VACON 100
HVAC DRIVES

INSTALLATION MANUAL

VACON
DRIVEN BY DRIVES

INDEX

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VACON
DRIVEN BY DRIVES

EU 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 100 frequency converter
Model designation:	Vacon 100 3L 0003 4...3L 0105 4

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

Safety:	EN 61800-5-1 (2007)
EMC:	EN 61800-3 (2004) EN 61000-3-12

and conforms to the relevant safety provisions of the Low Voltage Directive 2006/95/EC and 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, 11th of May, 2009

Vesa Laisi
President

The year the CE marking was affixed: 2009

1. SAFETY

This manual contains clearly marked cautions and warnings which are intended for your personal safety and to avoid any 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 follows:

	**= DANGEROUS VOLTAGE!**
	**= WARNING or CAUTION**
	**= Caution! Hot surface**

Table 1. Warning signs

1.1 DANGER

	The **components of the power unit of Vacon 100 are live** when the AC drive is connected to mains potential. Coming into contact with this voltage is **extremely dangerous** and may cause death or severe injury.
	The **motor terminals U, V, W and the brake resistor terminals are live** when Vacon 100 is connected to mains, even if the motor is not running.
	**After disconnecting** the AC drive from the mains, **wait** until the indicators on the keypad go out (if no keypad is attached see the indicators on the cover). Wait 5 more minutes before doing any work on the connections of Vacon100. Do not open the cover before this time has expired. After expiration of this time, use a measuring equipment to absolutely ensure that no voltage is present. **Always ensure absence of voltage before starting any electrical work!**
	The control I/O-terminals are isolated from the mains potential. However, the **relay outputs and other I/O-terminals may have a dangerous control voltage** present even when Vacon 100 is disconnected from mains.
	**Before connecting** the AC drive to mains make sure that the front and cable covers of Vacon 100 are closed.
	During a ramp stop (see the Application Manual), the motor is still generating voltage to the drive. Therefore, do not touch the components of the AC drive before the motor has completely stopped. Wait until the indicators on the keypad go out (if no keypad is attached see the indicators on the cover). Wait additional 5 minutes before starting any work on the drive.

1.2 WARNINGS

⚠	Vacon 100 AC drive is meant for **fixed installations only**.
⚠	**Do not perform any measurements** when the AC drive is connected to the mains.
⚠	The **earth leakage current** of Vacon 100 AC drives exceeds 3.5mA AC. According to standard EN61800-5-1, **a reinforced protective ground connection** must be ensured. See chapter 1.3.
⚠	If the AC drive is used as a part of a machine, the **machine manufacturer is responsible** for providing the machine with a **supply disconnecting device** (EN 60204-1).
⚠	Only **spare parts** delivered by Vacon can be used.
⚠	At power-up, power brake or fault reset **the motor will start immediately** if the start signal is active, unless the pulse control for Start/Stop logic has been selected. Futhermore, the I/O functionalities (including start inputs) may change if parameters, applications or software are changed.Disconnect, therefore, the motor if an unexpected start can cause danger.
⚠	The **motor starts automatically** after automatic fault reset if the autoreset function is activated. See the Application Manual for more detailed information.
⚠	**Prior to measurements on the motor or the motor cable**, disconnect the motor cable from the AC drive.
⚠	**Do not touch the components on the circuit boards**. Static voltage discharge may damage the components.
⚠	Check that the **EMC level** of the AC drive corresponds to the requirements of your supply network. See chapter 1.4.
⚠	In a domestic environment, this product may cause radio interference in which case supplementary mitigation measures may be required.

1.3 EARTHING AND EARTH FAULT PROTECTION

CAUTION!

The Vacon 100 AC drive must always be earthed with an earthing conductor connected to the earthing terminal marked with ⏚.

The earth leakage current of Vacon 100 exceeds 3.5mA AC. According to EN61800-5-1, one or more of the following conditions for the associated protective circuit shall be satisfied:

a) The protective conductor shall have a cross-sectional area of at least 10 mm² Cu or 16 mm² Al, through its total run.

b) Where the protective conductor has a cross-sectional area of less than 10 mm² Cu or 16 mm² Al, a second protective conductor of at least the same cross-sectional area shall be provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm² Cu or 16 mm² Al.

c) Automatic disconnection of the supply in case of loss of continuity of the protective conductor. See chapter 4.

The cross-sectional area of every protective earthing conductor which does not form part of the supply cable or cable enclosure shall, in any case, be not less than:

- 2.5mm² if mechanical protection is provided or
- 4mm² if mechanical protection is not provided.

The earth fault protection inside the AC drive protects only the drive itself against earth faults in the motor or the motor cable. It is not intended for personal safety.

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

Do not perform any voltage withstand tests on any part of Vacon 100. There is a certain procedure according to which the tests shall be performed. Ignoring this procedure may result in damaged product.

1.4 CHANGING EMC PROTECTION CLASS

If your supply network is an IT (impedance-grounded) system but your AC drive is EMC-protected according to classes C1 or C2 you need to modify the EMC protection of the AC drive to EMC-level **T**. This is done by removing the built-in RFI-filters from ground with a simple procedure described below:

⚠	Warning! Do not perform any modifications on the AC drive when it is connected to mains.

1.4.1 FRAMES MR4 TO MR7

1	Remove the main cover (frames MR4 to MR7) and the cable cover (frames MR6 and MR7) of the AC drive (see pages 25 and 26) and locate the jumpers connecting the built-in RFI-filters to ground. See Figure 1.

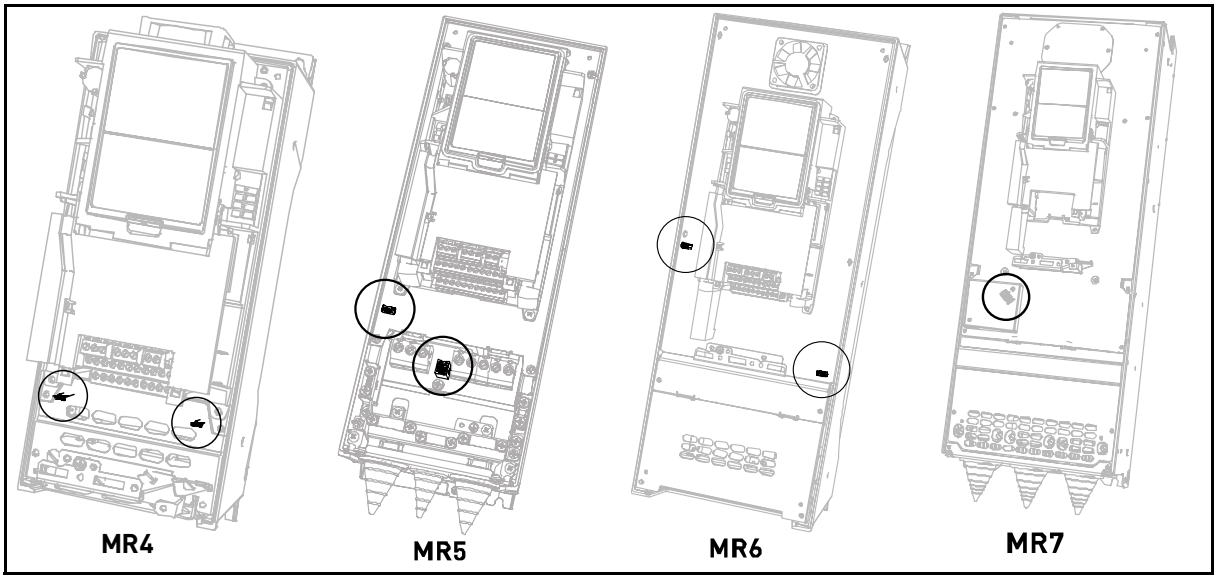

Figure 1. Locations of the built-in RFI-filters in frames MR4 to MR7

2	Disconnect the RFI-filters from ground by **lifting** the jumpers **up** from their default positions. See Figure 2.
3	**NOTE!** Secure the upper position of jumpers with locking clip (provided in Accessories bag, see chapter 2.4) as shown in Figure 2. in order to prevent the jumpers from being accidentally pushed down.

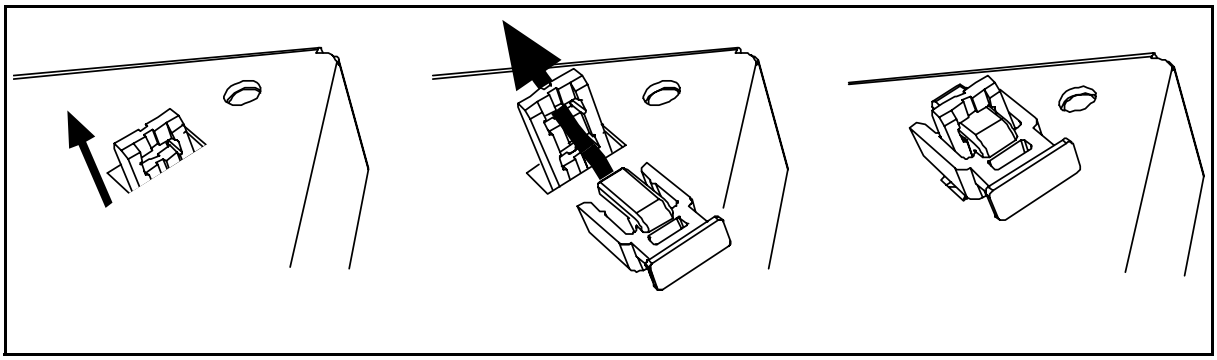

Figure 2. Disconnecting the jumper and locking to upper position (MR7 as example)

4	Additionally **for MR7**, locate the DC grounding busbar between connectors R- and U and connect the busbar to the frame with an M4 screw (provided in the Accessories bag).

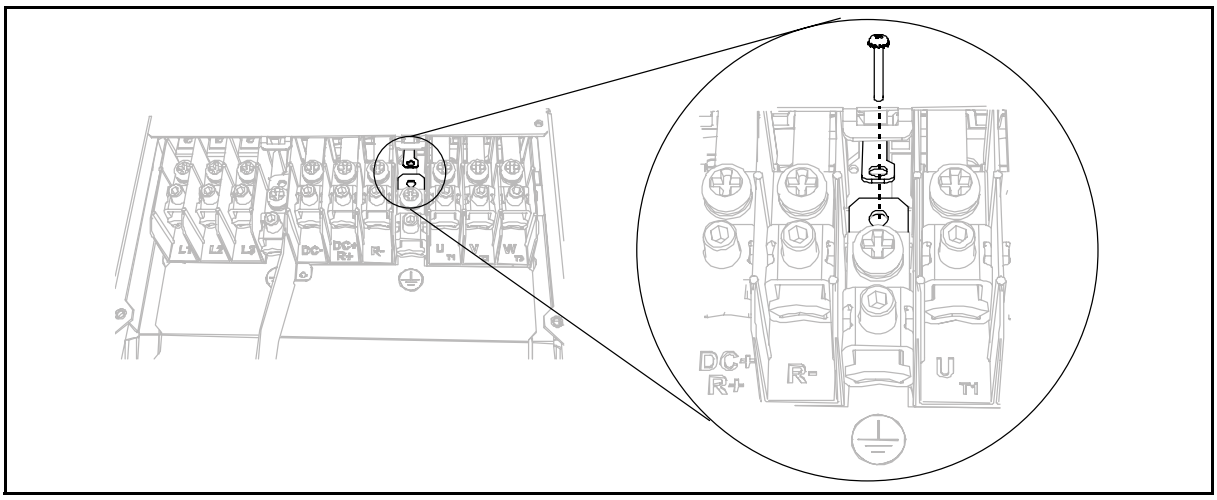

Figure 3. MR7: Connecting the DC grounding busbar to frame

	CAUTION! Before connecting the AC drive to mains make sure that the EMC protection class of the drive has the proper setting on.
	NOTE! After having performed the change write *'EMC level modified'* on the sticker included in the Vacon 100 delivery (see below) and note the date. Unless already done, attach the sticker close to the name plate the AC drive. **Product modified** Date: Date: EMC-level modified C1->T Date: DD.MM.YY

1.5 RUNNING THE MOTOR

MOTOR RUN CHECK LIST

	**Before starting the motor**, check that the motor is **mounted properly** and ensure that the machine connected to the motor allows the motor to be started.
	Set the maximum motor speed (frequency) according to the motor and the machine connected to it.
	**Before reversing the motor** make sure that this can be done safely.
	Make sure that no power correction capacitors are connected to the motor cable.
	Make sure that the motor terminals are not connected to mains potential.

2. RECEIPT OF DELIVERY

Check the correctness of delivery by comparing your order data to the drive information found on the package label. If the delivery does not correspond to your order, contact the supplier immediately. See chapter 2.3.

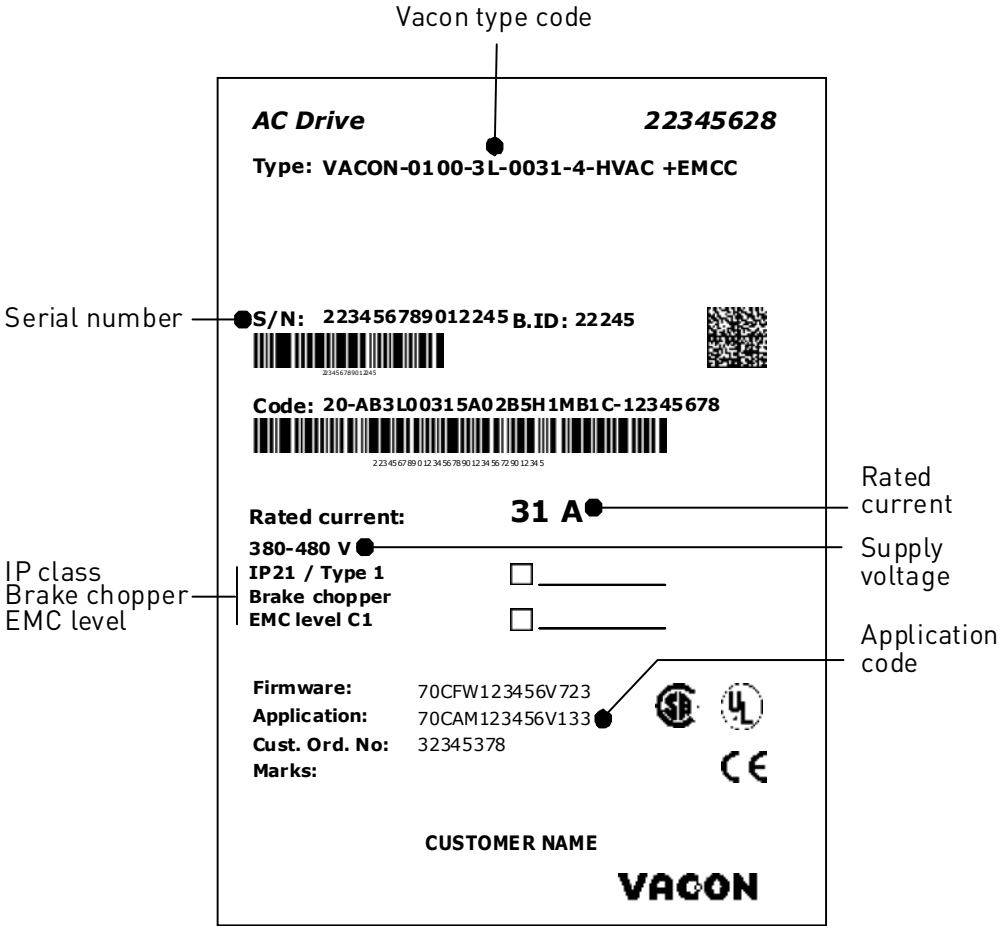

Figure 4. Vacon package label

2.1 'PRODUCT MODIFIED' STICKER

In the small plastic bag included in the delivery you will find a silver *Product modified* sticker. The purpose of the sticker is to notify the service personnel about the modifications made in the AC drive. Attach the sticker on the side of the AC drive to avoid losing it. Should the AC drive be later modified mark the change on the sticker.

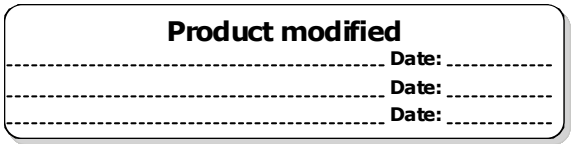

Figure 5. 'Product modified' sticker

2.2 UNPACKING AND LIFTING THE AC DRIVE

The weights of the AC drives vary greatly according to the size. You may need to use a piece of special lifting equipment to move the converter from its package. Note the weights of each individual frame size in Table 2 below.

Frame	Weight [kg]
MR4	6.0
MR5	10.0
MR6	20.0
MR7	37.5

Table 2. Frame weights

If you decide to use a piece of lifting equipment see picture below for recommendations to lift the converter.

2.2.1 LIFTING FRAMES MR4 TO MR7

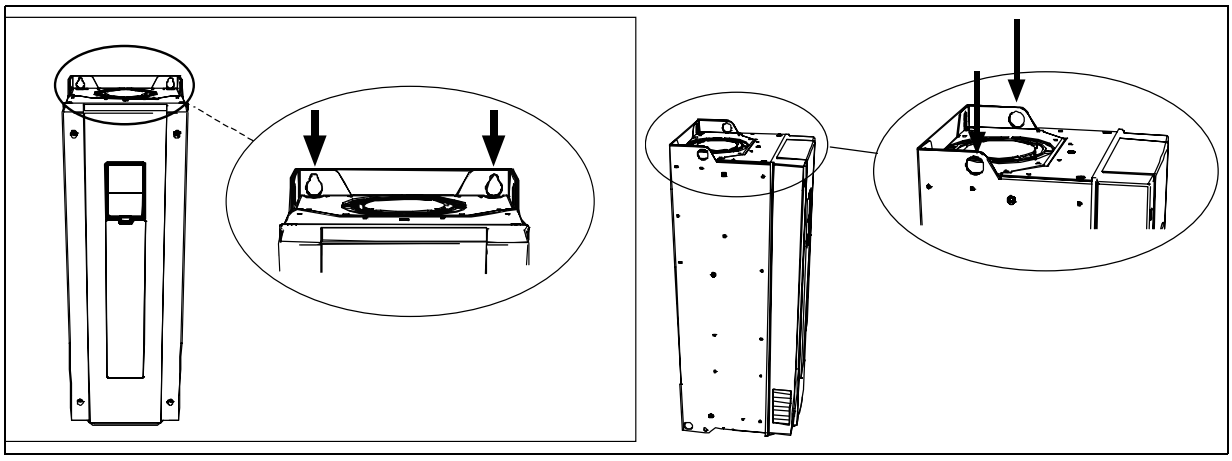

Figure 6. Placing the lifting hooks, MR4-MR6 (left) and MR7 (right)

Vacon 100 AC drives have 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 transport damages are to be found on the product and that the delivery is complete.

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

2.3 TYPE DESIGNATION CODE

Vacon type designation code is formed of a nine-segment code and optional +codes. Each segment of the type designation code uniquely corresponds to the product and options you have ordered. The code is of the following format:

VACON0100-3L-0061-4-HVAC +xxxx +yyyy

VACON

This segment is common for all products.

0100

Product range:

0100 = Vacon 100

3L

Input/Function:

3L = Three-phase input

0061

Drive rating in ampere; e.g. 0061 = 61 A

4

Supply voltage:

2 = 230 V
4 = 380-480 V

HVAC

-IP21/Type 1

-EMC-level C2:

-EN61800-3 (2004), category C2

-HVAC Application software (standard)

-HVAC documentation (standard)

-Graphical display panel

-Three relay outputs

+xxxx +yyyy

Additional codes.

Examples of additional codes:

+IP54

AC drive with IP protection class IP54

+SBF2

Two relays and thermistor input instead of three relays

2.4 ACCESSORIES BAG

After having opened the transport package and lifted the converter out, check immediately that a plastic bag with various accessories was included in the delivery. The bag should contain the following items:

- Rubber grommets (sizes vary according to frame)
- Power cable clamps for EMC grounding
- Screws for fixing the power cable clamps
- Control cable grounding clamps
- EMC-jumper locking clips (not necessarily needed, see chapter 1.4)
- M4 screw for EMC level change in frame MR7
- Additional grounding screw (if necessary, see chapter 1.3)

*

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3. MOUNTING

The AC drive must be mounted in vertical position on the wall or on the back plane of a cubicle. Ensure that the mounting plane is relatively even.

The AC drive shall be fixed with four screws (or bolts, depending on the unit size).

3.1 DIMENSIONS

3.1.1 NORMAL MOUNT, MR4-MR7

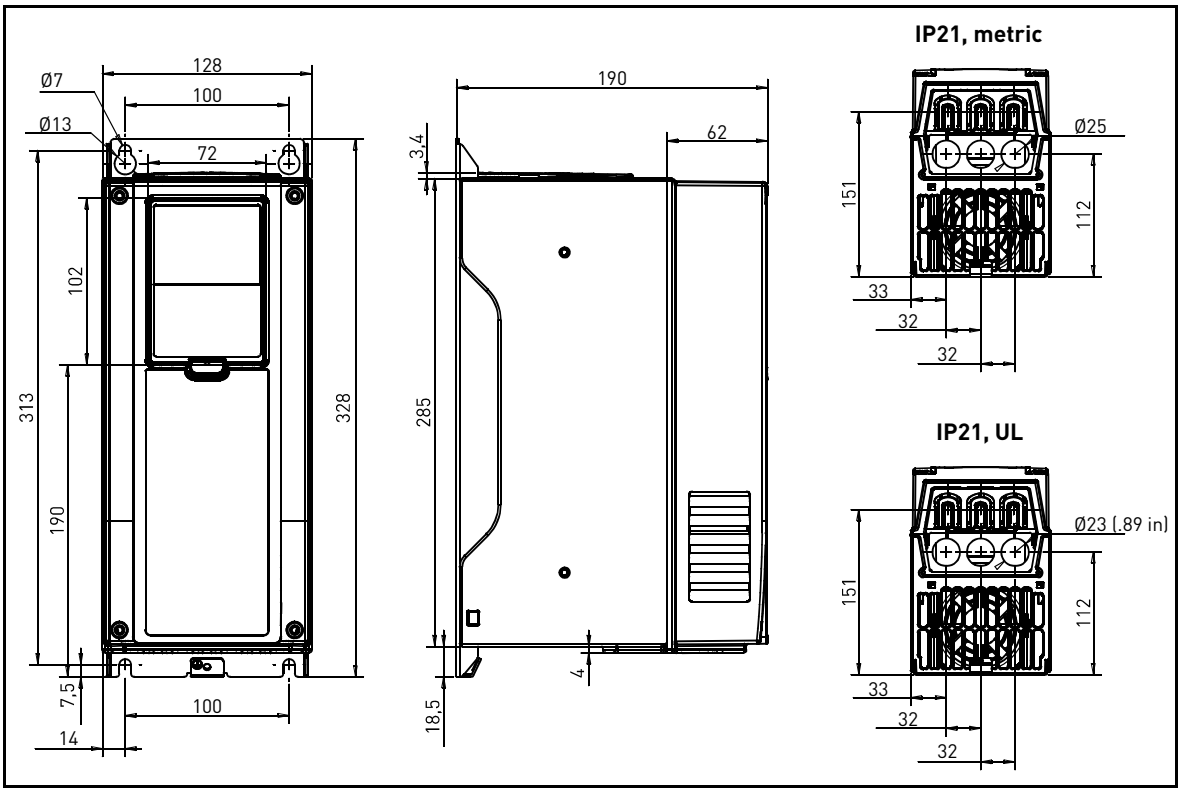

Figure 7. Vacon AC drive dimensions, MR4, normal mount

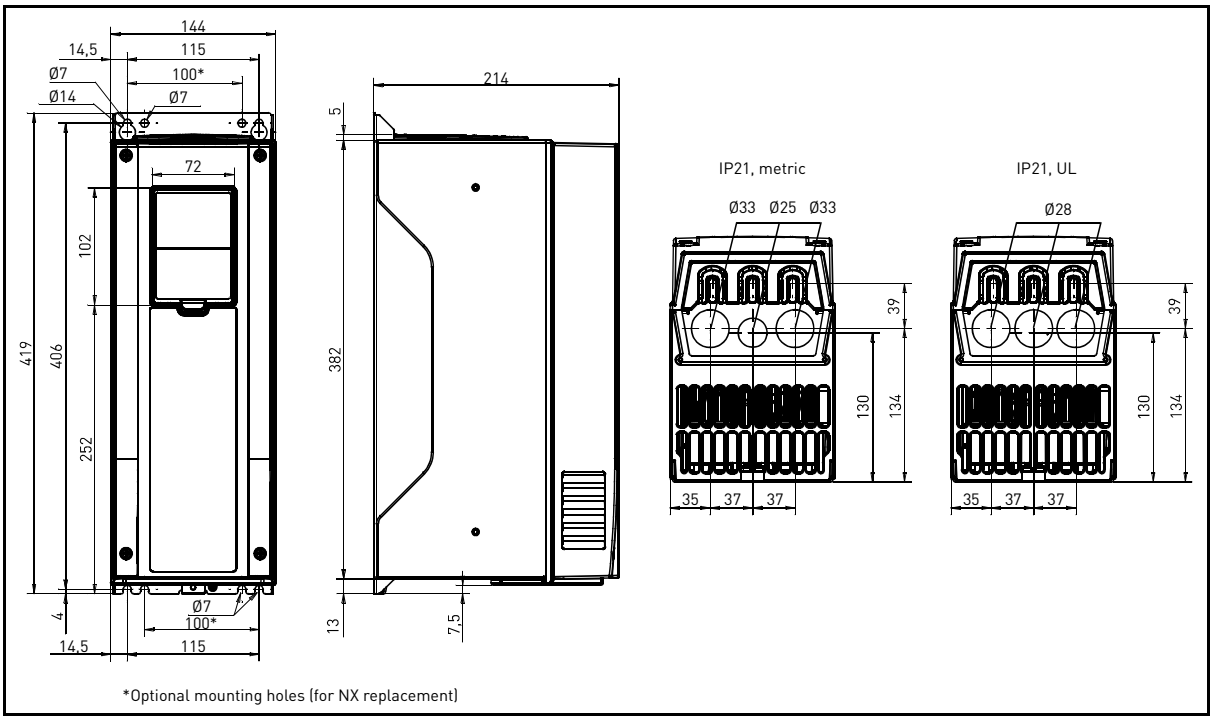

Figure 8. Vacon AC drive dimensions, MR5, normal mount

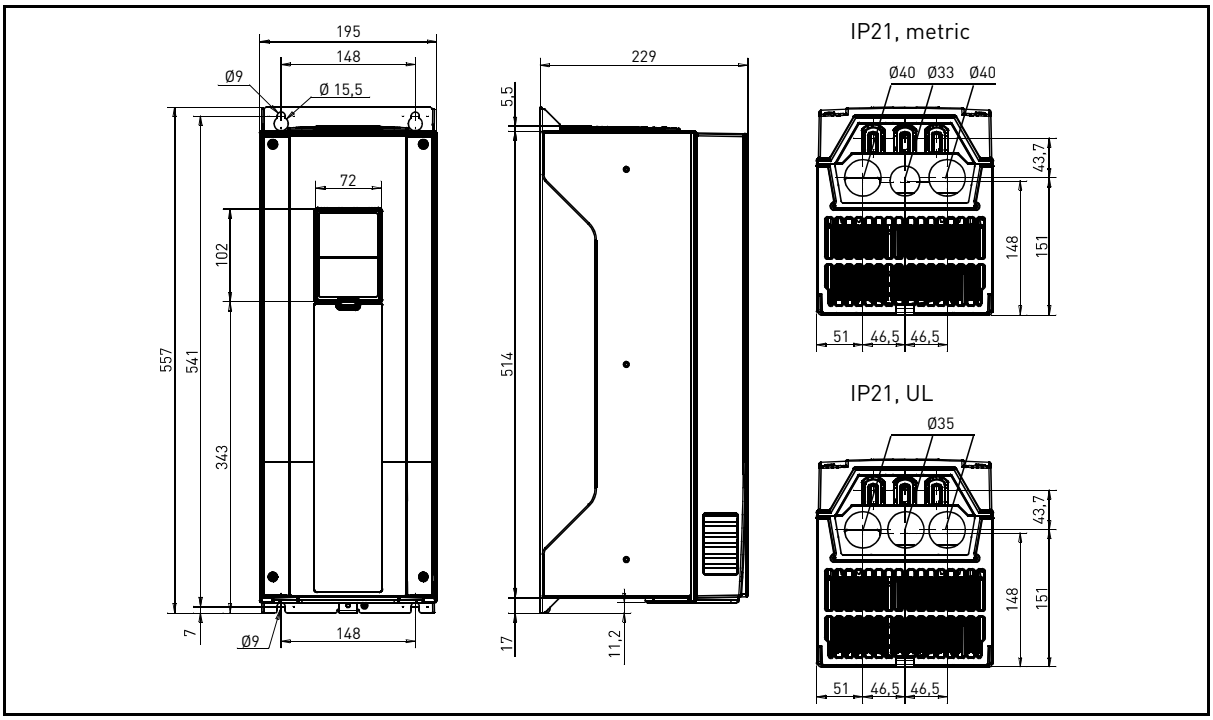

Figure 9. Vacon AC drive dimensions, MR6, normal mount

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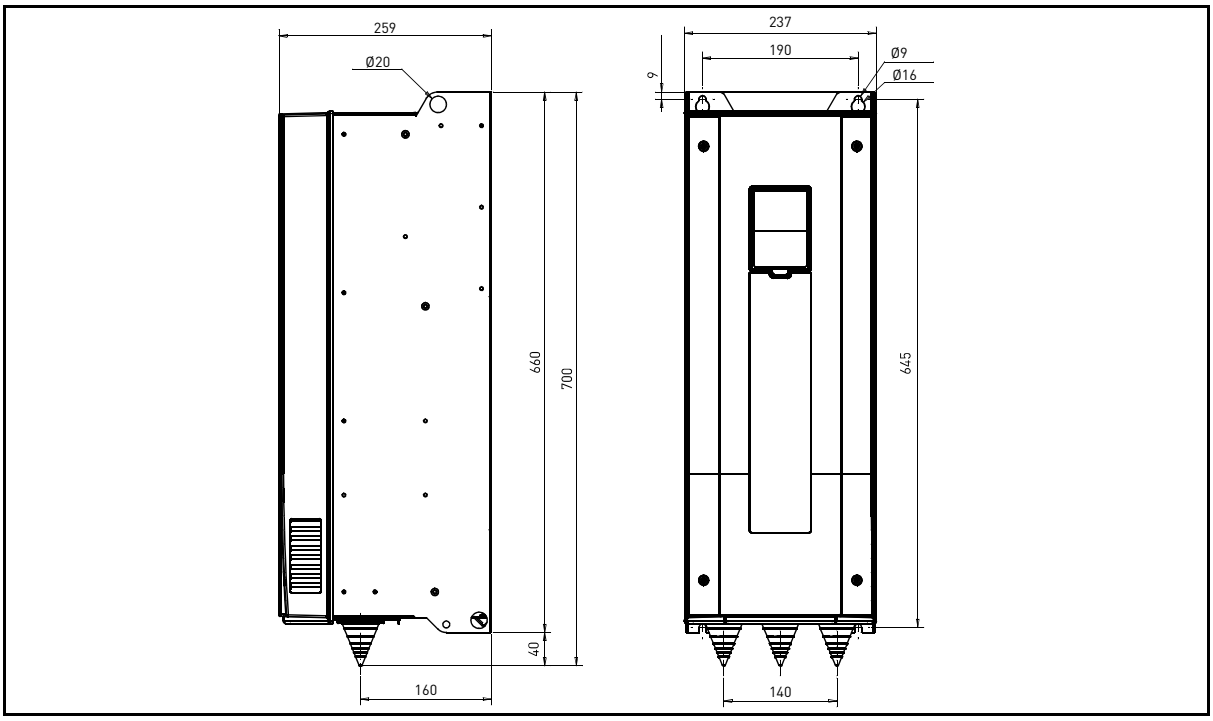

Figure 10. Vacon AC drive dimensions, MR7, normal mount

3.1.2 FLUSH MOUNT, MR4 TO MR7

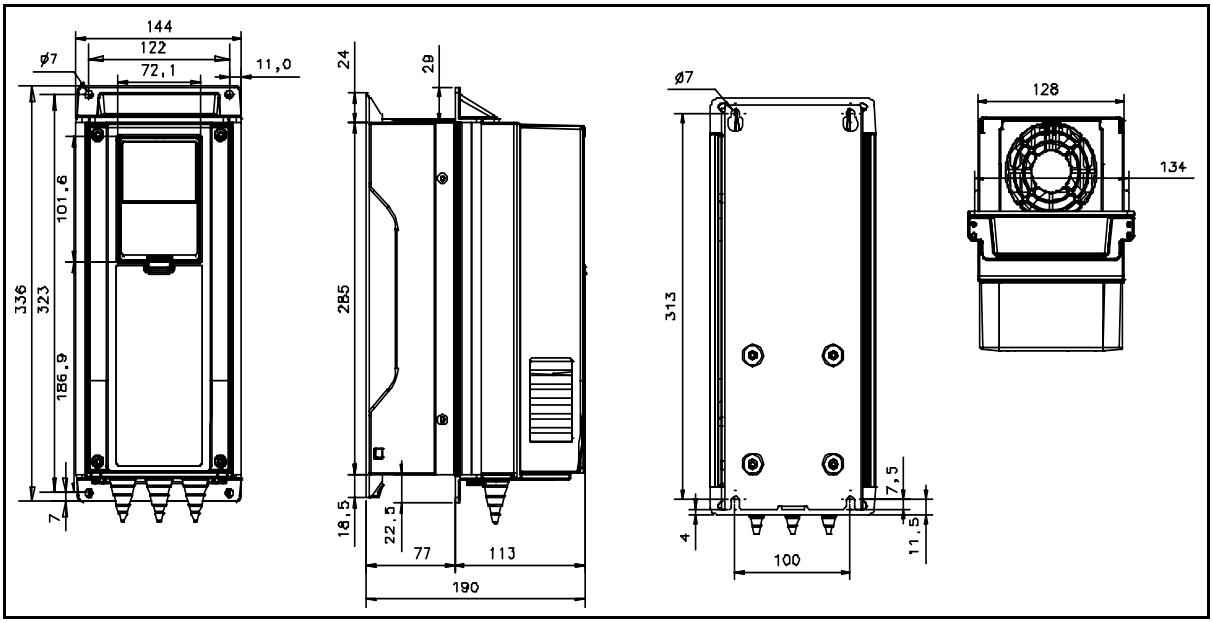

Figure 11. Vacon AC drive dimensions, MR4, flush mount

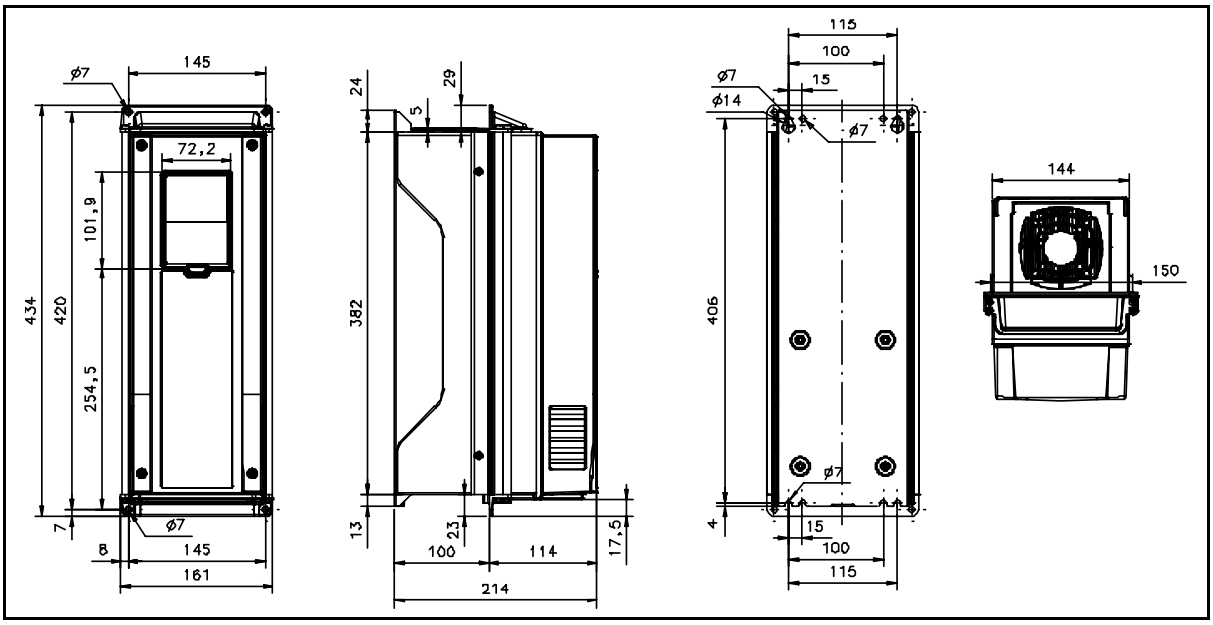

Figure 12. Vacon AC drive dimensions, MR5, flush mount

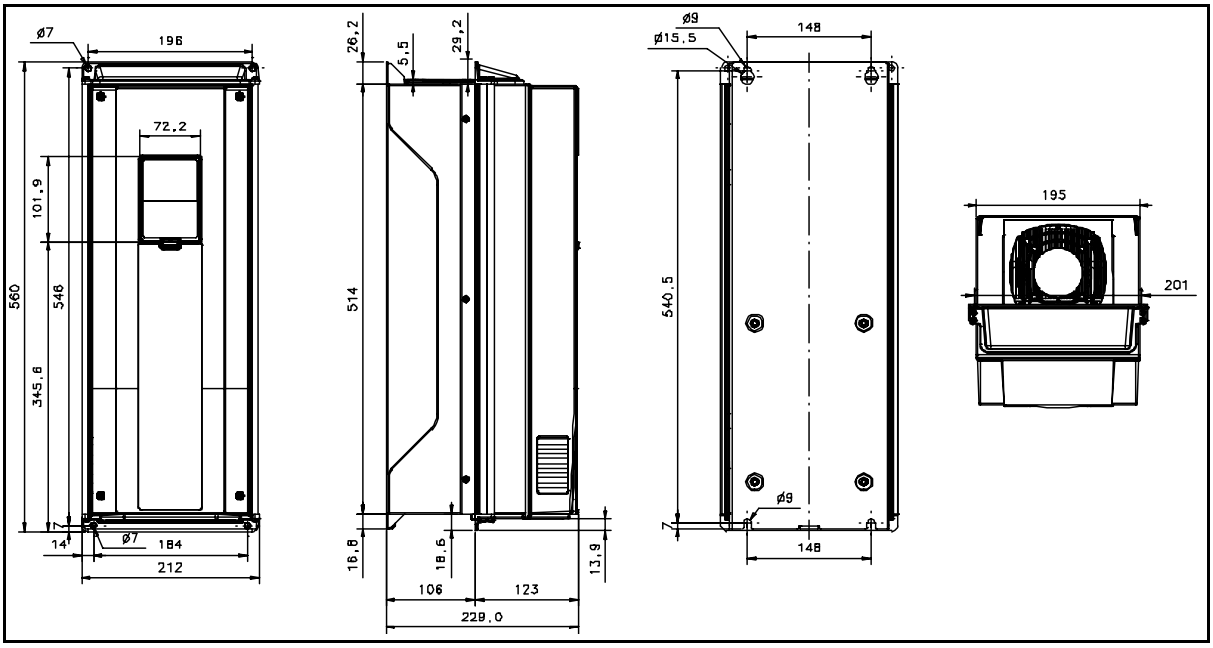

Figure 13.Vacon AC drive dimensions, MR6, flush mount

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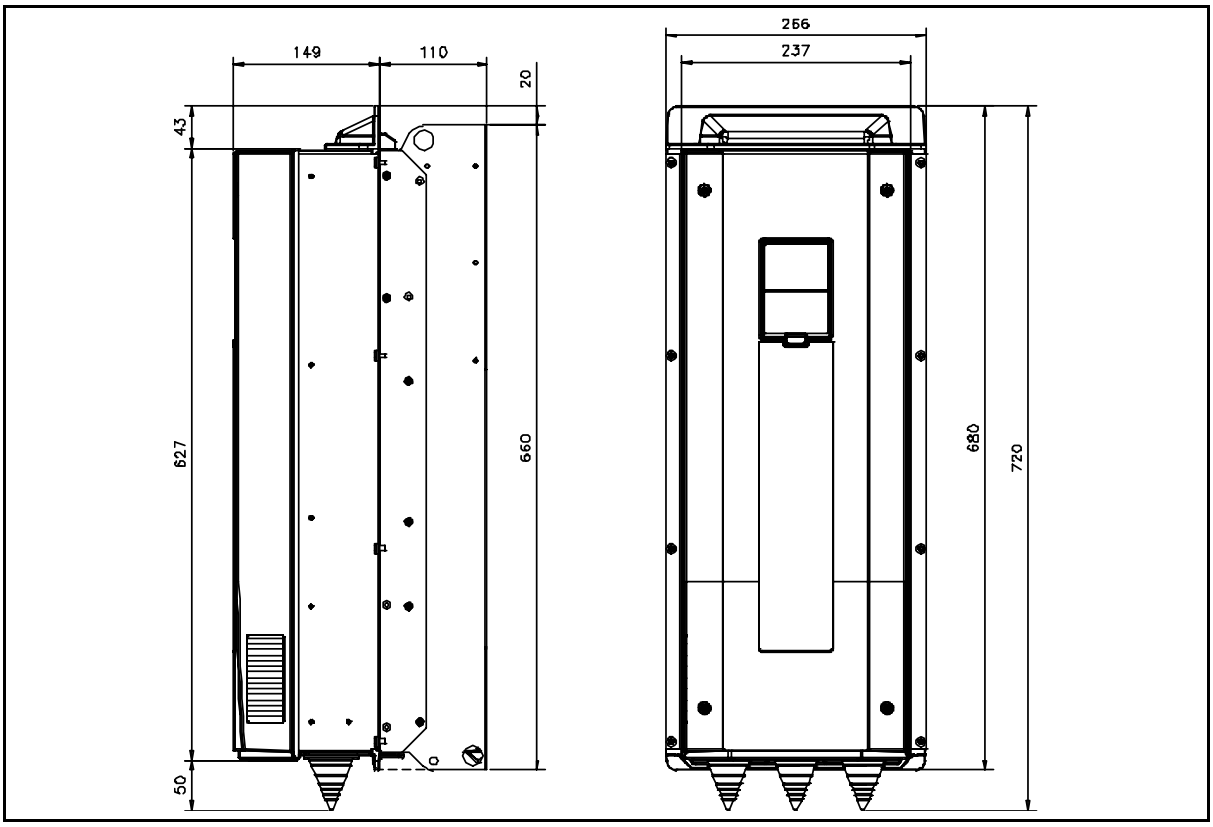
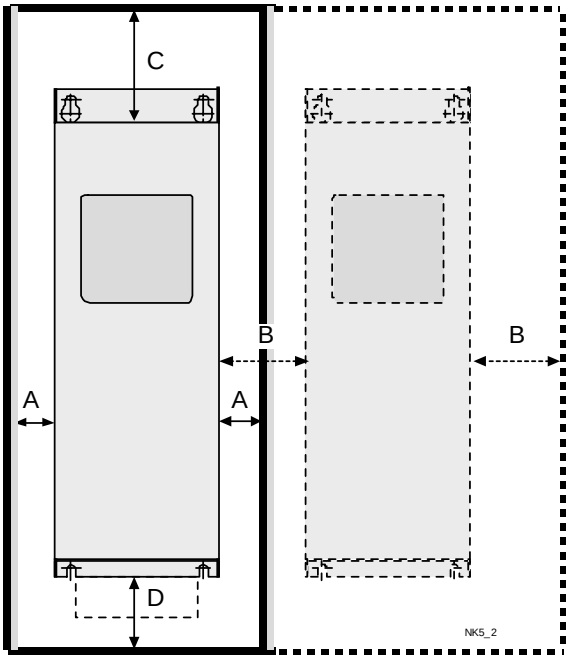


Figure 14. Vacon AC drive dimensions, MR7, flush mount

3.2 COOLING

The AC drives produce heat in operation and are cooled down by air circulated by a fan. Enough free space shall therefore be left around the AC drive to ensure sufficient air circulation and cooling. Different acts of maintenance also require certain amount of free space.

Make sure that the temperature of the cooling air does not exceed the maximum ambient temperature of the converter.



Min clearance [mm], IP21				
Type	A*	B*	C	D
MR4	20	20	100	50
MR5	20	20	120	60
MR6	20	20	160	80
MR7	30	30	250	100

*. Min clearances A and B for drives with IP54 enclosure is **0 mm**.

Table 3. Min. clearances around AC drive

Figure 15. Installation space

A = clearance around the freq. converter (see also B)
B = distance from one AC drive to another or distance to cabinet wall
C = free space above the AC drive
D = free space underneath the AC drive

Note that if several units are mounted **above** each other the required free space equals C + D (see Figure 15.). Moreover, the outlet air used for cooling by the lower unit must be directed away from the air intake of the upper unit.

Type	Cooling air required [m³/h]
MR4	45
MR5	75
MR6	190
MR7	185

Table 4. Required cooling air

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4. POWER CABLING

The mains cables are connected to terminals L1, L2 and L3 and the motor cables to terminals marked with U, V and W. See Table 5 for the cable recommmendations for different EMC levels.

Use cables with heat resistance of at least +70°C. The cables and the fuses must be dimensioned according to the AC drive nominal OUTPUT current which you can find on the rating plate.

Cable type	1st environment 2nd environment EMC levels According to EN61800-3 (2004)		
	Category C2	Category C3	Level T
Mains cable	1	1	1
Motor cable	3*	2	2
Control cable	4	4	4

Table 5. Cable types required to meet standards

1 = Power cable intended for fixed installation and the specific mains voltage. Shielded cable not required. (MCMK or similar recommended).
2 = Symmetrical power cable equipped with concentric protection wire and intended for the specific mains voltage. (MCMK or similar recommended). See Figure 16.
3 = Symmetrical power cable equipped with compact low-impedance shield and intended for the specific mains voltage. [MCCMK, EMCMK or similar recommended; Recommended cable transfer impedance (1Mhz...30MHz) max. 100mohm/m]. See Figure 16.
*360º earthing of the shield with cable glands in **motor end** needed for EMC level C2.
4 = Screened cable equipped with compact low-impedance shield (JAMAK, SAB/ÖZCuY-O or similar).

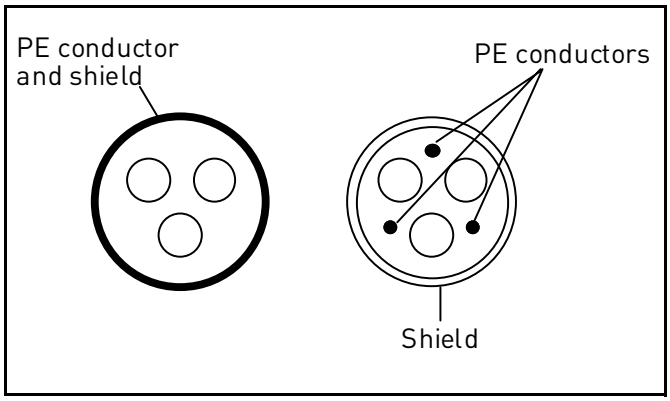

Figure 16.

NOTE: The EMC requirements are fulfilled at factory defaults of switching frequencies (all frames). For the definitions of EMC protection levels, see Vacon Product Book.
NOTE: If safety switch is connected the EMC protection shall be continuous over the whole cable installation.

4.1 UL STANDARDS ON CABLING

To meet the UL (Underwriters Laboratories) regulations, use a UL-approved copper cable with a minimum heat-resistance of +60/75°C. Use Class 1 wire only.

The units are suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes, 600V maximum.

4.1.1 CABLE DIMENSIONING AND SELECTION

Table 6 shows the minimum dimensions of the Cu/Al-cables and the corresponding fuse sizes. Recommended fuse types are gG/gL.

If the motor temperature protection of the drive (see Application Manual) is used as an overload protection, the cable shall be chosen accordingly.

These instructions apply only to cases with one motor and one cable connection from the AC drive to the motor. In any other case, ask the factory for more information.

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4.1.1.1 CABLE AND FUSE SIZES, FRAMES MR4 TO MR6

The recommended fuse types are gG/gL (IEC 60269-1) or class T (UL & CSA). The fuse voltage rating should be selected according to the supply network. The final selection should be made according to local regulations, cable installation conditions and cable specification. Bigger fuses than what is recommended below shall not be used.

Check that the fuse operating time is less than 0.4 seconds. Operating time depends on used fuse type and impedance of the supply circuit. Consult the factory about faster fuses. Vacon offers recommendations also for high speed J (UL & CSA), aR (UL recognized, IEC 60269-4) and gS (IEC 60269-4) fuse ranges.

Frame	Type	I_L [A]	Fuse (gG/gL) [A]	Mains and motor cable Cu [mm^2]	Terminal cable size	
					Main terminal [mm^2]	Earth terminal [mm^2]
MR4	0003 4—0004 4	3.4—4.8	6	3*1.5+1.5	1—6 solid 1—4 stranded	1—6
	0005 4—0008 4	5.6—8.0	10	3*1.5+1.5	1—6 solid 1—4 stranded	1—6
	0009 4—0012 4	9.6—12.0	16	3*2.5+2.5	1—6 solid 1—4 stranded	1—6
MR5	0016 4	16.0	20	3*6+6	1—10 Cu	1—10
	0023 4	23.0	25	3*6+6	1—10 Cu	1—10
	0031 4	31.0	32	3*10+10	1—10 Cu	1—10
MR6	0038 4	38.0	40	3*10+10	2.5—50 Cu/Al	2.5—35
	0046 4	46.0	50	3*16+16 (Cu) 3*25+16 (Al)	2.5—50 Cu/Al	2.5—35
	0061 4	61.0	63	3*25+16 (Cu) 3*35+10 (Al)	2.5—50 Cu/Al	2.5—35

Table 6. Cable and fuse sizes for Vacon 100 (MR4 to MR6)

The cable dimensioning is based on the criteria of the International Standard **IEC60364-5-52**:Cables must be PVC-isolated; Max ambient temperature +30°C, max temperature of cable surface +70°C; Use only cables with concentric copper shield; Max number of parallel cables is 9.
When using cables in parallel, **NOTE HOWEVER** that the requirements of both the cross-sectional area and the max number of cables must be observed.
For important information on the requirements of the earthing conductor, see chapter Earthing and earth fault protection of the standard.

For the correction factors for each temperature, see International Standard **IEC60364-5-52**.

4.1.1.2 CABLE AND FUSE SIZES, FRAME MR7

The recommended fuse types are gG/gL (IEC 60269-1) or class T (UL & CSA). The fuse voltage rating should be selected according to the supply network. The final selection should be made according to local regulations, cable installation conditions and cable specification. Bigger fuses than what is recommended below shall not be used.

Check that the fuse operating time is less than 0.4 seconds. Operating time depends on used fuse type and impedance of the supply circuit. Consult the factory about faster fuses. Vacon offers recommendations also for high speed J (UL & CSA), aR (UL recognized, IEC 60269-4) and gS (IEC 60269-4) fuse ranges.

Frame	Type	I_L [A]	Fuse (gG/gL) [A]	Mains and motor cable Cu [mm²]	Terminal cable size	
					Main terminal [mm²]	Earth terminal [mm²]
MR7	0072 4	72,0	80	3*35+16 (Cu) 3*50+16 (Al)	6-70 Cu/Al	6-70
	0087 4	87,0	100	3*35+16 (Cu) 3*70+21 (Al)	6-70 Cu/Al	6-70
	0105 4	105,0	125	3*50+25 (Cu) 3*70+21 (Al)	6-70 Cu/Al	6-70

Table 7. Cable and fuse sizes for Vacon 100 (MR7)

The cable dimensioning is based on the criteria of the International Standard **IEC60364-5-52**:Cables must be PVC-isolated; Max ambient temperature +30°C, max temperature of cable surface +70°C; Use only cables with concentric copper shield; Max number of parallel cables is 9.
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For important information on the requirements of the earthing conductor, see chapter Earthing and earth fault protection of the standard.

For the correction factors for each temperature, see International Standard **IEC60364-5-52**.

4.1.1.3 CABLE AND FUSE SIZES, FRAMES MR4 TO MR6, NORTH AMERICA

The recommended fuse types are gG/gL (IEC 60269-1) or class T (UL & CSA). The fuse voltage rating should be selected according to the supply network. The final selection should be made according to local regulations, cable installation conditions and cable specification. Bigger fuses than what is recommended below shall not be used.

Check that the fuse operating time is less than 0.4 seconds. Operating time depends on used fuse type and impedance of the supply circuit. Consult the factory about faster fuses. Vacon offers recommendations also for high speed J (UL & CSA), aR (UL recognized, IEC 60269-4) and gS (IEC 60269-4) fuse ranges.

Frame	Type	I_L [A]	Fuse (class T) [A]	Mains, motor and ground cable Cu	Terminal cable size	
					Main terminal	Earth terminal
MR4	0003 4	3.4	6	AWG14	AWG24-AWG10	AWG17-AWG10
	0004 4	4.8	6	AWG14	AWG24-AWG10	AWG17-AWG10
	0005 4	5.6	10	AWG14	AWG24-AWG10	AWG17-AWG10
	0008 4	8.0	10	AWG14	AWG24-AWG10	AWG17-AWG10
	0009 4	9.6	15	AWG14	AWG24-AWG10	AWG17-AWG10
	0012 4	12.0	20	AWG14	AWG24-AWG10	AWG17-AWG10
MR5	0016 4	16.0	25	AWG10	AWG20-AWG5	AWG17-AWG8
	0023 4	23.0	30	AWG10	AWG20-AWG5	AWG17-AWG8
	0031 4	31.0	40	AWG8	AWG20-AWG5	AWG17-AWG8
MR6	0038 4	38.0	50	AWG4	AWG13-AWG0	AWG13-AWG2
	0046 4	46.0	60	AWG4	AWG13-AWG0	AWG13-AWG2
	0061 4*	61.0	80	AWG4	AWG13-AWG0	AWG13-AWG2

*. The 460V models require 90-degree wire to meet UL regulations

Table 8. Cable and fuse sizes for Vacon 100 (MR4 to MR6)

The cable dimensioning is based on the criteria of the Underwriters' Laboratories UL508C:Cables must be PVC-isolated; Max ambient temperature +30°C, max temperature of cable surface +70°C; Use only cables with concentric copper shield; Max number of parallel cables is 9.
When using cables in parallel, **NOTE HOWEVER** that the requirements of both the cross-sectional area and the max number of cables must be observed.
For important information on the requirements of the earthing conductor, see standard Underwriters' Laboratories UL508C.

For the correction factors for each temperature, see the instructions of standard Underwriters' Laboratories UL508C.

4.1.1.4 CABLE AND FUSE SIZES, FRAME MR7, NORTH AMERICA

The recommended fuse types are gG/gL (IEC 60269-1) or class T (UL & CSA). The fuse voltage rating should be selected according to the supply network. The final selection should be made according to local regulations, cable installation conditions and cable specification. Bigger fuses than what is recommended below shall not be used.

Check that the fuse operating time is less than 0.4 seconds. Operating time depends on used fuse type and impedance of the supply circuit. Consult the factory about faster fuses. Vacon offers recommendations also for high speed J (UL & CSA), aR (UL recognized, IEC 60269-4) and gS (IEC 60269-4) fuse ranges.

Frame	Type	I_L [A]	Fuse (class T) [A]	Mains, motor and ground cable Cu	Terminal cable size	
					Main terminal	Earth terminal
MR7	0072 4	72,0	100	AWG2	AWG9-AWG2/0	AWG9-AWG2/0
	0087 4	87,0	110	AWG1	AWG9-AWG2/0	AWG9-AWG2/0
	0105 4	105,0	150	AWG1/0	AWG9-AWG2/0	AWG9-AWG2/0

Table 9. Cable and fuse sizes for Vacon 100 (MR7 to MR9)

The cable dimensioning is based on the criteria of the Underwriters' Laboratories UL508C:Cables must be PVC-isolated; Max ambient temperature +30°C, max temperature of cable surface +70°C; Use only cables with concentric copper shield; Max number of parallel cables is 9.
When using cables in parallel, **NOTE HOWEVER** that the requirements of both the cross-sectional area and the max number of cables must be observed.
For important information on the requirements of the earthing conductor, see standard Underwriters' Laboratories UL508C.

For the correction factors for each temperature, see the instructions of standard Underwriters' Laboratories UL508C.

4.2 BRAKE RESISTOR CABLES

Vacon AC drives are equipped with terminals for an optional external brake resistor. These terminals are marked with **R+** and **R-** (MR4-MR6) or **DC+/R+** and **R-** (MR7 and bigger).

4.3 CONTROL CABLES

For information on control cables see chapter Control unit cabling.

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4.4 CABLE INSTALLATION

- Before starting, check that none of the components of the AC drive is live. Read carefully the warnings in chapter 1.
- Place the motor cables sufficiently far from other cables
- Avoid placing the motor cables in long parallel lines with other cables.
- If the motor cables run in parallel with other cables note the minimum distances between the motor cables and other cables given in table below.

Distance between cables, [m]	Shielded cable, [m]
0.3	≤ 50
1.0	≤ 200

- The given distances also apply between the motor cables and signal cables of other systems.
- The **maximum lengths of motor cables** are **100 m** (MR4), **150 m** (MR5 and MR6) and **200 m** (MR7).
- The motor cables should cross other cables at an angle of 90 degrees.
- If cable insulation checks are needed, see chapter Cable and motor insulation checks.

Start the cable installation according to the instructions below:

4.4.1 FRAMES MR4 TO MR7

1	Strip the motor and mains cables as advised below.

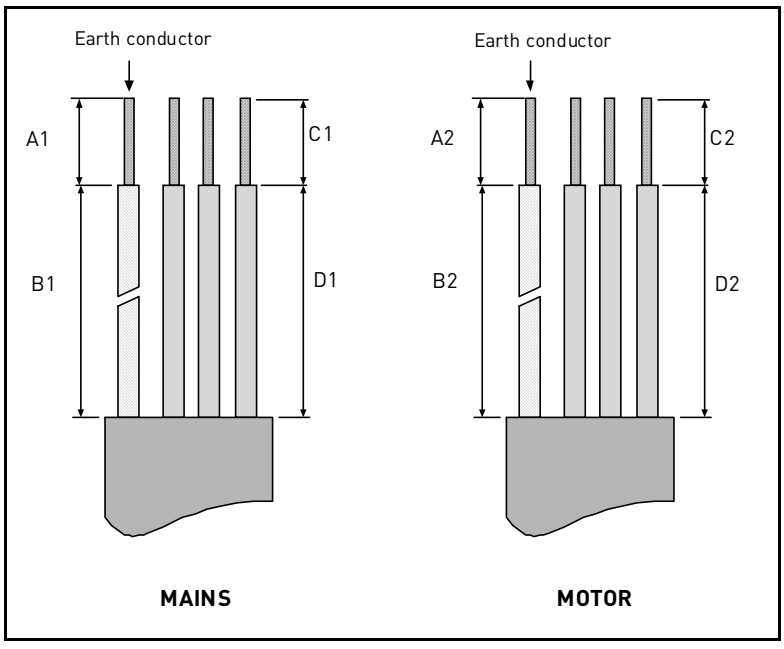

Figure 17. Stripping of cables

Frame	A1	B1	C1	D1	A2	B2	C2	D2
MR4	15	35	10	20	7	50	7	35
MR5	20	40	10	30	20	60	10	40
MR6	20	90	15	60	20	90	15	60
MR7	20	80	20	80	20	80	20	80

Table 10. Cables stripping lengths [mm]

2	Open the cover of the AC drive.

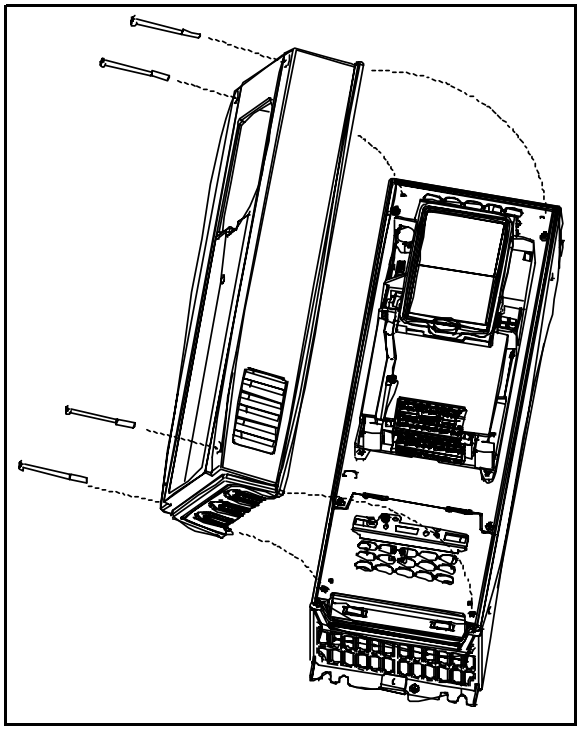

Figure 18.

3	**Remove the screws** of the cable protection plate. Do not open the cover of the power unit!

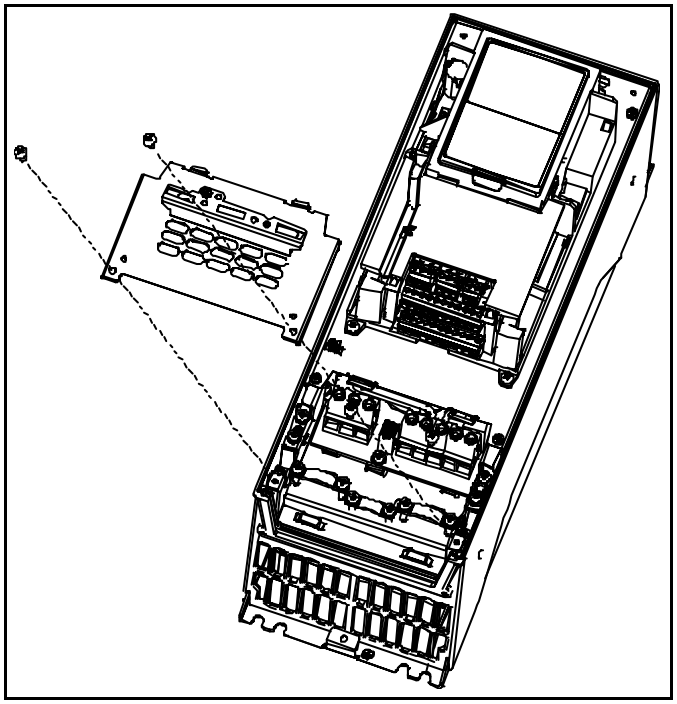

Figure 19.

4	Insert the cable grommets (included in the delivery) in the openings of the cable entry plate (included) as shown in the picture (upper pictures EU version, lower pictures US version).

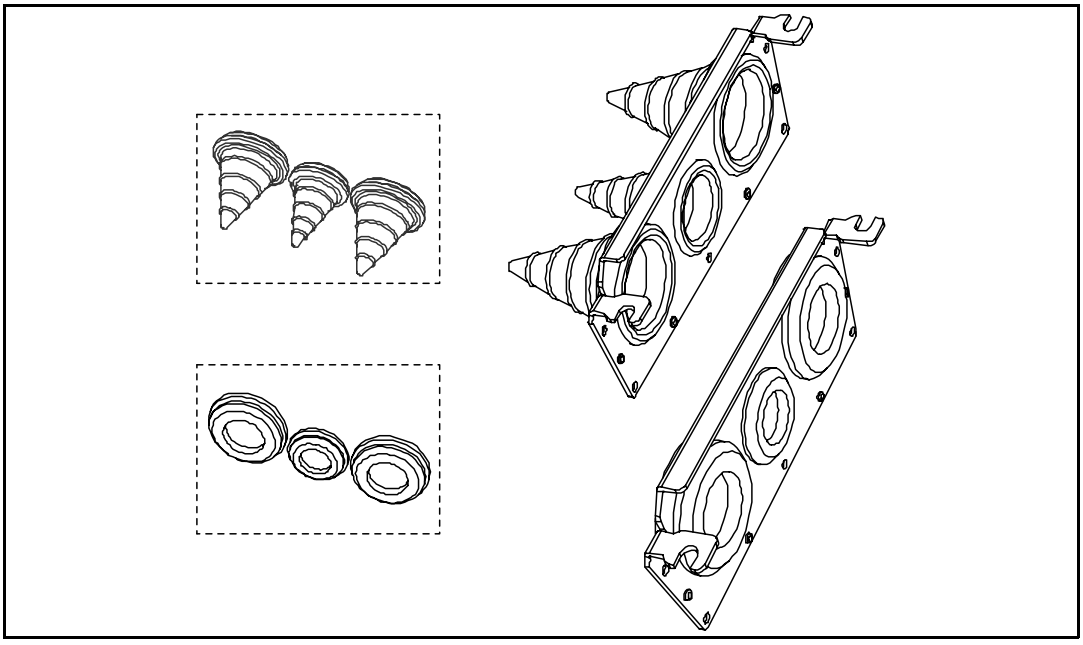

Figure 20.

5	Insert the cables - supply cable, motor cable and optional brake cable - in the openings of the cable entry plate. Then cut the rubber grommets open to slide the cables through. Should the grommets fold in while inserting the cable, just draw the cable back a bit to straighten the grommets up. Do not cut the grommet openings wider than what is necessary for the cables you are using. **IMPORTANT NOTE FOR IP54 INSTALLATION:** To meet the requirements of the enclosure class IP54, the connection between the grommet and the cable must be tight. Therefore, lead the first bit of the cable out of the grommet **straight** before letting it bend. If this is not possible, the tightness of the connection must be ensured with insulation tape or a cable tie.

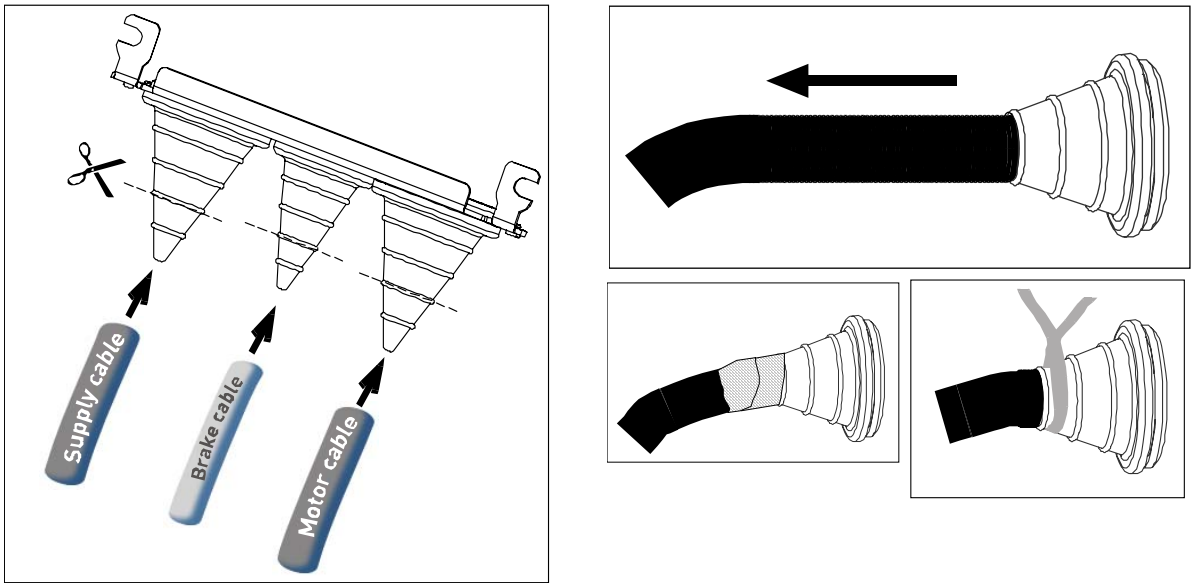

Figure 21.

6	Detach the cable clamps and the grounding clamps (Figure 22) and place the cable entry plate with the cables in the groove on the AC drive frame (Figure 23).

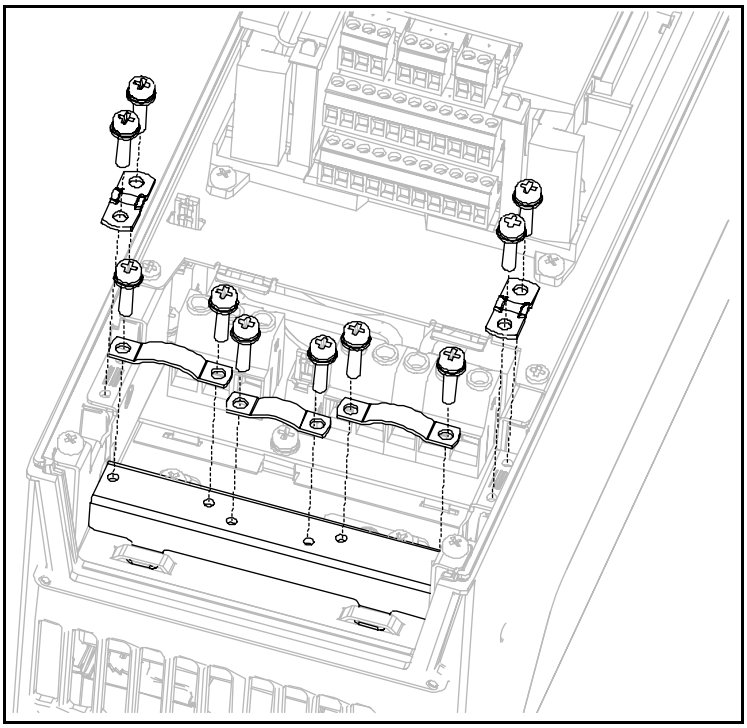

Figure 22.

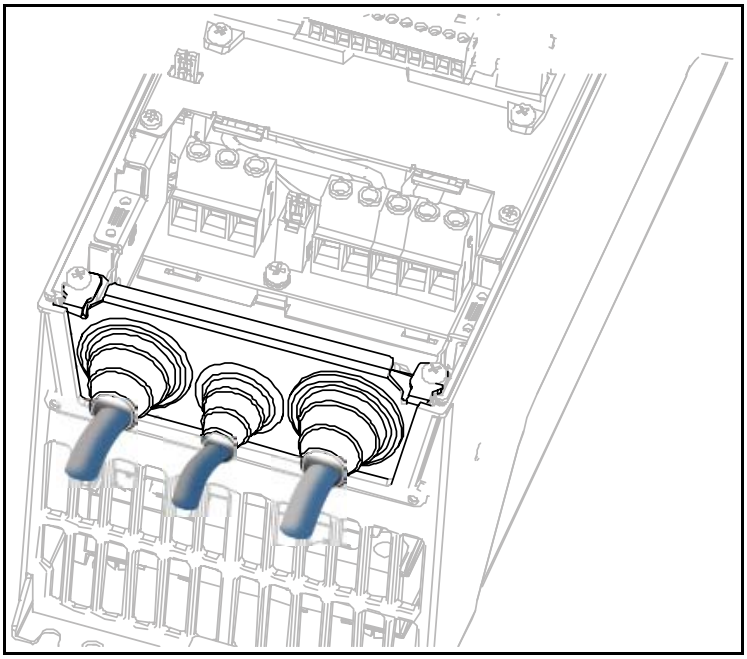

Figure 23.

7	Connect the stripped cables as shown in Figure 24. • Expose the shield of all three cables in order to make a 360-degree connection with the cable clamp (1). • Connect the (phase) conductors of the supply, brake and motor cables into their respective terminals (2). • Form the rest of the cable shield of all three cables into "pigtails" and make a grounding connection with a clamp as shown in Figure 24 (3).

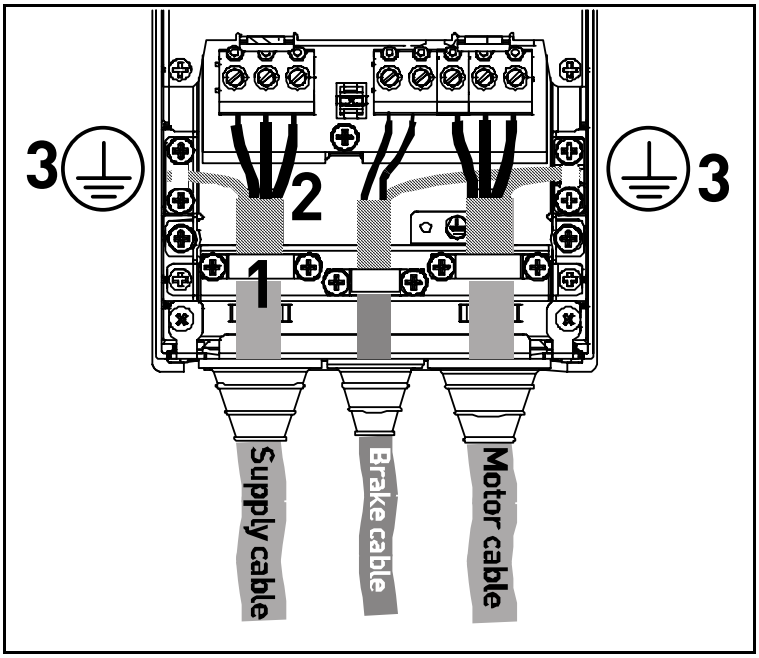

Figure 24.

Tightening torques of cable terminals:

Frame	Type	Tightening torque [Nm]/[lb-in.] Power and motor terminals		Tightening torque [Nm]/[lb-in.] EMC grounding clamps		Tightening torque, [Nm]/[lb-in.] Grounding terminals	
		[Nm]	lb-in.	[Nm]	lb-in.	[Nm]	lb-in.
MR4	0003 4—0012 4	0.5—0.6	4.5—5.3	1.5	13.3	2.0	17.7
MR5	0016 4—0031 4	1.2—1.5	10.6—13.3	1.5	13.3	2.0	17.7
MR6	0038 4—0061 4	10	88.5	1.5	13.3	2.0	17.7
MR7	0072 4—0105 4	8/15*	70.8/132.8*	1.5	13.3	8/15*	70.8/132.8*

*. Cable clamping (Ouneva Pressure Terminal Connector)

Table 11. Tightening torques of terminals

8	Check the connection of the earth cable to the motor and the AC drive terminals marked with ⏚. **NOTE**: Two protective conductors are required according to standard EN61800-5-1. See Figure 25 and chapter Earthing and earth fault protection. Use an M5 size screw and tighten it to 2.0 Nm (17.7 lb-in.).

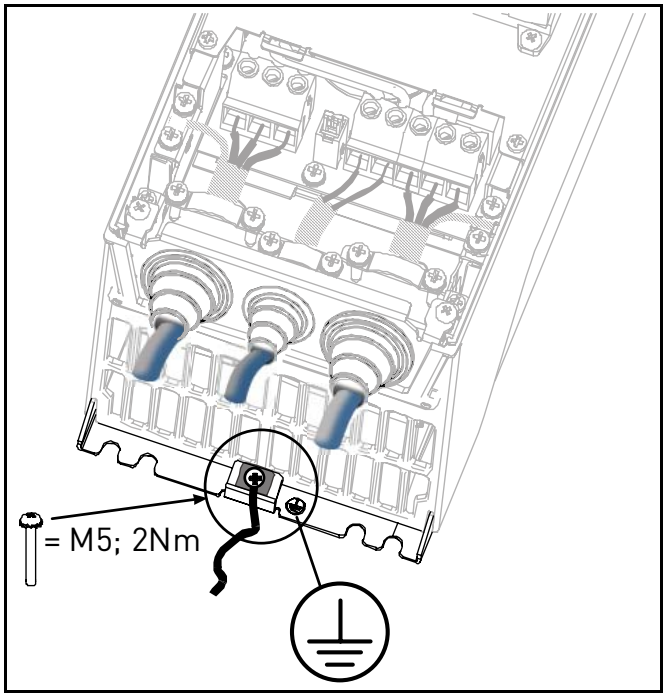

Figure 25. Additional protective earthing connector

9	Re-mount the cable protection plate (Figure 26) and the cover of the AC drive.

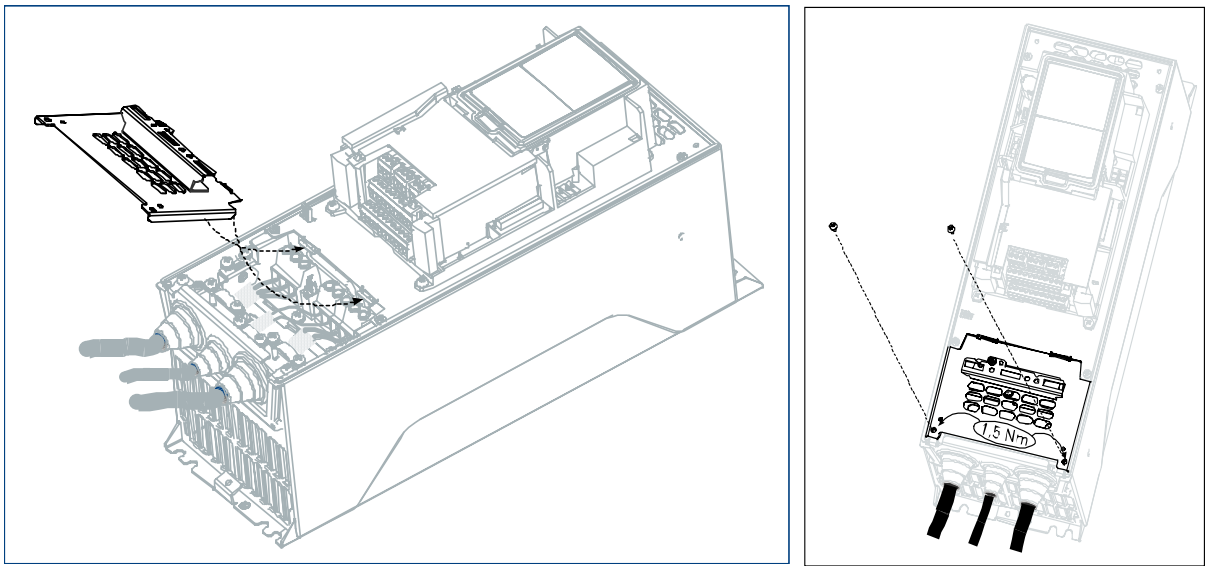

Figure 26. Re-mounting of cover components

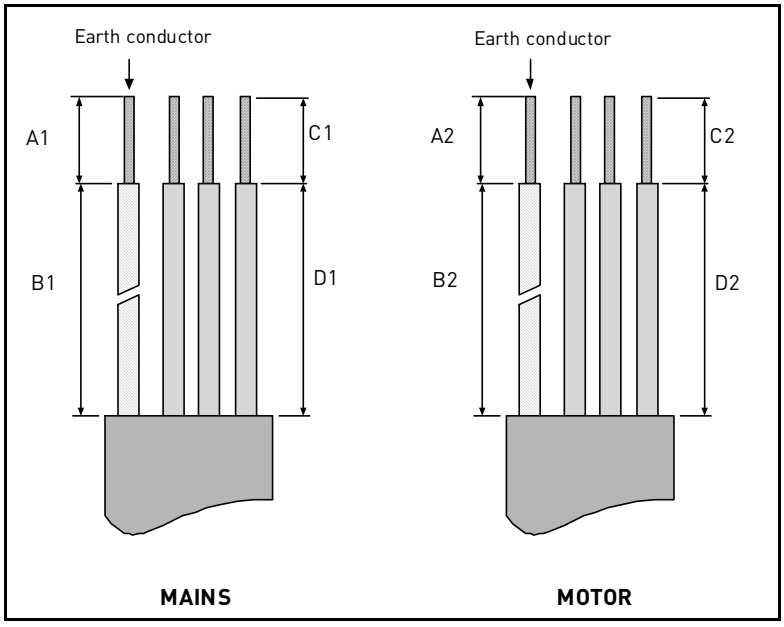

Figure 27. Stripping of cables

4.4.2 CABLE AND MOTOR INSULATION CHECKS

1. Motor cable insulation checks
   Disconnect the motor cable from terminals U, V and W of the AC drive and from the motor. Measure the insulation resistance of the motor cable between each phase conductor as well as between each phase conductor and the protective ground conductor. The insulation resistance must be >1MΩ at ambient temperature of 20°C.
2. Mains cable insulation checks
   Disconnect the mains cable from terminals L1, L2 and L3 of the AC drive and from the mains. Measure the insulation resistance of the mains cable between each phase conductor as well as between each phase conductor and the protective ground conductor. The insulation resistance must be >1MΩ at ambient temperature of 20°C.
3. Motor insulation checks
   Disconnect the motor cable from the motor and open the bridging connections in the motor connection box. Measure the insulation resistance of each motor winding. The measurement voltage must equal at least the motor nominal voltage but not exceed 1000 V. The insulation resistance must be >1MΩ at ambient temperature of 20°C.

5. COMMISSIONING

Before commissioning, note the following directions and warnings:

⚠	Internal components and circuit boards of Vacon 100 (except for the galvanically isolated I/O terminals) are live when it is connected to mains potential. **Coming into contact with this voltage is extremely dangerous and may cause death or severe injury.**
⚠	The motor terminals **U**, **V**, **W** and the brake resistor terminals **B-/B+ are live** when Vacon 100 is connected to mains, **even if the motor is not running**.
⚠	The control I/O-terminals are isolated from the mains potential. However, the **relay outputs and other I/O-terminals may have a dangerous control voltage** present even when Vacon 100 is disconnected from mains.
⚠	Do not make any connections to or from the frequency converter when it is connected to the mains.
⚠	**After disconnecting** the frequency converter from the mains, **wait** until the fan stops and the indicators on the keypad go out (if no keypad is attached see the indicators on the cover). Wait 5 more minutes before doing any work on the connections of Vacon100. Do not open the cover before this time has expired. After expiration of this time, use a measuring equipment to absolutely ensure that no voltage is present. **Always ensure abscence of voltage before electrical work!**
⚠	**Before connecting** the frequency converter to mains make sure that the front and cable covers of Vacon 100 are closed.

5.1 COMMISSIONING OF THE FREQUENCY CONVERTER

1	Read carefully the safety instructions in Chapter 1 and above and follow them.
2	After the installation, pay attention to: • that both the frequency converter and the motor are grounded. • that the mains and motor cables comply with the requirements given in chapter 4.1.1. • that the control cables are located as far as possible from the power cables, see chapter 4.4. • that the shields of the shielded cables are connected to protective earth marked with ⏚. • that the wires do not touch the electrical components of the frequency converter. • that the common inputs of digital input groups are connected to +24V or ground of the I/O terminal or the external supply.
3	Check the quality and quantity of cooling air (chapter 3.2 and Table 4).
4	Check the inside of the frequency converter for condensation.
5	**Check that all Start/Stop switches connected to the I/O terminals are in Stop-position.**
6	Connect the frequency converter to mains.
7	Run the Startup Wizard (see the Application Manual).

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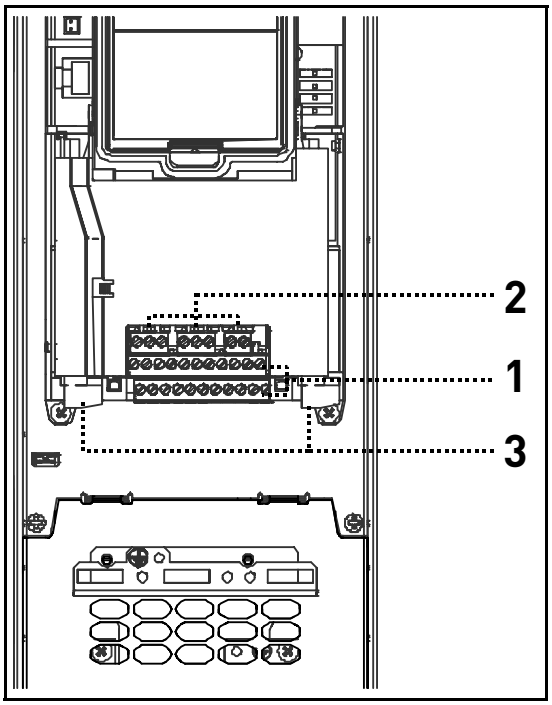
6. CONTROL UNIT

The control unit of the AC drive consists of the control board and additional boards (option boards) connected to the slot connectors of the control board.



Locations of essential control unit components:

1 = Control terminals of the control board

2 = Terminals of relay board; **NOTE:** There are two different compilations of relay boards available. See section 6.1.

3 = Optional boards

Figure 28. Location of control unit components

When delivered from the factory, the control unit of the AC drive contains the standard controlling interface - the control terminals of the control board and the relay board - unless otherwise specifically ordered. On the next pages you will find the arrangement of the control I/O and the relay terminals, the general wiring diagram and the control signal descriptions.

The control board can be powered externally (+24V, ±10%) by connecting the external power source to terminal #30, see page 38. This voltage is sufficient for parameter setting and for keeping the control unit active. Note however that the measurements of the main circuit (e.g. DC-link voltage, unit temperature) are not available when the mains is not connected.

6.1 CONTROL UNIT CABLING

The basic control unit connections are presented in Figure 29 below. The control board is equipped with 22 fixed control I/O terminals and the relay board with 8 or 9. The relay board is available in two different configurations (see Table 14 and 15). All signal descriptions are given in Tables 13 to 15.

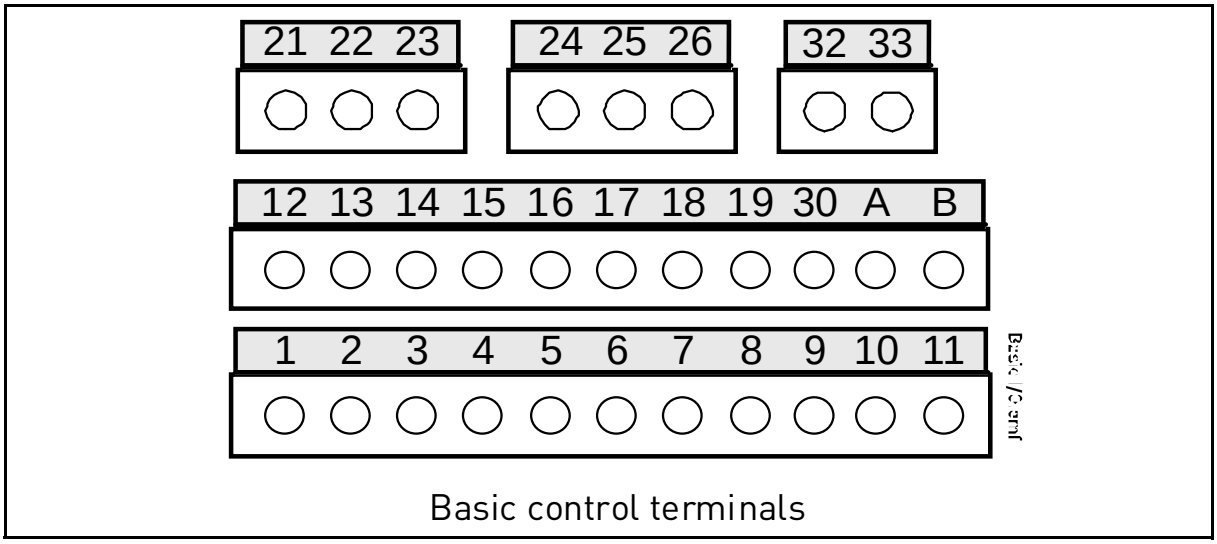


Figure 29.

6.1.1 CONTROL CABLE SIZING

The control cables shall be at least 0.5 mm² screened multicore cables, see Table 5. The maximum terminal wire size is 2.5 mm² for the relay and other terminals.

Find the tightening torques of the control and relay board terminals in Table 12 below.

Terminal screw	Tightening torque	
	Nm	lb-in.
All I/O and relay terminals (screw M3)	0.5	4.5

Table 12. Control cable tightening torques

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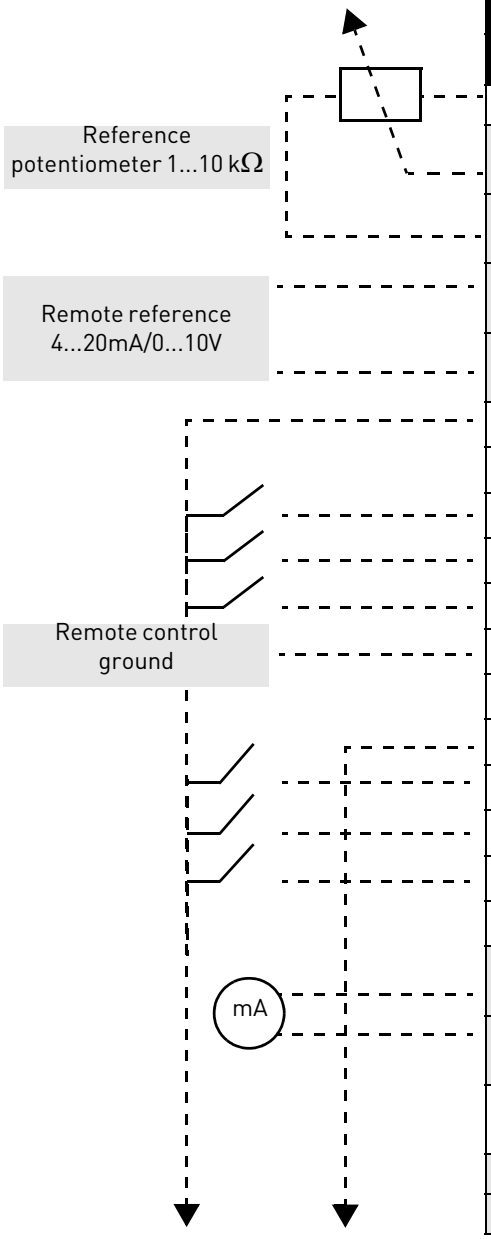
6.1.2 CONTROL TERMINALS AND DIP SWITCHES

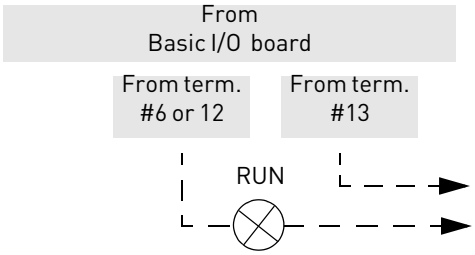
The terminals of the *Basic I/O board* and the *Relay boards* are described below. For more information on the connections, see chapter 7.2.1.

The terminals shown on shadowed background are assigned for signals with optional functions selectable with DIP switches. See more information in chapter 6.1.2.1 on page 38.



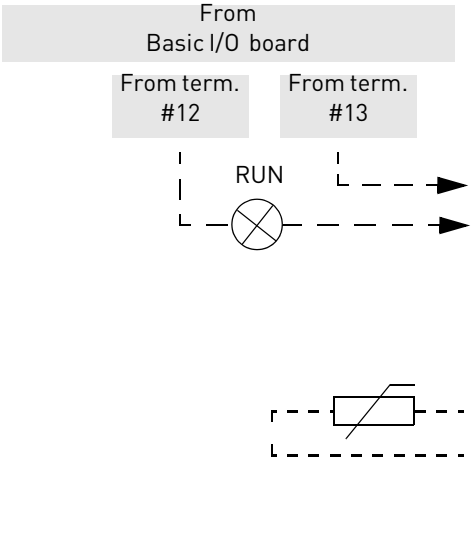
Basic I/O board		
Terminal		Signal
1	+10 Vref	Reference output
2	AI1+	Analogue input, voltage or current
3	AI1-	Analogue input common (current)
4	AI2+	Analogue input, voltage or current
5	AI2-	Analogue input common (current)
6	24Vout	24V aux. voltage
7	GND	I/O ground
8	DI1	Digital input 1
9	DI2	Digital input 2
10	DI3	Digital input 3
11	CM	Common for DI1-DI3.
12	24Vout	24V aux. voltage
13	GND	I/O ground
14	DI4	Digital input 4
15	DI5	Digital input 5
16	DI6	Digital input 6
17	CM	Common for DI4-DI6.
18	AO1+	Analogue signal (+output)
19	AO-/GND	Analogue output common
30	+24 Vin	24V auxiliary input voltage
A	RS485	Negative
B	RS485	Positive

Table 13. Control I/O terminal signals on basic I/O board and connection example



Relay board 1		
Terminal		Signal
21	RO1/1 NC	Relay output 1
22	RO1/2 CM	
23	RO1/3 NO	
24	RO2/1 NC	Relay output 2
25	RO2/2 CM	
26	RO2/3 NO	
32	RO3/1 CM	Relay output 3
33	RO3/2 NO	

Table 14. Control I/O terminal signals on relay board 1 and connection example



Relay board 2		
Terminal		Signal
21	RO1/1	Relay output 1
22	RO1/2	
23	RO1/3	
24	RO2/1	Relay output 2
25	RO2/2	
26	RO2/3	
28	TI1+	Thermistor input
29	TI1-	

Table 15. Control I/O terminal signals on relay board 2 and connection example

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6.1.2.1 SELECTION OF TERMINAL FUNCTIONS WITH DIP SWITCHES

The shadowed terminals in Table 13 allow for two functional selections each with the so-called *dip switches*. The switches have two positions, left and right. See figure to locate the switches and make appropriate selections for your requirements.

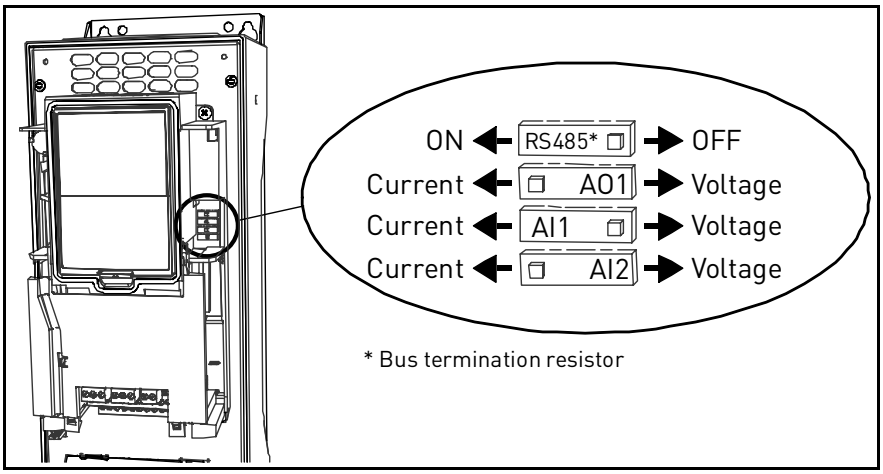


Figure 30. Dip switches

6.2 FIELDBUS CONNECTION

The AC drive can be connected to fieldbus either through RS485 or Ethernet. The connection for RS485 is on the basic I/O board (terminals A and B) and the connection for Ethernet is under the drive cover, left to the control keypad. See Figure 31.

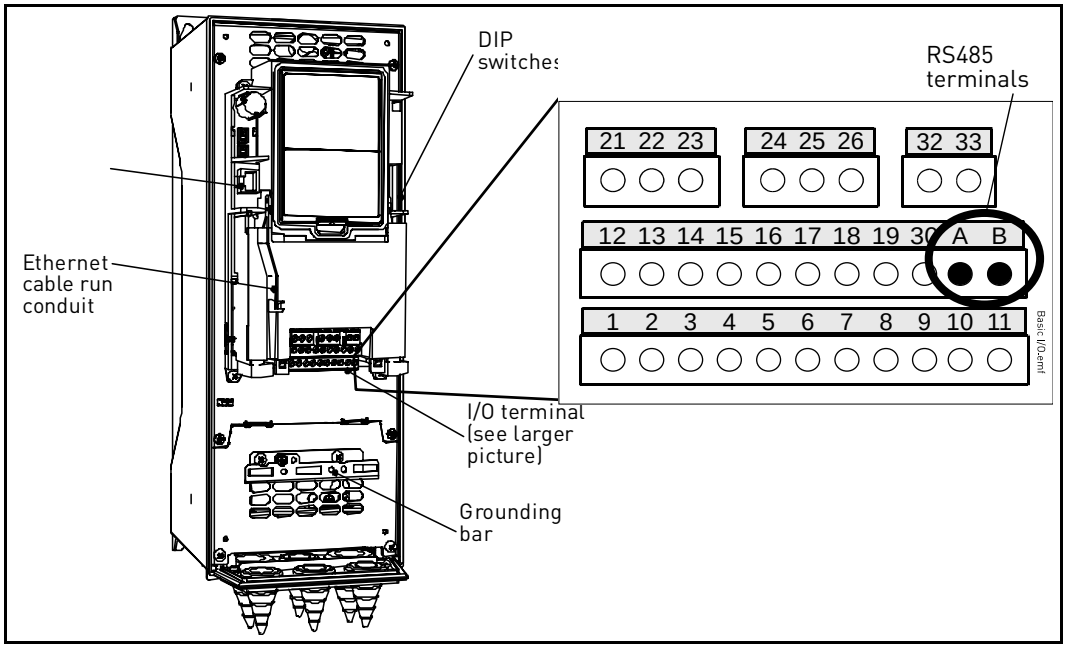


Figure 31.

6.2.1 PREPARE FOR USE THROUGH ETHERNET

1	Connect the Ethernet cable (see specification on page 41) to its terminal and run the cable through the conduit as shown in Figure 32.

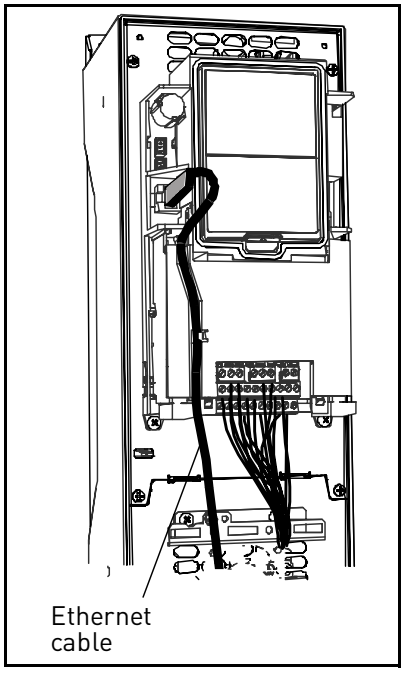


Figure 32.

2	Cut free the opening on the AC drive cover for the Ethernet cable (protection class IP21).

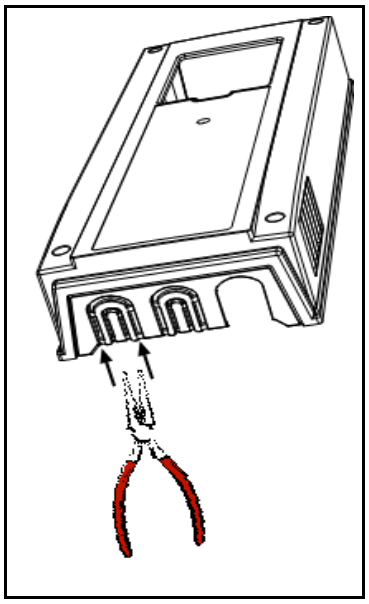


Figure 33.

3	Remount the AC drive cover. **NOTE:** When planning the cable runs, remember to keep the distance between the Ethernet cable and the motor cable at a **minimum of 30 cm**.

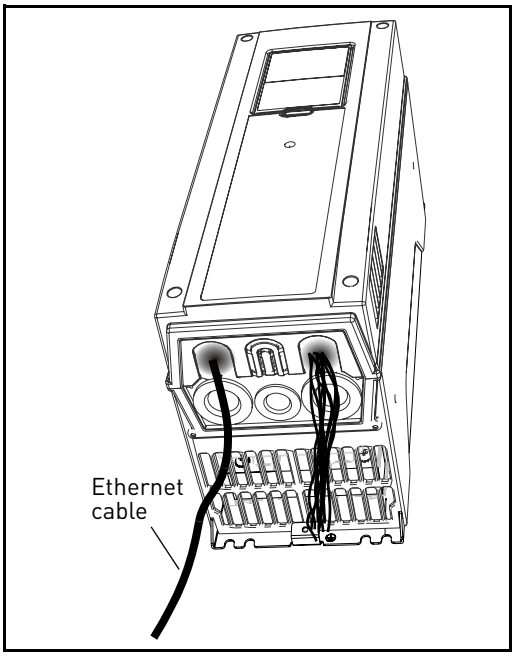


Figure 34.

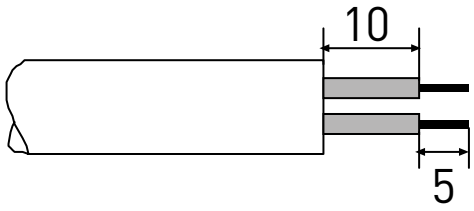
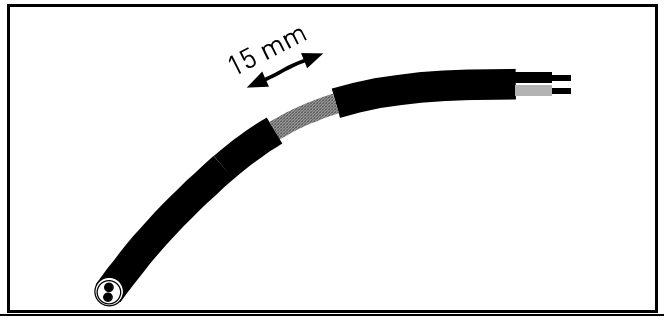
For more detailed information, see the user's manual of the fieldbus you are using.

6.2.1.1 ETHERNET CABLE DATA

Connector	Shielded RJ45 connector
Cable type	CAT5e STP
Cable length	Max .100m

Table 16. Ethernet cable data

6.2.2 PREPARE FOR USE THROUGH MS/TP

1	Strip about 15 mm of the RS485 cable (see specification on page 44) and cut off the grey cable shield. Remember to do this for both bus cables (except for the last device). Leave no more than 10 mm of the cable outside the terminal block and strip the cables at about 5 mm to fit in the terminals. See picture below.  Also strip the cable now at such a distance from the terminal that you can fix it to the frame with the grounding clamp. Strip the cable at a maximum length of 15 mm. **Do not strip the aluminum cable shield!** 

2	Then connect the cable to its appropriate terminals on Vacon 100 AC drive standard terminal block, terminals **A and B** (A = negative, B = positive). See Figure 35.

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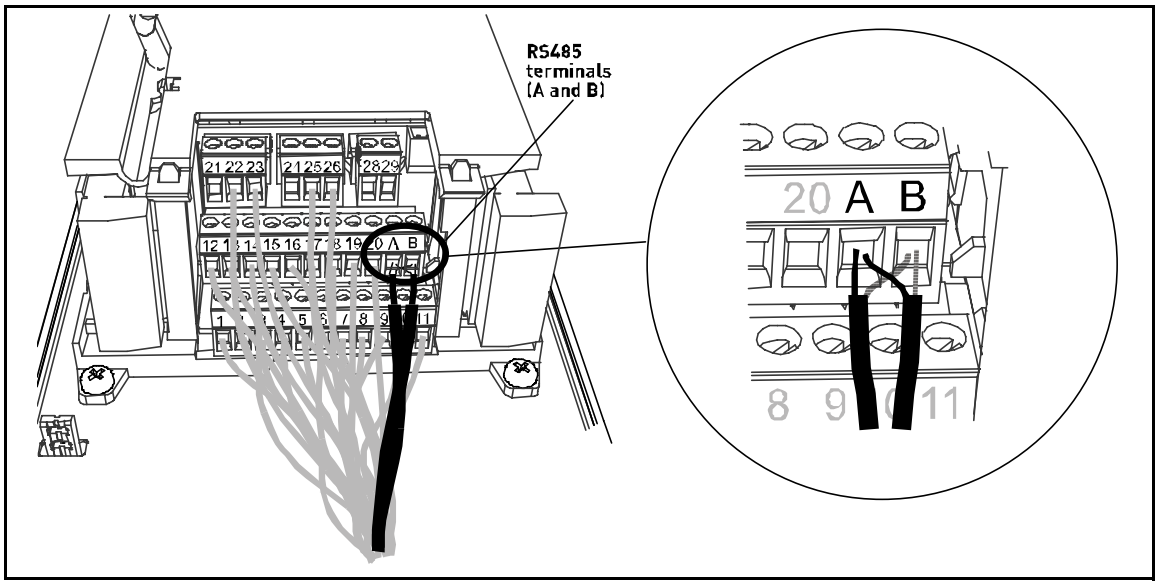
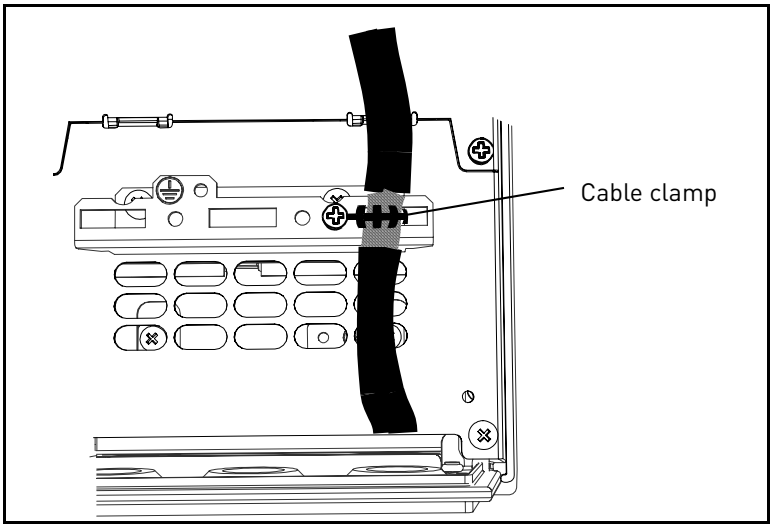
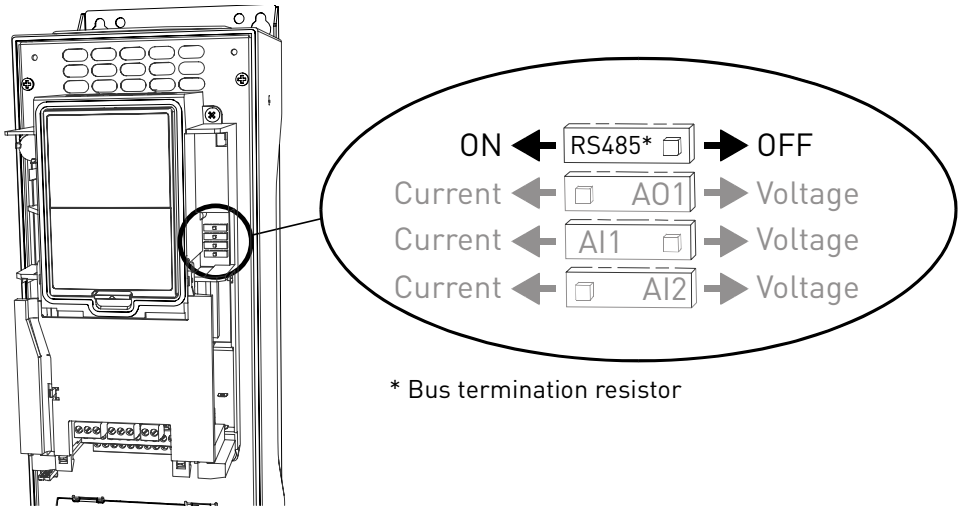
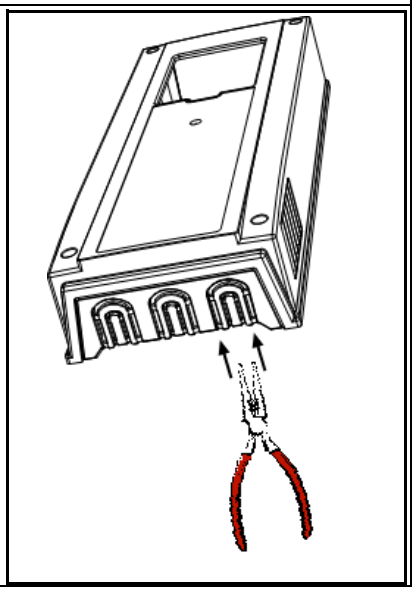


Figure 35.

3	Using the cable clamp included in the delivery of the drive, ground the shield of the RS485 cable to the frame of the AC drive. 

4	**If Vacon 100 is the last device on the bus**, the bus termination must be set. Locate the DIP switches to the right of the control keypad of the drive and turn the switch for the RS485 bus termination resistor to position ON. Biasing is built in the termination resistor. See also step 7 on page 44.  * Bus termination resistor
5	Unless already done for the other control cables, cut free the opening on the AC drive cover for the RS485 cable (protection class IP21). 

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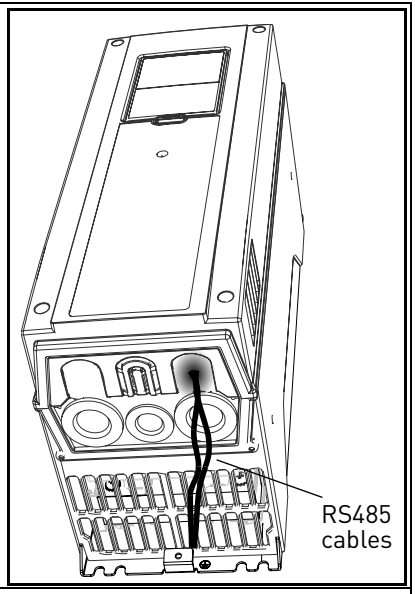
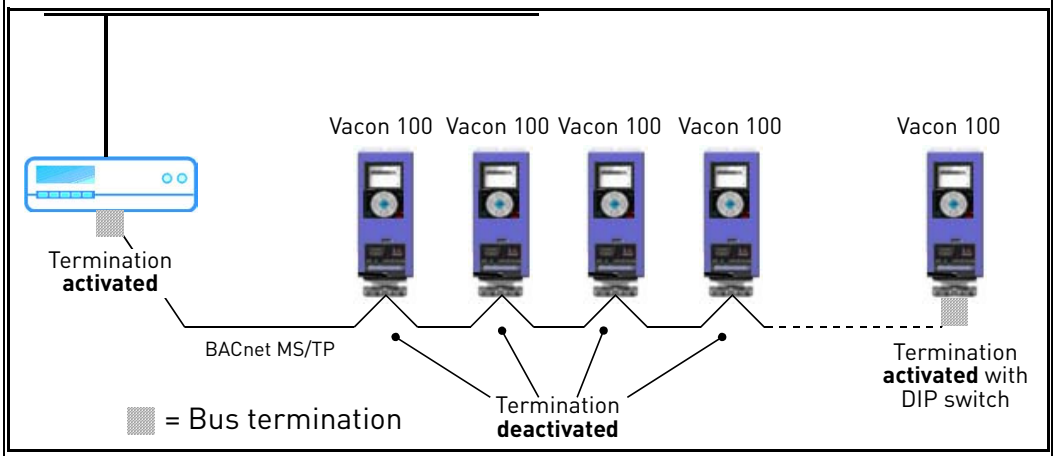
6	Remount the AC drive cover and run the RS485 cables as shown in picture. **NOTE:** When planning the cable runs, remember to keep the distance between the fieldbus cable and the motor cable at a **minimum of 30 cm**. 
7	The bus termination must be set for the first and the last device of the fieldbus line. See picture below. See also step 4 on page 43. We recommend that the first device on the bus and, thus, terminated was the Master device. 

6.2.3 RS485 CABLE DATA

Connector	2.5 mm^2
Cable type	STP (Shielded Twisted Pair), type Belden 9841 or similar
Cable length	Depends on the used fieldbus. See respective bus manual.

Table 17. RS485 cable data

6.3 BATTERY INSTALLATION FOR REAL TIME CLOCK (RTC)

Enabling the functions of the *Real Time Clock (RTC)* requires that an optional battery is installed in the Vacon 100 HVAC drive.

The place for the battery can be found in all frames MR4 to MR9 left to the control keypad (see Figure 36).

Detailed information on the functions of the *Real Time Clock (RTC)* can be found in the Vacon 100 HVAC Application Manual.

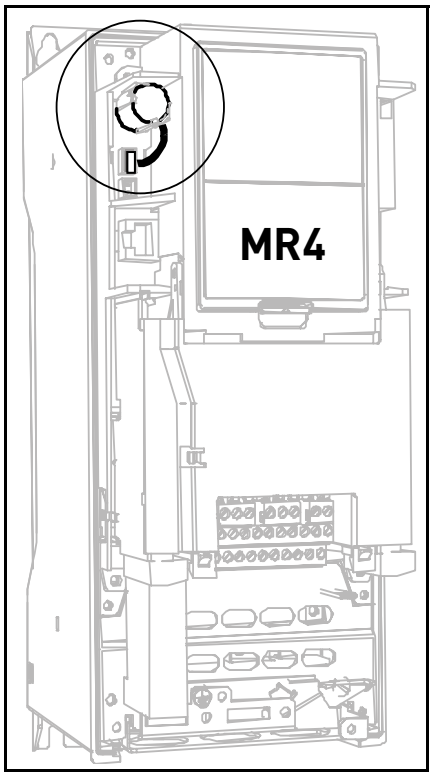


Figure 36. Optional battery

6.4 GALVANIC ISOLATION BARRIERS

The control connections are isolated from the mains potential and the GND terminals are permanently connected to ground. See Figure 37.

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

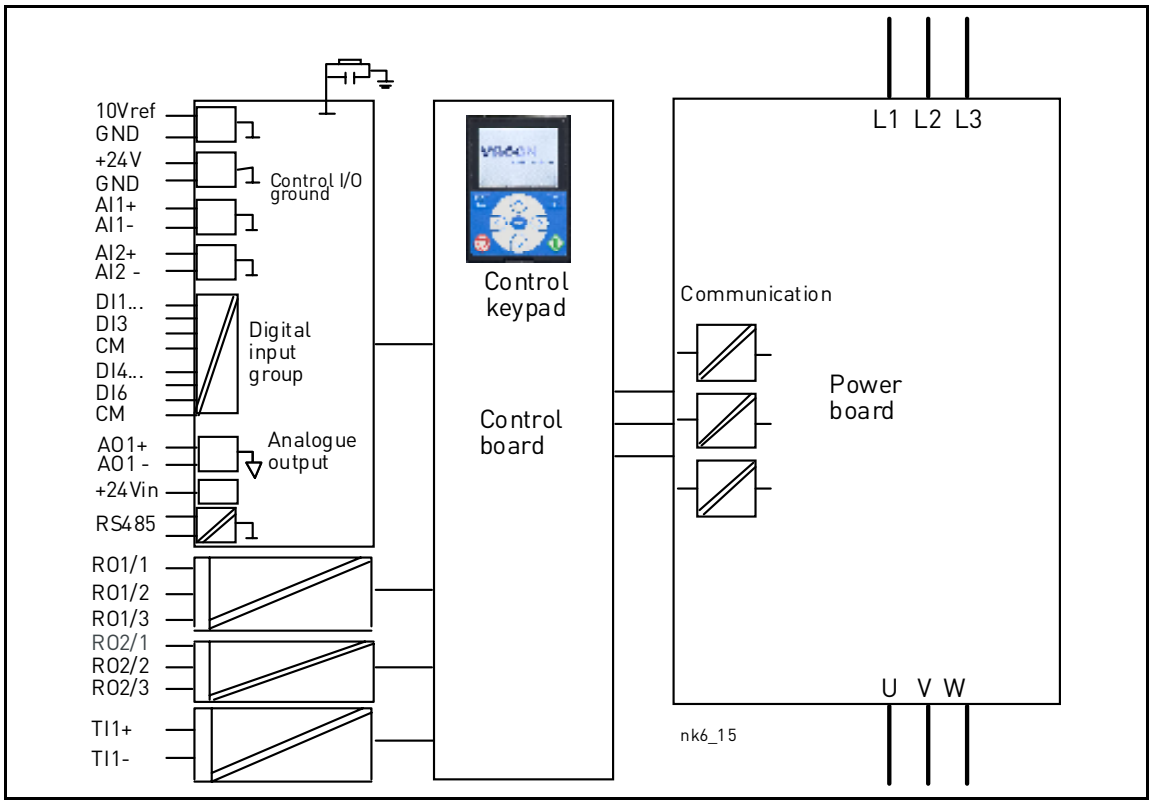


Figure 37. Galvanic isolation barriers

7. PRODUCT DATA

7.1 CONVERTER POWER RATINGS

	Mains voltage 380-480V, 50-60 Hz, 3~					
	Converter type	Loadability			Motor shaft power	
		Low*			400V supply	480V supply
		Rated continuous current I_L [A]	10% overload current [A]	Max current I_S	10% overload 40°C [kW]	10% overload 40°C [HP]
MR4	0003	**3,4**	3,7	5,2	**1,1**	**1,5**
	0004	**4,8**	5,3	6,8	**1,5**	**2,0**
	0005	**5,6**	6,2	8,6	**2,2**	**3,0**
	0008	**8,0**	8,8	11,2	**3,0**	**5,0**
	0009	**9,6**	10,6	16,0	**4,0**	**5,0**
	0012**	**12,0**	13,2	19,2	**5,5**	**7,5**
MR5	0016	**16,0**	17,6	24,0	**7,5**	**10**
	0023	**23,0**	25,3	32,0	**11,0**	**15,0**
	0031***	**31,0**	34,1	46,0	**15,0**	**20,0**
MR6	0038	**38,0**	41,8	62,0	**18,5**	**25,0**
	0046	**46,0**	50,6	76,0	**22,0**	**30,0**
	0061****	**61,0**	67,1	92,0	**30,0**	**40,0**
MR7	0072	**72,0**	79,2	122,0	**37**	**60**
	0087	**87,0**	95,7	144,0	**45**	**60**
	0105	**105,0**	115,5	174,0	**55**	**75**

* See chapter 7.1.1

** Given low loadabilities valid for 480V drives at a switching frequency of 4kHz

*** Given low loadabilities valid for 480V drives at a switching frequency of 4kHz

**** Given low loadabilities valid for 480V drives at a switching frequency of 4kHz

Table 18. Power ratings of Vacon 100, supply voltage 380-480V.

NOTE: The rated currents in given ambient temperatures (in Table 19) are achieved only when the switching frequency is equal to or less than the factory default.

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7.1.1 DEFINITIONS OF OVERLOADABILITY

Low overload = Following continuous operation at rated output current I_L, the converter is fed with 110% * I_L for 1 min, followed by a period of I_L.

Example: If the duty cycle requires 110% rated current I_L for 1 min in every 10 min, the remaining 9 min must be at rated current or less.

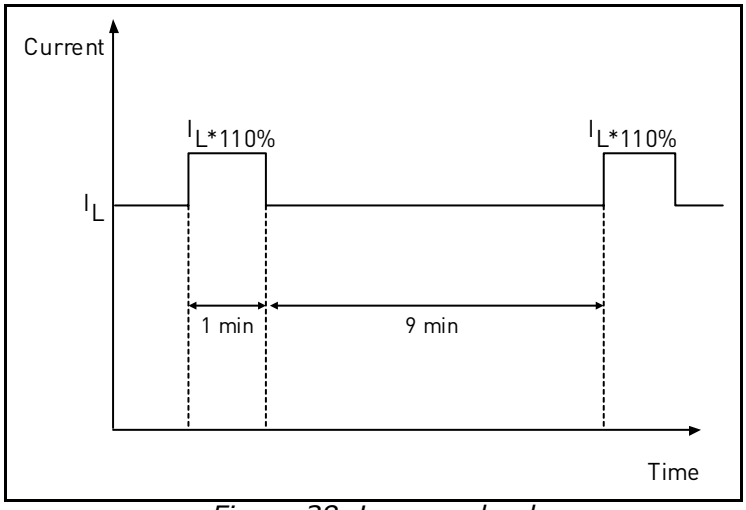

Figure 38. Low overload

7.2 VACON 100 - TECHNICAL DATA

Mains connection	Input voltage U_{in}	380...480V; -10%...+10%
	Input frequency	47...66 Hz
	Connection to mains	Once per minute or less
	Starting delay	2 s (MR4 to MR6); 6 s (MR7)
Motor connection	Output voltage	0-U_{in}
	Continuous output current	I_L:Ambient temperature max. +40°C, overload 1.1 x I_L (1 min./10 min.)
	Starting current	I_S for 2 s every 20 s
	Output frequency	0...320 Hz (standard)
	Frequency resolution	0.01 Hz
Control characteris-tics	Switching frequency (see parameter 3.2.1.9)	1.5...10 kHz; Defaults: 6 kHz (MR4-6), 4 kHz (MR7) Automatic switching frequency derating in case of overheating
	Frequency reference Analogue input Panel reference	 Resolution 0.1% (10-bit), accuracy ±1% Resolution 0.01 Hz
	Field weakening point	8...320 Hz
	Acceleration time	0.1...3000 sec
	Deceleration time	0.1...3000 sec
Ambient conditions	Ambient operating temperature	**MR4-MR7:** I_L : -10°C (no frost)...+40°C
	Storage temperature	-40°C...+70°C
	Relative humidity	0 to 95% R_H, non-condensing, non-corro-sive
	Air quality: • chemical vapours • mechanical particles	 IEC 60721-3-3, unit in operation, class 3C2 IEC 60721-3-3, unit in operation, class 3S2
	Altitude	100% load capacity (no derating) up to 1,000 m 1-% derating for each 100m above 1,000m Max. altitudes: **380...480V:** 3,000m (TN and IT systems)

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Ambient conditions (cont.)	Vibration EN61800-5-1/ EN60068-2-6	5...150 Hz Displacement amplitude 1 mm (peak) at 5...15.8 Hz (MR4...MR9) Max acceleration amplitude 1 G at 15.8...150 Hz (MR4...MR9)
	Shock EN61800-5-1 EN60068-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max 15 G, 11 ms (in package)
	Enclosure class	IP21/Type 1 standard in entire kW/HP range IP54/Type 12 option Note! Keypad required for IP54/Type 12
EMC (at default settings)	Immunity	Fulfils EN61800-3 (2004), first and second environment
	Emissions	Depend on EMC level. +EMC2: EN61800-3 (2004), Category C2 Vacon 100 will be delivered with class C2 EMC filtering, if not otherwise specified. Vacon 100 can be modified for IT-networks. See chapter1.4.
Safety		EN 61800-5-1 (2007), CE, cUL; (see unit nameplate for more detailed approvals)
Control connections	See chapter 7.2.1.	
Protections	Overvoltage trip limit Undervoltage trip limit	Yes Yes
	Earth fault protection	In case of earth fault in motor or motor cable, only the AC drive is protected
	Mains supervision	Yes
	Motor phase supervision	Trips if any of the output phases is missing
	Overcurrent protection	Yes
	Unit overtemperature protection	Yes
Protections (cont.)	Motor overload protection	Yes
	Motor stall protection	Yes
	Motor underload protection	Yes
	Short-circuit protection of +24V and +10V reference voltages	Yes

Table 19. Vacon 100 technical data

7.2.1 Technical information on control connections

Basic I/O board		
Terminal	Signal	Technical information
1	Reference output	+10V, +3%; Maximum current 10 mA
2	Analogue input, voltage or current	Analogue input channel 1 0- +10V (Ri = 200 kΩ) 4-20 mA (Ri =250 Ω) Resolution 0.1 %, accuracy ±1 % Selection V/mA with dip-switches (see page 38)
3	Analogue input common (current)	Differential input if not connected to ground; Allows ±20V differential mode voltage to GND
4	Analogue input, voltage or current	Analogue input channel 1 Defauit: 4-20 mA (Ri =250 Ω) 0-10 V (Ri=200kΩ) Resolution 0.1 %, accuracy ±1 % Selection V/mA with dip-switches (see page 38)
5	Analogue input common (current)	Differential input if not connected to ground; Allows 20V differential mode voltage to GND
6	24V aux. voltage	+24V, ±10%, max volt. ripple < 100mVrms; max. 250mA Dimensioning: max. 1000mA/control box. Short-circuit protected
7	I/O ground	Ground for reference and controls (connected internally to frame earth through 1MΩ)
8	Digital input 1	Positive or negative logic Ri = min. 5kΩ 18...30V = "1"
9	Digital input 2	
10	Digital input 3	
11	Common A for DIN1-DIN6.	
12	24V aux. voltage	+24V, ±10%, max volt. ripple < 100mVrms; max. 250mA Dimensioning: max. 1000mA/control box. Short-circuit protected
13	I/O ground	Ground for reference and controls (connected internally to frame earth through 1MΩ)
14	Digital input 4	Positive or negative logic Ri = min. 5kΩ 18...30V = "1"
15	Digital input 5	
16	Digital input 6	
17	Common A for DIN1-DIN6.	
18	Analogue signal (+output)	Analogue output channel 1, selection 0 -20mA, load <500 Ω Default: 0-20 mA 0-10V Resolution 0.1 %, accuracy ±2 % Selection V/mA with dip-switches (see page 38)
19	Analogue output common	
30	24V auxiliary input voltage	Can be used as external power backup for the control unit (and fieldbus)
A	RS485	Differential receiver/transmitter Set bus termination with dip switches (see page 38)
B	RS485	

Table 20. Technical information on basic I/O board

Relay board 1	Relay board with two Type 8A/STST and one Type 8A/STDT relays. 5,5 mm isolation between channels. External interface connector See chapter 6.		
Terminal	**Signal**	**Technical information**	
21	Relay output 1*	Switching capacity	24VDC/8A 250VAC/8A 125VDC/0.4A
22			
23		Min.switching load	5V/10mA
24	Relay output 2*	Switching capacity	24VDC/8A 250VAC/8A 125VDC/0.4A
25			
26		Min.switching load	5V/10mA
32	Relay output 3*	Switching capacity	24VDC/8A 250VAC/8A 125VDC/0.4A
33			
		Min.switching load	5V/10mA

* If 230VAC is used as control voltage from the output relays, the control circuitry must be powered with a separate isolation transformer to limit short circuit current and overvoltage spikes. This is to prevent welding on the relay contacts. Refer to standard EN 60204-1, section 7.2.9

Table 21. Technical information on Relay board 1

Relay board 2	Relay board with two Type 8A/STST and standard thermistor input. 5,5 mm isolation between channels. External interface connector See chapter 6.		
Terminal	**Signal**	**Technical information**	
21	Relay output 1*	Switching capacity	24VDC/8A 250VAC/8A 125VDC/0.4A
22			
23		Min.switching load	5V/10mA
24	Relay output 2*	Switching capacity	24VDC/8A 250VAC/8A 125VDC/0.4A
25			
26		Min.switching load	5V/10mA
28	Thermistor input	Rtrip = 4.7 kΩ (PTC); Measuring voltage 3.5V	
29			

* If 230VAC is used as control voltage from the output relays, the control circuitry must be powered with a separate isolation transformer to limit short circuit current and ovrvoltage spikes. This is to prevent welding on the relay contacts. Refer to standard EN 60204-1, section 7.2.9

Table 22. Technical information on Relay board 2

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