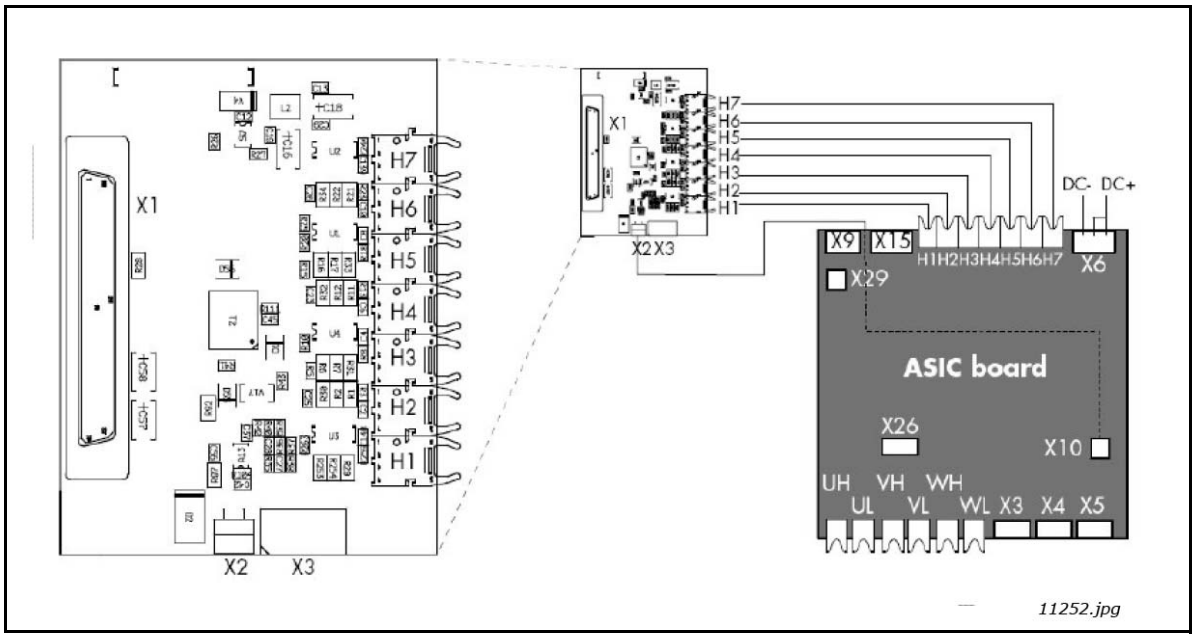

Figure 13. Optical cable adapter board

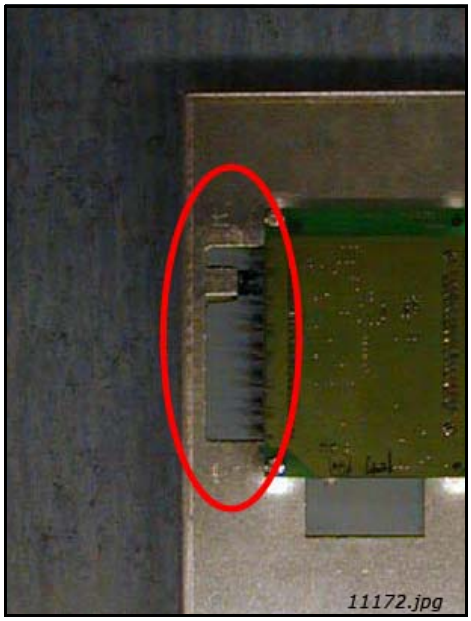

Figure 14. Optical cable adapter board

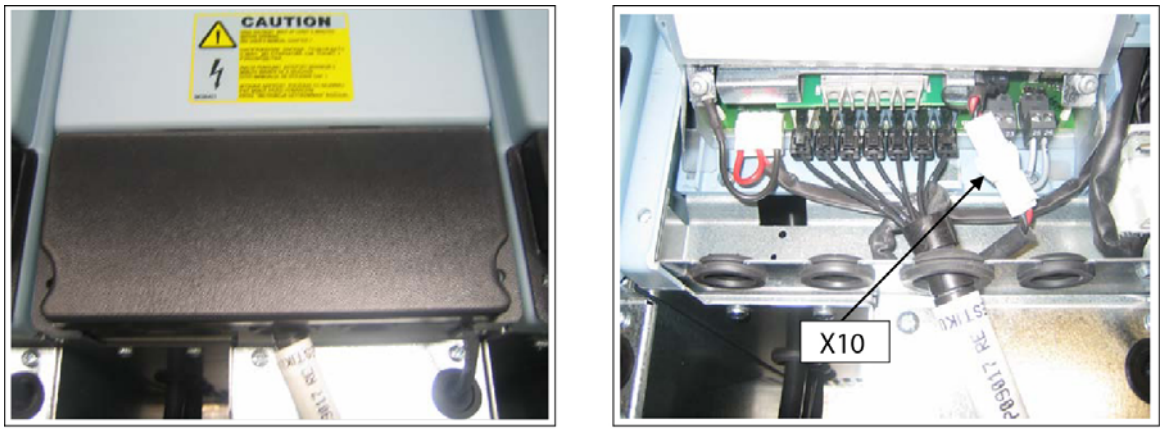

Figure 15. Optical cable terminals in the unit (FI13 example)

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.

4.7.2 LCL WIRING DIAGRAM

The LCL filter contains a choke on the mains side, capacitors and a choke on the AFE side, Figure 16. The LCL also includes capacitors connected against ground potential. There are resistors connected across the capacitors for discharging them when the LCL filter is disconnected from the input power. The discharging resistors are 10 MΩ, 500 V and 0,5 W.

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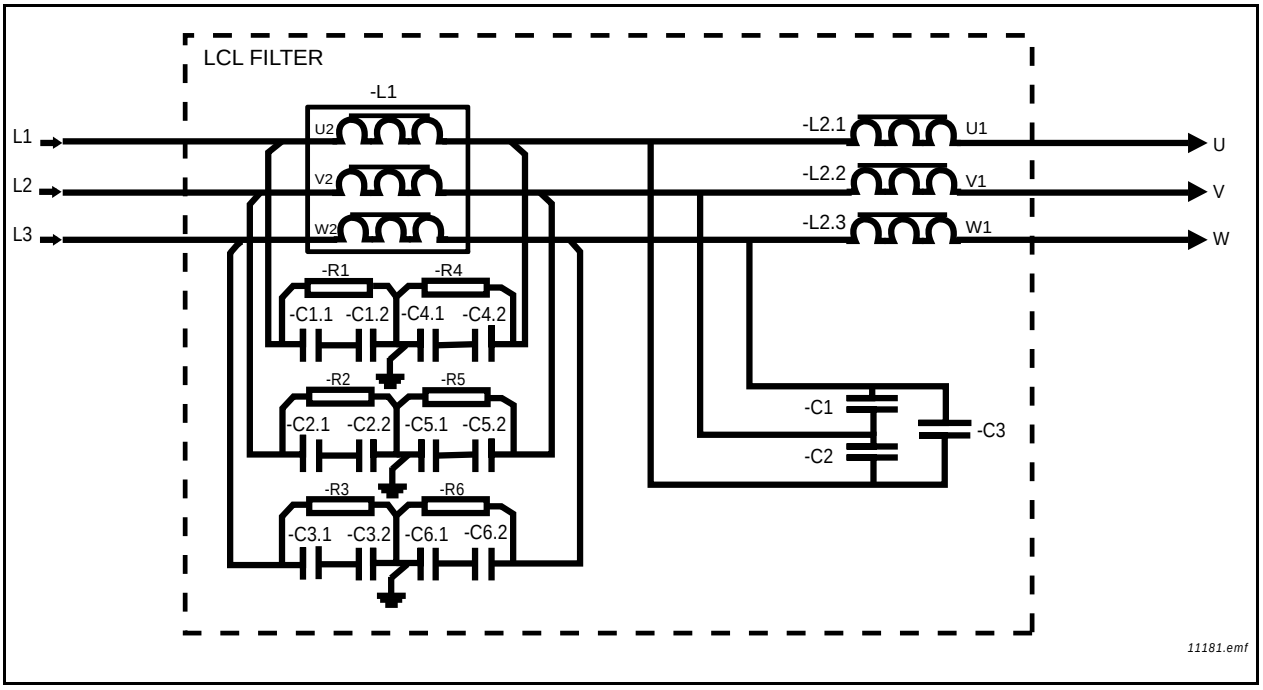

Figure 16. Vacon LCL filter wiring diagram

4.7.2.1 Removing discharging resistors

If the LCL filter is used in a network fitted with an earth fault protection relay, these discharging resistors should be removed. If the discharging resistors are not removed, the earth fault monitoring device might indicate a very low leakage resistance. The resistors must be connected so that the capacitors are discharged when disconnecting from the input power. The wiring diagram of an alternative discharging circuit can be seen in Figure 18. Figure 17 shows the default wiring of the LCL filter. The discharging resistors should be 10 kΩ, 500 V and 2 W. 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 19 (for FI9 and FI10) and Figure 20 (for FI13) have a blue marking on the lead that has to be removed from each capacitor if the discharge resistor is 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.

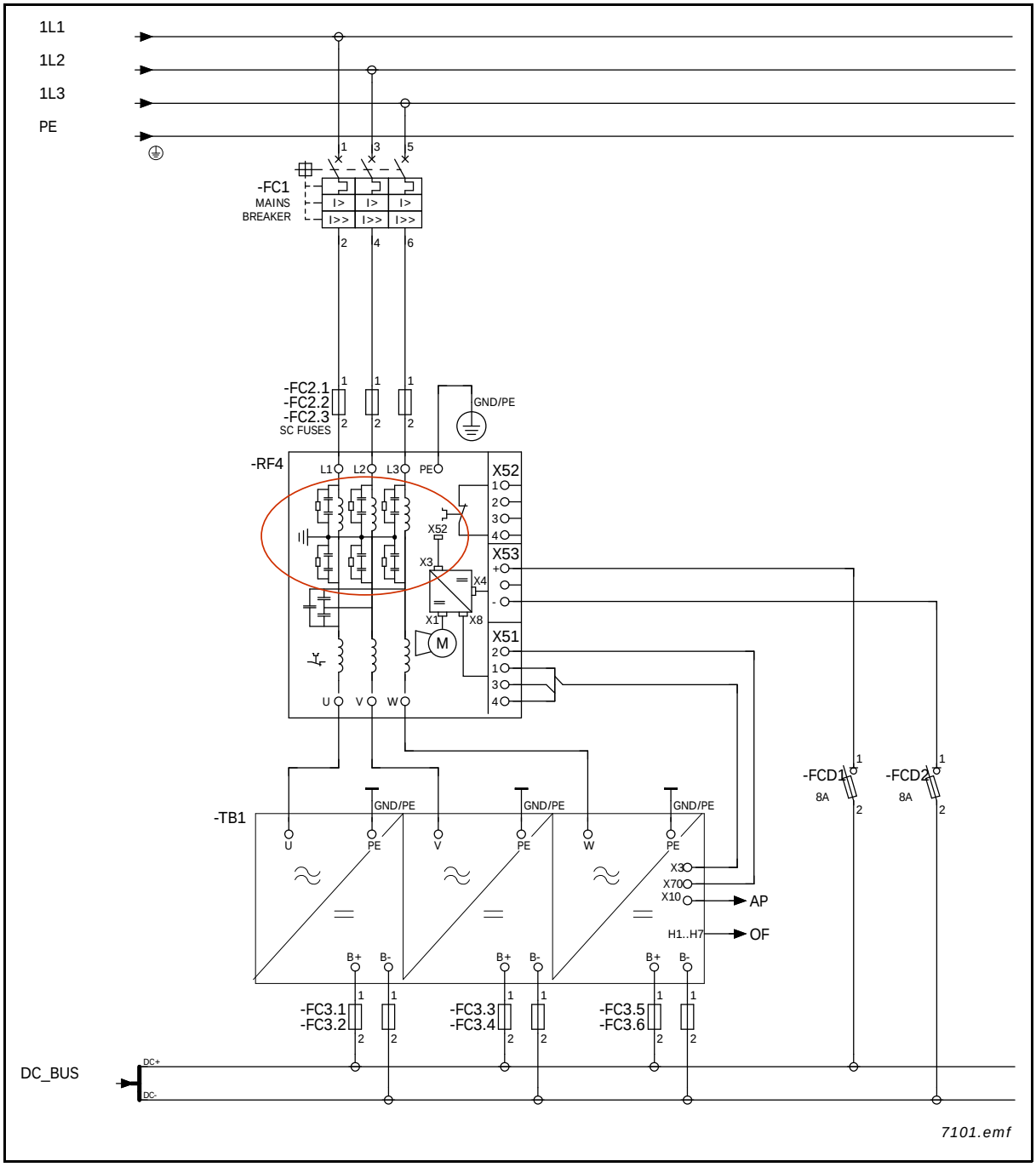

Figure 17. Wiring diagram of the default LCL filter

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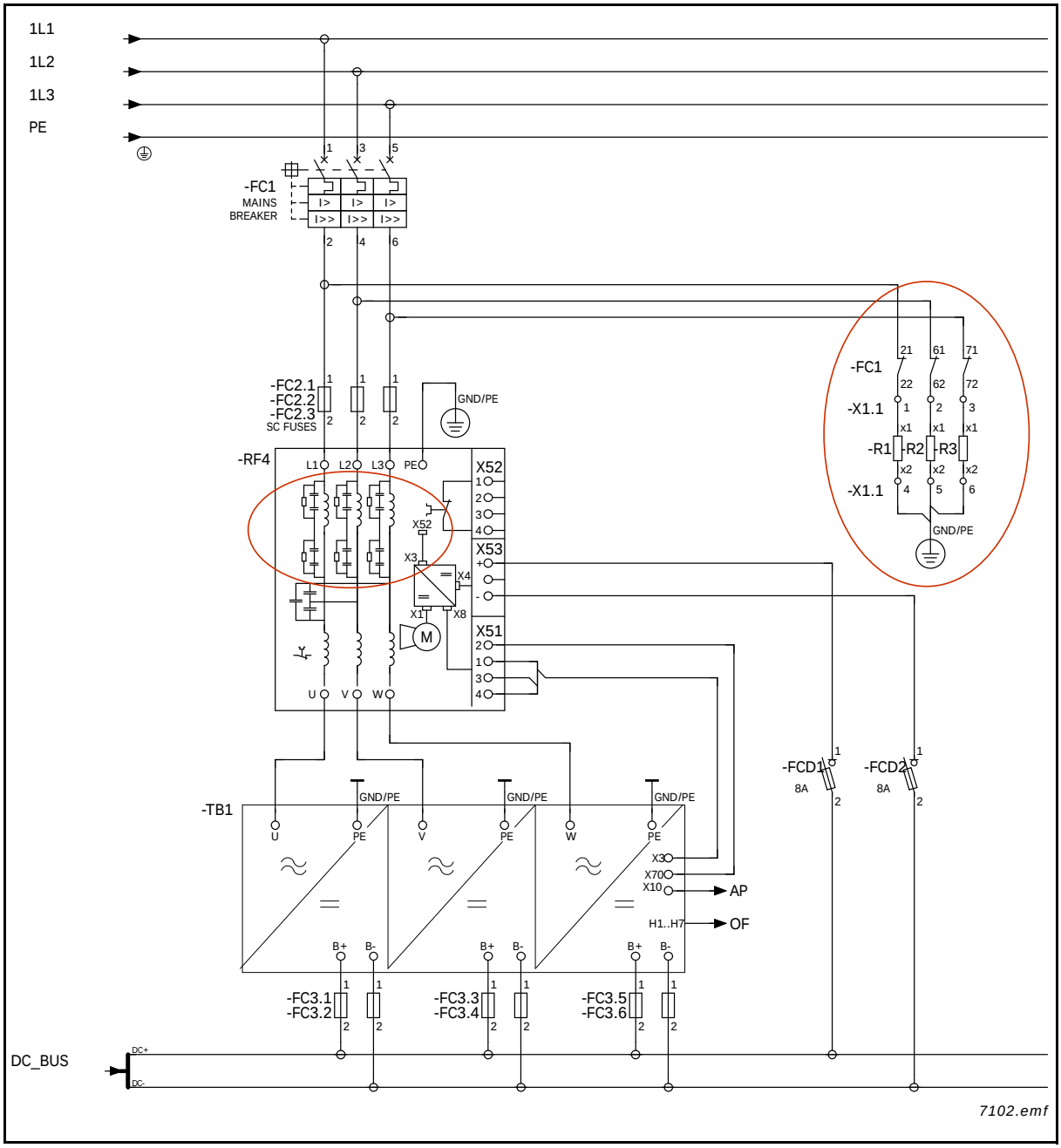

Figure 18. Wiring diagram of LCL and AFE circuit when used in IT network, or when AFE of other manufacturer is connected to same transformer secondary supply

4.7.2.2 Removing HF capacitors

If a PWM modulated rectifier from another manufacturer is connected to the same input transformer, the HF capacitor must be removed, because the HF capacitors will be filtering the high frequency disturbances from another manufacturer's active front ends. It is recommended to always use own transformers if more than one manufacturer's AFEs are used.

Figure 19 (for FI9 and FI10) and Figure 20 (for FI13) have a red marking on the lead that has to be removed from each capacitor if the HF capacitors are not to be used. Removing the lead disconnects the capacitors from ground potential.

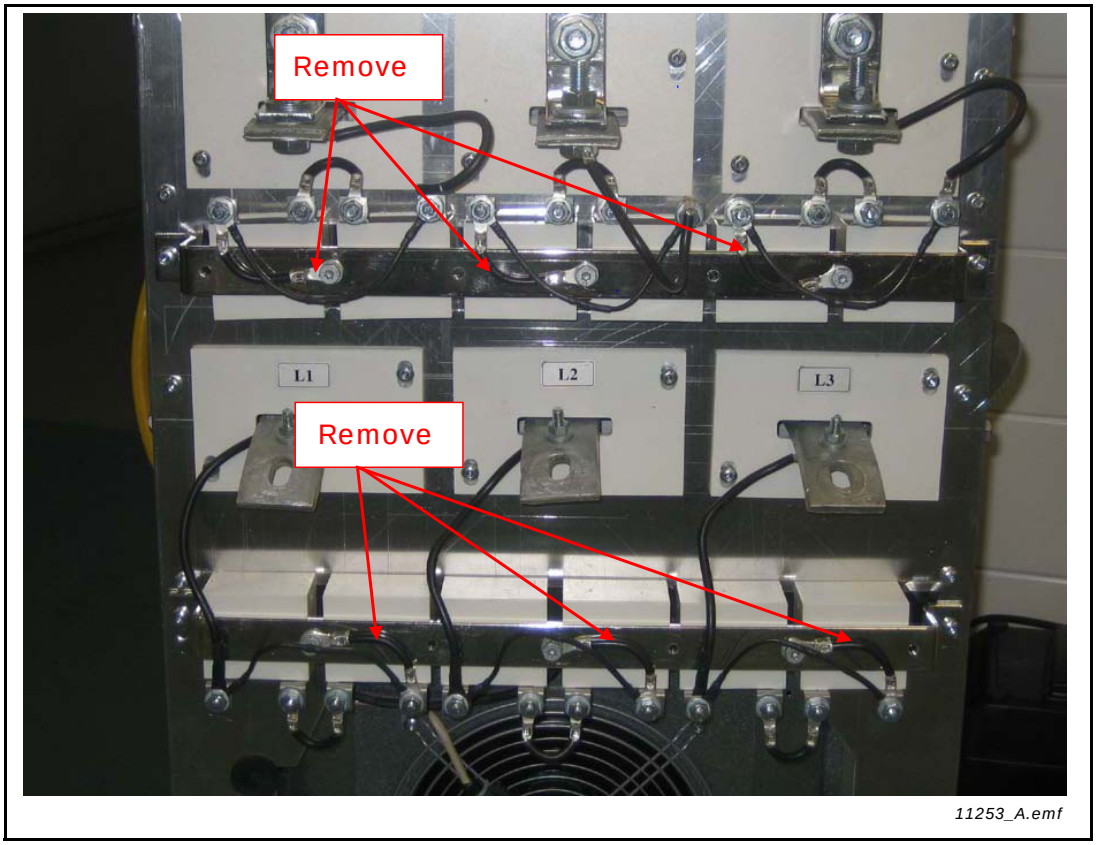

Figure 19. HF capacitors in FI9 and FI10 LCL filter

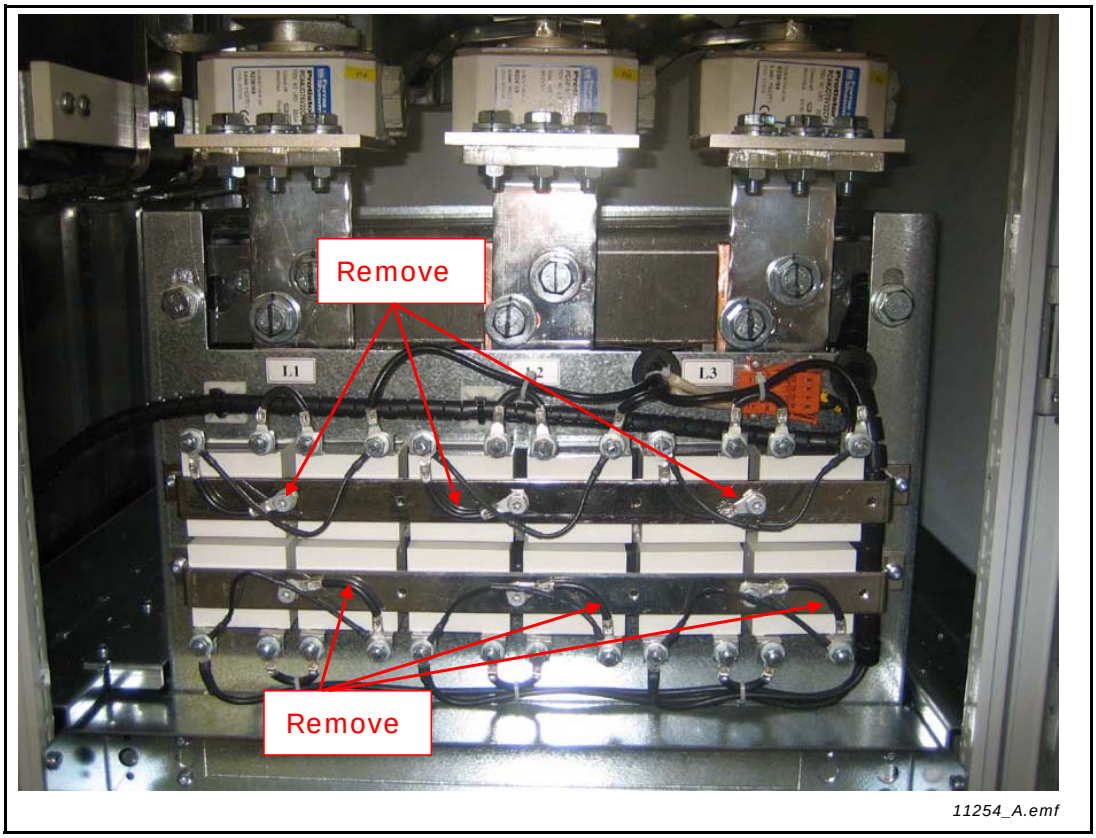

Figure 20. HF capacitors in FI13 LCL filter

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4.8 ACTIVE FRONT END POWER RATINGS

4.8.1 VACON NXA; DC VOLTAGE 380–500 V

Table 6. Power ratings of Vacon NXA, supply voltage 380–500 VAC

Type	Unit		Low oveload (AC current)		High oveload (AC current)		DC Power (continuous)	
	Code	Frame	$I_{L\text{-cont}}$ [A]	I_{1min} [A]	$I_{H\text{-cont}}$ [A]	I_{1min} [A]	400 V mains P [kW]	500 V mains P [kW]
AFE	NXA_0261 5	FI9	261	287	205	308	175	229
	NXA_0460 5	FI10	460	506	385	578	309	387
	NXA_1300 5	FI13	1300	1430	1150	1725	874	1092

For dimensions of NXA units, see Table 8 and LCL filters Table 9.

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} = AFEs DC power

η_{INU} = efficiency of the inverter

η_{Motor} = efficiency of the motor

4.8.2 VACON NXA; DC VOLTAGE 525–690 V

Table 7. Power ratings of Vacon NXA, supply voltage 525–690 VAC

Type	Unit		Low oveload (AC current)		High oveload (AC current)		DC Power (continuous)
	Code	Frame	$I_{L\text{-cont}}$ [A]	I_{1min} [A]	$I_{H\text{-cont}}$ [A]	I_{1min} [A]	690 V mains P [kW]
AFE	NXA_0170 6	FI9	170	187	144	216	197
	NXA_0325 6	FI10	325	358	261	392	377
	NXA_1030 6	FI13	1030	1133	920	1380	1194

For dimensions of NXA units, see Table 8 and LCL filters Table 9.

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} = AFEs DC power

η_{INU} = efficiency of the inverter

η_{Motor} = efficiency of the motor

4.9 ACTIVE FRONT END UNIT – DIMENSIONS

Table 8. The NXA unit dimensions

Module		Module Dimension			
Type	**Frame**	**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 Appendix 73, Appendix 74 and Appendix 75.

4.10 LCL FILTER – DIMENSIONS

Table 9. LCL filter dimensions

Module		Module Dimension			
Type	**Frame**	**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 Appendix 76 and Appendix 77.

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4.11 ACTIVE FRONT END UNIT – FUSE SELECTION

4.11.1 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. Vacon Plc will not assume any responsibility for damages caused by insufficient protection.

4.11.2 FUSES; MAINS VOLTAGE 380–500 V

4.11.2.1 AC fuses

Table 10. Ferraz Shawmut AC fuse selection, mains voltage 380–500 Vac

Module			AC fuses				
Type	Code	Frame	Ferraz Shawmut type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0261 5	FI9	NH2UD69V500PV	690	500	2	3
	NXA_0460 5	FI10	NH3UD69V800PV	690	800	3	3
	NXA_1300 5	FI13	PC44UD75V22CTQ	750	2200	44	3

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

Table 11. Bussman AC fuse selection, mains voltage 380–500 Vac

Module			AC fuses				
Type	Code	Frame	Bussman type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0261 5	FI9	170M6202	1250	500	3SHT	3
	NXA_0460 5	FI10	170M6277	1250	1000	3SHT	3
	NXA_1300 5	FI13	170M6277	1250	1000	3SHT	3x3

NOTE! All fuses are blade type. If some other type is needed, please contact Vacon.

4.11.2.2 DC fuses

Table 12. Ferraz Shawmut DC fuse selection, mains voltage 465–800 Vdc

Module			DC fuses				
Type	Code	Frame	Ferraz Shawmut type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0261 5	FI9	PC73UD13C500TF	1250	500	3	2
	NXA_0460 5	FI10	PC73UD95V11CTF	950	1100	3	2
	NXA_1300 5	FI13	PC84UD11C24CTQ	1100	2400	84	2

Table 13. Bussman DC fuse selection, mains voltage 465–800 Vdc

Module			DC fuses				
Type	Code	Frame	Bussman type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0261 5	FI9	170M6562	690	800	3GKN/50	2
	NXA_0460 5	FI10	170M6566	690	1250	3GKN/50	2
	NXA_1300 5	FI13	170M6566	690	1250	3GKN/50	3x2

NOTE! All fuses are flush-end type. If some other type is needed, please contact Vacon.

4.11.3 FUSES; MAINS VOLTAGE 525–690 V

4.11.3.1 AC fuses

Table 14. Ferraz Shawmut AC fuse selection, mains voltage 525–690 Vac

Module			AC fuses				
Type	Code	Frame	Ferraz Shawmut type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0170 6	FI9	PC71UD13C315PA	1250	315	1	3
	NXA_0325 6	FI10	PC73UD13C630PA	1150	630	3	3
	NXA_1030 6	FI13	PC84UD12C18CTQ	1150	1800	84	3

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

Table 15. Bussman AC fuse selection, mains voltage 525–690 Vac

Module			AC fuses				
Type	Code	Frame	Bussman type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0170 6	FI9	170M4199	1250	400	1SHT	3
	NXA_0325 6	FI10	170M6305	1250	700	3SHT	3
	NXA_1030 6	FI13	170M6305	1250	700	3SHT	3x3

NOTE! All fuses are blade type. If some other type is needed, please contact Vacon.

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4.11.3.2 DC fuses

Table 16. Ferraz Shawmut DC fuse selection, mains voltage 640–1100 Vdc

Module			DC fuses				
Type	Code	Frame	Ferraz Shawmut type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0170 6	FI9	PC71UD13C400TF	1250	400	1	2
	NXA_0325 6	FI10	PC73UD13C630TF	1250	630	3	2
	NXA_1030 6	FI13	PC84UD11C20CTQ	1100	2000	84	2

Table 17. Bussman DC fuse selection, mains voltage 640–1100 Vdc

Module			DC fuses				
Type	Code	Frame	Bussman type [aR]*	U_N [V]	I_N [A]	Size	Q'ty
AFE	NXA_0170 6	FI9	170M4926	1250	400	1GKN/75	2
	NXA_0325 6	FI10	170M8507	1250	700	3GKN/75	2
	NXA_1030 6	FI13	170M8510	1100	1000	3GKN/75	3x2

NOTE! All fuses are flush-end type. If some other type is needed, please contact Vacon.

4.12 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 Table 18. If a circuit-breaker from another manufacturer is used, it must be equivalent to the circuit-breakers shown. Further information on the circuit-breakers shown is available from the manufacturer. Circuit-breakers do not provide the same level of protection as fuses. 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. The circuit-breakers shown are suitable for equipment rated at 380 V–500 V or 525 V–690 V.

Table 18. Circuit breaker for Vacon NXA

Type	T5H400FF3LS		
FI9	T5H400FF3LS MOE230V/T4-5 UVRC230V/T4-5 ES-6/T5 AUX-C3+1/T4-5 PB100/T4-5-3P AUX-SA1-S51+1/T4-5	MCCB Motor Undervoltage rel. (cabled) Spreaded ext. term. incl. PB100 Aux./alarm cont. (cabled) Phase separators for upper/lower terminals S51 NC	1SDA054349R1 1SDA054897R1 1SDA054891R1 1SDA055038R1 1SDA054911R1 1SDA054970R1 1SDA064518R1
Type	**T5H630FF3LS**		
FI10	T5H630FF3LS MOE230V/T4-5 UVRC230V/T4-5 ES-6/T5 AUX-C3+1/T4-5 PB100/T4-5-3P AUX-SA1-S51+1/T4-5	MCCB Motor Undervoltage rel. (cabled) Spreaded ext. term. incl. PB100 Aux./alarm cont. (cabled) Phase separators for upper/lower terminals S51 NC	1SDA054412R1 1SDA054897R1 1SDA054891R1 1SDA055038R1 1SDA054911R1 1SDA054970R1 1SDA064518R1
Type	**T7S16FF3PR231LS**		
FI13	Spring chargin motor 220...250 V AC/DC AUX 2Q 400 V AC SOR 220...240 V AC/DC T7S16FF3PR231LS UVR 220...240 V AC/DC SCR 220..240 V AC/DC AUX-RTC 250 V AC/DC Trip reset 200-240 V AC/DC AUX-SA 1 S51 T7-T7M	SPRING CHARGING MOTOR AUX. CONTACT SHUNT OPENING RELEASE MOULDED CASE CIRCUIT BREAKER UNDER VOLTAGE RELAY SHUNT CLOSING RELEASE READY TO CLOSE TRIP RESET UNIT AUX-SA 1 S51 T7-T7M	1SDA062116R1 1SDA062102R1 1SDA063548R1 1SDA063010R1 1SDA063552R1 1SDA063550R1 1SDA062109R1 1SDA062119R1 1SDA063553R1

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4.13 MAIN CONTACTOR

If a main contactor is to be used, the types shown in Table 19 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 19. 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

4.14 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 Vacon's standard pre-charging circuits are shown in Table 20. Pre-charging circuits are suitable for 380-500 Vac and 525-690 Vac.

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 Appendix 70.

Table 20. Capacitance Min and Max value for Pre-charging circuit

Frame 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, please contact the nearest Vacon office.

The example shown in Appendix 70 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 Appendix 72. 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 what are used for connecting the pre-charging circuit to the intermediate circuit has to be double insulated.

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

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4.15 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 bet-ween the units is required; they work independently. Vacon's standard LCL filters must be used for paralleling. If filters other than Vacon's 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 4.11. 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 deice 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 interediate DC circuit.

4.15.1 COMMON PRE-CHARGING CIRCUIT

In case of paralleled Active Front End units, one common pre-charging circuit can be used, see Figure 21. 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 Appendix 70 and Appendix 72.

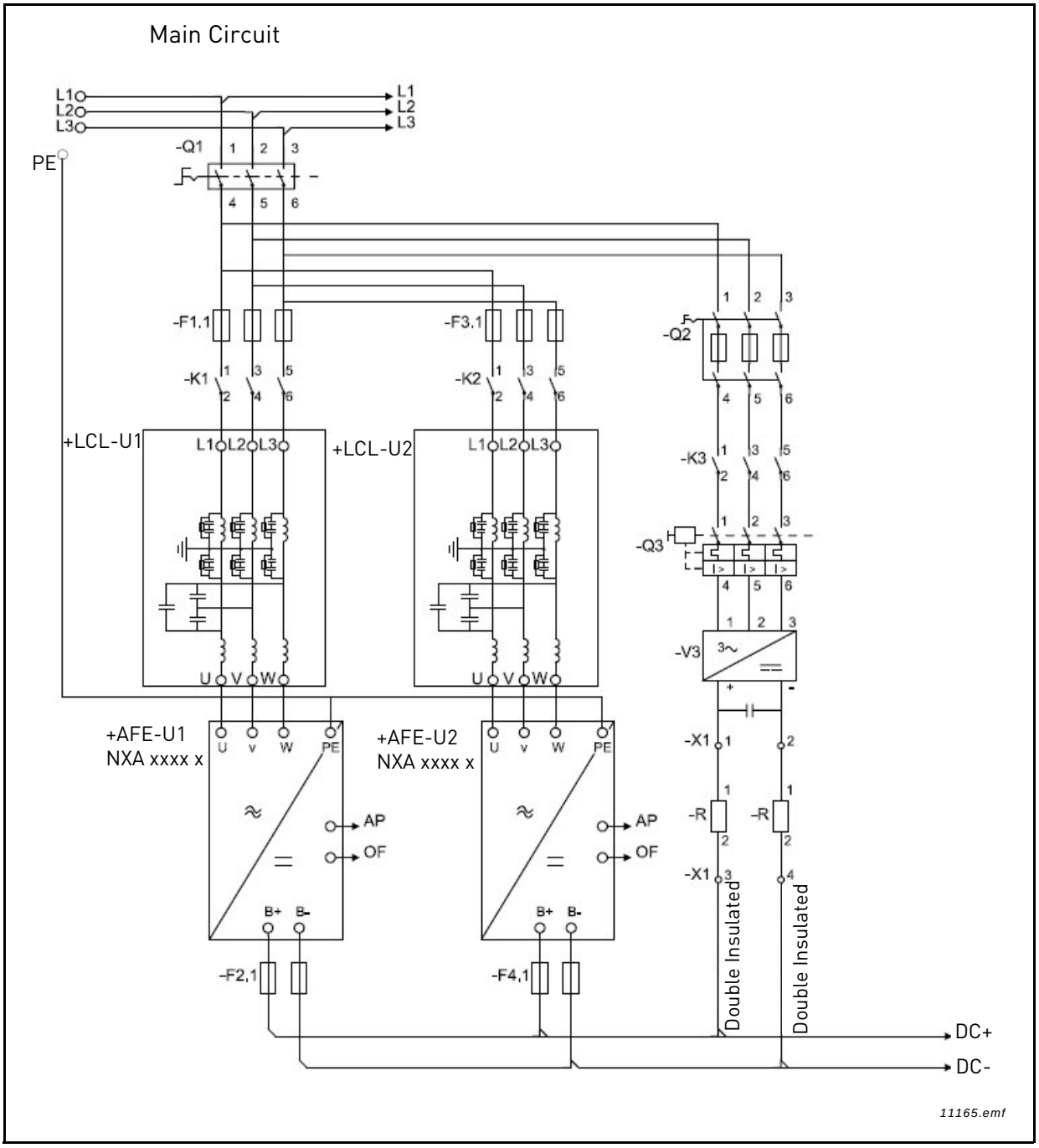

Figure 21. Active Front End units parallel connection with one common pre-charging circuit

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4.15.2 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 22. 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 Appendix 70 and Appendix 72.

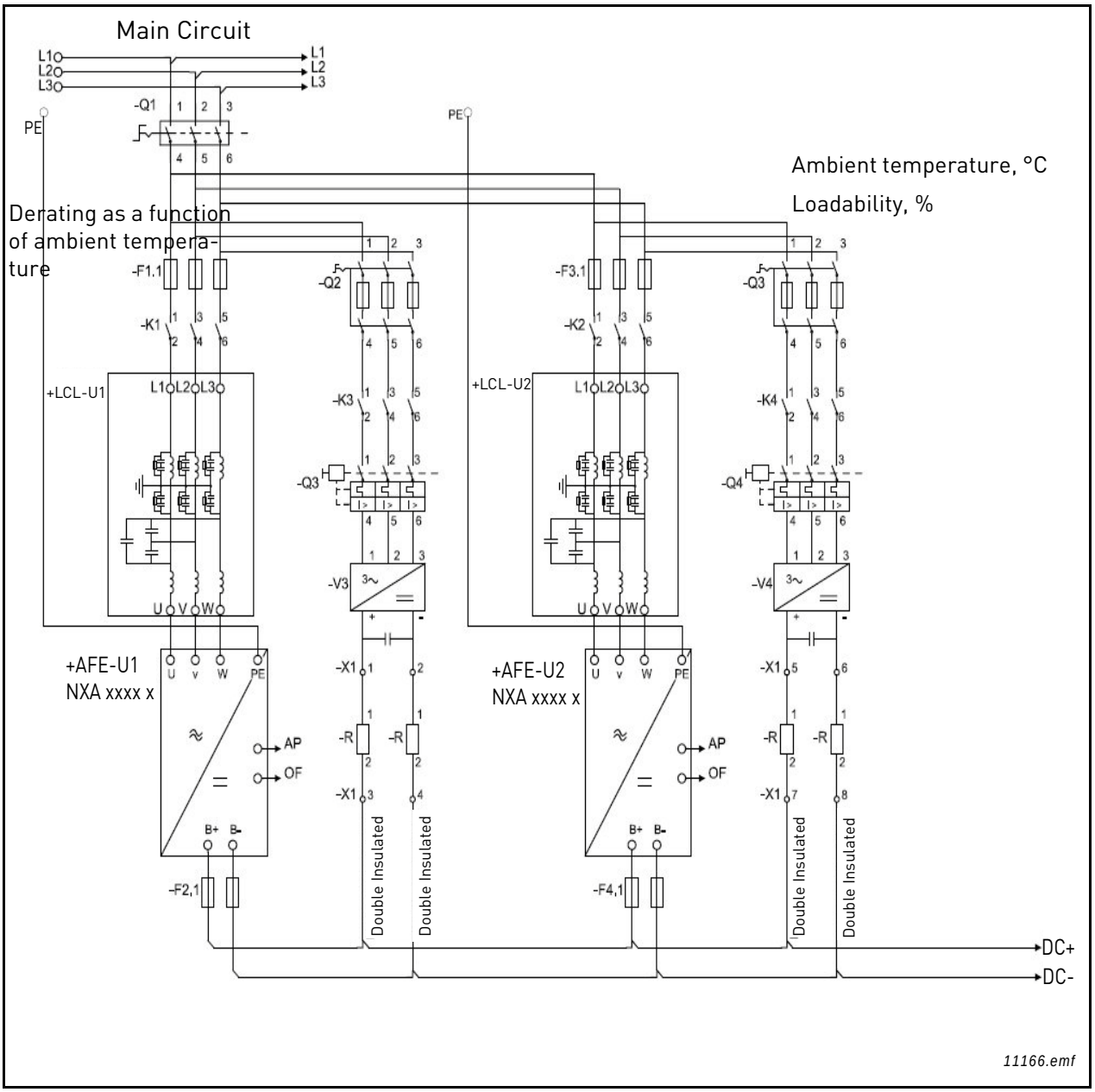

Figure 22. Active Front End units parallel connection with own pre-charging circuits

4.16 DERATING

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

- Ambient temperature is more than 40 °C.
- Installation altitude is more than 1000 m.

4.16.1 AMBIENT TEMPERATURE

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

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

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

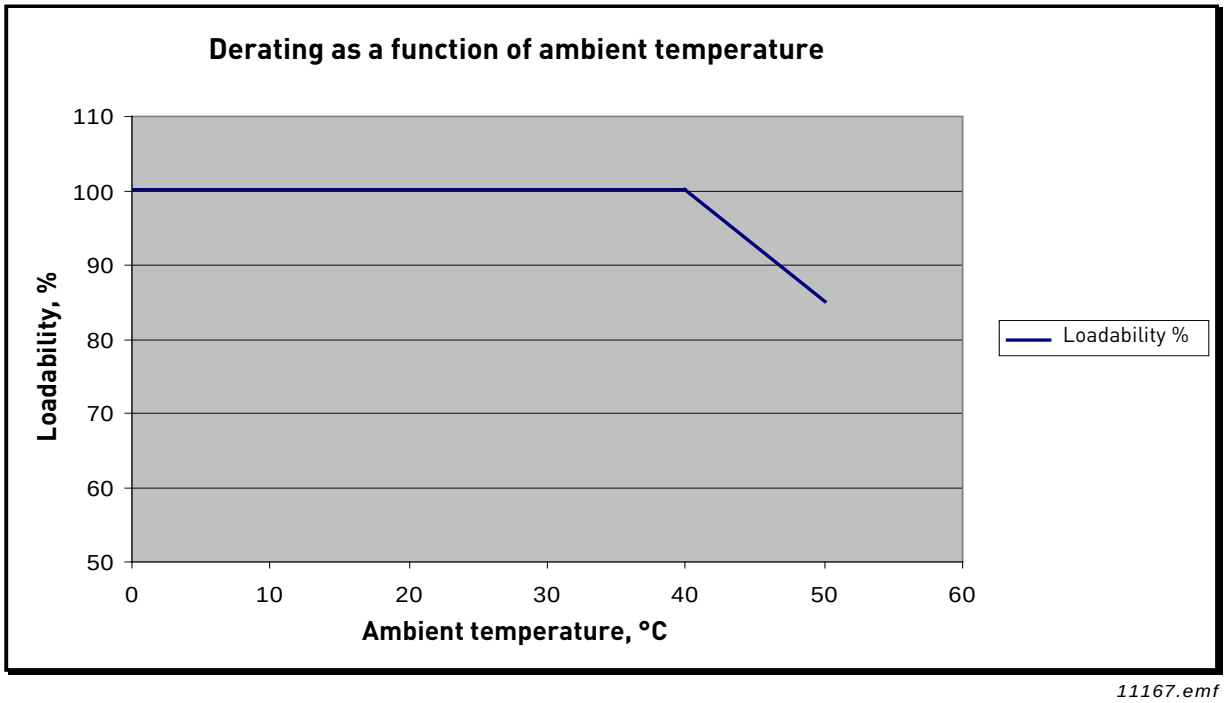

Figure 23. Derating as the ambient temperature

4.16.2 INSTALLATION ALTITUDE

The standard power ratings of the Active Frond End unit are valid for a maximum installation altitude of 1 000 m. If the device is to be used in higher installation altitudes, its power ratings must be subjected to derating. The derating coefficient is 1.5% per 100 m. The power rating of the device can be reduced to a maximum installation altitude of 4000 m (500 V) and 2000 m (690 V). The reduced power can be calculated using the formula:

$$P_{de} = p_n * ((100\% - (h_{inst} - h_{base}) * X)/100)$$

P_n = nominal power of the unit
h_{inst} = intended installation altitude
h_{base} = 1,000 m
x = derating coefficient

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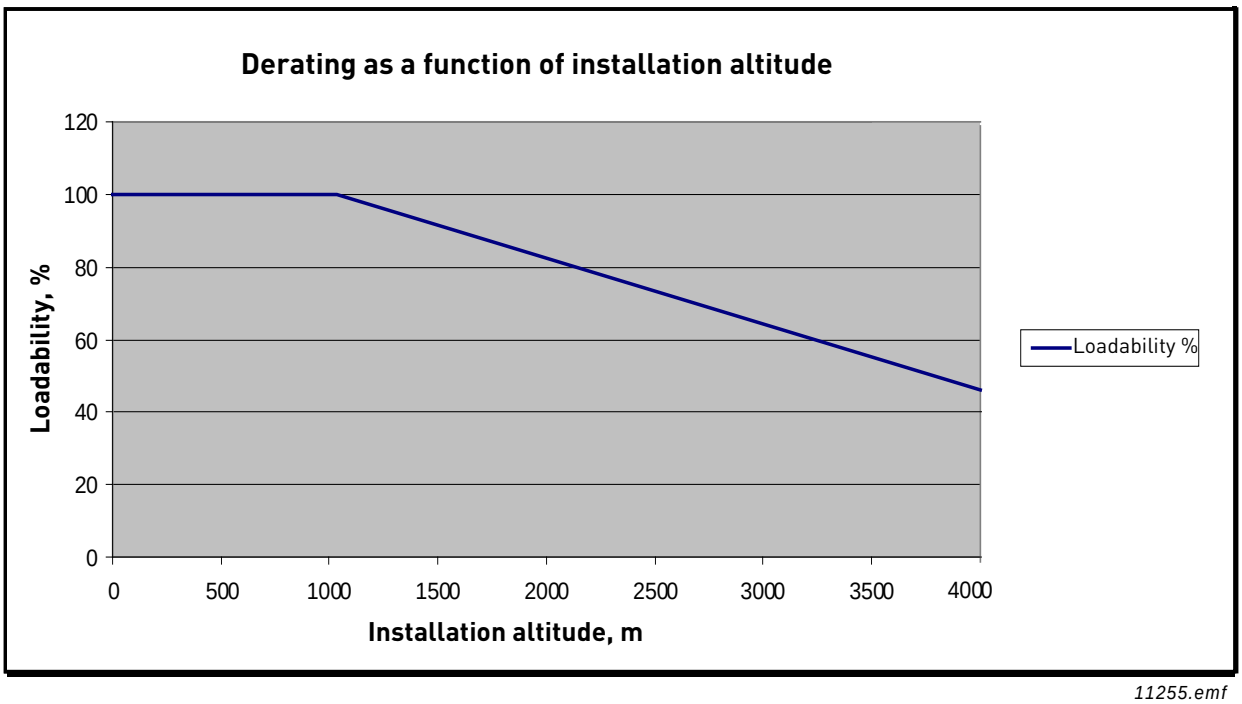

Figure 24. Derating as the installation altitude 380-500 V

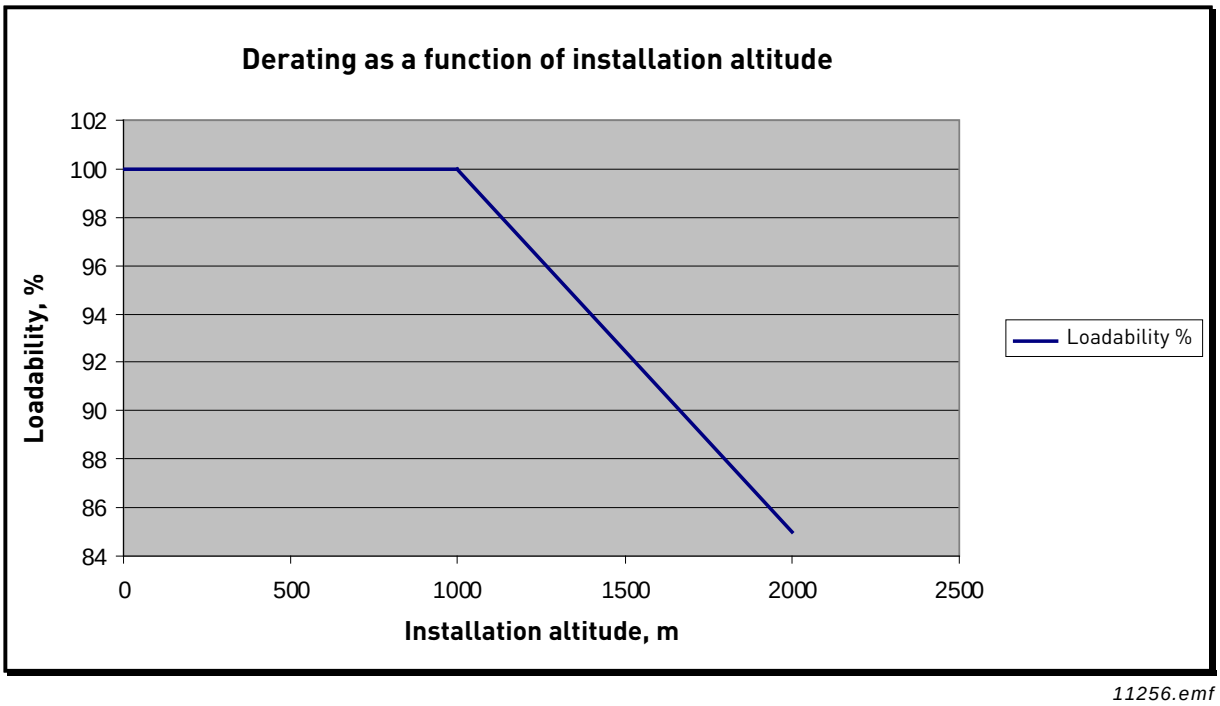

Figure 25. Derating as the installation altitude 525-690 V

NOTE! If higher installation altitude is considered please contact Your nearest Vacon office.

5. INSTALLATION

5.1 MOUNTING

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 (IP2x). 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 33. Follow the minimum dimensions for installation, see Table 21. Required cooling air capacity and minimum air holes on the switchgear, see Table 22. Also make sure that the mounting plane is relatively even. The Active Front End is fixed with four bolts, Figure 26, Figure 27 and Figure 28.

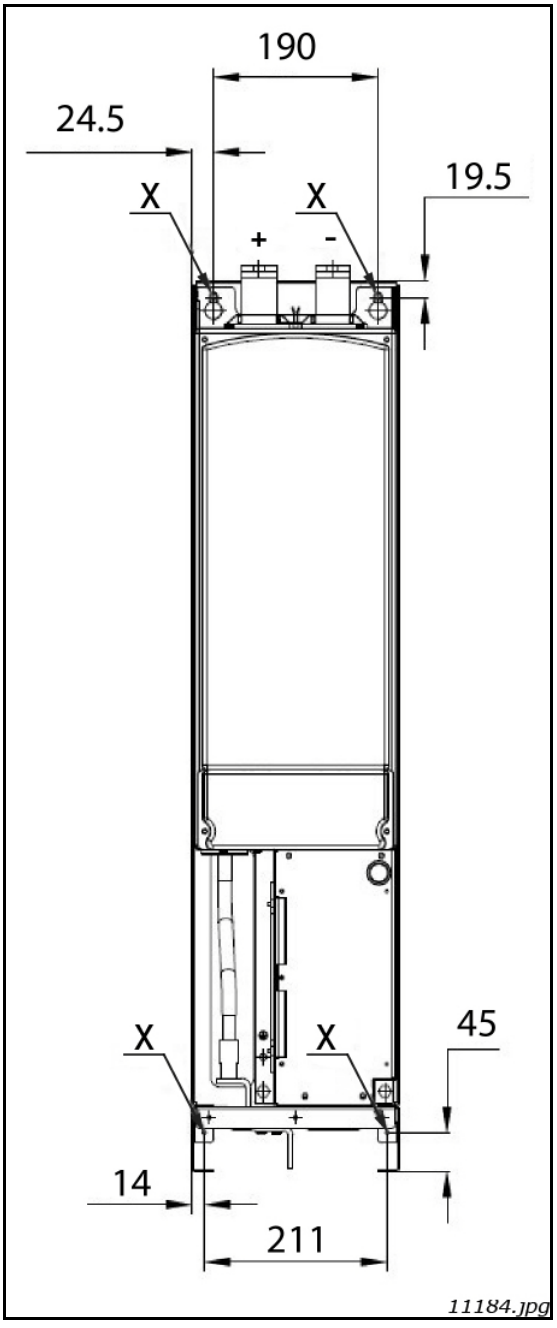

Figure 26. Mounting points of FI9 AFE unit

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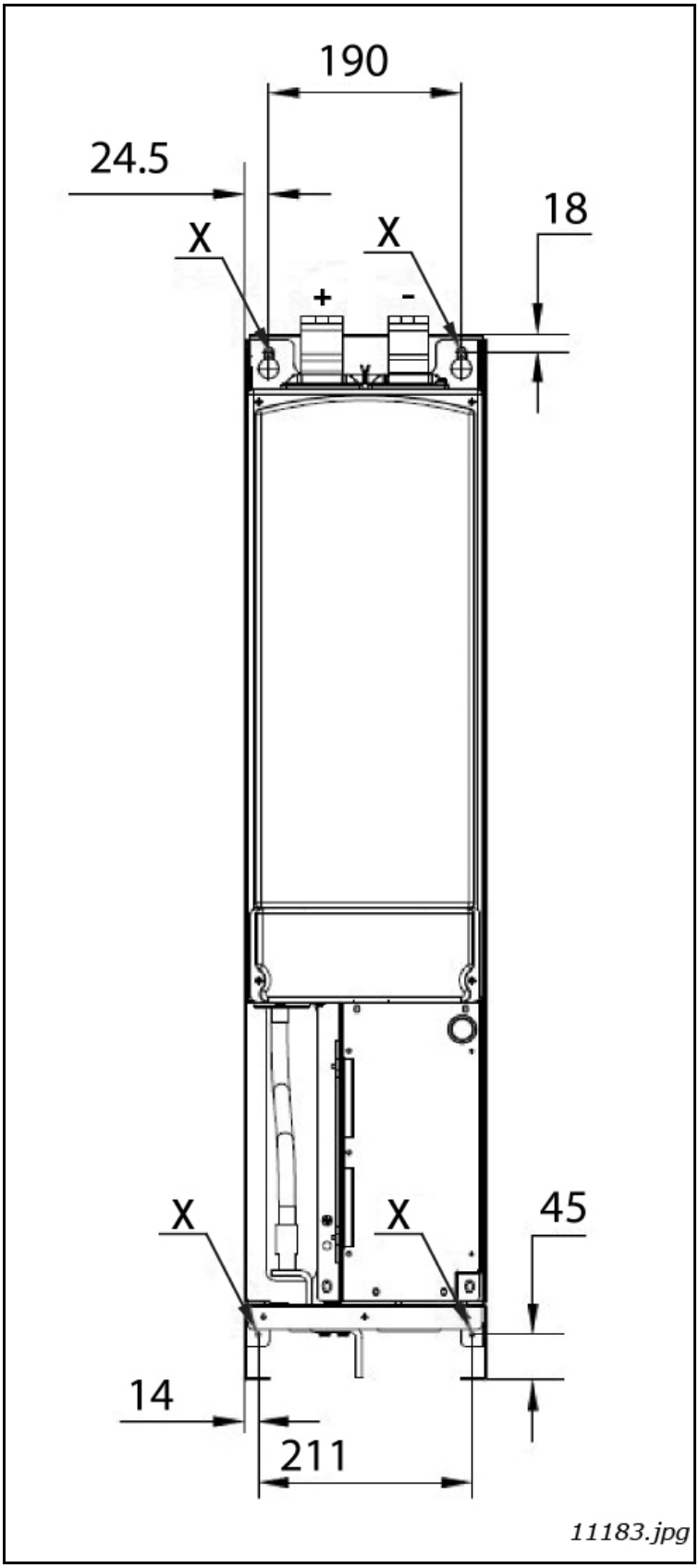

Figure 27. Mounting points of FI10 AFE unit

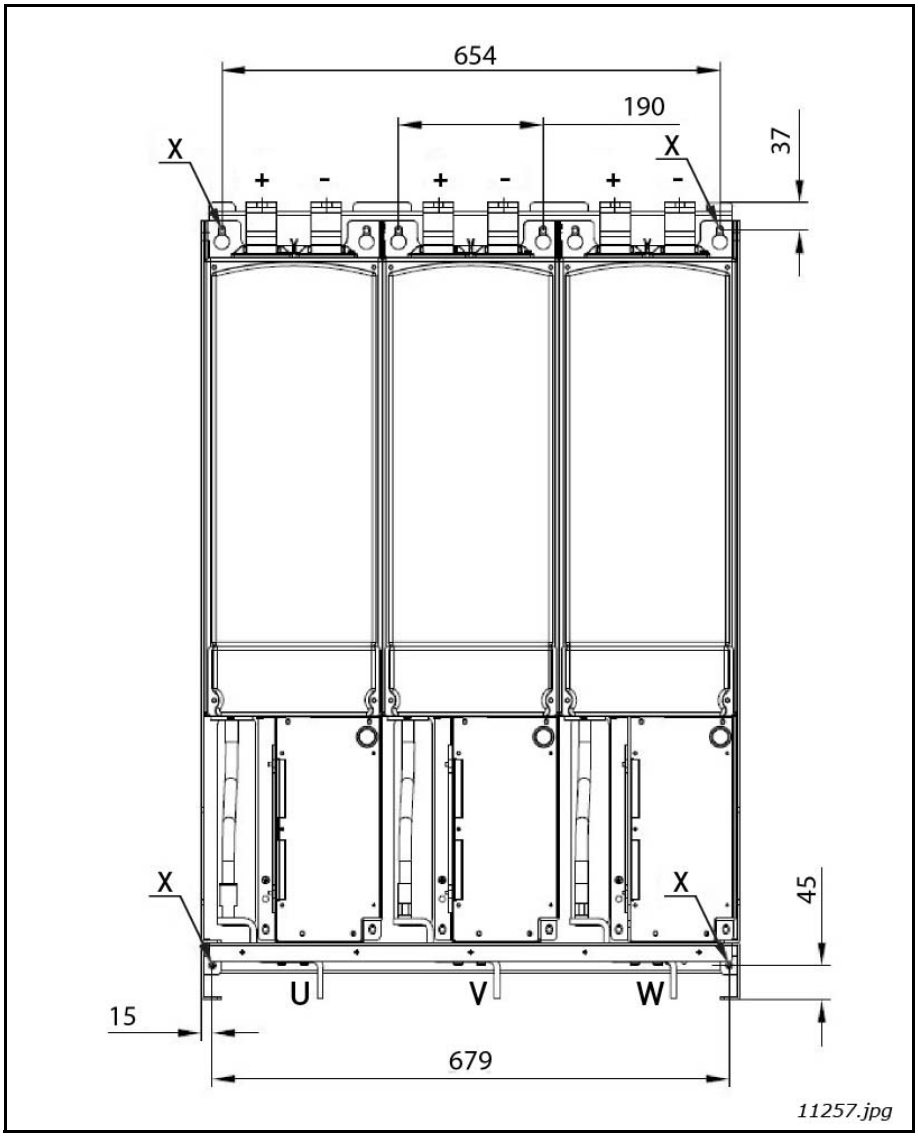

Figure 28. Mounting points of FI13 AFE unit

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 36. Follow the minimum dimensions for installation, see Table 23. Required cooling air capacity and minimum air holes on the switchgear, see Table 24. LCL filters cooling air airflow is present in Figure 37 and Figure 38. 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 Appendix 77 and Appendix 78. Follow the instruction below:

1. Open fastenings numbered by 1 in Figure 29.
2. Open fastenings numbered by 2 in Figure 29.
3. Remove bus bars.
4. Remove the (dark grey) from the right side and place it in same place to the left.
5. Place the bus bars like in Figure 30.
6. Close fastenings numbered by 2 in Figure 30.
7. Close fastenings numbered by 1 in Figure 30.

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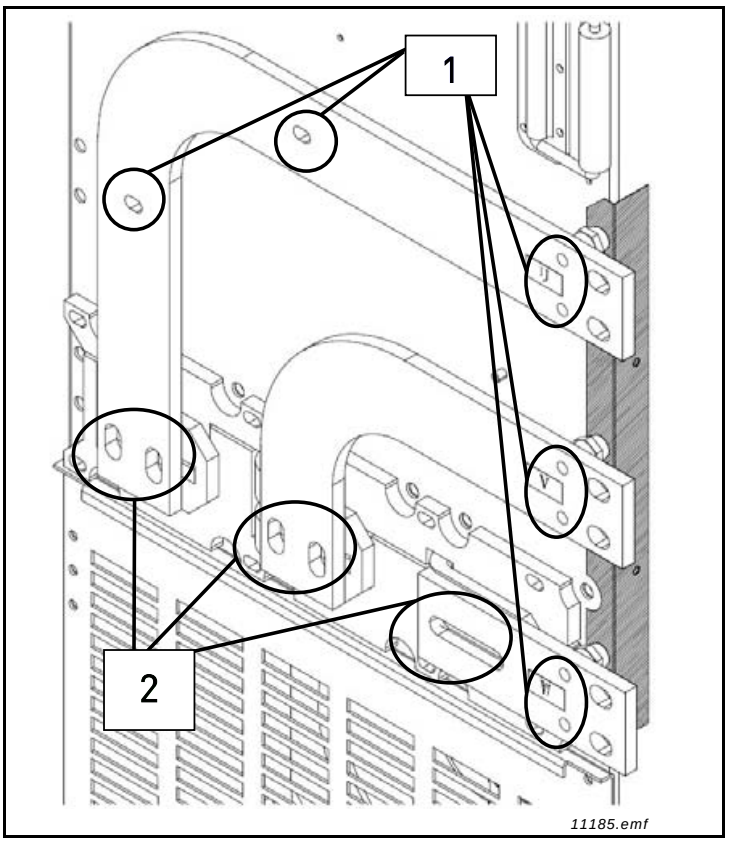

Figure 29. Right-side connection

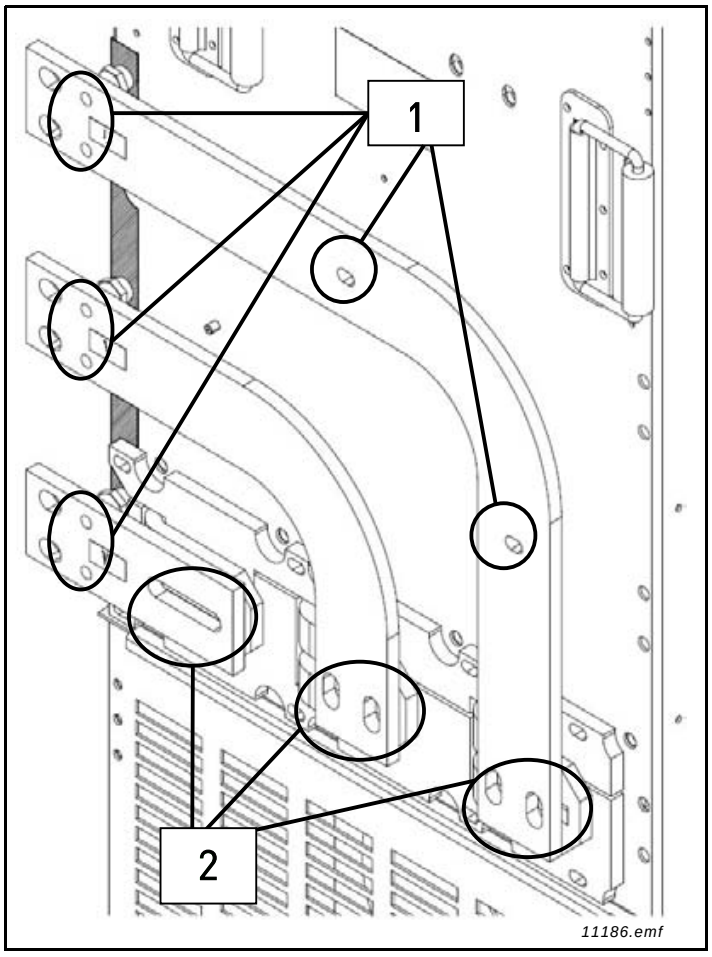

Figure 30. Left-side connection

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 31 and Figure 32. 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 Appendix 81. In that case the keypad connects to the control unit with an RS232 cable. Pay special attention to the earthing of the cable, see the instructions below.

Figure 31. Control unit installed into the mounting box; Left: front; Right: back

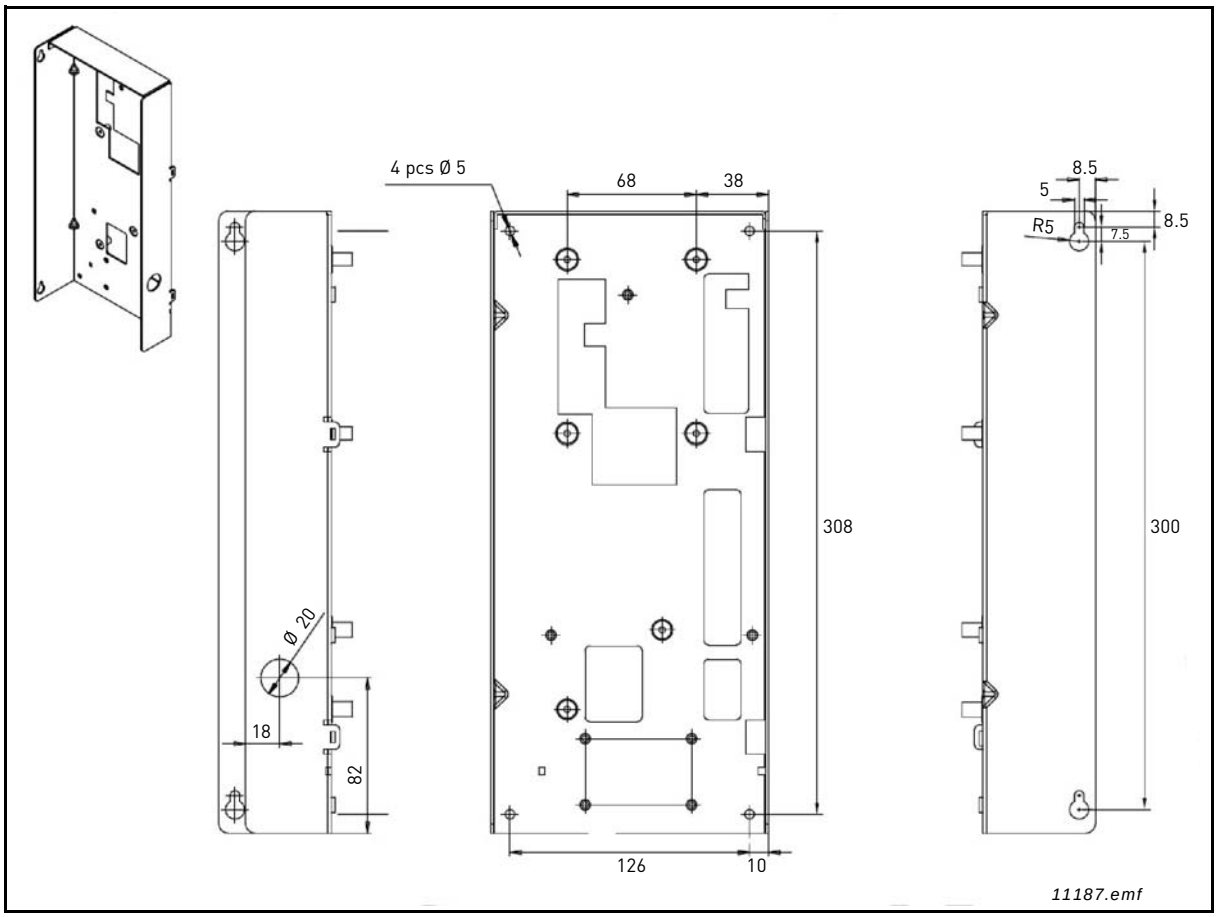

Figure 32. Mounting points of Control Box

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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 Vacon 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. Earthing of keypad cable: Earth the keypad cable in the mounting box frame by fixing the branch cable with a screw underneath the control unit. See Figures 3 and 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 4.7.1 Connection between control unit and power unit and Figures 6 - 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.

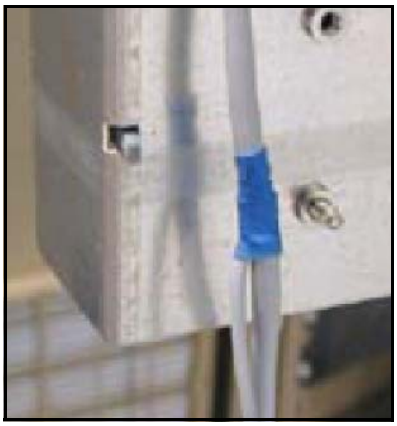
Figure 3.

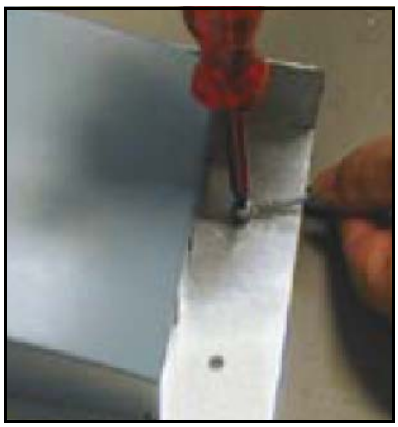
Figure 4.


Figure 5.


Figure 6.


Figure 7.


Figure 8.


Figure 9.

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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 21. You will find the required cooling air, minimum air holes and heat dissipation in the Table 22.

When planning the cooling for the space, take into consideration that the Active Front End unit heat loss is approx. 2% of the nominal capacity. Air flow, see Figure 34 and Figure 35.

Table 21. Mounting space dimensions

Type	Dimensions [mm]			
	A	*B*	B_2	C
NXA0261 5 NXA0170 6	200	0	0	100
NXA0460 5 NXA0325 6	200	0	0	100
NXA01300 5 NXA01030 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

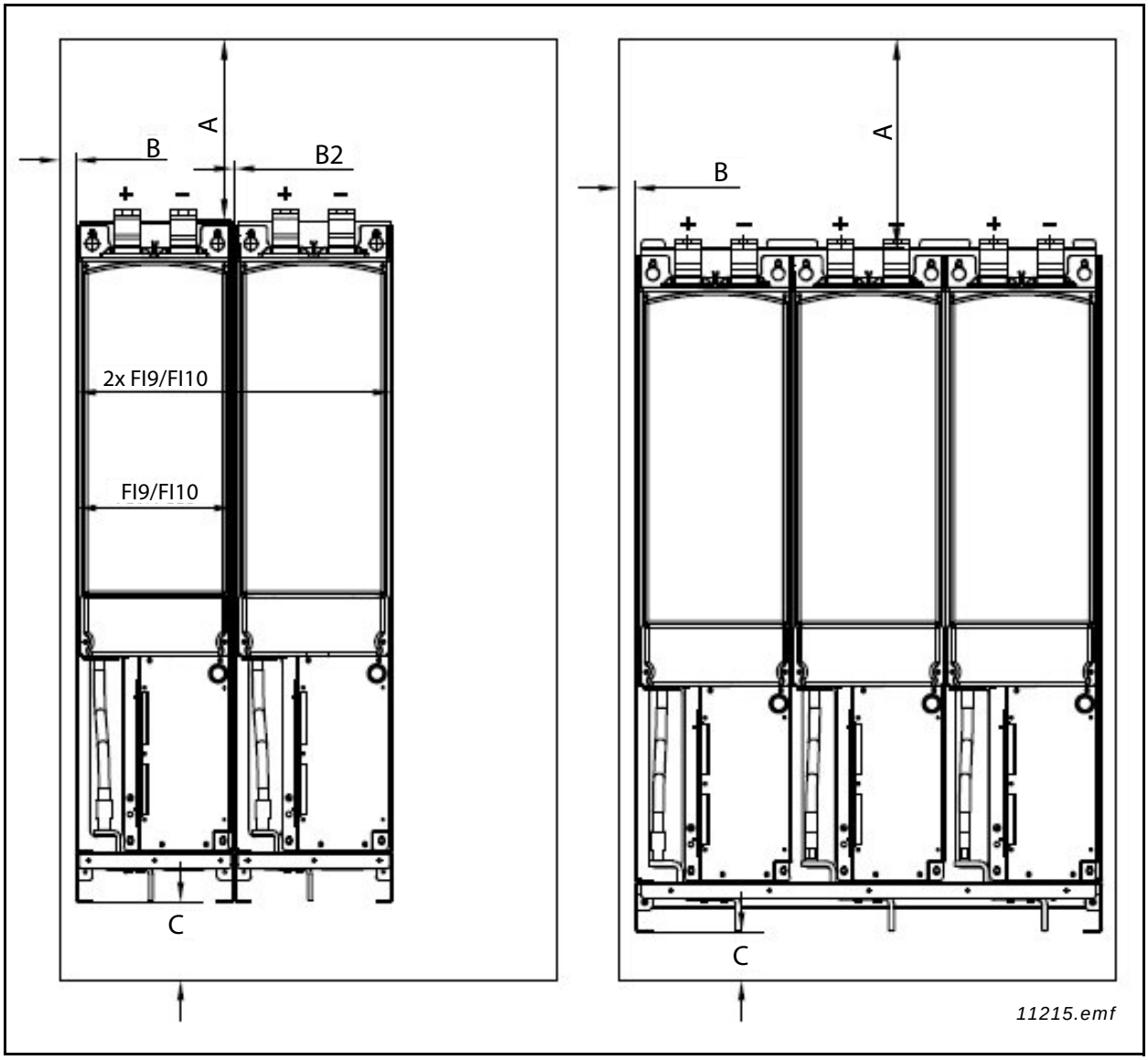

Figure 33. Installation space for FI9, FI10 and FI13

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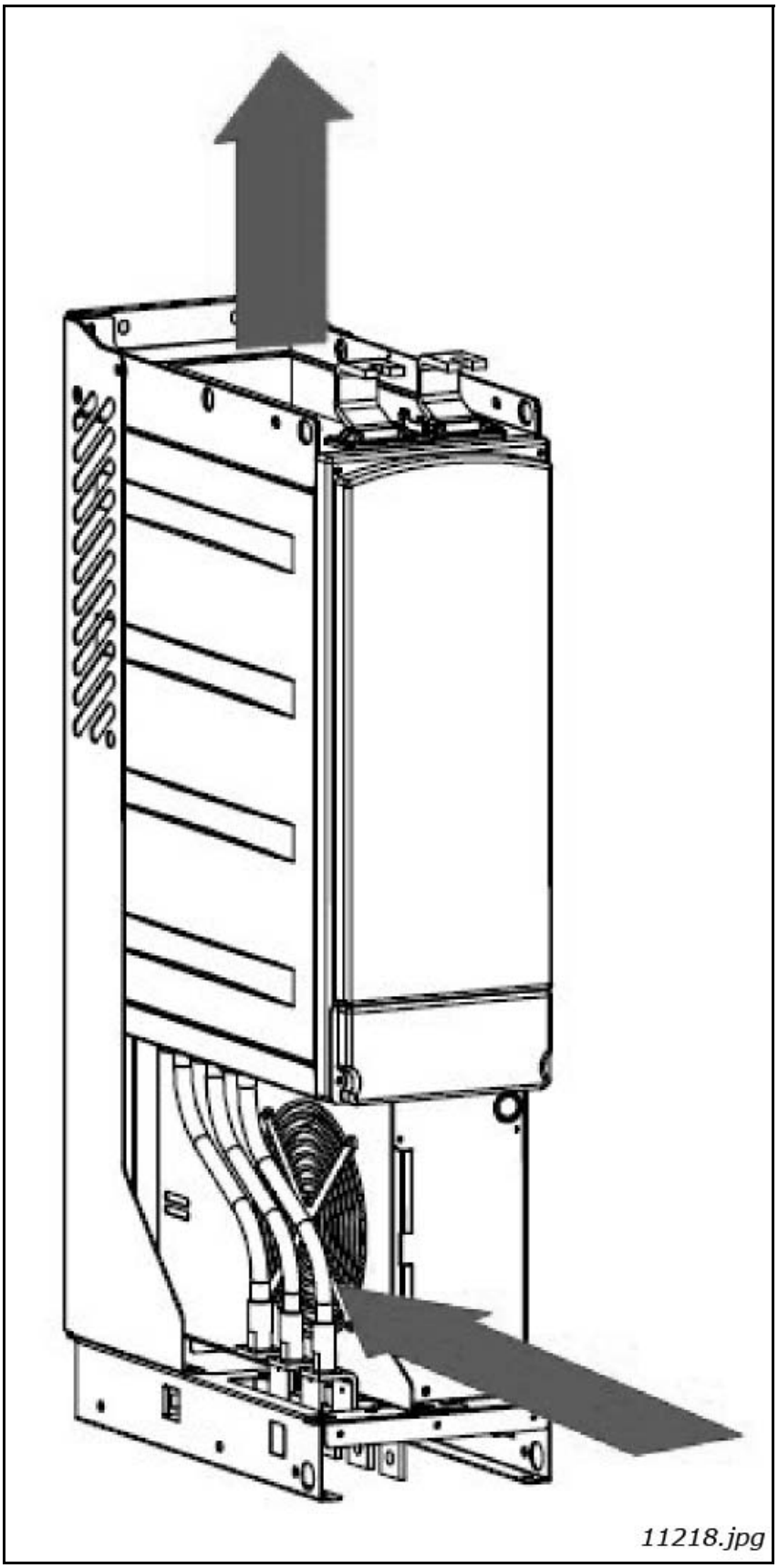

Figure 34. Cooling airflow for FI9 and FI10 units

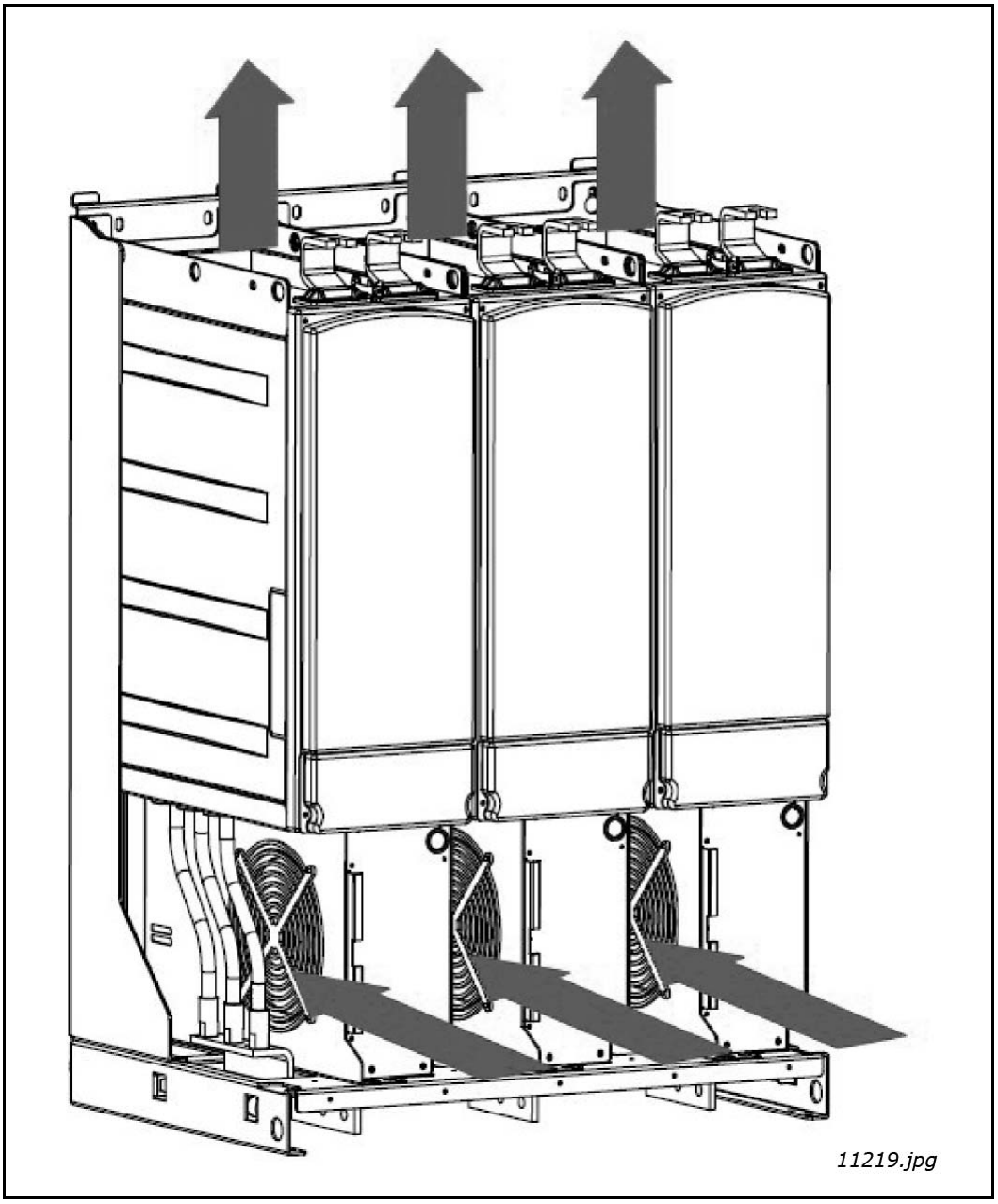

Figure 35. Cooling airflow for the FI13 unit

Table 22. Power losses and required cooling air for the Active Front End units

Type	Heat dissipation (W)	Cooling air required (m^3/h)	Minimum air holes on switchgear (input and output) (mm^2)
NXA_0261 5 NXA_0170 6	3540 3320	1150	50000
NXA_0460 5 NXA_0325 6	6160 6070	1400	60000
NXA_1300 5 NXA_1030 6	17920 19050	4200	180000

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5.2.2 LCL FILTER

Enough free space must be left around the LCL filter to ensure sufficient air circulation and cooling. You will find the required dimensions for free space in the Table 23. You will find the required cooling air, minimum air holes and heat dissipation in the Table 24.

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 37 and Figure 38.

Table 23. 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

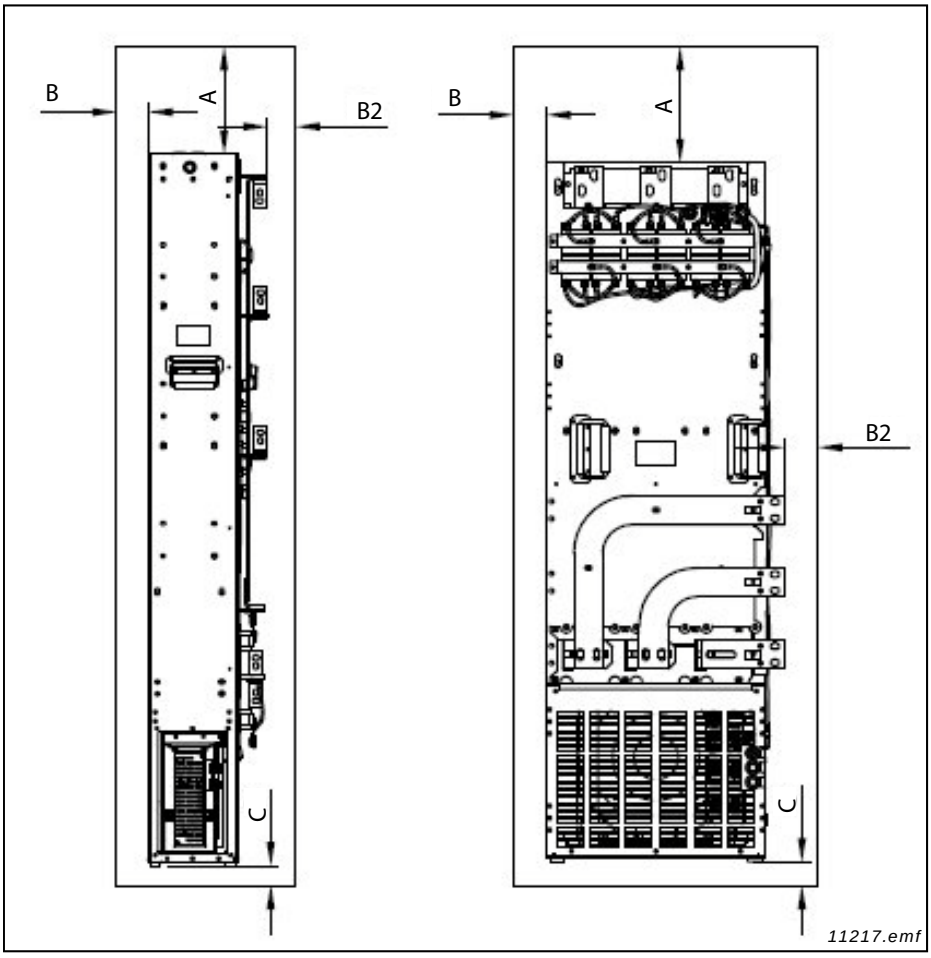

Figure 36. Installation space

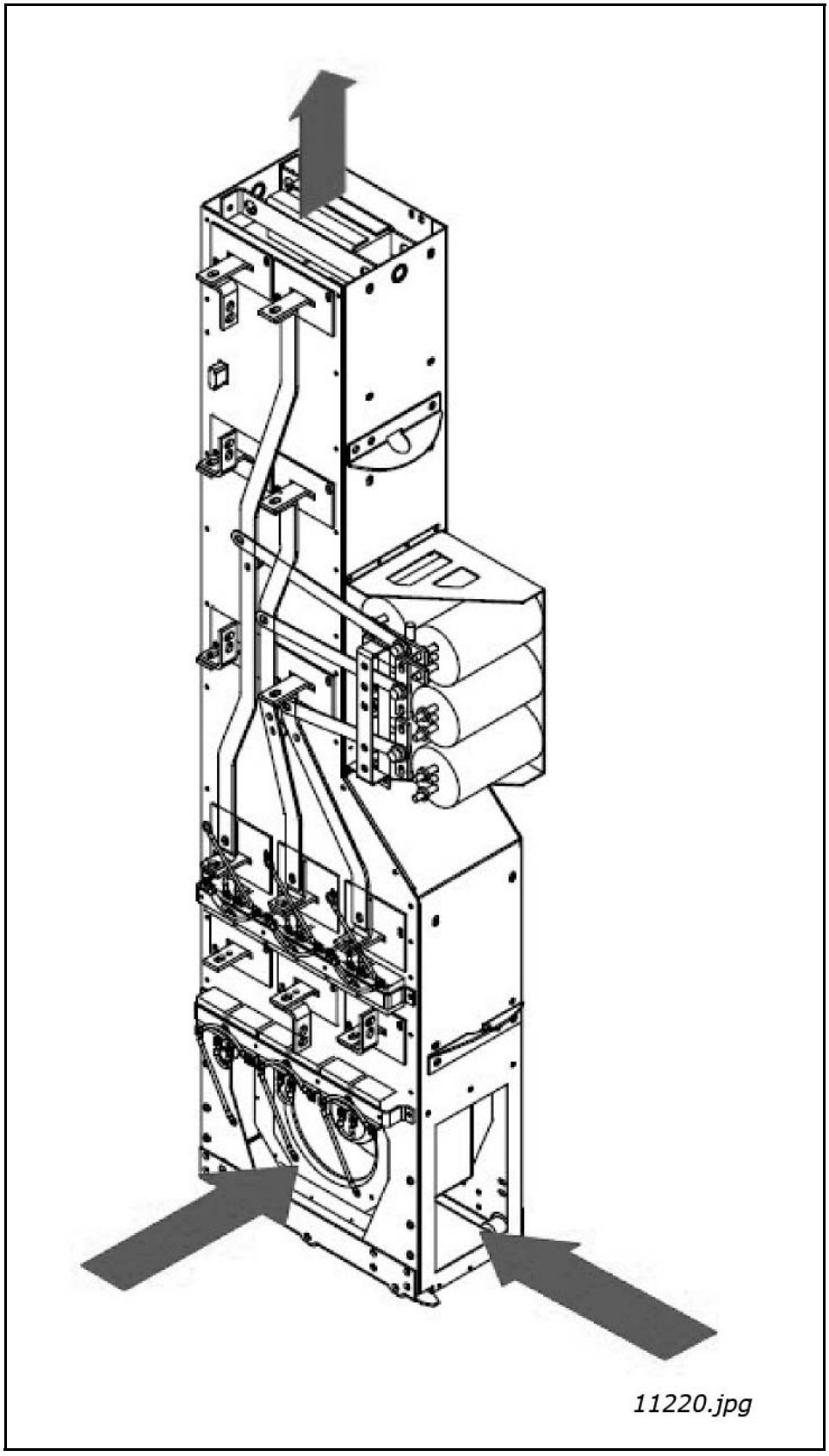

Figure 37. Cooling airflow for FI9 and FI10 LCL filters

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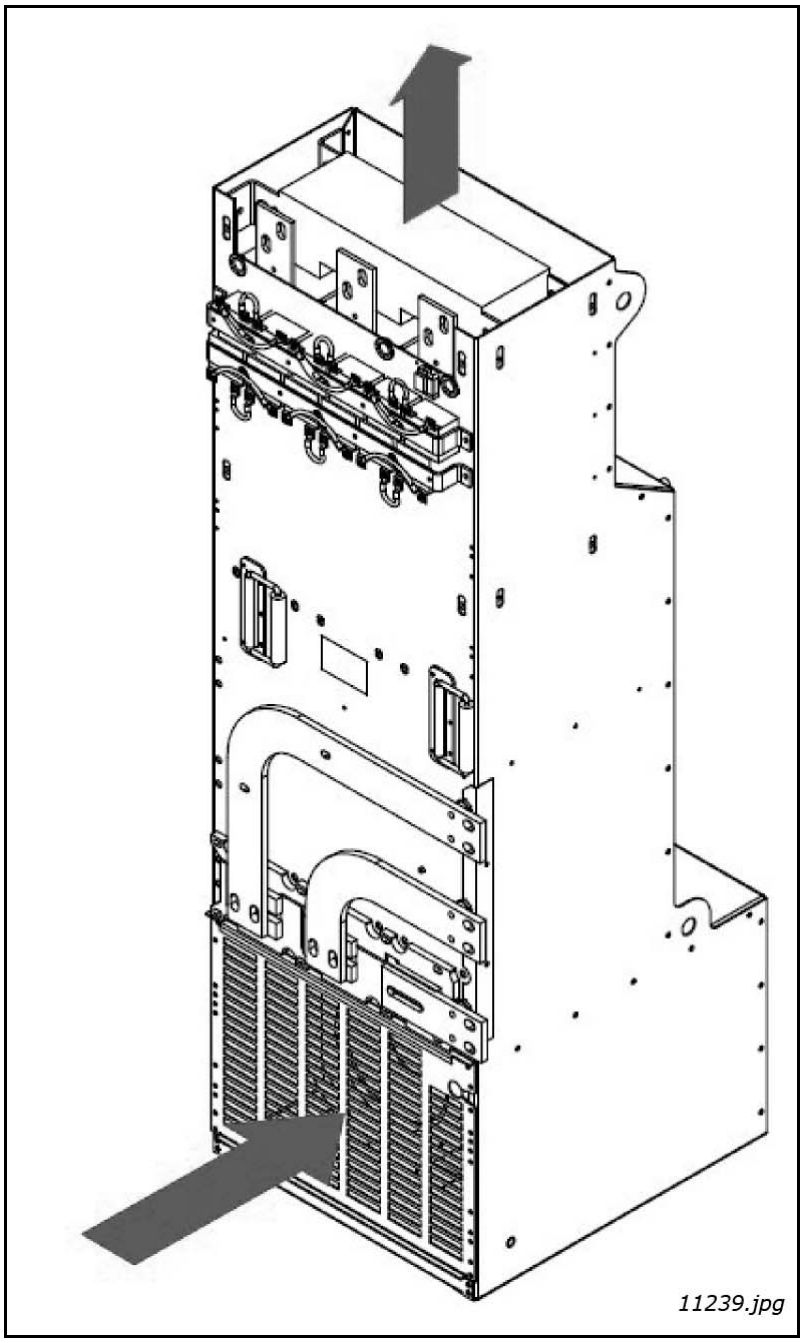

Figure 38. Cooling airflow guides for FI13 LCL filter

Table 24. 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 22 and Table 24 must be followed. For instance, there could be two screened gaps as presented in Figure 39 (Vacon's 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 22 and Table 24. 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 fulfill 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 39 cannot be used.

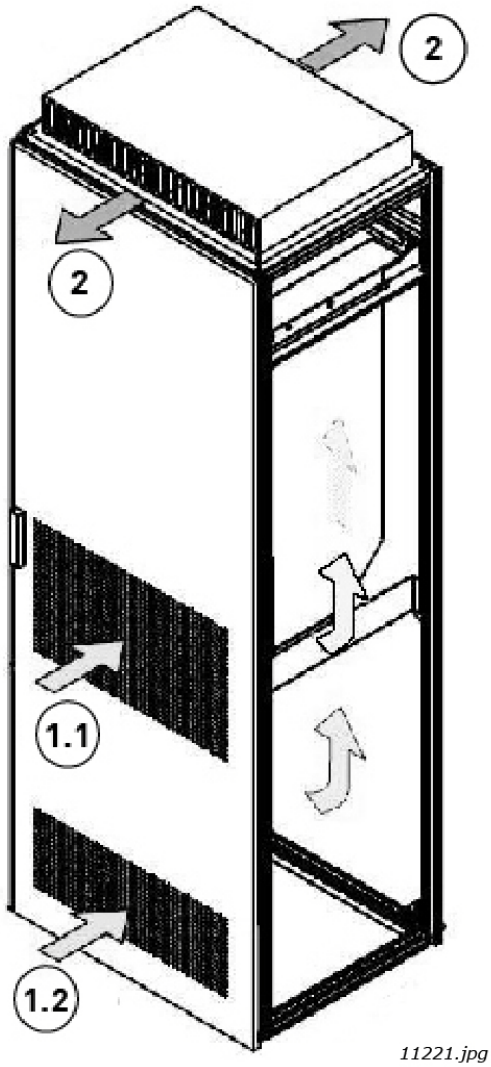

Figure 39. Cabinet openings for cooling

1. Cooling air inlets
2. Hot air exhaust

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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 40).
B. Install shields in the gaps between the power unit and the cabinet walls (B in Figure 40). Place the shields above the air outlet gaps at the sides of the module.

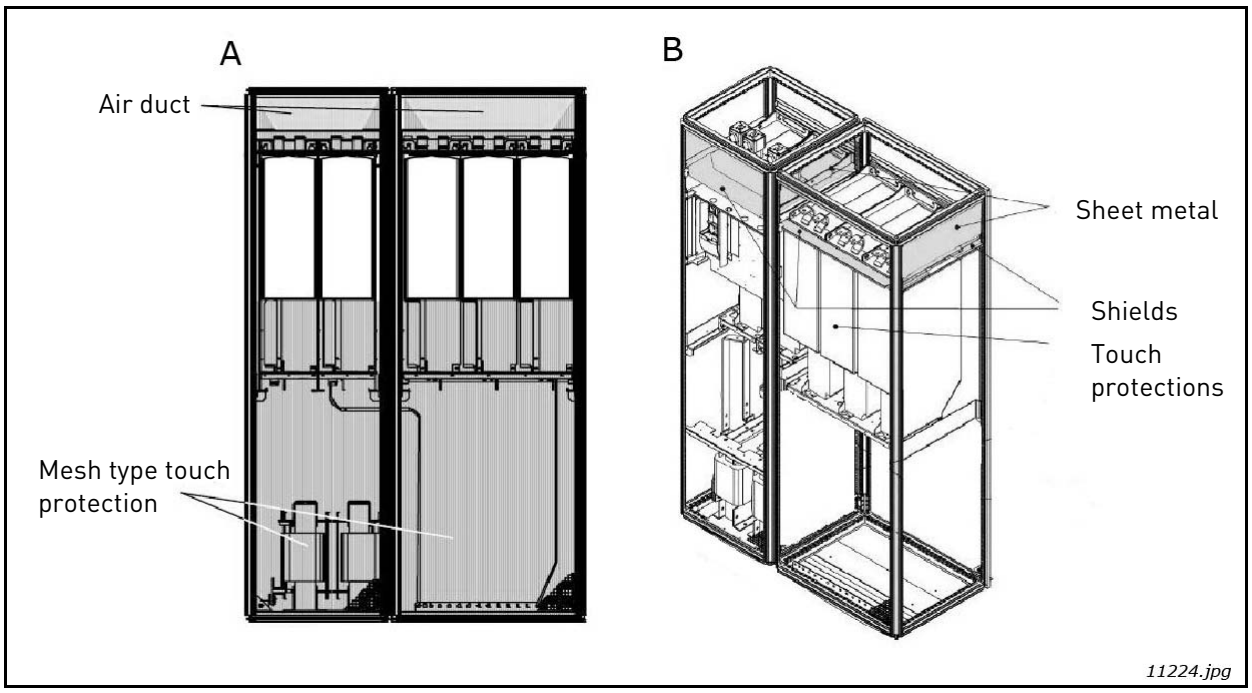

Figure 40. Cabinet cooling airflow guides

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 41.

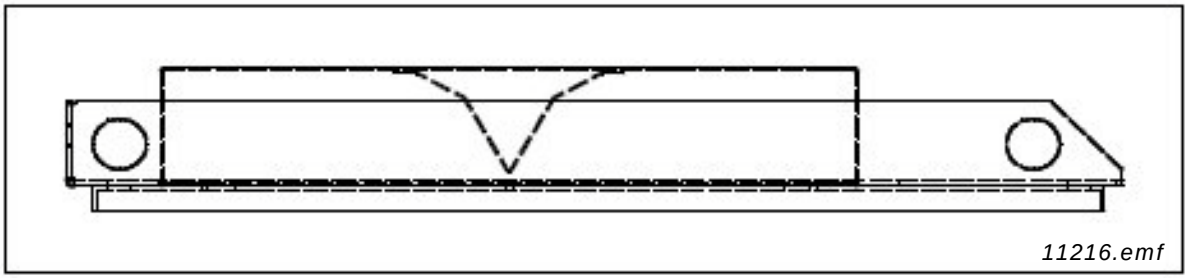

Figure 41. Roof structure seen from the side

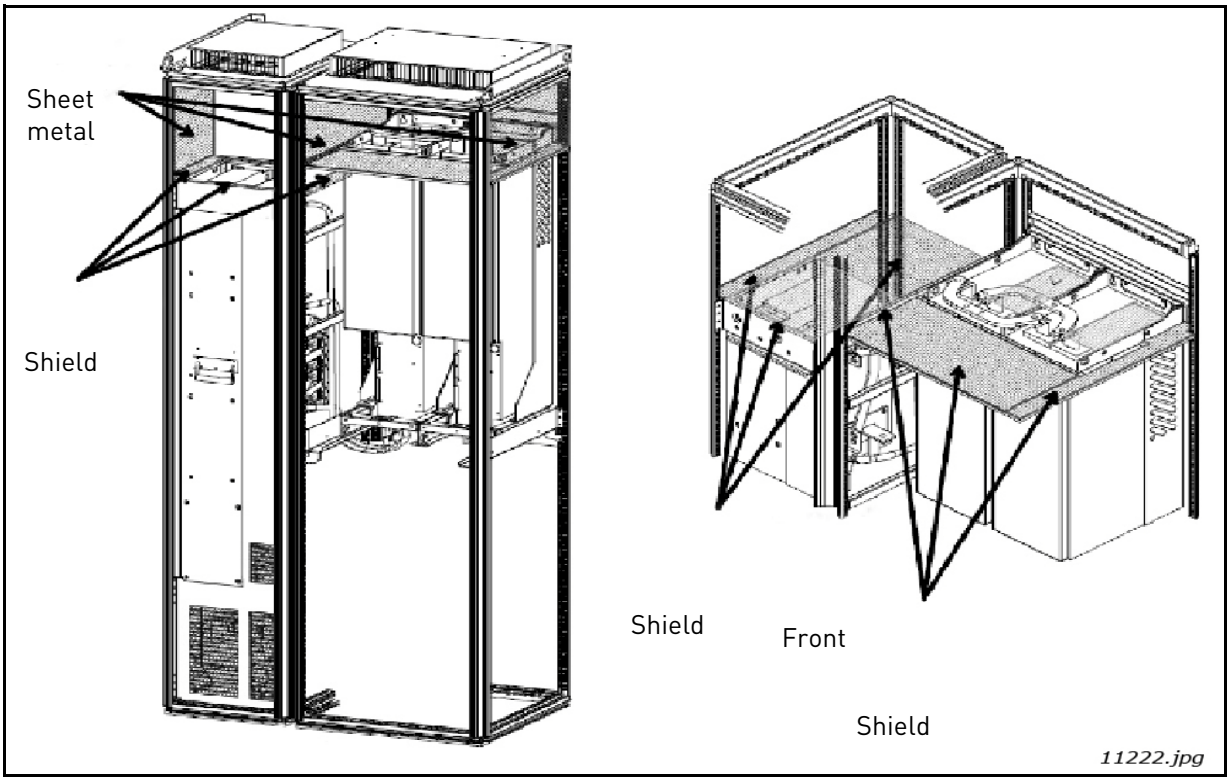

Figure 42. Cabinet cooling airflow guides for FI9 and FI10 AFE unit and LCL filter

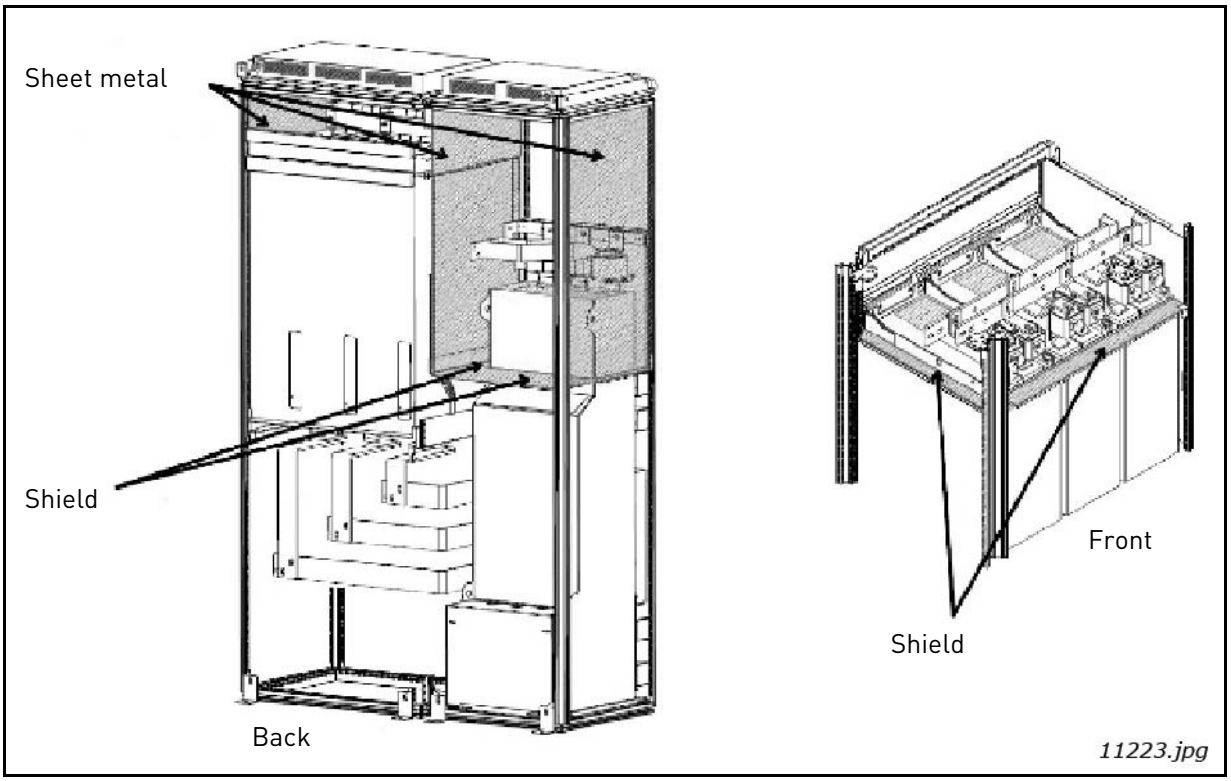

Figure 43. Cabinet cooling airflow guides for FI13 AFE unit and LCL filter

The sheet metal airflow guides (deflectors) marked in green prevents air circulation between different sections of the equipment. The shield guides marked in green prevent air circulation inside a section. The points marked in red show the exhaust air holes. These holes must not be covered, nor must anything be placed above them to stop the free exit of warm air from inside the

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equipment. The points marked in blue show the cooling air intake holes. These 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 8. The AC input of the AFE input group must be protected against short circuit. The fuses suitable for protection are shown in Chapter 4.11. A circuit breaker can also be used for protection, see Chapter 4.12. 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 8.

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 Appendix 82 and their locations are shown in Appendix 73, Appendix 74 and Appendix 75. Locations of terminals in the LCL filter are shown in Appendix 76 and Appendix 77.

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 4.11. The terminal dimensions are shown in Appendix 82.

5.3.3 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.

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

The DC/DC power supply is integrated in the structure of the LCL filter, Figure 44 and Figure 45. The integrated DC/DC power supply takes its input voltage from the intermediate circuit, Appendix 79. 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 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 44 - 45 and Appendix 79 and Appendix 80.

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 44 and Figure 45. The control cable has to be connected to the terminal X3 on the Active Front End unit, see Figure 47. The terminal X3 can be found under the black cover. In the FI13, the terminal X3 is located in the left-most unit. The delivery includes the cable for the control connection. The length of the standard cable is 1,6 m.

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

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

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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 Appendix 80. If the over-temperature 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 over-temperature 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 45. The delivery includes the cable for connecting the terminals X52 and X3. The wiring diagram can be seen in Appendix 80. If over-temperature monitoring is connected to the DC/DC power supply, the Active Front End unit will monitor over-temperature. The response to an over-temperature 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" will be shown.

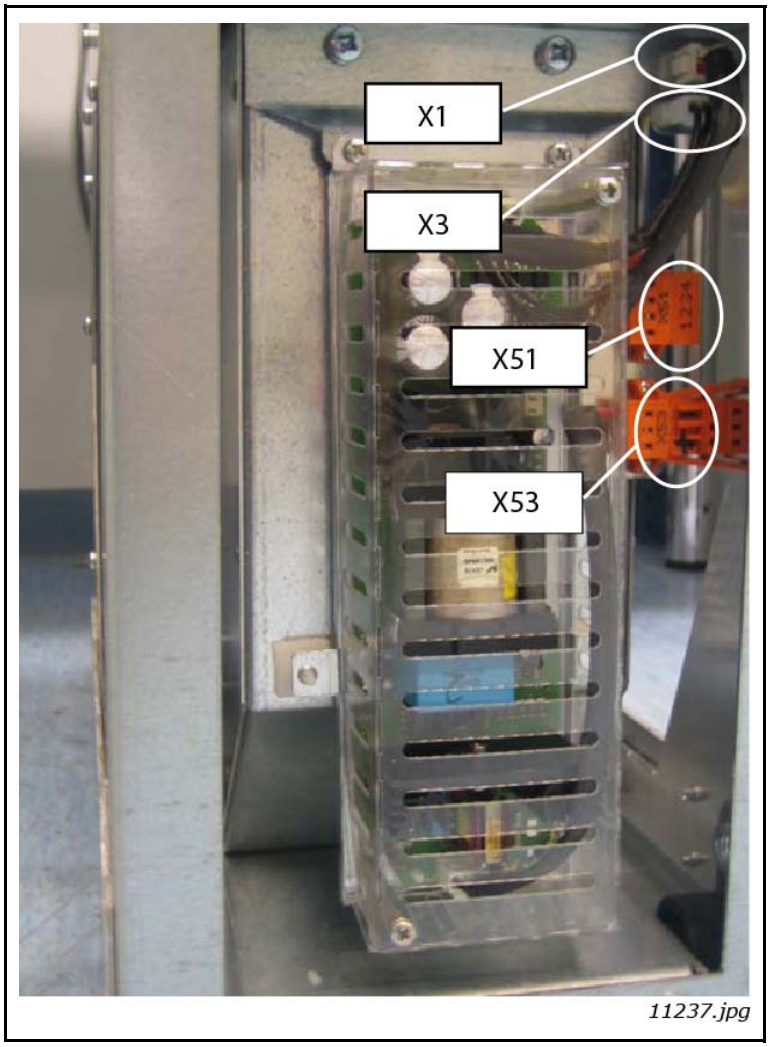

Figure 44. Integrated DC/DC-power in the FI9 and FI10 LCL filter

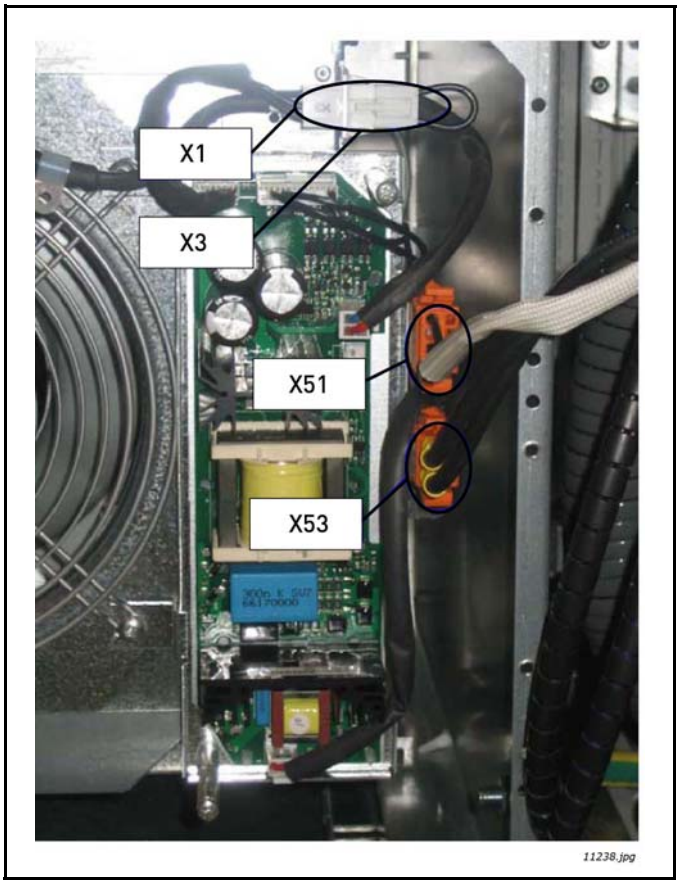

Figure 45. Integrated DC/DC-power in the FI13 LCL filter

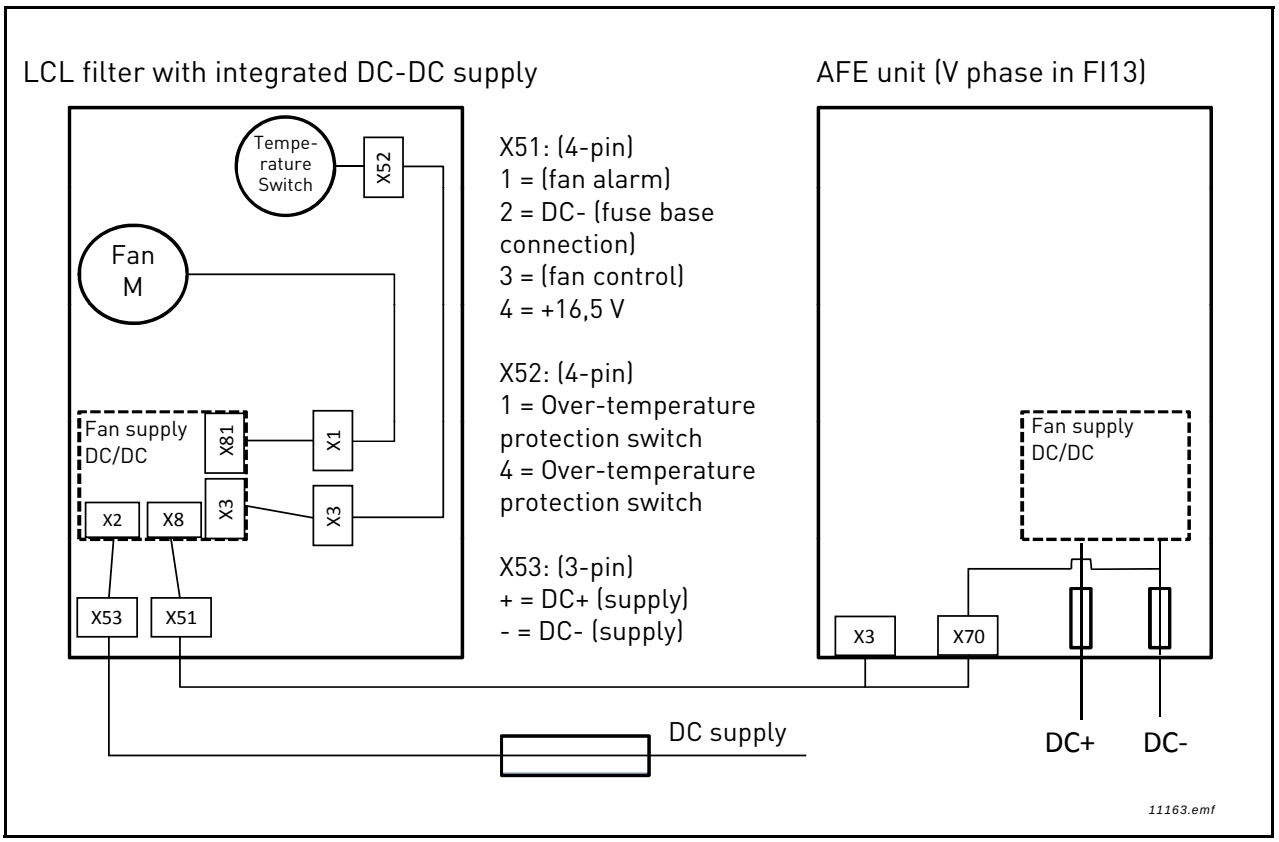

Figure 46. Wiring diagram of integrated DC/DC-power

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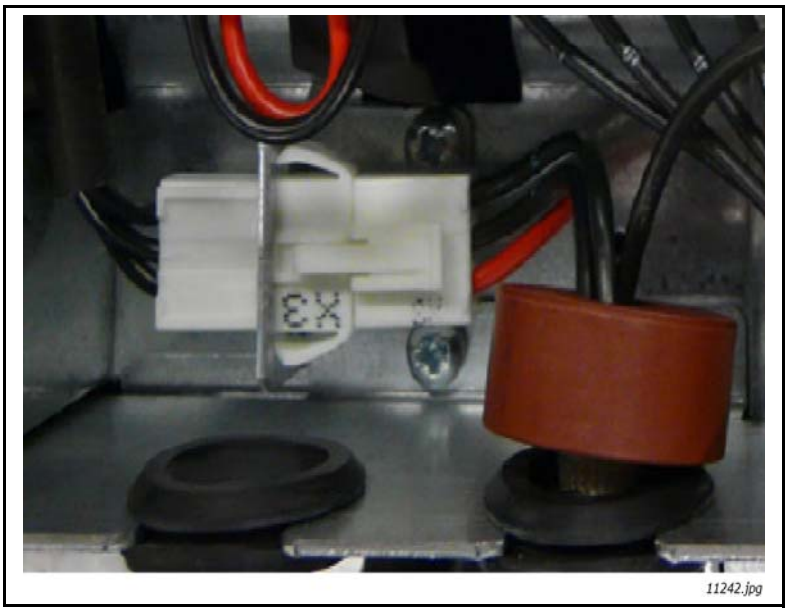

Figure 47. Terminal X3 (U-phase in FI13) in the unit

5.3.3.2 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 2. 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 Appendix 81) 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 48.

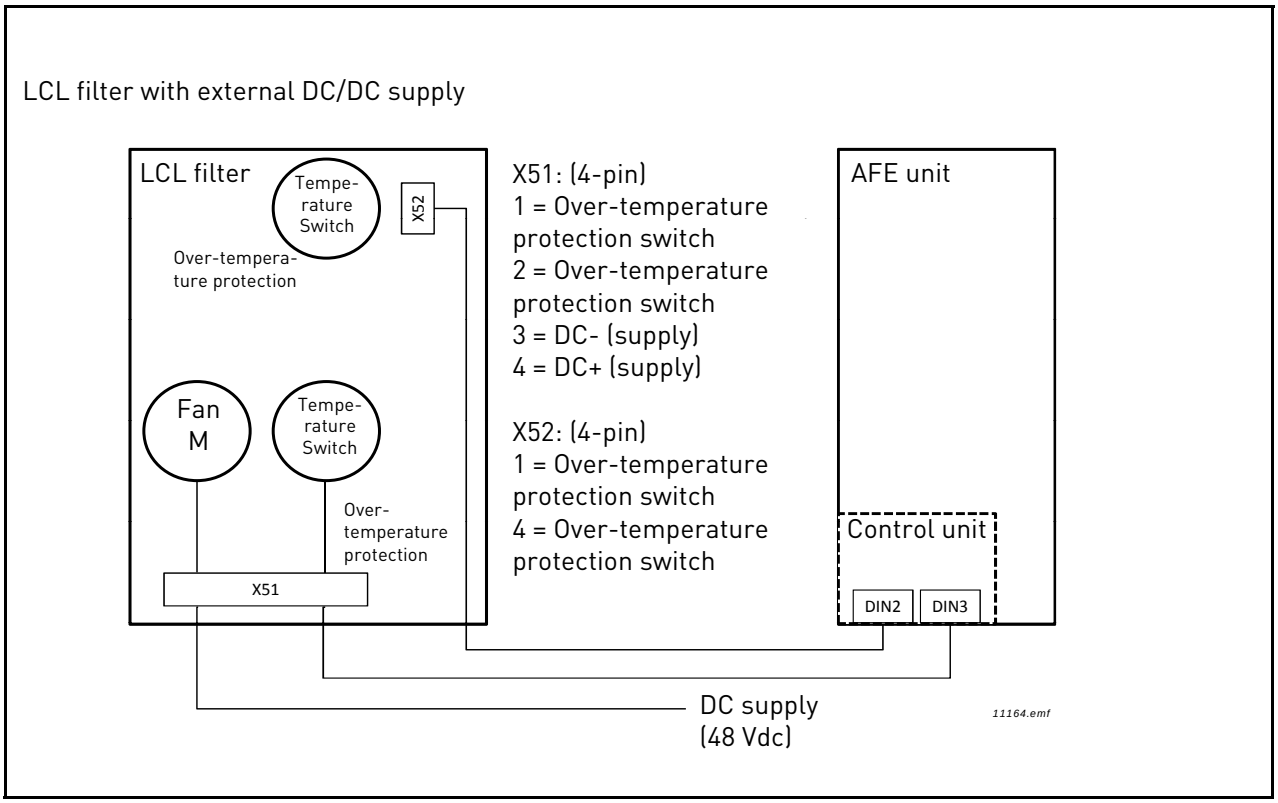

Figure 48. Wiring diagram of external DC-power

5.4 CONTROL UNIT

The control unit of Vacon® NX Active Front End consists of the control board and option boards (see Figure 49 and Figure 50) connected to the five slot connectors (A to E) on the control board. The control board is connected to the power unit through a D connector (1).

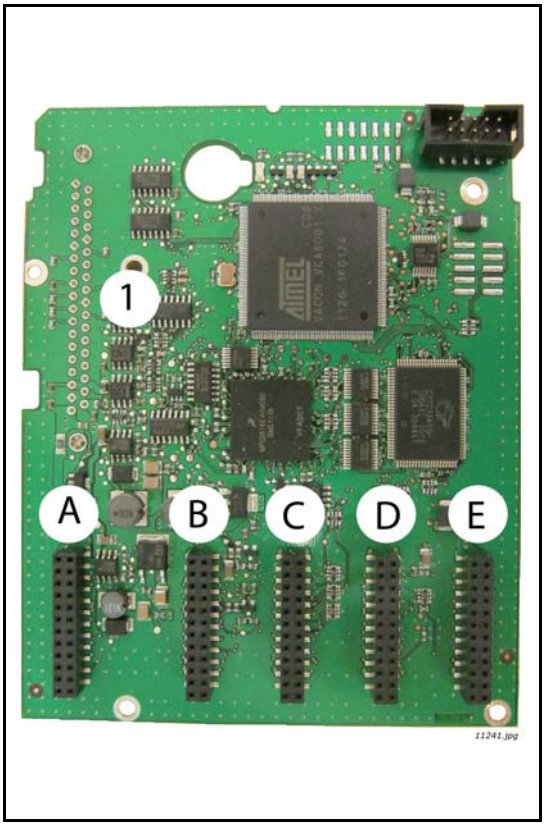

Figure 49. Control board

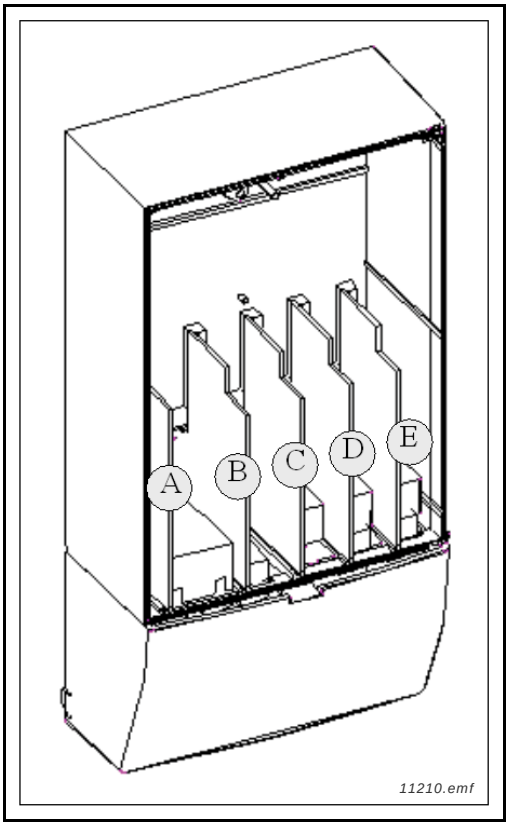

Figure 50. Basic and option board connections on the control board

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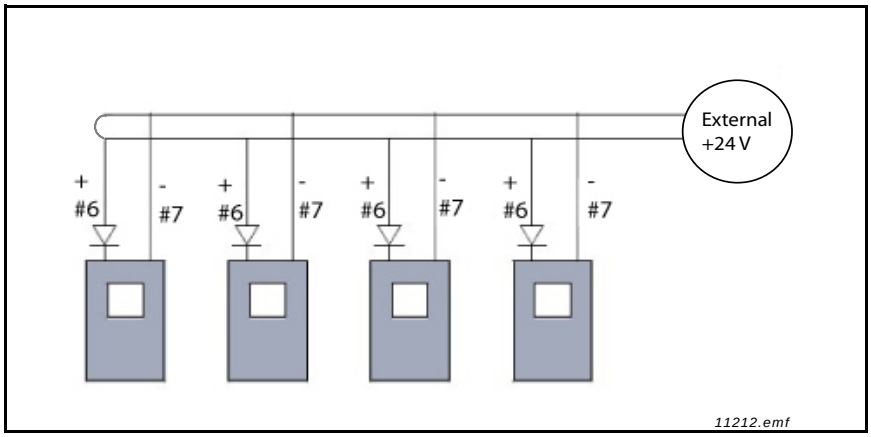
When Vacon® NX Active Front End is delivered from the factory, the control unit usually includes two basic boards (I/O board and relay board), which are normally installed in slots A and B. On the next pages you will find the arrangement of the control I/O and the relay terminals of the two basic boards, the general wiring diagram and the control signal descriptions. The I/O boards mounted at the factory are indicated in the type code. For more information on the option boards, see Vacon NX option board manual (ud741).

The control board can be powered externally (+24 V) by connecting the external power source to bidirectional terminal #6. This voltage is sufficient for parameter setting and for keeping the fieldbus active.

NOTE! If the +24 V input of several brake choppers or other loads are connected in parallel, we recommend to use a diode in terminal #6 to avoid the current to flow in opposite direction, which might damage the control board.



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 51.

The digital inputs are galvanically isolated from the I/O ground. The relay outputs are additionally double-isolated from each other at 300 VAC (EN-50178). See Figure 51.

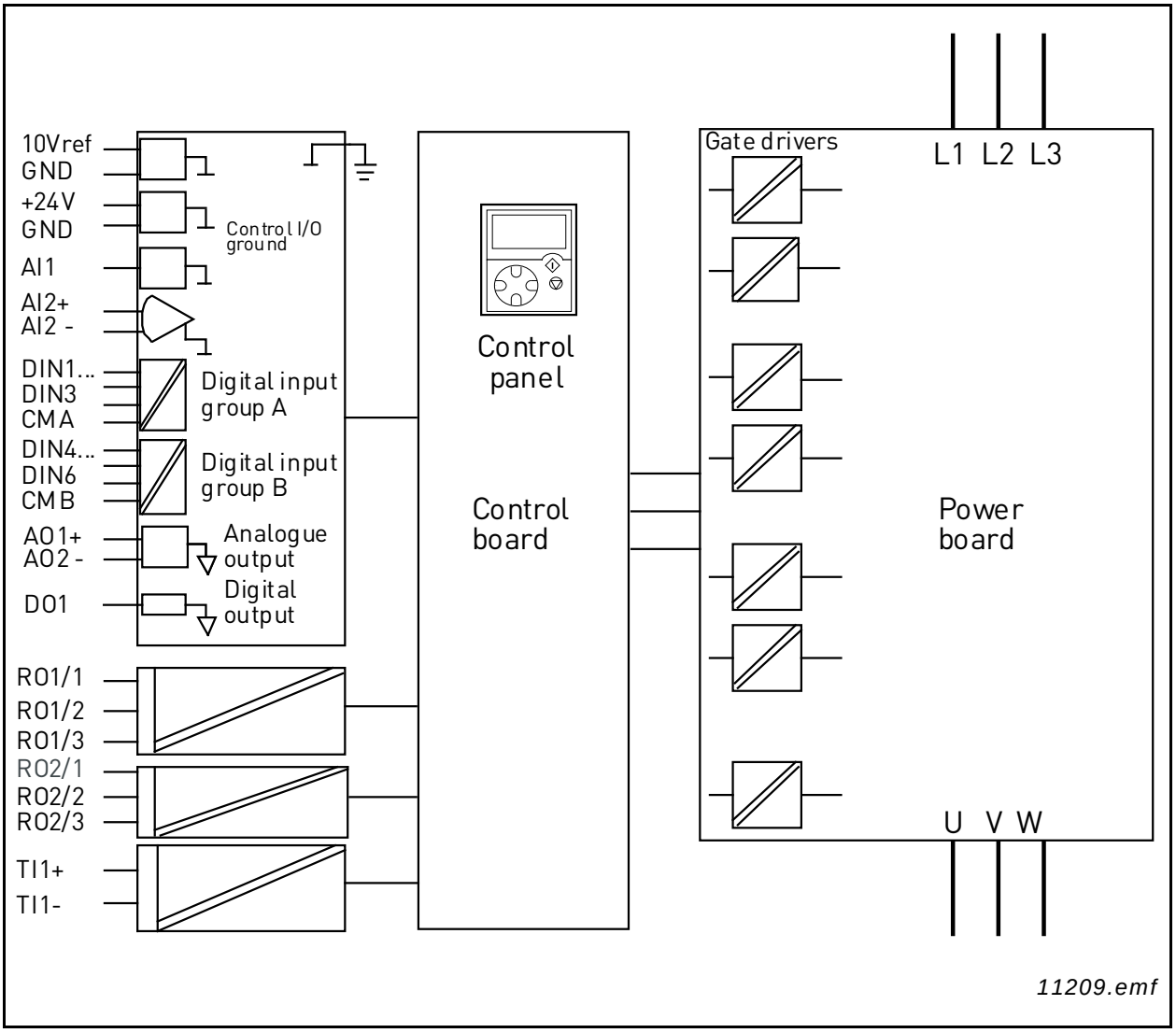


Figure 51. Galvanic isolation barriers

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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

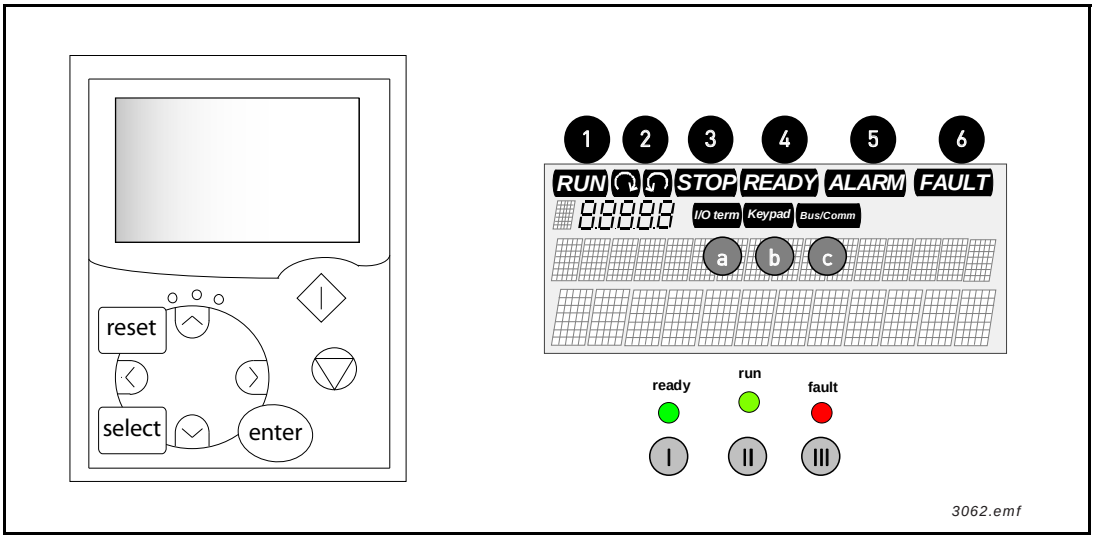

Figure 52. Vacon control keypad and drive status indications

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	●	=	Lights up with the AC power connected to the drive. Simultaneously, the drive status indicator READY is lit up.
II	●	=	Lights up when the drive is running (modulating).
III	●	=	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.

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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.

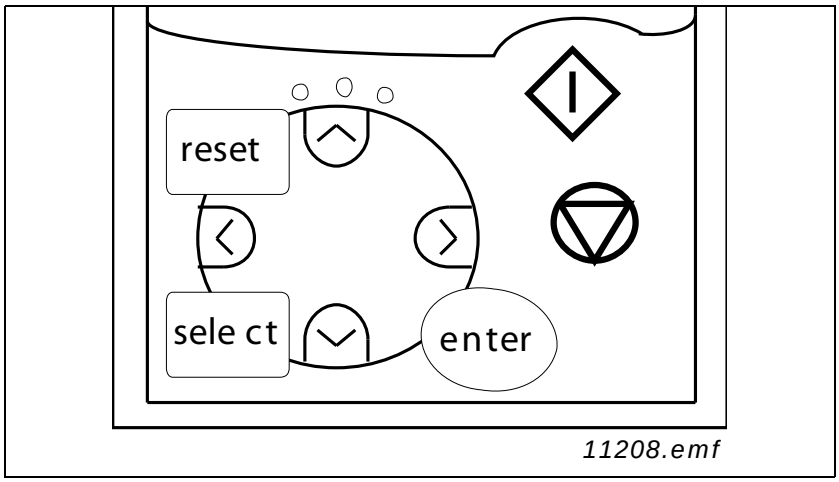

Figure 53. Keypad push-buttons

6.2.1 BUTTONS 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.

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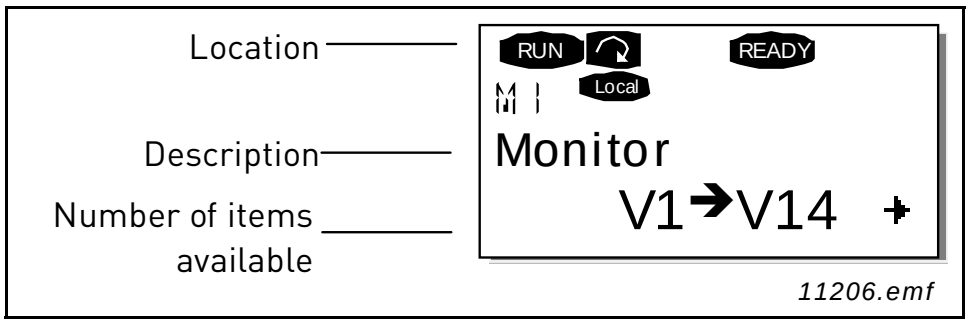
6.3 NAVIGATION ON THE CONTROL KEYPAD

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. Please 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.

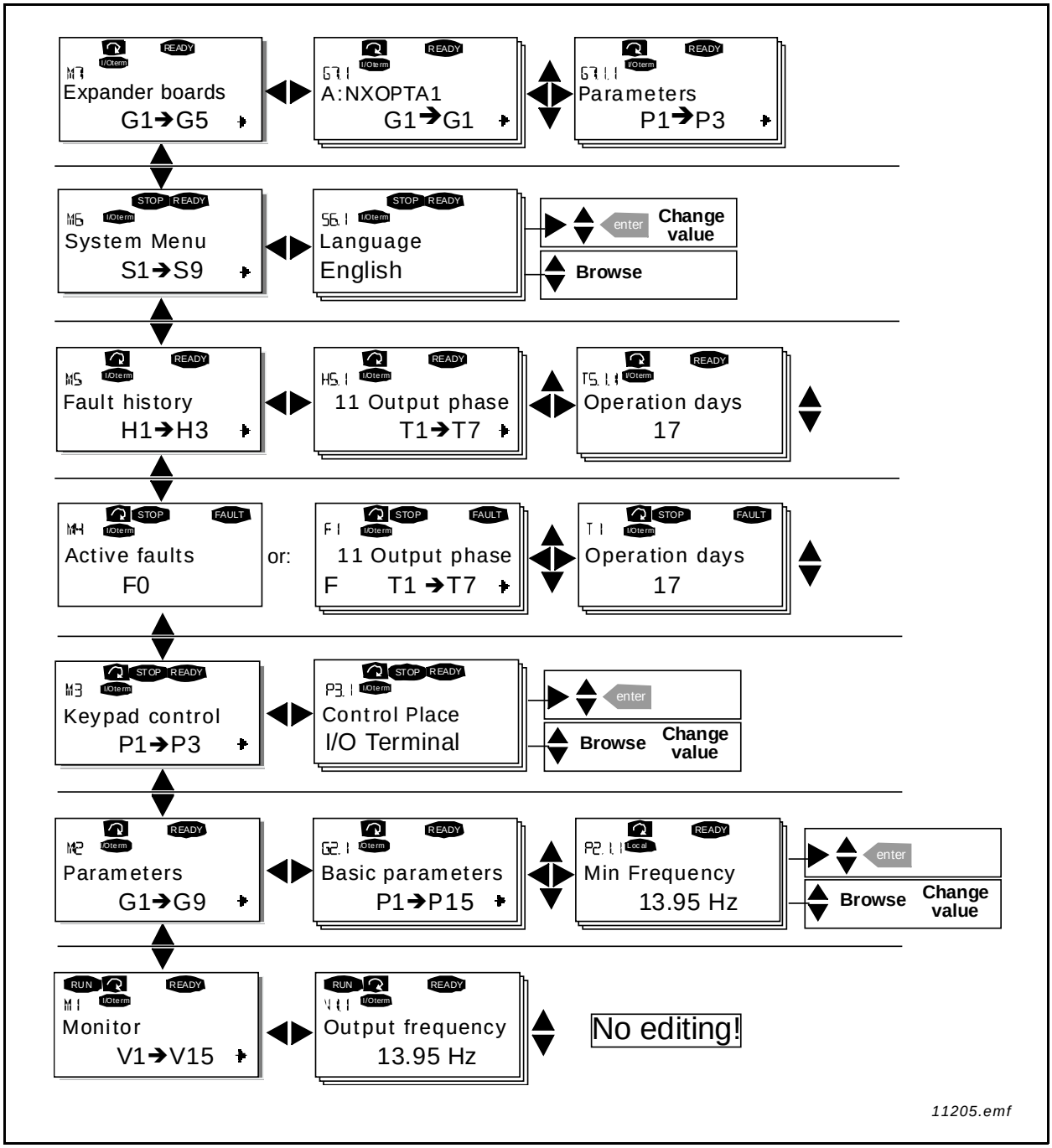


Figure 54. Keypad navigation chart

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 55 shows how to browse through the monitored values.

The monitored signals carry the indication V#.# and they are listed in Table 25. 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.

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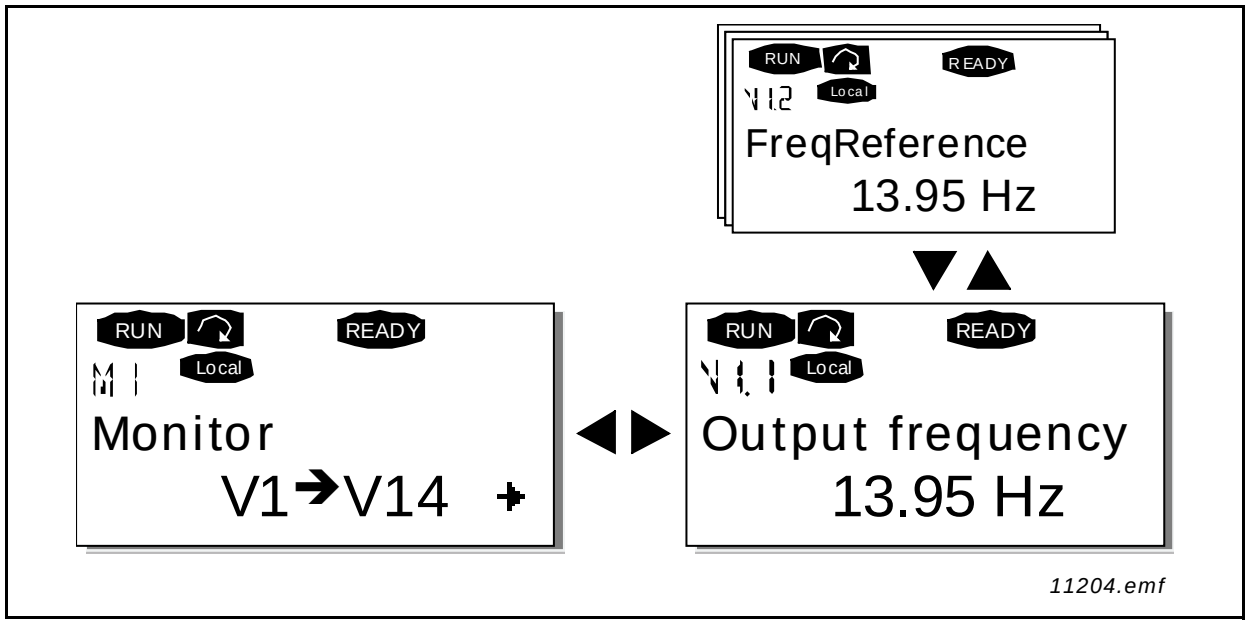

Figure 55. Monitoring menu

Table 25. 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	°C	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 56.

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 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 56.

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.

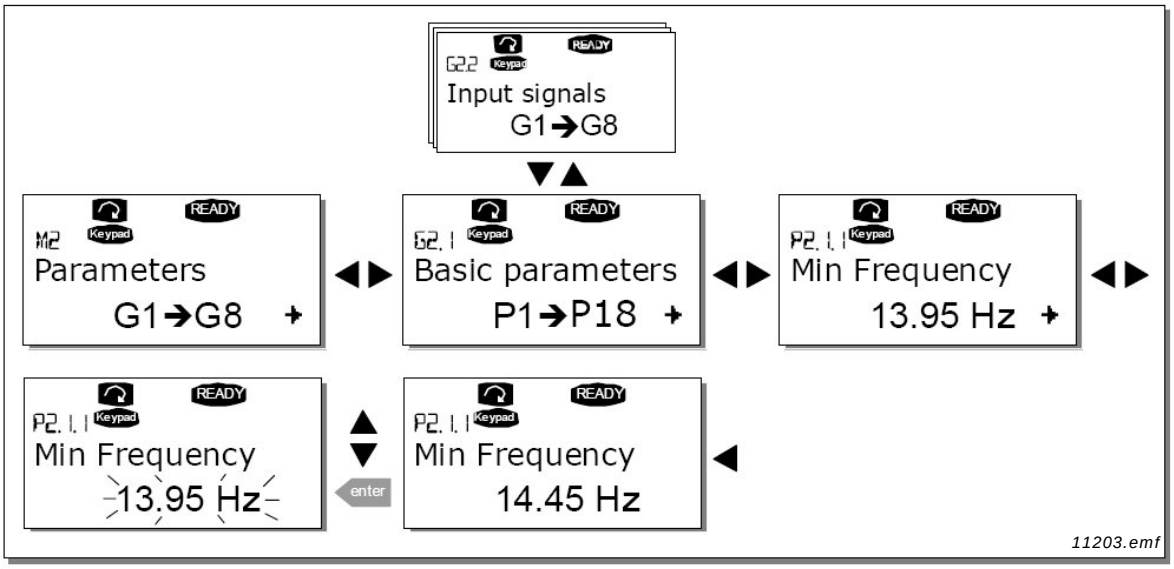

Figure 56. Parameter value change procedure

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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	
Keypad (panel)	
Fieldbus	

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 56 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

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 26.

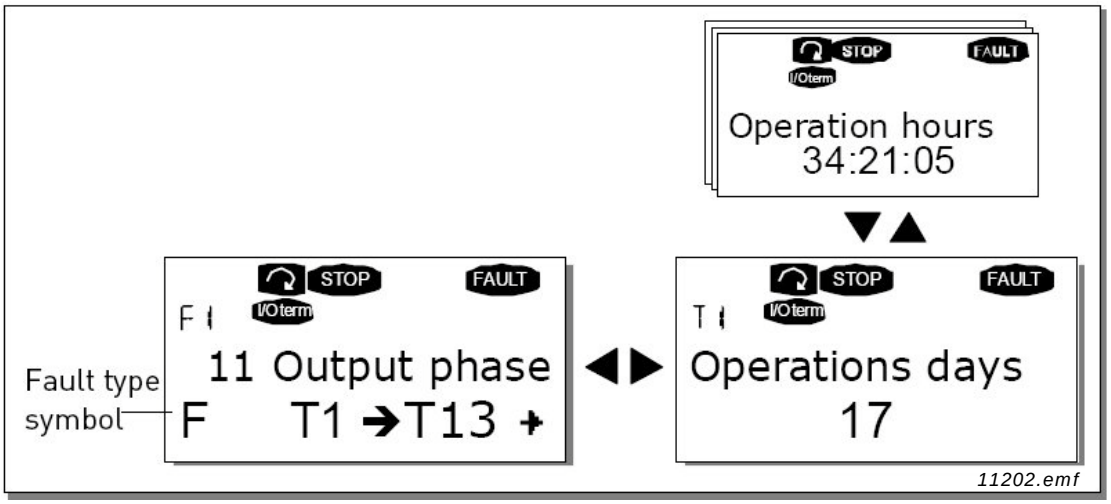

Figure 57. Fault display

Table 26. 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.

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6.3.6 FAULT CODES

The fault codes, their causes and correcting actions are presented in the Table 27. 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 27. 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 oroverload.	- 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 frequency converter. - Check the supply voltage. - If it is adequate, an internal failure has occurred. - Contact your local distributor.
13	AFE undertemperature	Heatsink temperature is under –10 °C	
14	AFE overtemperature	Heatsink temperature is over 90 °C. Overtemperature warning is issued when the heatsink temperature exceeds 85 °C.	- Check the correct amount and flow of cooling air. - Check the heatsink for dust. - Check the ambient temperature.

Table 27. 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.
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.
50	External fault	Digital input fault.	Remove fault situation from external device.
54	Slot fault	Defective option board or slot	Check board and slot. Contact the nearest Vacon distributor.
58	PT100 fault	Temperature limit values set for the PT100 have been exceeded.	Find the cause of temperature rise.
60	KLIXON	Status of KLIXON input is LOW.	
61	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).

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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 28. 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 on the brake chopper, 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

6.3.7 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.

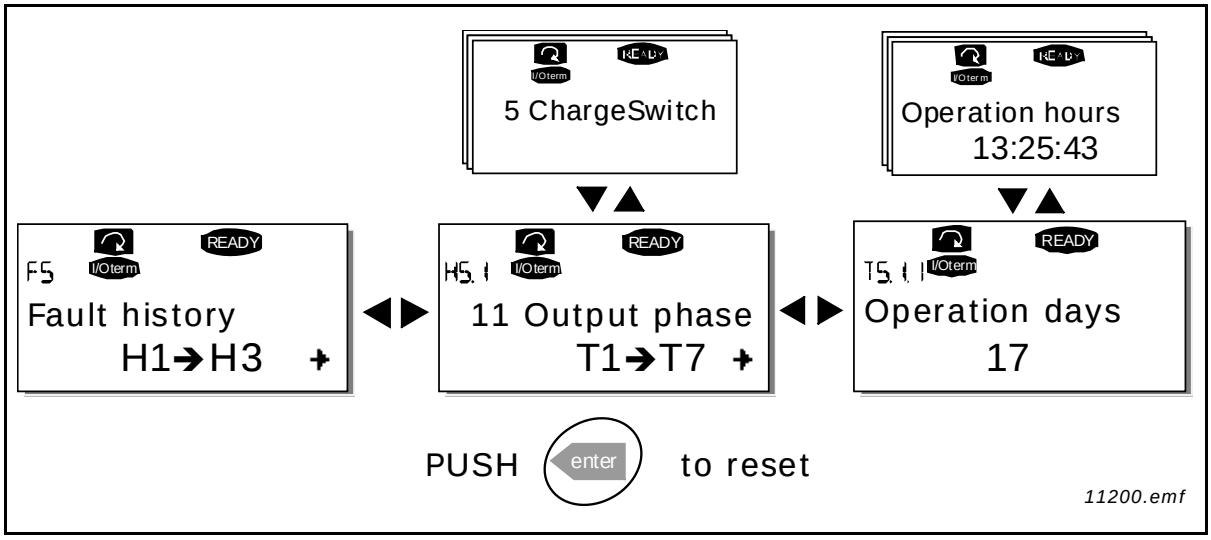

Figure 58. Fault history menu

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 29.

System menu functions

Table 29. 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					
S6.3.1	Parameter sets					Load factory defaults Store set 1 Load set 1 Store set 2 Load set 2
S6.3.2	Load to keypad					All parameters
S6.3.3	Load from keypad					All parameters All but motor parameters Application parameters

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Table 29. System menu functions

Code	Function	Min	Max	Unit	Default	Selections
P6.3.4	Parameter backup				Yes	No Yes
S6.4	Parameter comparison					
S6.5	Safety					
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
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
P6.7.3	HMI acknowledgment	200	5000	ms	200	
P6.7.4	HMI: no. of retries	1	10		5	
S6.8	System information					
S6.8.1	Total counters					
C6.8.10.1.	MWh counter			kWh		
C6.8.10.2.	Operation day counter					
C6.8.1.3.	Operation hour counter					

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*.

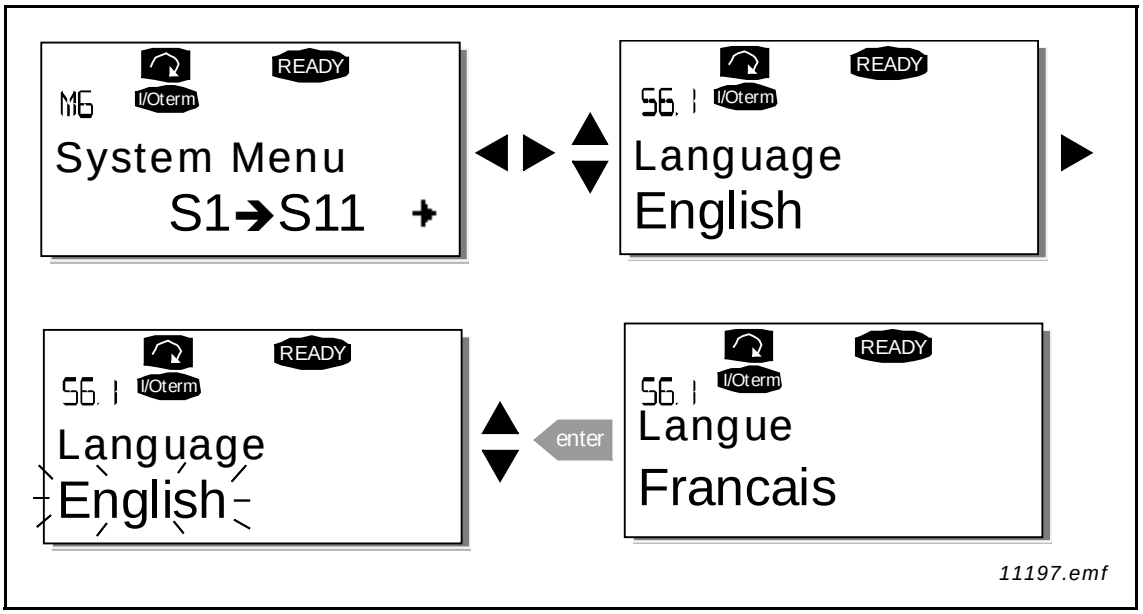

Figure 59. Selection of language

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 87.

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.

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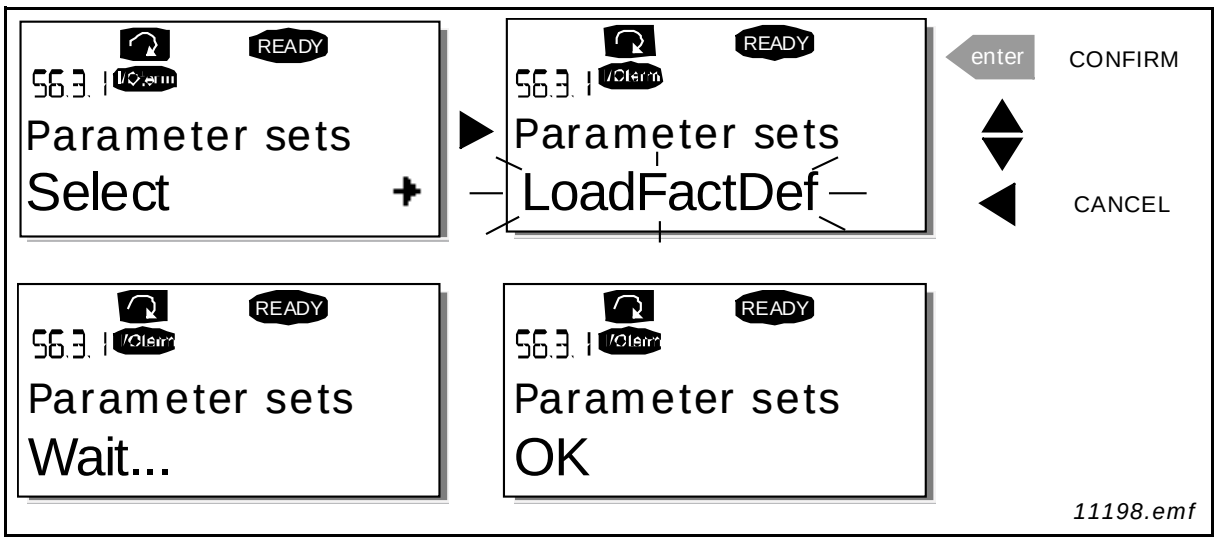

Figure 60. Storing and loading of parameter sets

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.

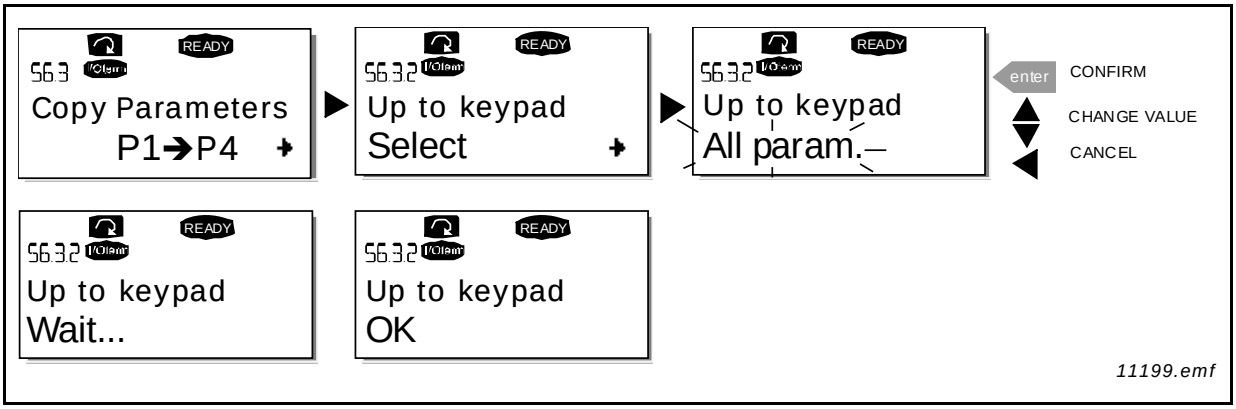

Figure 61. Parameter copy to keypad

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 60.

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.

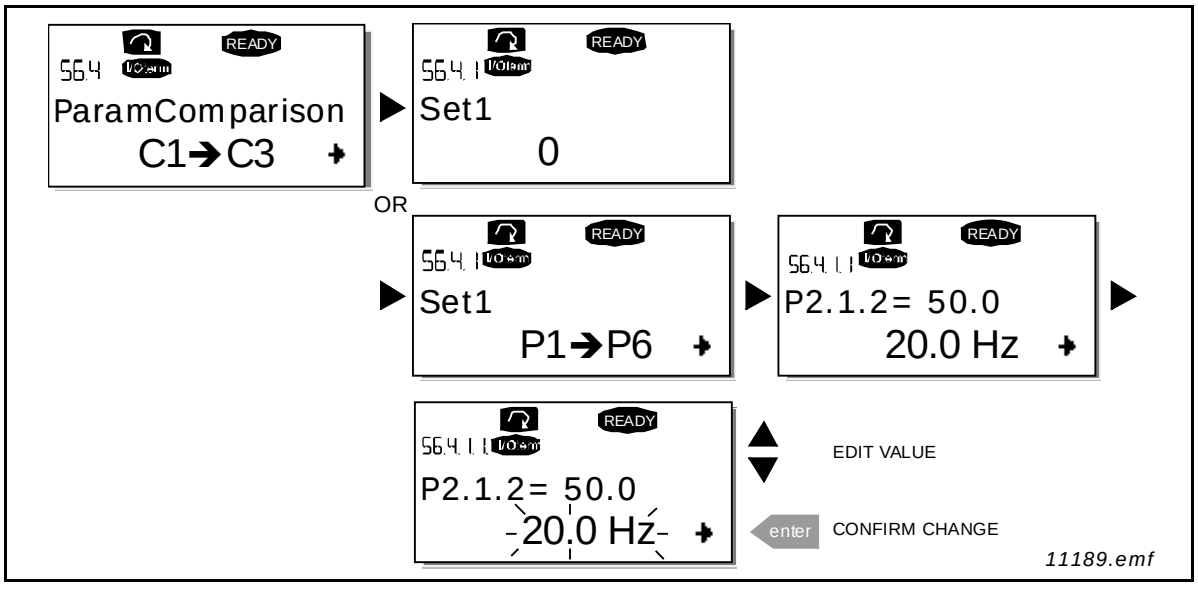

Figure 62. Parameter comparison

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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.

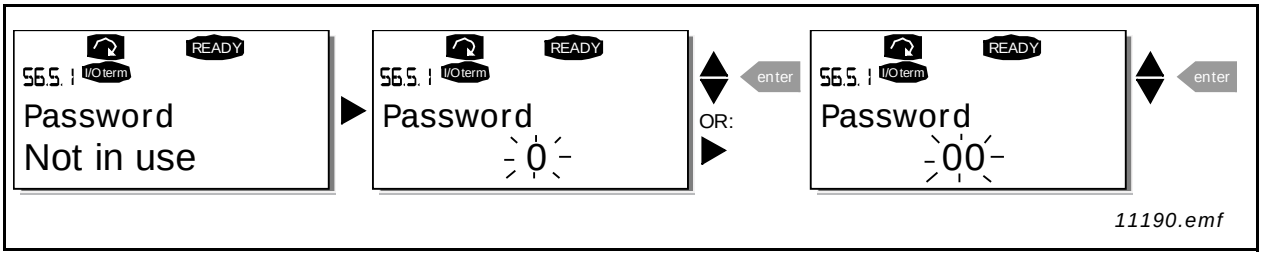

Figure 63. Password setting

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.*

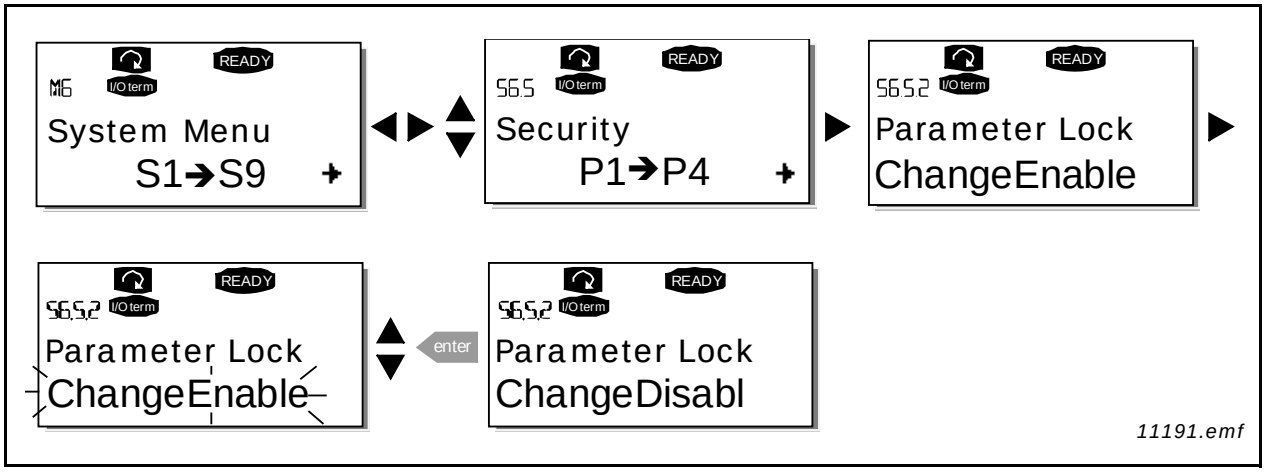

Figure 64. Parameter locking

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*.

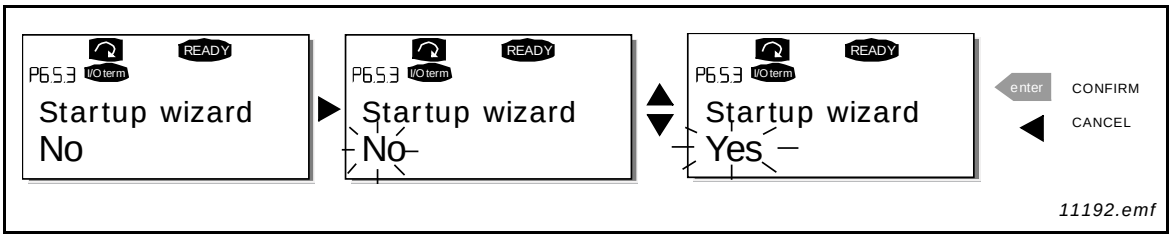

Figure 65. Activation of Start-up wizard

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 66.

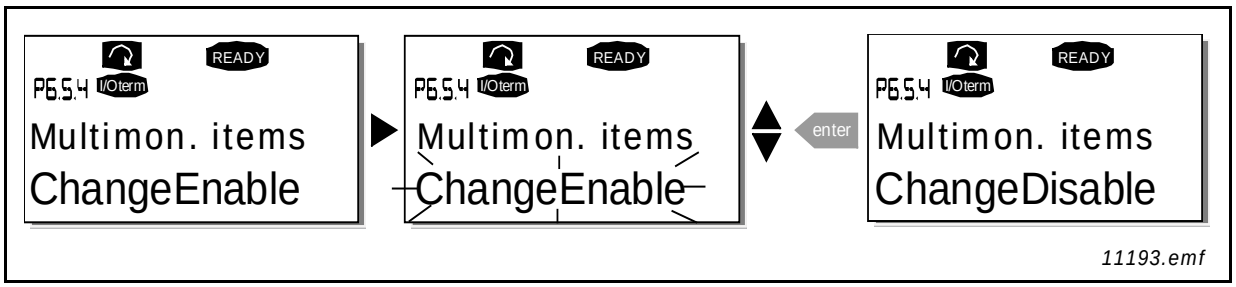

Figure 66. Disabling the change of multimonitoring items

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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:

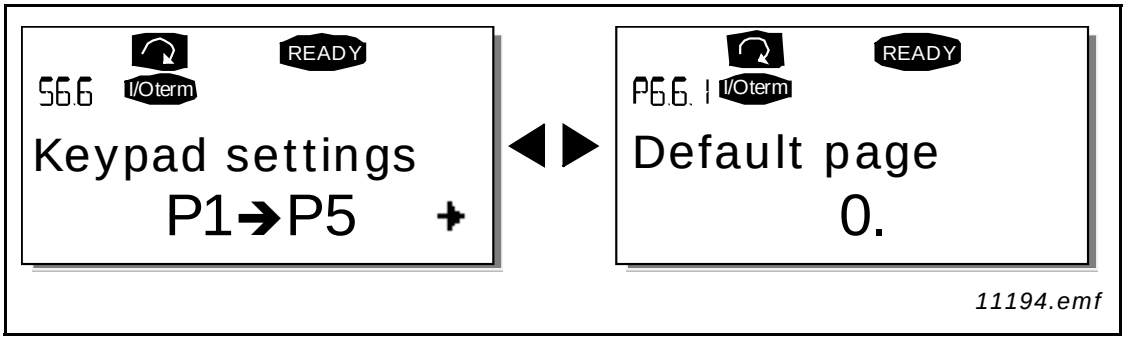

Figure 67. Keypad settings submenu

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*.

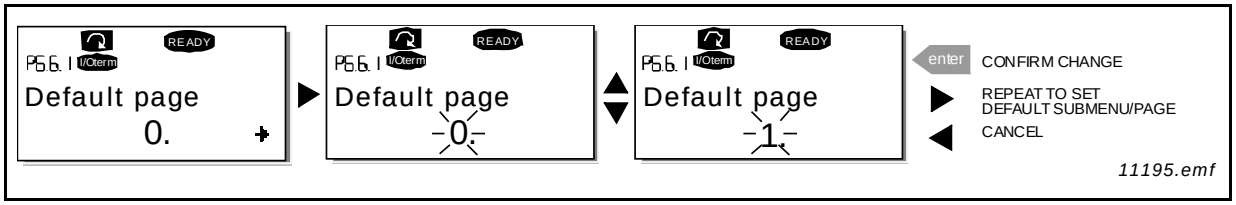

Figure 68. Default page function

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 68).

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*.

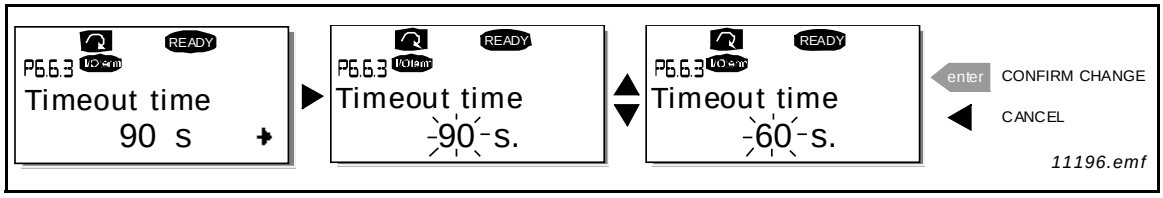

Figure 69. Timeout time setting

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).

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7. APPENDICES

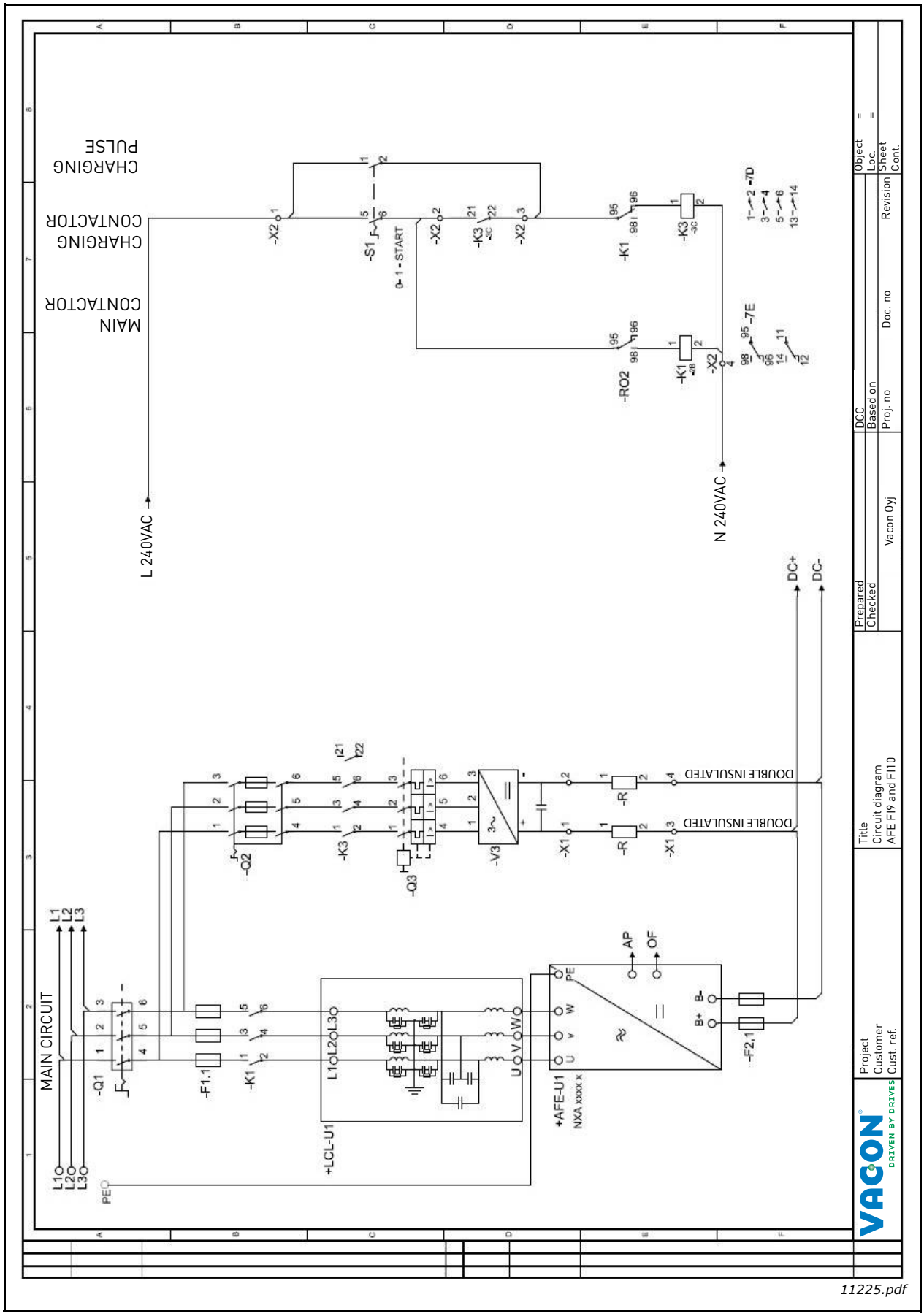

Figure 70. Wiring diagram for FI9 and FI10

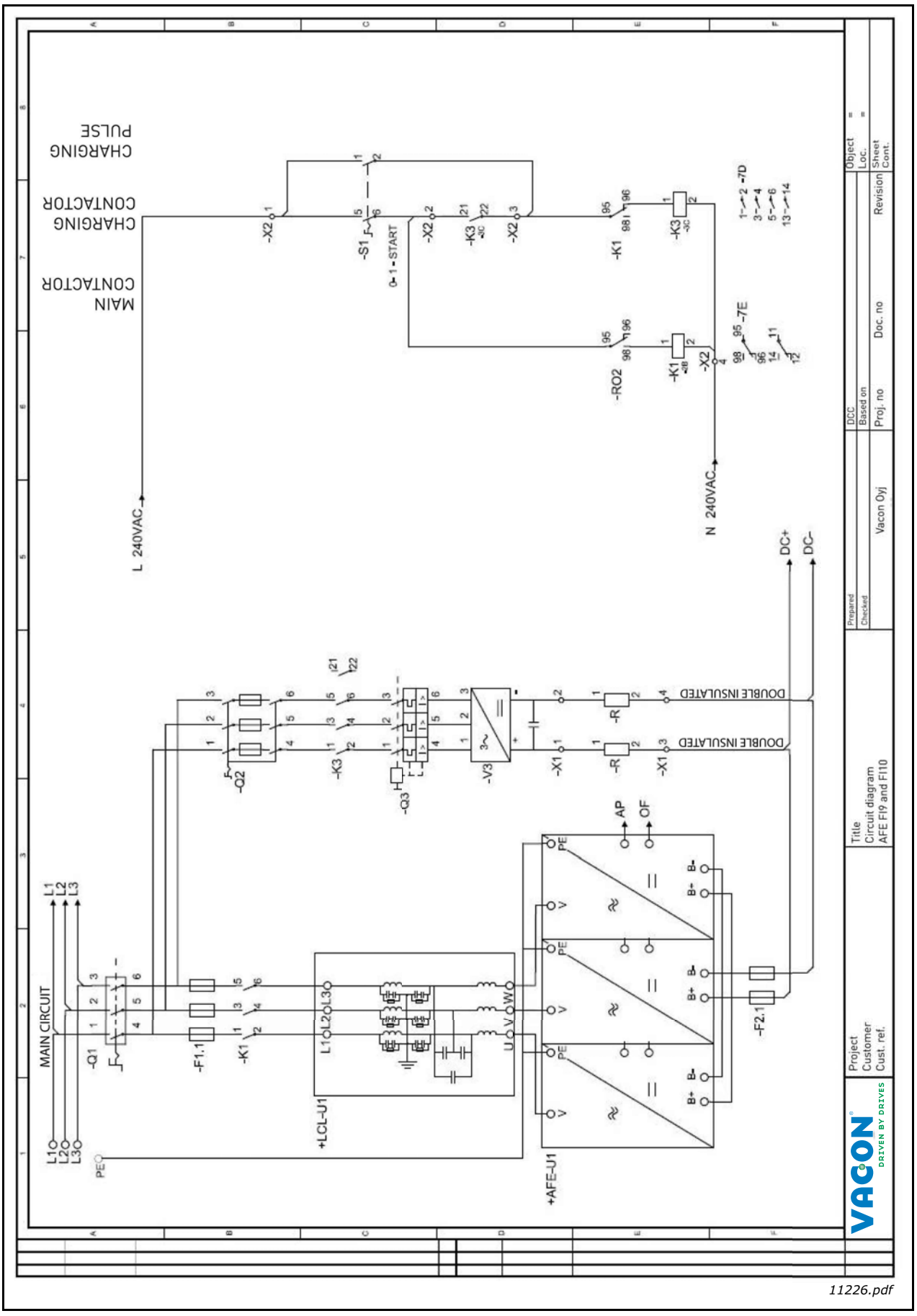

Figure 71. Wiring diagram for FI13

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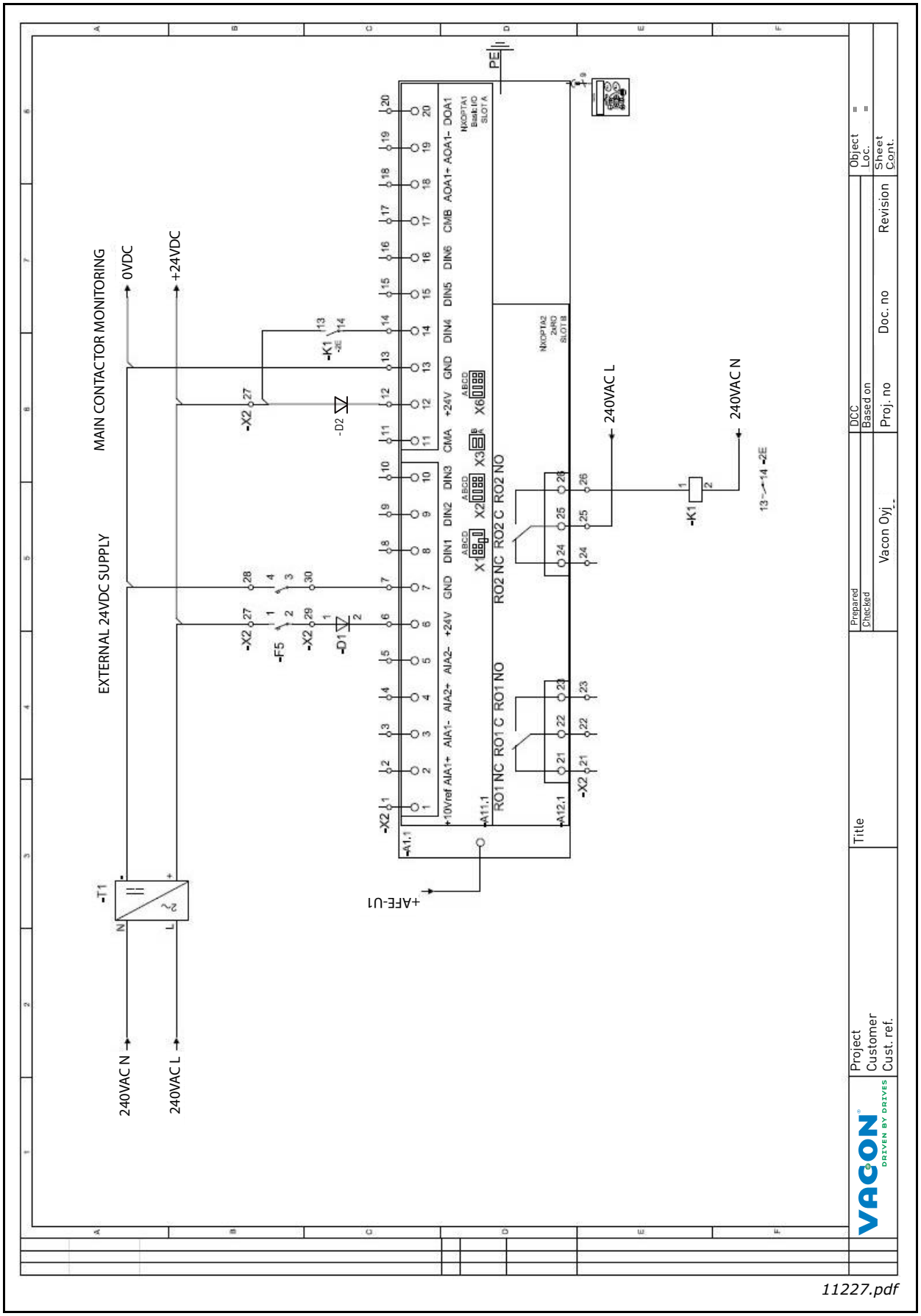

Figure 72. Wiring diagram for control circuit

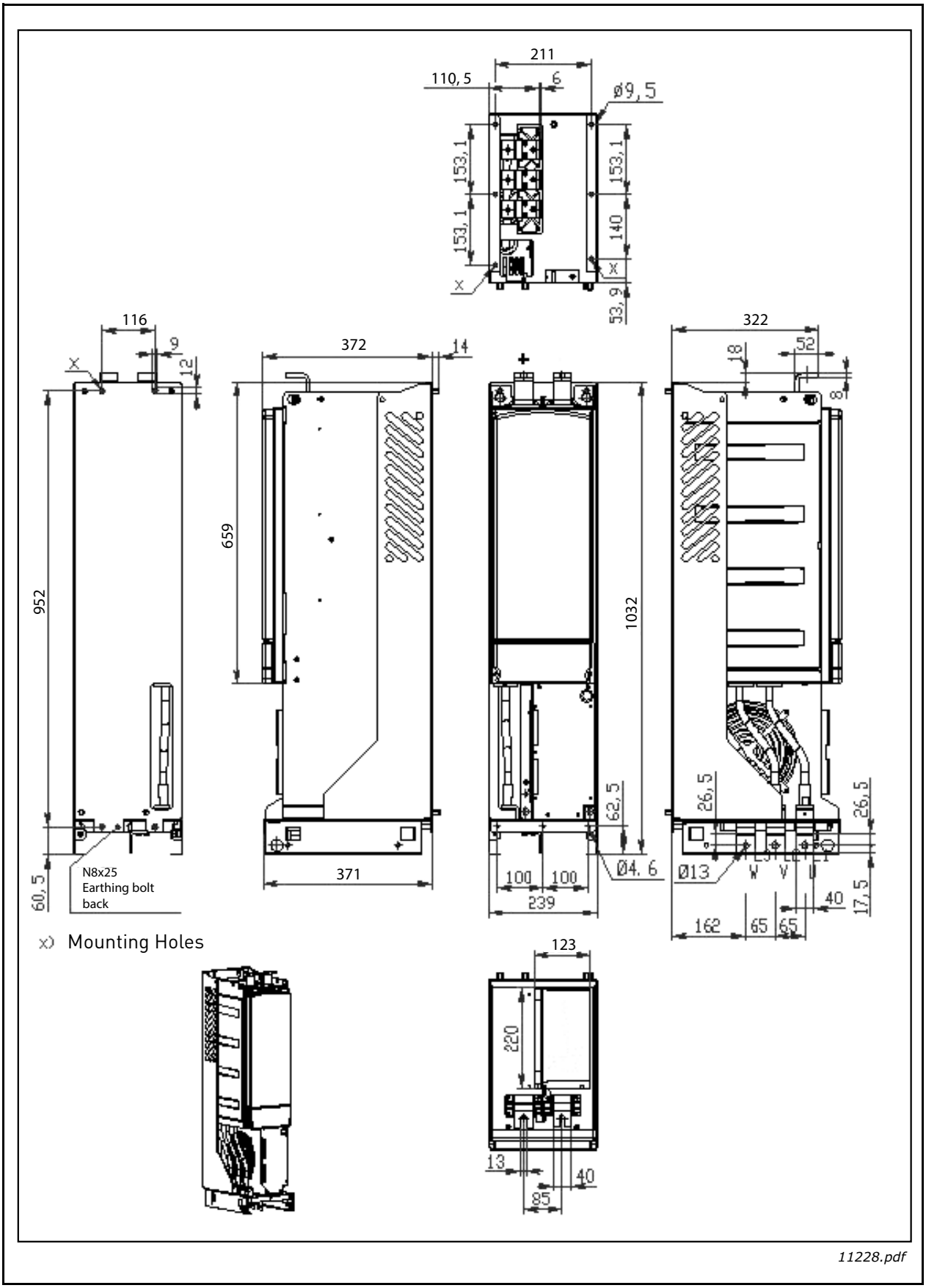

Figure 73. FI9 Dimensions

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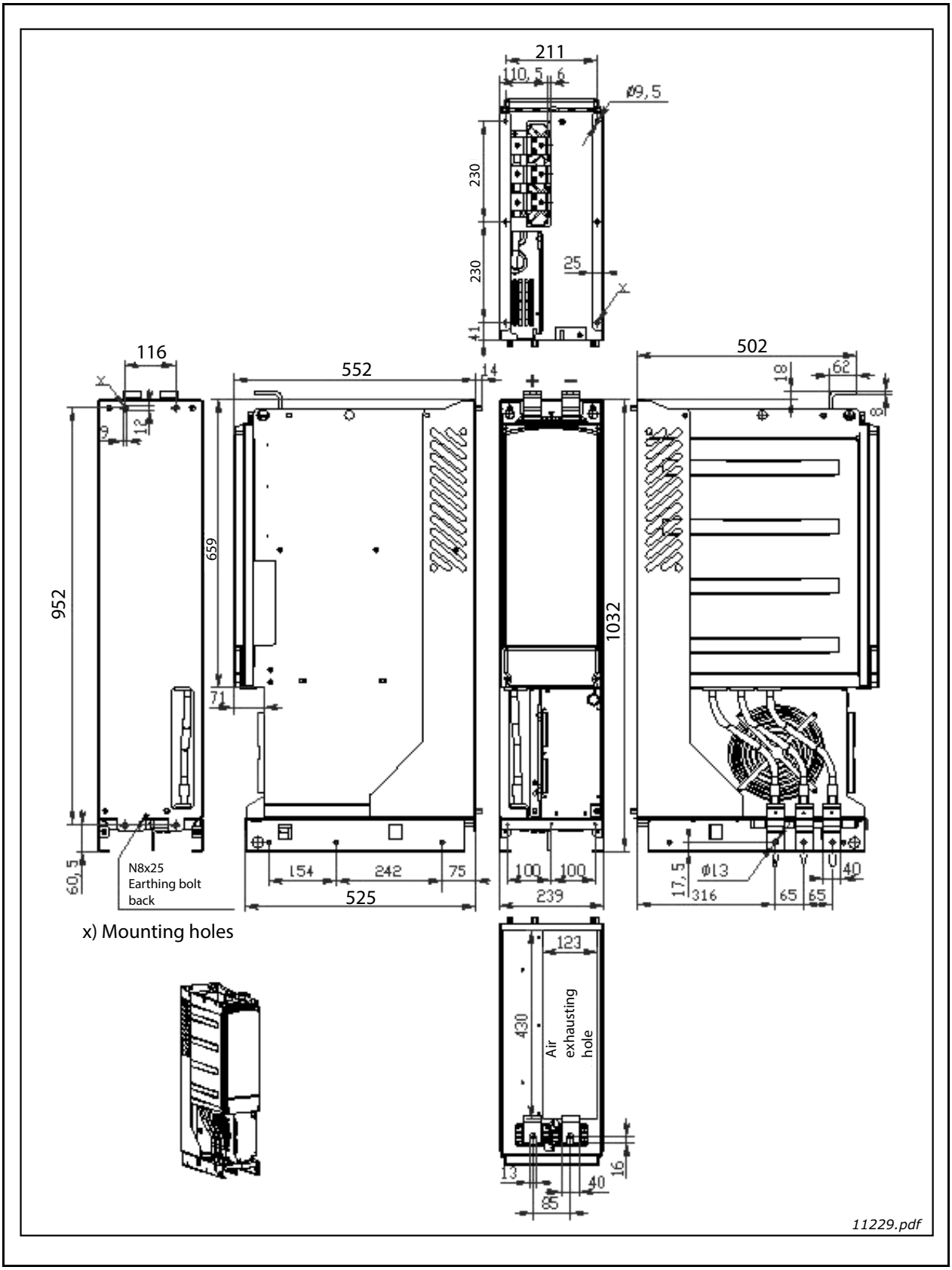

Figure 74. FI10 Dimensions

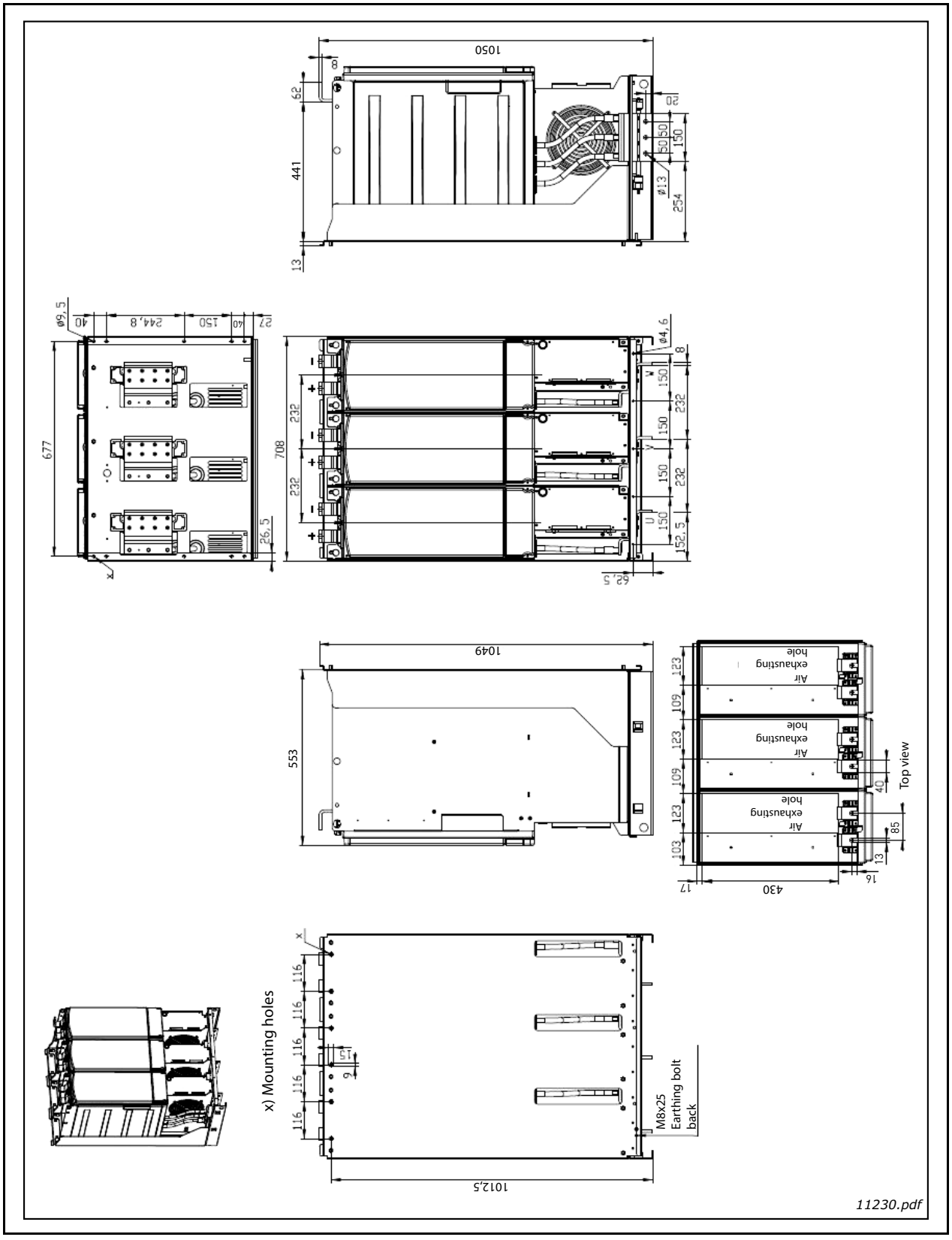

Figure 75. FI13 Dimensions

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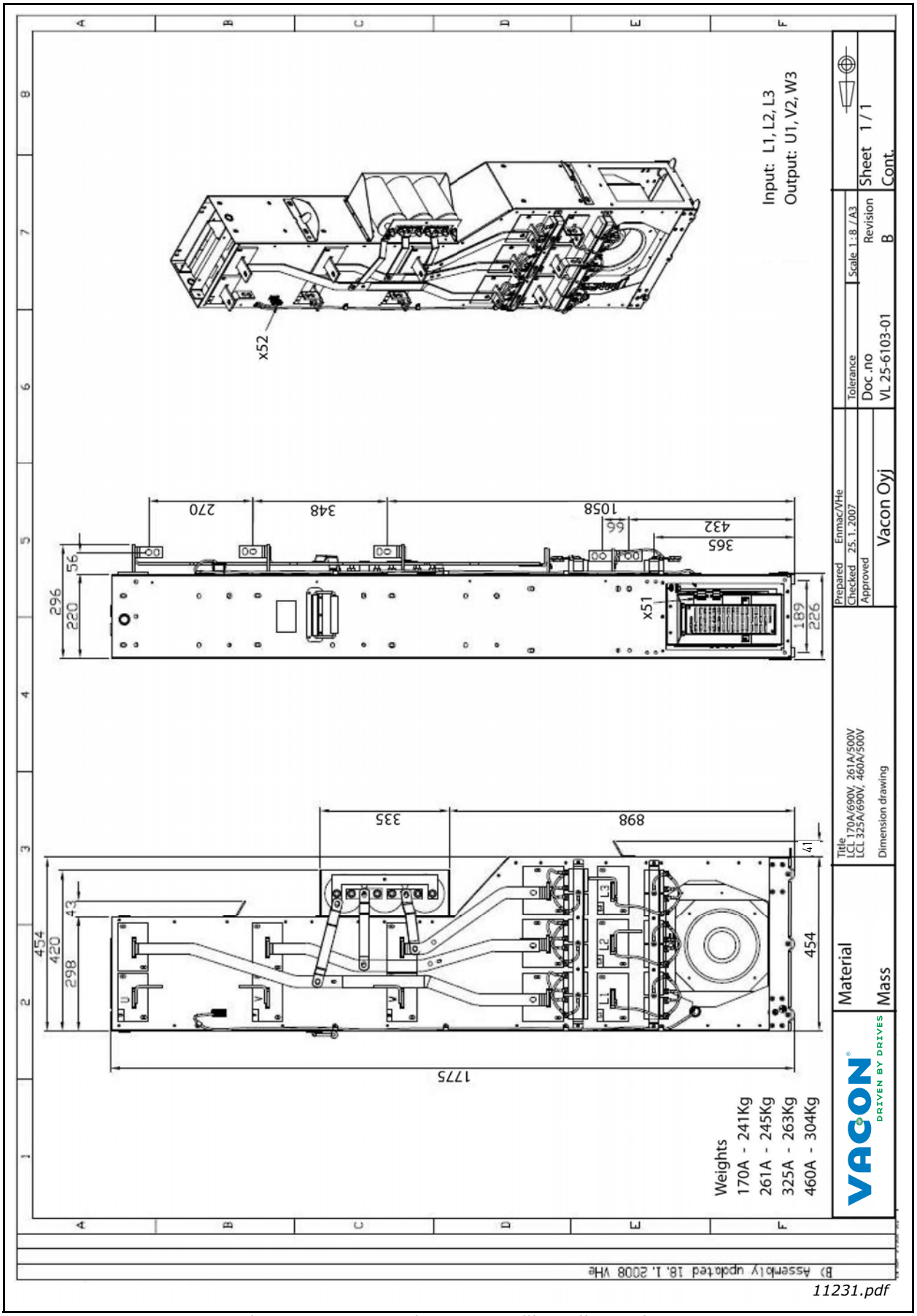

Figure 76. FI9 and FI10 LCL filter dimensions

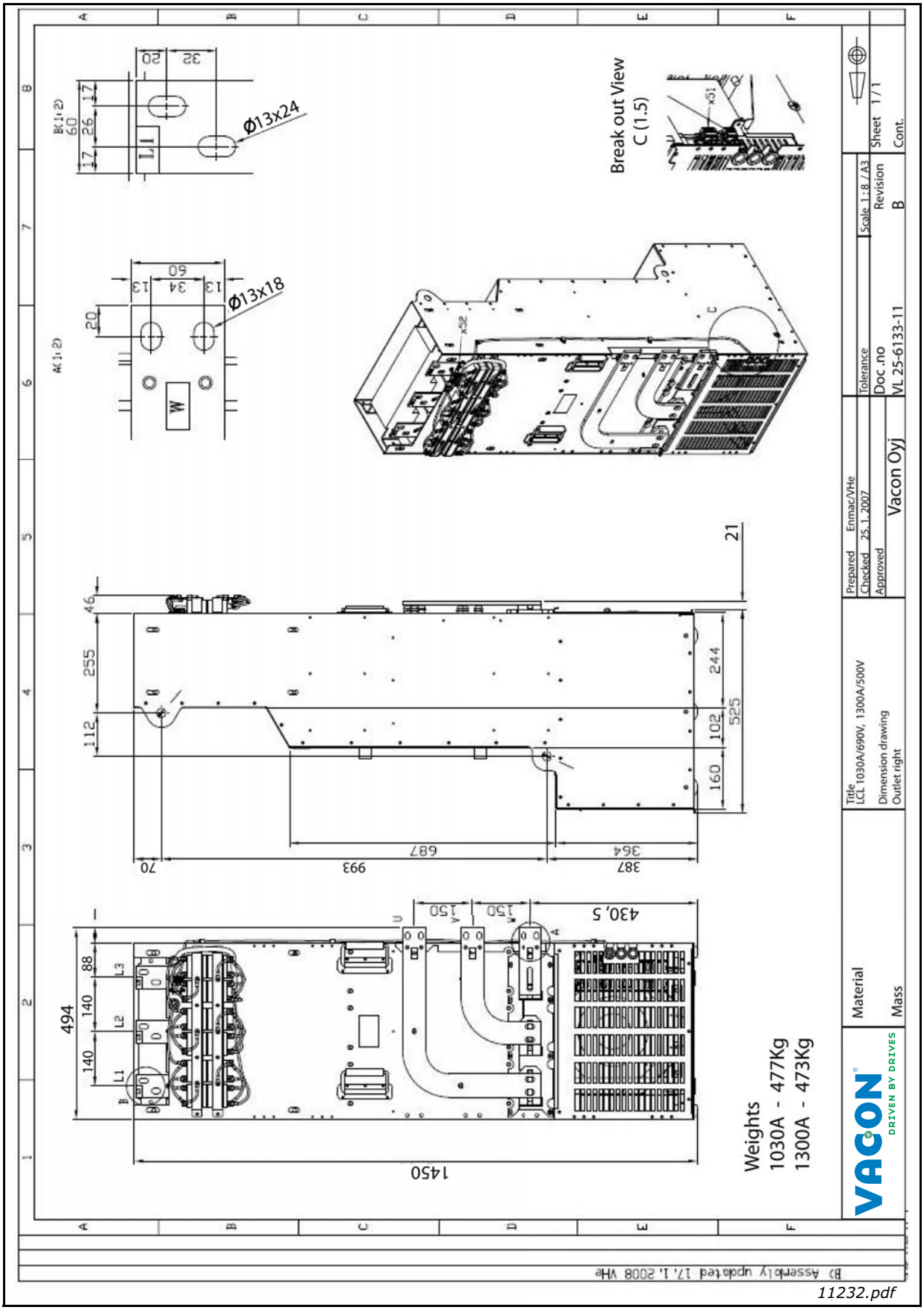

Figure 77. FI13 LCL filter dimensions, output connections right

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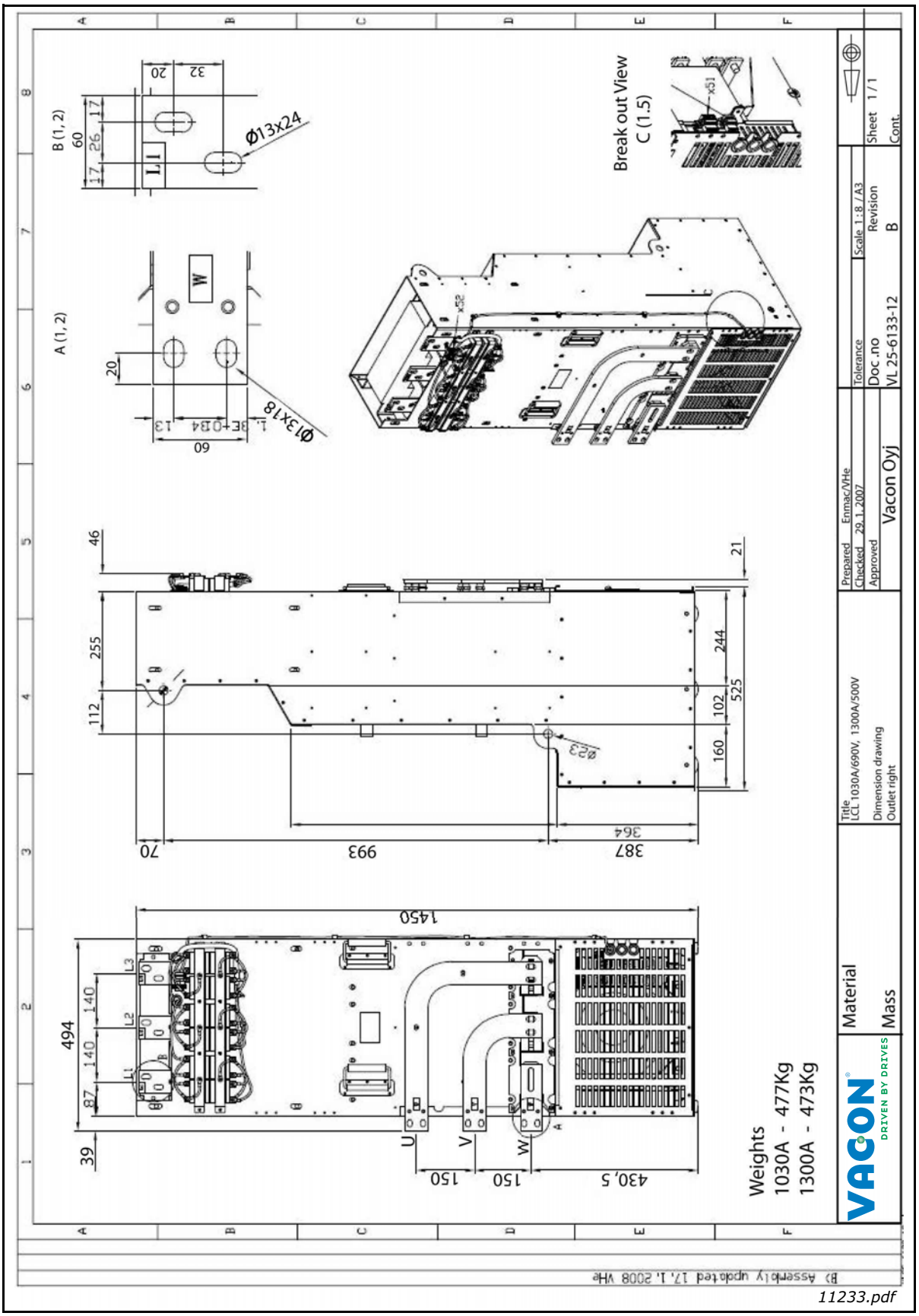

Figure 78. FI13 LCL filter dimensions, output connections left

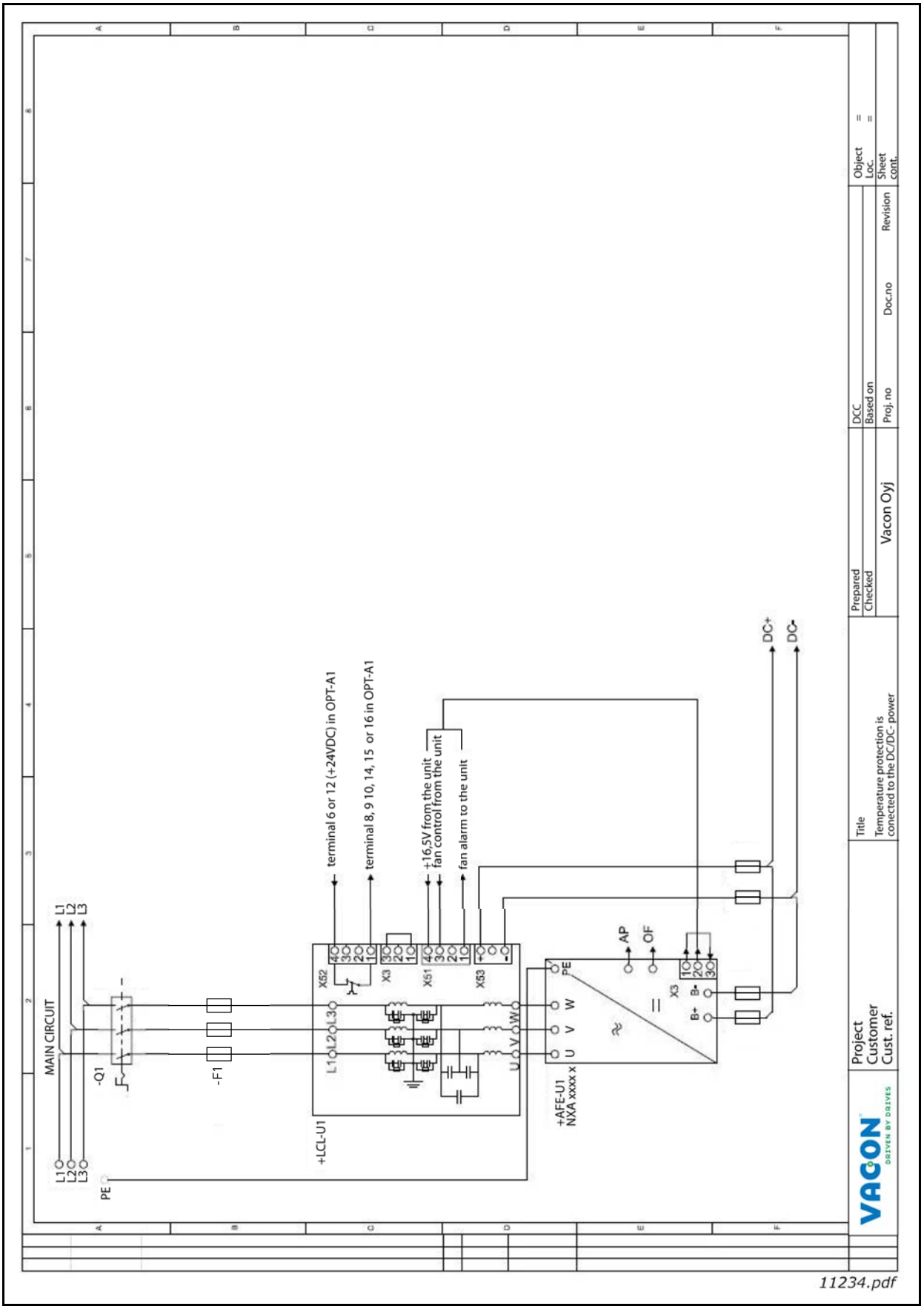

Figure 79. Circuit diagram for DC/DC-power supply if over-temperature protection is connected to the I/O

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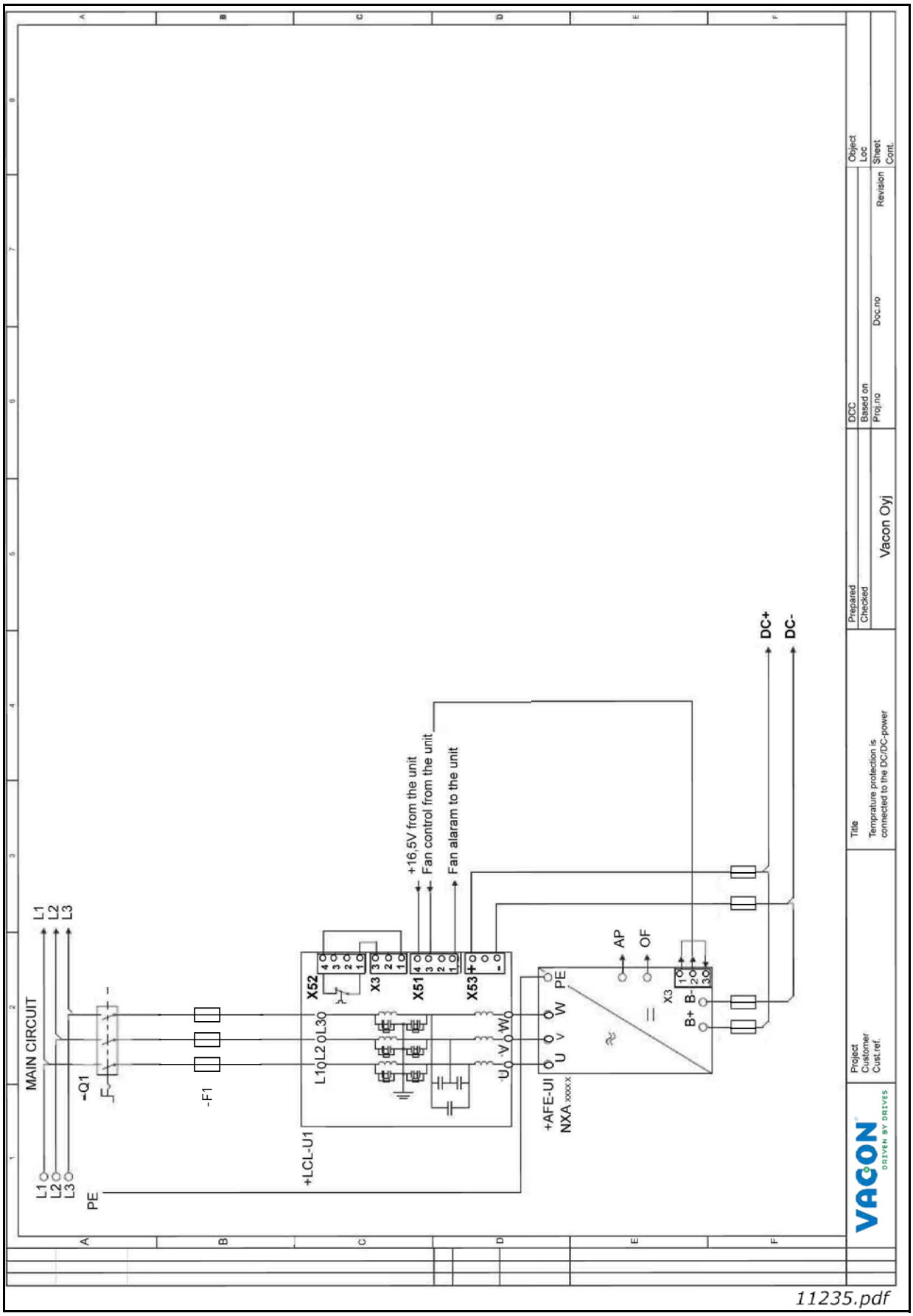

Figure 80. Circuit diagram for DC/DC-power supply if over-temperature protection is connected to the DC/DC-power supply

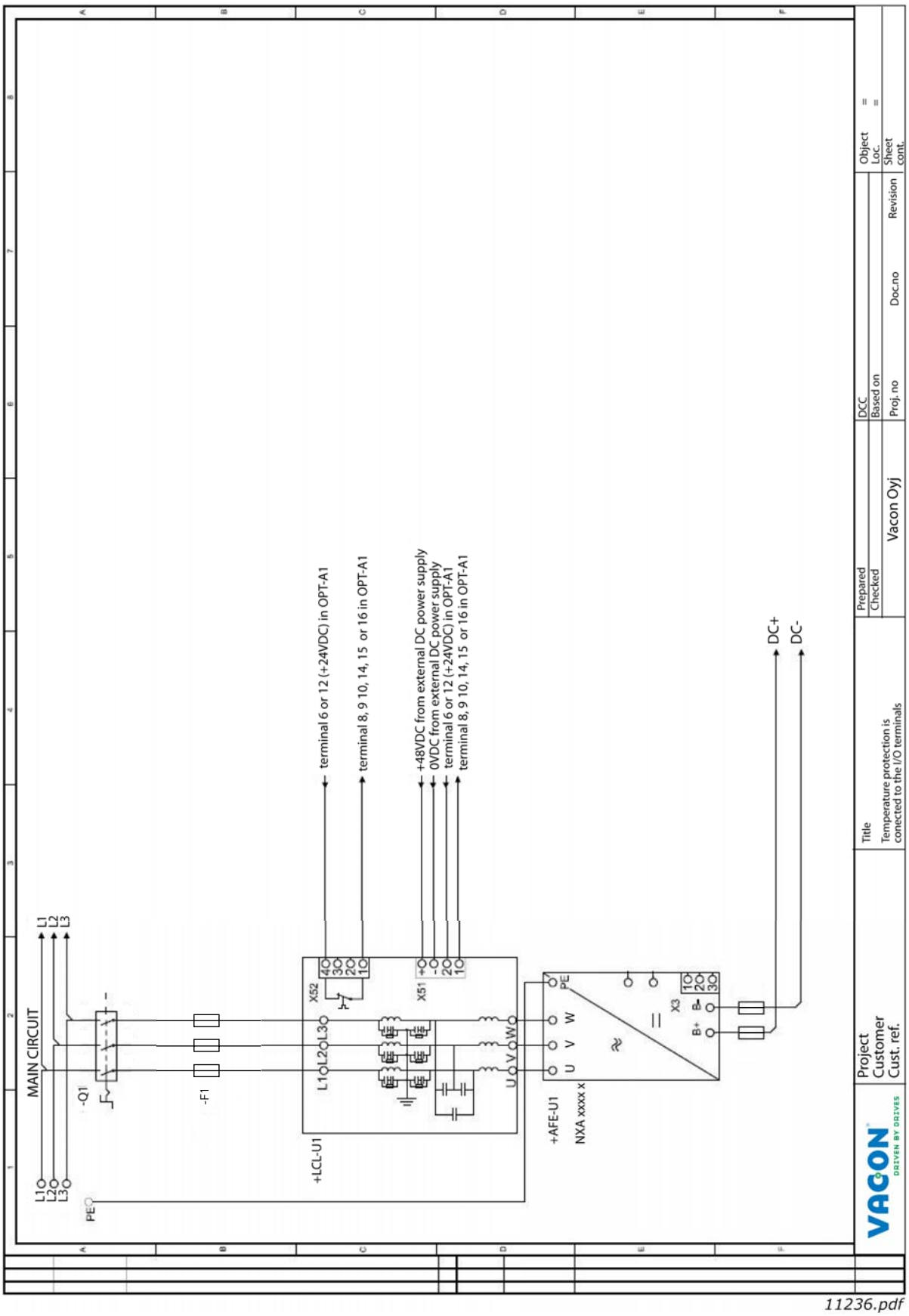

Figure 81. Circuit diagram for LCL filter without integrated DC/DC-power supply

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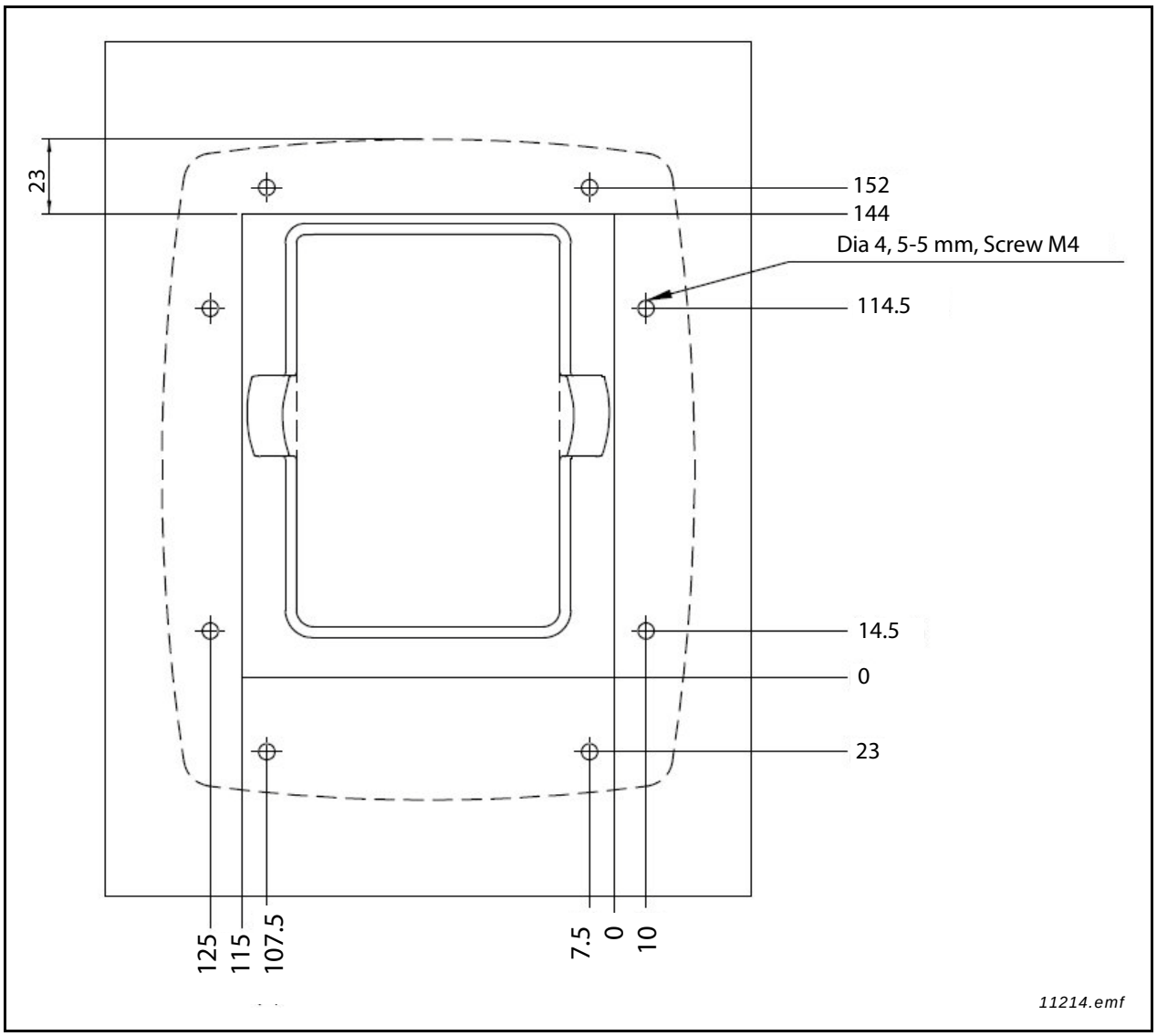


Figure 82. Dimensions of the door mounting kit

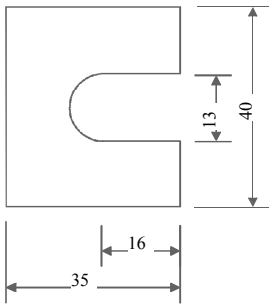
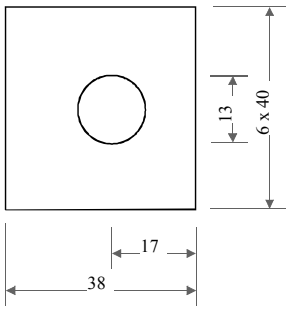
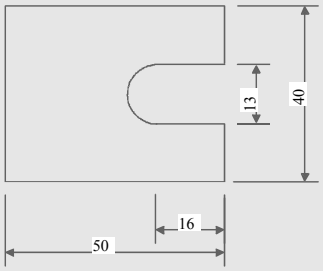
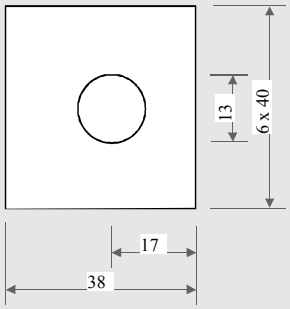
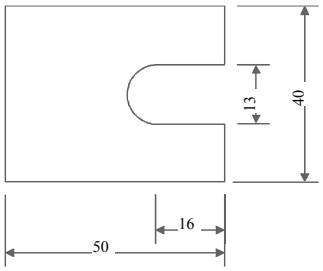
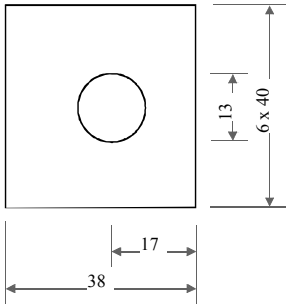
Frame	Type	IL [A]	DC terminal	AC Terminal
NXA_0261 5	FI9	261	 PE: M8×25	
NXA_0170 6		170		
NXA_0460 5	FI10	460	 PE: M8×25	
NXA_0325 6		325		
NXA_1300 5	FI13	1300	 PE: M8×25	 11213.emf
NXA_1030 6		1030		

Figure 83. Terminal sizes for Vacon NX Active Front End units

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