Nidec

All for dreams

Power Installation Guide

Power Module Frame 12

Universal Variable Speed AC Drive
for induction and servo motors

Part Number: 0478-0613-02
Issue: 2

Original Instructions

For the purposes of compliance with the EU Machinery Directive 2006/42/EC, the English version of this manual is the Original Instructions. Manuals in other languages are Translations of the Original Instructions.

Documentation

Manuals are available to download from the following locations: **http://www.drive-setup.com/ctdownloads**

The information contained in this manual is believed to be correct at the time of printing and does not form part of any contract. The manufacturer reserves the right to change the specification of the product and its performance, and the contents of the manual, without notice.

Warranty and Liability

In no event and under no circumstances shall the manufacturer be liable for damages and failures due to misuse, abuse, improper installation, or abnormal conditions of temperature, dust, or corrosion, or failures due to operation outside the published ratings. The manufacturer is not liable for consequential and incidental damages. Contact the supplier of the drive for full details of the warranty terms.

Environmental policy

Control Techniques Ltd operates an Environmental Management System (EMS) that conforms to the International Standard ISO 14001.

Further information on our Environmental Policy can be found at: **http://www.drive-setup.com/environment**

Restriction of Hazardous Substances (RoHS)

The products covered by this manual comply with European and International regulations on the Restriction of Hazardous Substances including EU directive 2011/65/EU and the Chinese Administrative Measures for Restriction of Hazardous Substances in Electrical and Electronic Products.

Disposal and Recycling (WEEE)

When electronic products reach the end of their useful life, they must not be disposed of along with domestic waste but should be recycled by a specialist recycler of electronic equipment. Control Techniques products are designed to be easily dismantled into their major component parts for efficient recycling. The majority of materials used in the product are suitable for recycling.

Product packaging is of good quality and can be re-used. Large products are packed in wooden crates. Smaller products are packaged in strong cardboard cartons which have a high recycled fibre content. Cartons can be re-used and recycled. Polythene, used in protective film and bags for wrapping the product, can be recycled. When preparing to recycle or dispose of any product or packaging, please observe local legislation and best practice.

REACH legislation

EC Regulation 1907/2006 on the Registration, Evaluation, Authorisation and restriction of Chemicals (REACH) requires the supplier of an article to inform the recipient if it contains more than a specified proportion of any substance which is considered by the European Chemicals Agency (ECHA) to be a Substance of Very High Concern (SVHC) and is therefore listed by them as a candidate for compulsory authorisation.

Further information on our compliance with REACH can be found at: **http://www.drive-setup.com/reach**

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Registered in England and Wales. Company Reg. No. 01236886.

Copyright

How to use this guide

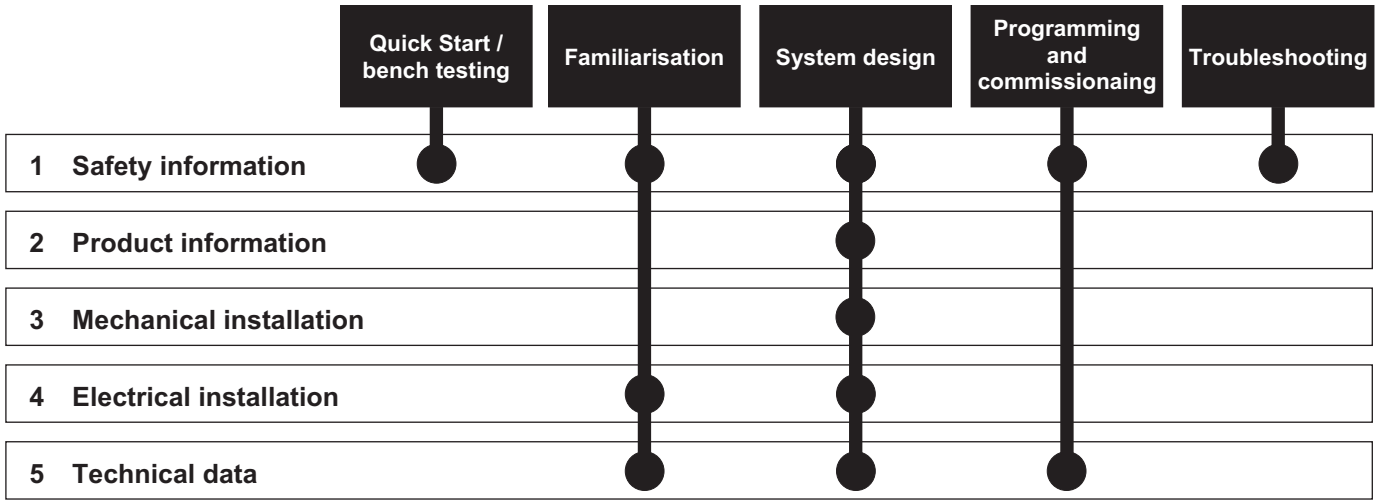
This user guide provides complete information for installing the drive.

The information is in logical order, taking the reader from receiving the drive through to installation.

NOTE

There are specific safety warnings throughout this guide, located in the relevant sections. In addition, Chapter 1 *Safety information* contains general safety information. It is essential that the warnings are observed and the information considered when working with or designing a system using the drive.

This map of the user guide helps to find the right sections for the task you wish to complete, but for specific information, refer to the table of contents overleaf.



Contents

EU Declaration of Conformity

1. Product model

Unidrive-M Variable Speed Motor Drives.

2. Name and address of the manufacturer

Nidec Control Techniques Ltd

The Gro
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SY16 3BE
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Registered in England and Wales. Company Reg. No. 01236886
Telephone: 00 44 1686 612300
E-mail: marketing.control techniques@mail.nidec.com

Web: www.controltechniques.com

3. This declaration is issued under the sole responsibility of the manufacturer.

4. Object of the declaration

Model No.	Interpretation	Nomenclature aaaa - bbc ddddde
aaaa	Basic series	M000 (configurable to M600, M700, M701, M702, F300, F600)
bb	Frame Size	12
c	Voltage Rating	4 = 400 V
ddddd	Current Rating	Example 01000 = 100 A
e	Drive Format	D = Inverter, T = 12P Rectifier + Inverter (can be operated in 6 and 12 pulse)

The model number may be followed by additional characters that do not affect the ratings.

5. The object of the declaration is in conformity with the relevant European Union harmonisation legislation.

Restriction of Hazardous Substances Directive (2011/65/EU)

Low Voltage Directive (2014/35/EU)

Electromagnetic Compatibility Directive (2014/30/EU).

6. References to the relevant harmonised standards used

The variable speed drive products listed above have been designed and manufactured in accordance with the following European harmonised standards:

EN 61800-5-1:2007+ A1:2017	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
EN 61800-3: 2018	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
EN 61000-6-2: 2005	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
EN 61000-6-4: 2007+ A1:2011	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
EN 61000-3-2:2014	Electromagnetic compatibility (EMC) - Part 3-2: Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)
EN 61000-3-3:2013	Electromagnetic compatibility (EMC) - Part 3-3: Limitation of voltage changes, voltage fluctuations and flicker in public, low voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection

EN 61000-3-2: 2014 Applicable where input current < 16 A. No limits apply for professional equipment where input power ≥ 1 kW.

7. Signed for and behalf of:

Jon Holman-White
Vice President of Research and Development
Nidec Control Techniques Ltd
Date: 27th June 2019
Newtown, Powys, UK.

These electronic drive products are intended to be used with appropriate motors, controllers, electrical protection components and other equipment to form complete end products or systems. Compliance with safety and EMC regulations depends upon installing and configuring drives correctly, including using the specified input filters.

The drives must be installed only by professional installers who are familiar with requirements for safety and EMC. Refer to the Product Documentation. An EMC data sheet is available giving detailed information. The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used.

1 Safety information

1.1 Warnings, Cautions and Notes

A Warning contains information which is essential for avoiding a safety hazard.

WARNING

A Caution contains information which is necessary for avoiding a risk of damage to the product or other equipment.

CAUTION

NOTE

A Note contains information which helps to ensure correct operation of the product.

1.2 General information

This guide applies to products which control electric motors either directly (drives) or indirectly (controllers, option modules and other auxiliary equipment and accessories). In all cases the hazards associated with powerful electrical drives are present, and all safety information relating to drives and associated equipment must be observed.

Specific warnings are given at the relevant places in this guide.

Drives and controllers are intended as components for professional incorporation into complete systems. If installed incorrectly they may present a safety hazard. The drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control equipment which can cause injury. Close attention is required to the electrical installation and the system design to avoid hazards either in normal operation or in the event of equipment malfunction. System design, installation, commissioning/start-up and maintenance must be carried out by personnel who have the necessary training and competence. They must read this safety information and this guide carefully.

1.3 Responsibility

It is the responsibility of the installer to ensure that the equipment is installed correctly with regard to all instructions given in this guide. They must give due consideration to the safety of the complete system, so as to avoid the risk of injury both in normal operation and in the event of a fault or of reasonably foreseeable misuse.

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation of the equipment.

1.4 Compliance with regulations

The installer is responsible for complying with all relevant regulations, such as national wiring regulations, accident prevention regulations and electromagnetic compatibility (EMC) regulations. Particular attention must be given to the cross-sectional areas of conductors, the selection of fuses or other protection, and protective ground (earth) connections.

This guide contains instructions for achieving compliance with specific EMC standards.

All machinery to be supplied within the European Union in which this product is used must comply with the following directives:

2006/42/EC Safety of machinery. 2014/30/EU: Electromagnetic Compatibility.

1.5 Electrical hazards

The voltages used in the drive can cause severe electrical shock and/or burns and could be lethal. Extreme care is necessary at all times when working with or adjacent to the drive. Hazardous voltage may be present in any of the following locations:

- AC and DC supply cables and connections
- Output cables and connections
- Many internal parts of the drive, and external option units

Unless otherwise indicated, control terminals are single insulated and must not be touched.

The supply must be disconnected by an approved electrical isolation device before gaining access to the electrical connections.

The STOP function of the drive does not isolate dangerous voltages from the output of the drive or from any external option unit.

The drive must be installed in accordance with the instructions given in this guide. Failure to observe the instructions could result in a fire hazard.

1.6 Stored electrical charge

The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.

1.7 Mechanical hazards

Careful consideration must be given to the functions of the drive or controller which might result in a hazard, either through their intended behaviour or through incorrect operation due to a fault. In any application where a malfunction of the drive or its control system could lead to or allow damage, loss or injury, a risk analysis must be carried out, and where necessary, further measures taken to reduce the risk - for example, an over-speed protection device in case of failure of the speed control, or a fail-safe mechanical brake in case of loss of motor braking.

The system designer is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards.

The design of safety-related control systems must only be done by personnel with the required training and experience. The system must be subject to a risk assessment to confirm that the residual risk of an unsafe event is at an acceptable level for the application.

1.8 Access to equipment

Access must be restricted to authorized personnel only. Safety regulations which apply at the place of use must be complied with.

1.9 Environmental limits

Instructions in this guide regarding transport, storage, installation and use of the equipment must be complied with, including the specified environmental limits. This includes temperature, humidity, contamination, shock and vibration. Drives must not be subjected to excessive physical force.

1.10 Hazardous environments

The equipment must not be installed in a hazardous environment (i.e. a potentially explosive environment).

1.11 Motor

The safety of the motor under variable speed conditions must be ensured.

To avoid the risk of physical injury, do not exceed the maximum specified speed of the motor.

Low speeds may cause the motor to overheat because the cooling fan becomes less effective, causing a fire hazard. The motor should be installed with a protection thermistor. If necessary, an electric forced vent fan should be used.

The values of the motor parameters set in the drive affect the protection of the motor. The default values in the drive must not be relied upon. It is essential that the correct value is entered in the Motor Rated Current parameter.

1.12 Mechanical brake control

Any brake control functions are provided to allow well co-ordinated operation of an external brake with the drive. While both hardware and software are designed to high standards of quality and robustness, they are not intended for use as safety functions, i.e. where a fault or failure would result in a risk of injury. In any application where the incorrect operation of the brake release mechanism could result in injury, independent protection devices of proven integrity must also be incorporated.

1.13 Adjusting parameters

Some parameters have a profound effect on the operation of the drive. They must not be altered without careful consideration of the impact on the controlled system. Measures must be taken to prevent unwanted changes due to error or tampering.

1.14 Electromagnetic compatibility (EMC)

Installation instructions for a range of EMC environments are provided in the relevant Power Installation Guide. If the installation is poorly designed or other equipment does not comply with suitable standards for EMC, the product might cause or suffer from disturbance due to electromagnetic interaction with other equipment. It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the relevant EMC legislation in the place of use.

2 Product information

This guide provides the information necessary to install and commission the Power Module Frame 12.

The power module is intended to be installed into the cubicle by the system integrator using the standard engineering accessories (SEA's). The SEA's consist of:

- Cubicle fitting kit
- Pallet truck lifting kit

The power module is constructed from a kit of the following sub-assemblies which can be ordered individually:

- Inverter
- Rectifier
- Power Control PCB
- SMPS assembly
- Fan assembly

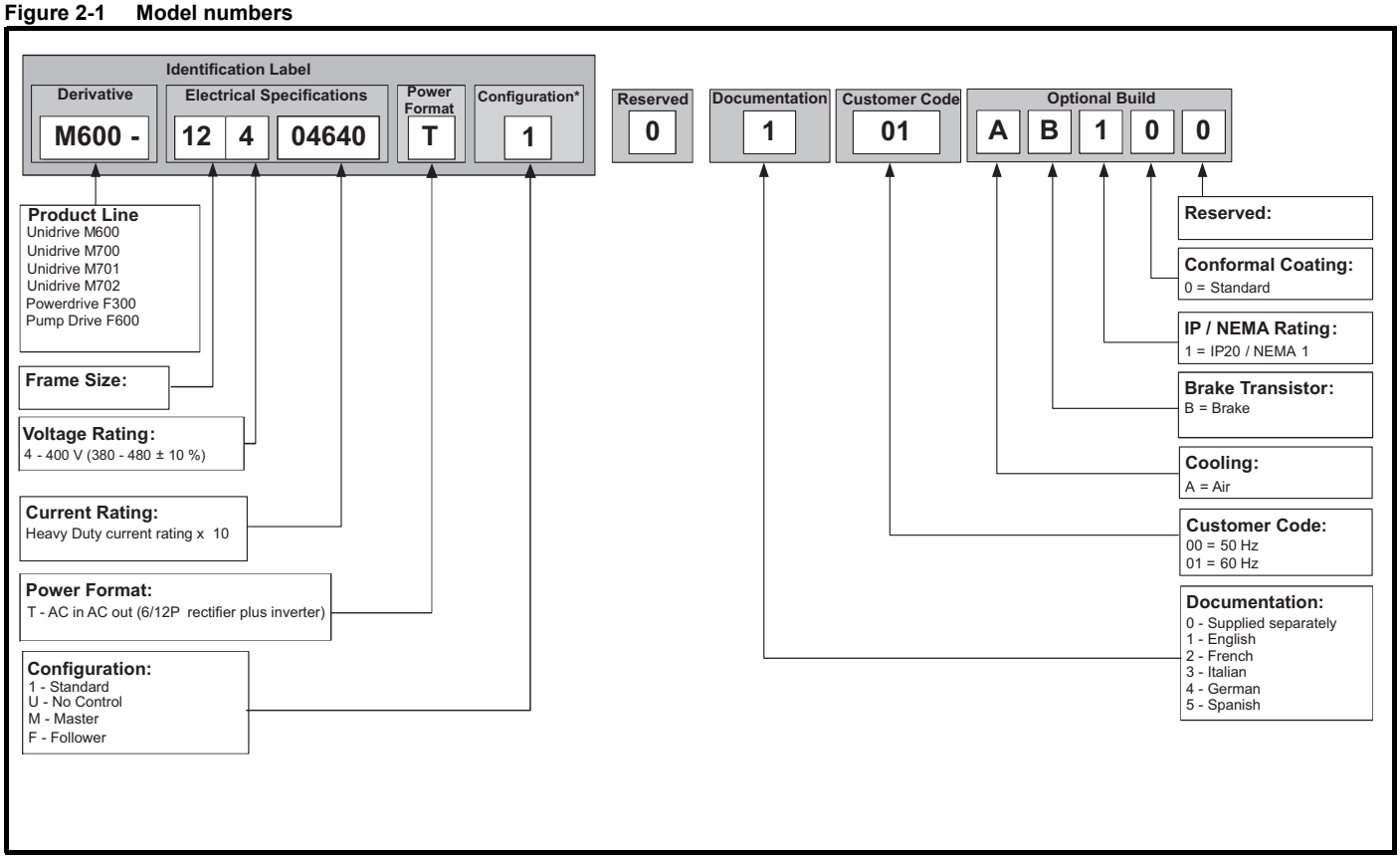
2.1 Drive software version

This product is supplied with the latest software version. If this drive is to be connected to an existing system or machine, all drive software versions should be verified to confirm the same functionality as drives of the same model already present. This may also apply to drives returned from a Control Techniques Service Centre or Repair Centre. If there is any doubt, please contact the supplier of the product. The software version of the drive can be checked by looking at Pr **11.029** and Pr **11.034**. This takes the form of xx.yy.zz where Pr **11.29** displays xx.yy and Pr **11.34** displays zz. (e.g. for software version 01.01.00, Pr **11.029** = 1.01 and Pr **11.034** displays 0).

2.2 Model number

The way in which the model numbers for the Unidrive M/ Pump drive range are formed is illustrated below.

Figure 2-1 Model numbers

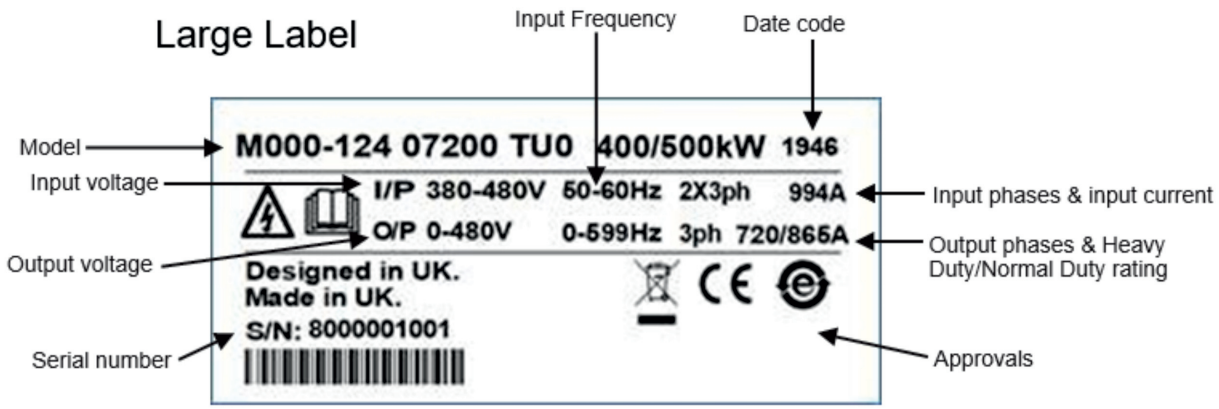


2.3 Nameplate description

Figure 2-2 Typical drive rating labels

Key to approvals

CE	**CE approval**	**Europe**
	WEEE Approved	**Europe**
	China RoHS	**China**



NOTE

Date code format

The date code is four numbers. The first two numbers indicate the year and the remaining numbers indicate the week of the year in which the drive was built.

Example:

A date code of 1910 would correspond to week 10 of year 2019.

2.4 Ratings

The continuous current ratings given are for maximum 40 °C (104 °F),1000 m altitude and 2 kHz switching frequency. Derating is required for higher switching frequencies, higher ambient temperatures and high altitude. For further information, refer to section 5 *Technical data*, *Power and current ratings (Derating for switching frequency and temperature)*.

NOTE

With regard to Table 2-1 to Table 2-2, derating is applied to all drives at low output frequencies. Please contact the supplier of the drive for more information if the application requires significant torque, at or close to zero speed for extended periods of time or if prolonged periods of overload (> 100 %) are required.

Table 2-1 400 V drive ratings at 40 °C (104 °F) 12 pulse (380 V to 480 V ±10 %)

Model	No overload			Normal Duty				Heavy Duty			
	Maximum continuous current	Nominal power at 400 V	Nominal power at 460 V	Maximum continuous current	Peak current	Nominal power at 400 V	Nominal power at 460 V	Maximum continuous output current	Peak current	Nominal power at 400 V	Nominal power at 460 V
	A	kW	hp	A	A	kW	hp	A	A	kW	hp
12404800T	635	315	500	608	668	315	500	480	672	250	400
12405660T	689	355	550	660	726	355	550	566	792	315	450
12406600T	788	450	650	755	831	400	650	660	924	355	550
12407200T	903	500	750	865	952	500	700	720	1008	400	600

2.4.1 Typical short-term overload limits

The maximum percentage overload limit changes depending on the selected motor. Variations in motor rated current, motor power factor and motor leakage inductance all result in changes in the maximum possible overload. The exact value for a specific motor can be calculated using the equations detailed in Menu 4 in the *Advanced User Guide*.

Typical values are shown in the table below for RFC and open loop (OL) modes:

Table 2-2 Typical overload limits

Operating mode	RFC from cold	RFC from 100 %	Open loop from cold	Open loop from 100 %
Normal Duty overload with motor rated current = drive rated current	110 % for 180 s	110 % for 10 s*	110 % for 180 s	110 % for 10 s*
Heavy Duty overload with motor rated current = drive rated current	140 % for 60 s	140 % for 10 s	140 % for 60 s	140 % for 10 s

* 1240720T rating provides 110 % for 3 s from rated normal duty current. 110 % is available for 10 s when limited to 850 A continuous.

12406600T and 12405660T support 110 % for 10 s.

Generally, the drive rated current is higher than the matching motor rated current allowing a higher level of overload than the default setting. The time allowed in the overload region is proportionally reduced at very low output frequency on some drive ratings.

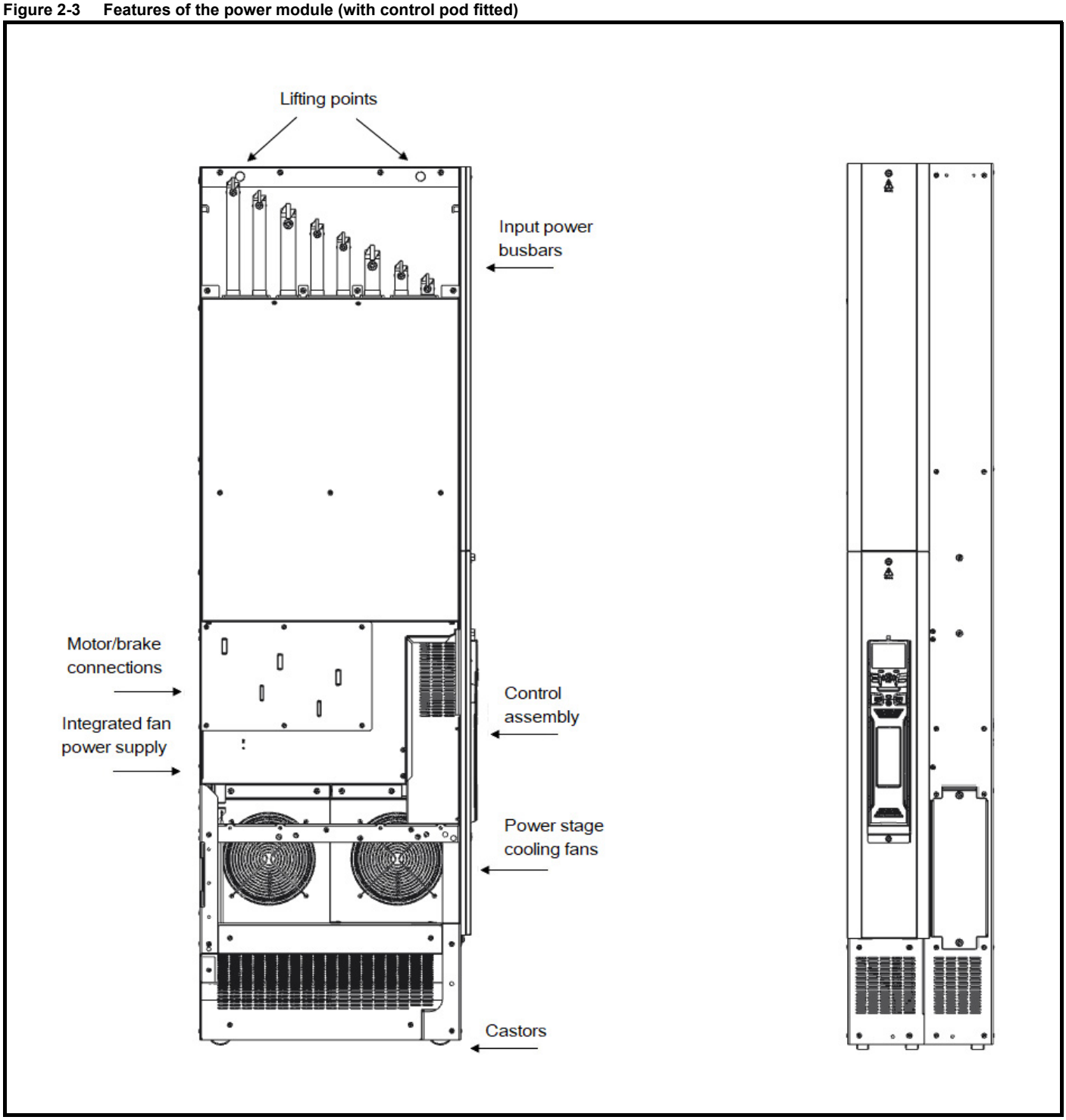
NOTE

The maximum overload level which can be attained is independent of the speed.

2.5 Product features

The power module is to be installed into a cubicle. It can be transported using the lifting trolley or can be wheeled using the castors.

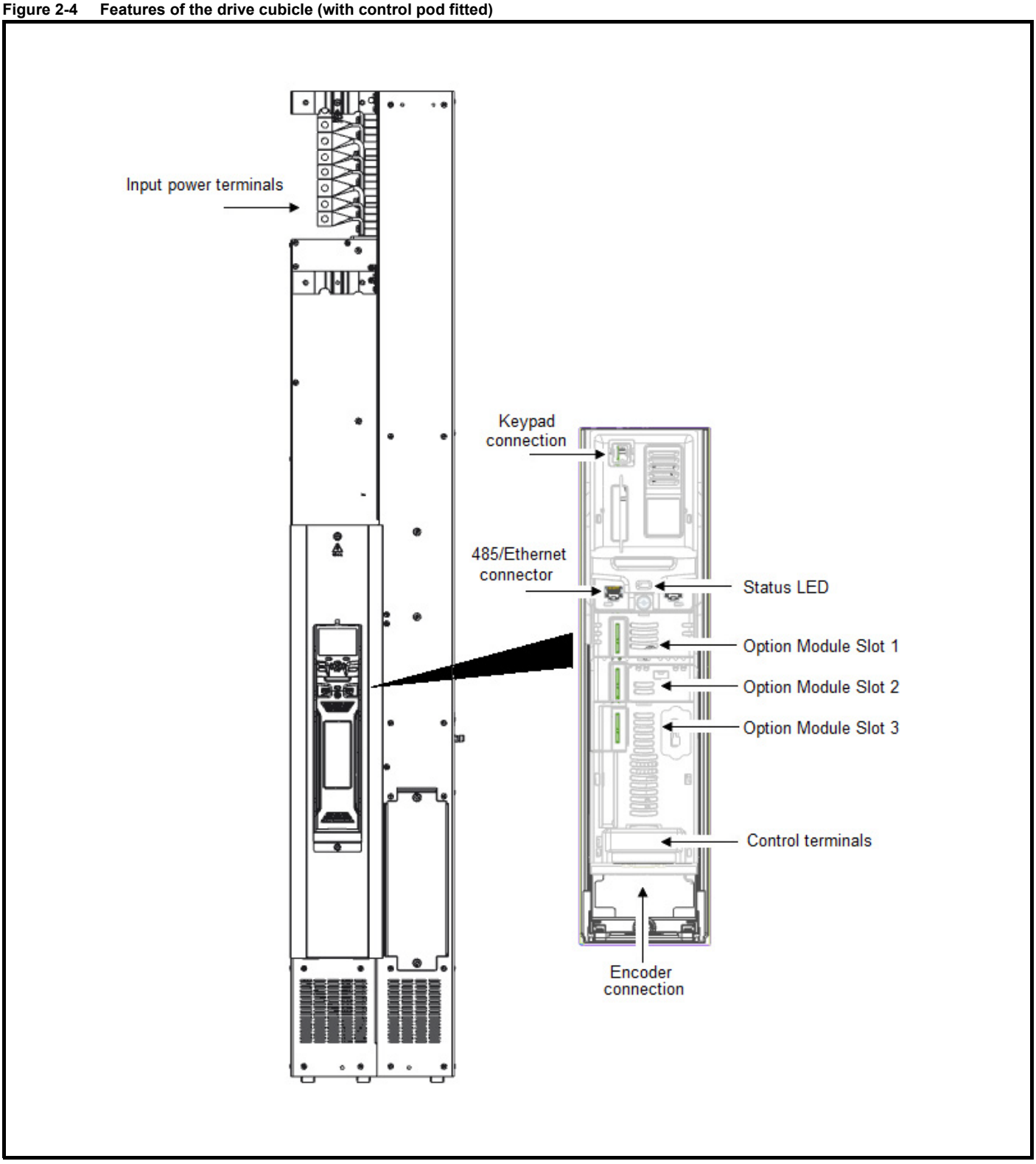
Figure 2-3 Features of the power module (with control pod fitted)



NOTE

The power module is supplied without a control pod. The drive derivative, e.g. M700, is achieved by fitting the appropriate control pod.

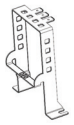
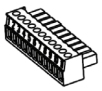
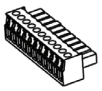
Figure 2-4 Features of the drive cubicle (with control pod fitted)



2.6 Power module accessories

The following items in Table 2-3 will be provided with the power module. The part number of the kit box is 3470-0082.

Table 2-3 Parts supplied with the power module

Part number	Description	Part supplied	Quantity
6541-0110	EMC frame (control)		1
3438-3813	13-way terminal plug		1
3438-2002	2-way terminal plug (relay)		1
3438-2011	11-way terminal block (marked 1-11)		1
3438-3011	11-way terminal block (marked 21-31)		1
3438-4202	2-way terminal block (24 Vdc back-up)		1

2.6.1 Standard Engineering Accessories

To facilitate the installation of the power module into a cubicle, one, or more of the following kits are required.

Table 2-4 Standard Engineering Accessories

Part number	Description	Availability
6772-0006	VX25/TS8 input wiring kit	Available from Control Techniques
6772-0007	VX25/TS8 output wiring kit	Available from Control Techniques
6772-0008	VX25/TS8 earth kit	Available from Control Techniques
6772-0009	VX25 fitting kit	Available from Control Techniques
6500-0159	VX25 Pallet truck lifting kit	Available from Control Techniques
6500-0158	VX25 Pallet kit ramp	Available from Control Techniques
6772-0012	+/- DC input busbar kit	Available from Control Techniques
GTBU580F	External brake chopper	Available from NIS
9681.846	VX25 roof plate	Available from Rittal
4595.000	Wall blacket	Available from Rittal
3243.200	Outlet filter with filter mat	Available from Rittal
N/A	TS8 fitting kit	To be sourced locally. Drawings available on Support Suite
N/A	TS8 Pallet truck lifting kit	To be sourced locally. Drawings available on Support Suite
N/A	TS8 Pallet kit ramp	To be sourced locally. Drawings available on Support Suite

2.6.2 Power module and sub assembly part numbers

Table 2-5 Power module part numbers

Part number	Description
M000-12404800TU0100AB100	12404800T
M000-12405660TU0100AB100	12405660T
M000-12406600TU0100AB100	12406600T
M000-12407200TU0100AB100	12407200T

Table 2-6 Sub assembly part numbers

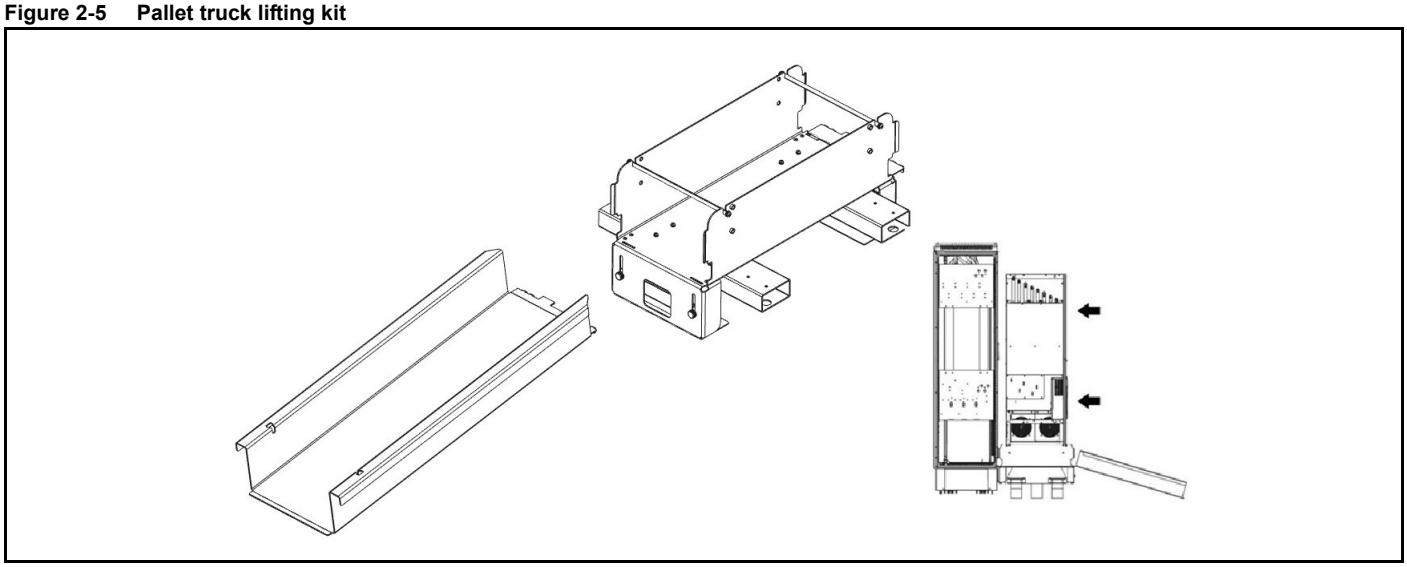
Part number	Description
M000-12XSMPS000000000000	400 V SMPS
M000-12XFANBOX0000000000	Fan Assembly
M000-124INVERTER00000000	400 V Inverter
M000-124RECTIFIER0000000	400 V Rectifier
M000-124INVCONTROL000000	UF25K Power control PCB

2.6.3 Pallet truck lifting kit

To aid the installation of the power module into the cubicle there are two types of accessory.

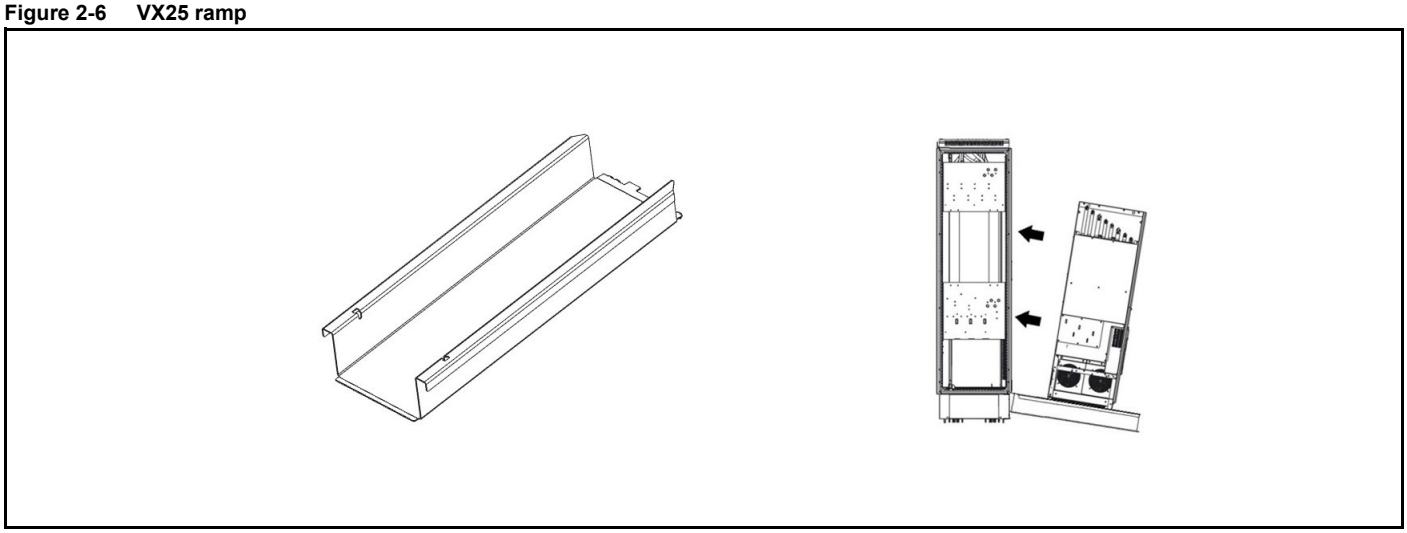
1. Pallet truck lifting kit - This includes a ramp and a transport cradle for transporting the power module using a pallet truck. Part number 6500-0159.

Figure 2-5 Pallet truck lifting kit



2. VX25 Ramp - The ramp attaches directly to the cubicle allowing the power module to be pushed into the cubicle. Part number 6500-0158

Figure 2-6 VX25 ramp



3 Mechanical installation

This chapter describes how to use all mechanical details to install the power module. Key features of this chapter include cubicle installation, terminal location and torque settings.

3.1 Safety information

Follow the instructions
The mechanical and electrical installation instructions must be adhered to. Any questions or doubt should be referred to the supplier of the equipment. It is the responsibility of the owner or user to ensure that the installation of the drive and any external option unit, and the way in which they are operated and maintained, comply with the requirements of the Health and Safety at Work Act in the United Kingdom or applicable legislation and regulations and codes of practice in the country in which the equipment is used.

Hazardous areas
The drive must not be installed in a classified hazardous area unless it is installed in an approved enclosure and the installation is certified.

Stored charge
The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated for at least ten minutes before work may continue.
Normally, the capacitors are discharged by an internal resistor. Under certain, unusual fault conditions, it is possible that the capacitors may fail to discharge or be prevented from being discharged by a voltage applied to the output terminals. If the drive has failed in a manner that causes the display to go blank immediately, it is possible the capacitors will not be discharged. In this case, consult Control Techniques or their authorized distributor.

Protection of equipment prior to installation
If the equipment is not to be installed immediately, it must be protected from moisture and dust. It is recommended that the equipment remains in its packaging prior to installation to protect it from mechanical damage, moisture and dust.

Isolation device
The AC supply must be disconnected from the drive using an approved isolation device before any cover is removed from the drive or before any servicing work is performed.

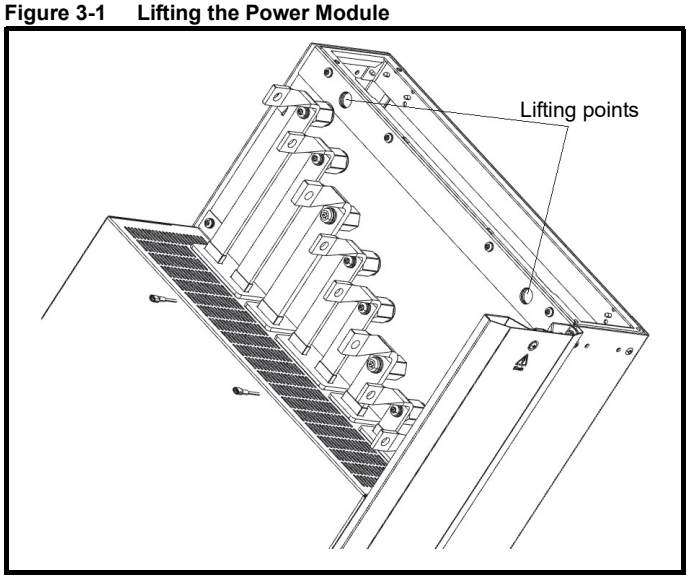
The weight of the product is: 130 kg (287 lb)

3.2 Lifting the Power Module

Lifting and handling
Always lift the drive by the lifting points. Care must be taken when lifting as the Power Module could overbalance if not lifted correctly. Wear safety shoes.

When removing the Power Module from the packaging, connect bow shackles rated to 500 kg (1102 lbs) to the two lifting points, which measure 17.5 mm diameter, shown in Figure 3-1, and slowly raise into a vertical position.

Figure 3-1 Lifting the Power Module



3.3 Planning the installation

The following considerations must be made when planning the installation:

3.3.1 Access

Access must be restricted to authorized personnel only.
Safety regulations which apply at the place of use must be complied with.

3.3.2 Environmental protection

The drive must be protected from:

- Moisture, including dripping water or spraying water and condensation.
- Contamination with electrically conductive material
- Contamination with any form of dust which may restrict the fan, or impair airflow over various components
- Temperature beyond the specified operating and storage ranges
- Corrosive gasses

3.3.3 Cooling

The inlet and outlet vents on the drive must not be restricted or covered. The ambient temperature must not exceed the specified operating temperature of the drive.

3.3.4 Electrical safety

The installation must be safe under normal and fault conditions. Electrical installation instructions are given in Chapter 4 *Electrical Installation* on page 45.

3.3.5 Fire protection

The drive enclosure is not classified as a fire enclosure. A separate fire enclosure must be provided.

For installation in the USA, a NEMA 12 enclosure is suitable.

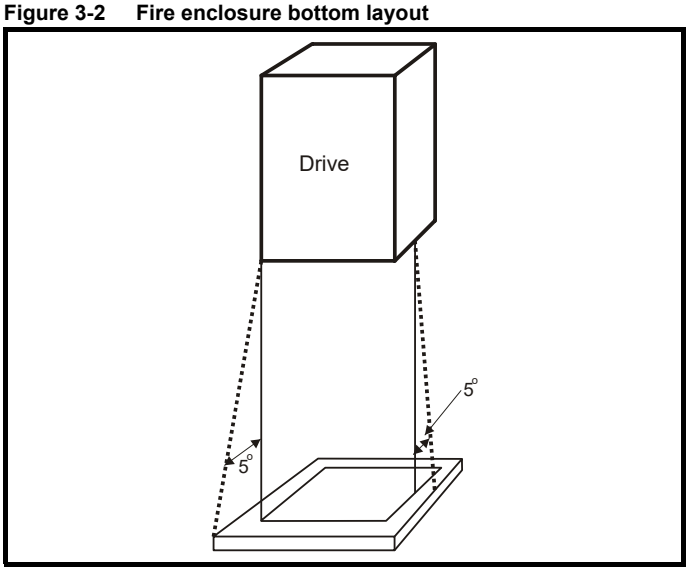
For installation outside the USA, the following (based on IEC 62109-1, standard for PV inverters) is recommended.

Enclosure can be metal and/or polymeric, polymer must meet requirements which can be summarized for larger enclosures as using materials meeting at least UL 94 class 5VB at the point of minimum thickness.

Air filter assemblies to be at least class V-2.

The location and size of the bottom shall cover the area shown in Figure 3-2. Any part of the side which is within the area traced out by the 5° angle is also considered to be part of the bottom of the fire enclosure.

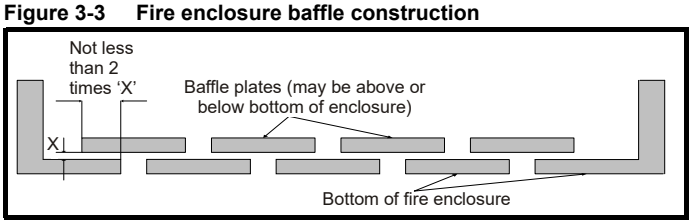
Figure 3-2 Fire enclosure bottom layout



The bottom, including the part of the side considered to be part of the bottom, must be designed to prevent escape of burning material - either by having no openings or by having a baffle construction. This means that openings for cables etc. must be sealed with materials meeting the 5VB requirement, or else have a baffle above.

See Figure 3-3 for acceptable baffle construction. This does not apply for mounting in an enclosed electrical operating area (restricted access) with concrete floor.

Figure 3-3 Fire enclosure baffle construction



3.3.6 Electromagnetic compatibility

Variable speed drives are powerful electronic circuits which can cause electromagnetic interference if not installed correctly with careful attention to the layout of the wiring.

Some simple routine precautions can prevent disturbance to typical industrial control equipment.

If it is necessary to meet strict emission limits, or if it is known that electromagnetically sensitive equipment is located nearby, then full precautions must be observed. In-built into the drive, is an internal EMC filter, which reduces emissions under certain conditions. If these conditions are exceeded, then the use of an external EMC filter may be required at the drive inputs, which must be located as close to the drive as possible.

3.3.7 Hazardous areas

The drive must not be located in a classified hazardous area.

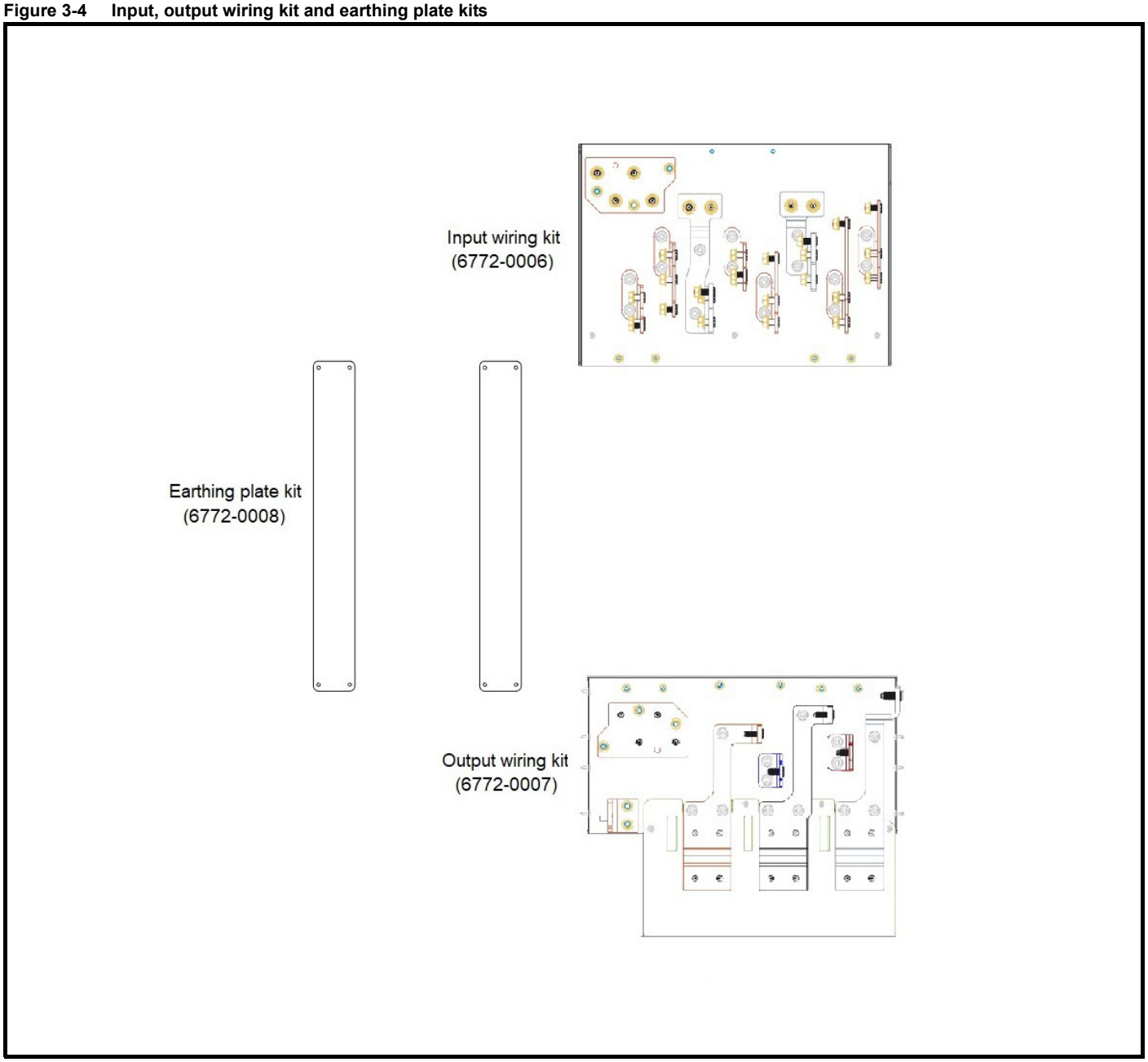
Hot surfaces
Care must be taken when opening the cubicle door as some components may be hot to the touch even after the 10 minutes discharge time.

Component IP ratings
The Power Module is rated to IP00. This must be taken into consideration when the cubicle doors are open.

3.4 Input and output wiring kits

The input and output wiring kits and earthing plate kit are supplied as separate parts.

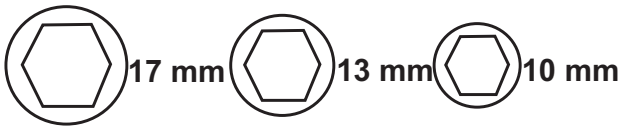
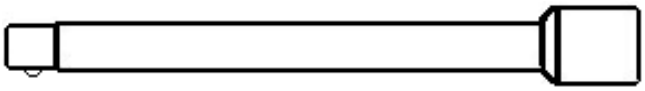
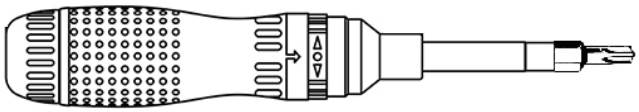
Figure 3-4 Input, output wiring kit and earthing plate kits



3.5 Tools required for installation

The tools required for installing the power module into the cubicle are shown in Figure 3-5.

Figure 3-5 Tools required for installation

Torque wrench	Socket size
	
Socket extension bar	**Length**
	**500 mm**
Torque driver	**Torx bit size**
	

3.5.1 Torx driver sizes by fastener

Table 3-1 Torx driver bit sizes by fastener

Description	Torx driver size
M5 x 12 double SEM torx screw	T25
M6 x 16 double SEM torx screw	T30
M6 x 20 double SEM torx screw	T30
M8 x 16 double SEM torx screw	T40
Multi-tooth screw 5.5 x 13 mm (Rittal screw)	T25

3.6 Cubicle roof plate (VX25)

3.6.1 Stand-alone applications

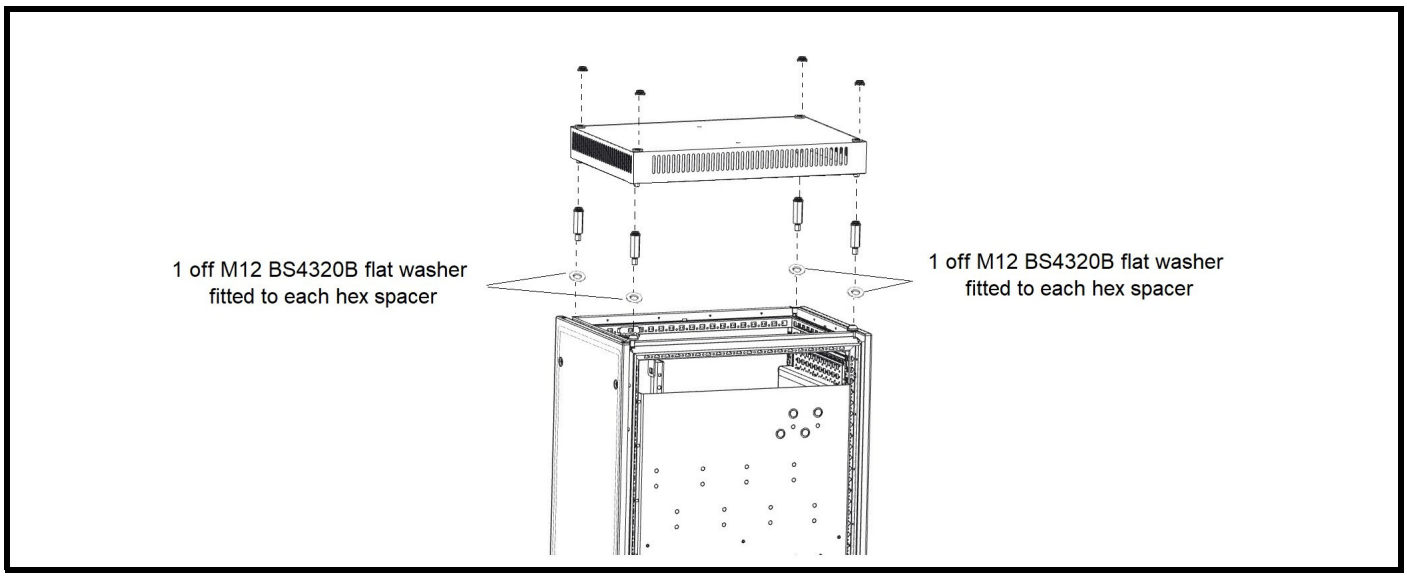
To allow the air to flow through the cubicle the VX25 roof plate (9681.846) must be fitted to the top of the cubicle. For stand-alone applications where attaching the cubicle to a fixed surface is not required the roof plate can be fitted as supplied.

Remove the standard top plate and fit the roof plate fittings as shown in Figure 3-7. Tighten 4 off M12 hex spacers to 20 Nm.

NOTE

The VX25 roof plate is rated to IP21

Figure 3-6 Fitting the VX25 roof plate

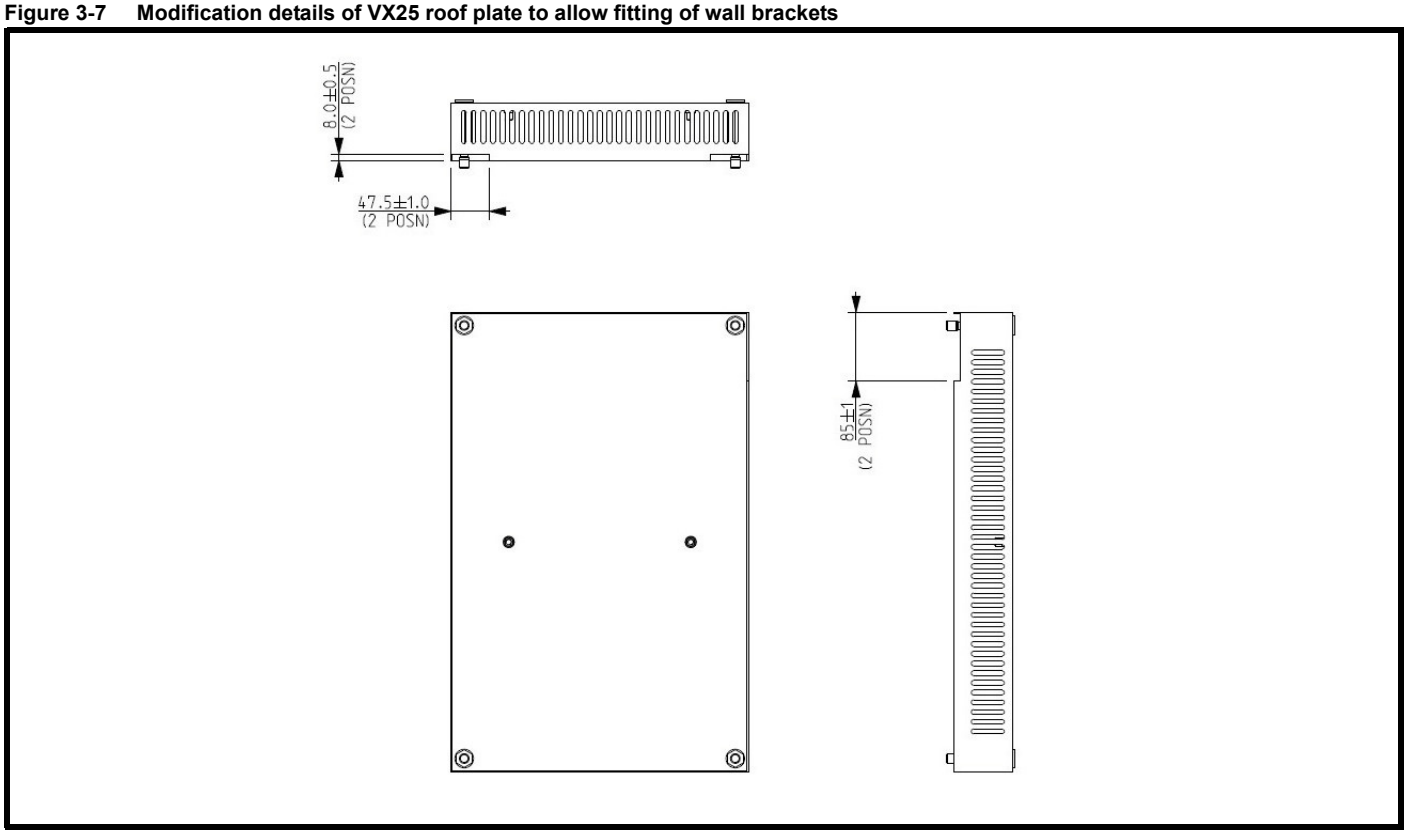


3.6.2 Fastening the cubicle to a fixed surface

It may be a requirement to fasten the cubicle to a fixed surface for applications where shock and vibration may be present.

This requires a modification of the VX25 roof plate to allow the Rittal wall brackets (4595.000) to be fitted. Figure 3-8 shows a modified VX25 roof plate.

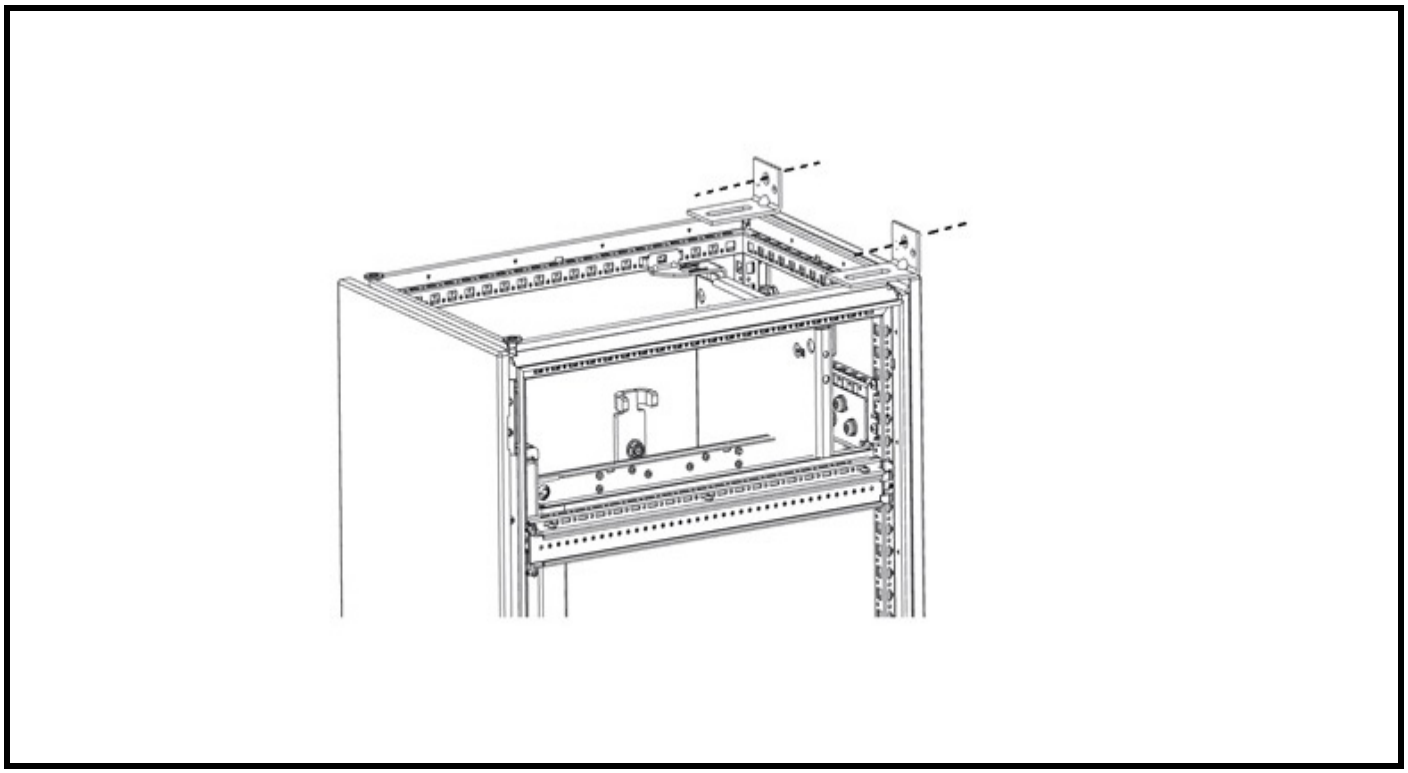
Figure 3-7 Modification details of VX25 roof plate to allow fitting of wall brackets



3.6.3 Fitting wall brackets to fixed surface

With the cubicle in the desired position mark the holes, drill the holes and fasten the wall brackets to the fixed surface as shown in Figure 3-8

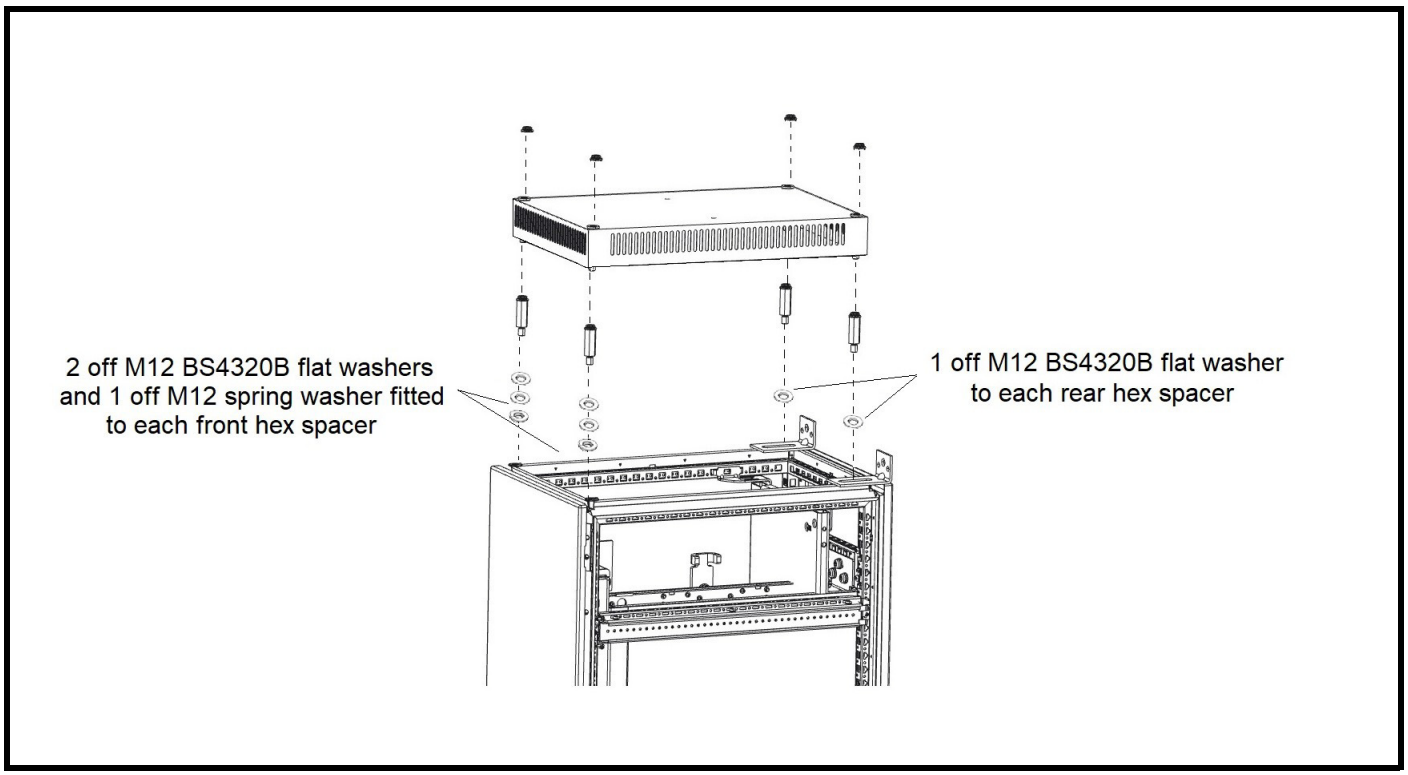
Figure 3-8 Fitting the wall brackets



3.6.4 Fit washers as shown in Figure 3-11

Fit 6 off M12 BS4320B flat washers and 2 off M12 spring washers as shown in Figure 3-11. Tighten 4 off M12 hex spacers to 60 Nm.

Figure 3-9 Preparing to fit the roof plate

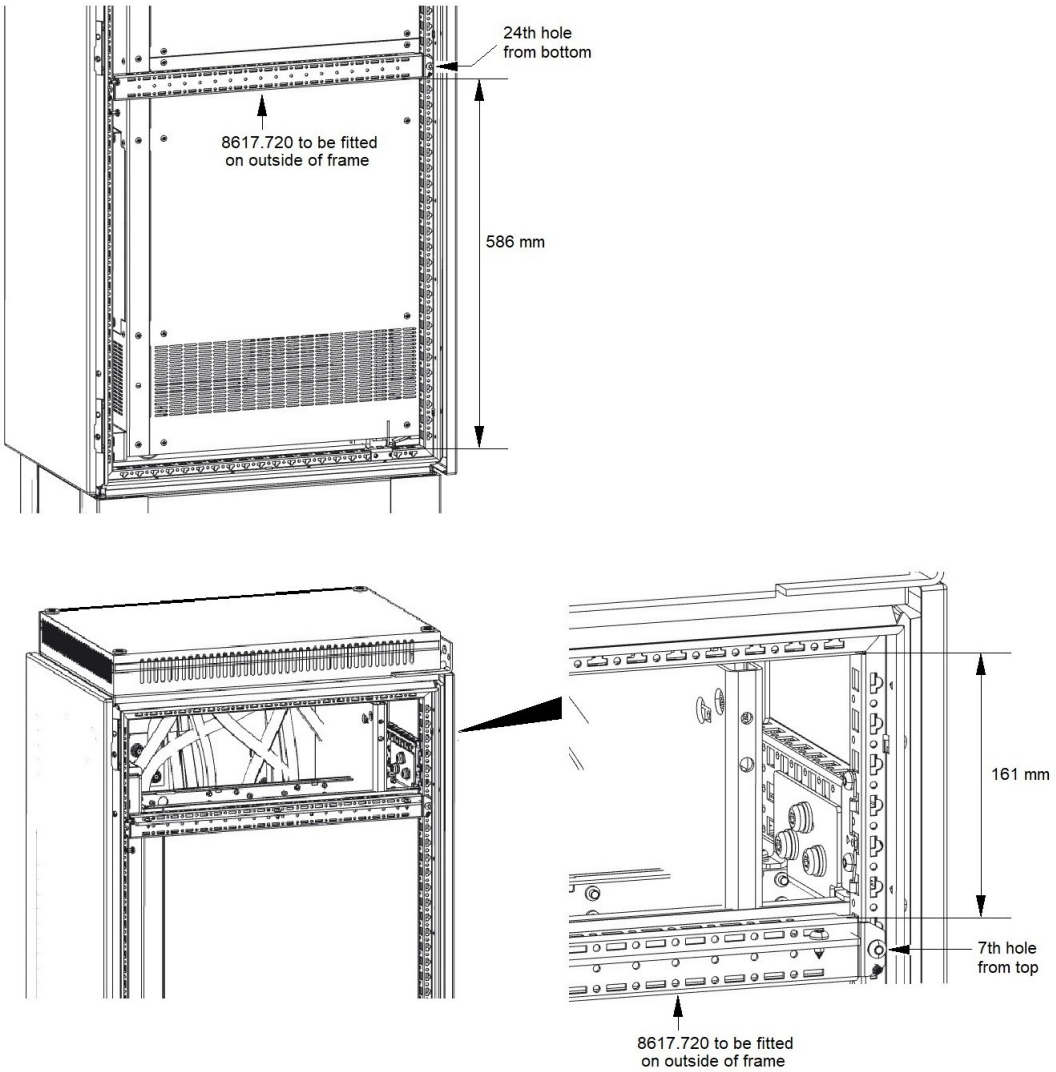


3.7 Installation of power module into cubicle

The following steps should be followed when installing a power module into a cubicle. The required parts are available as part of the power module installation kit.

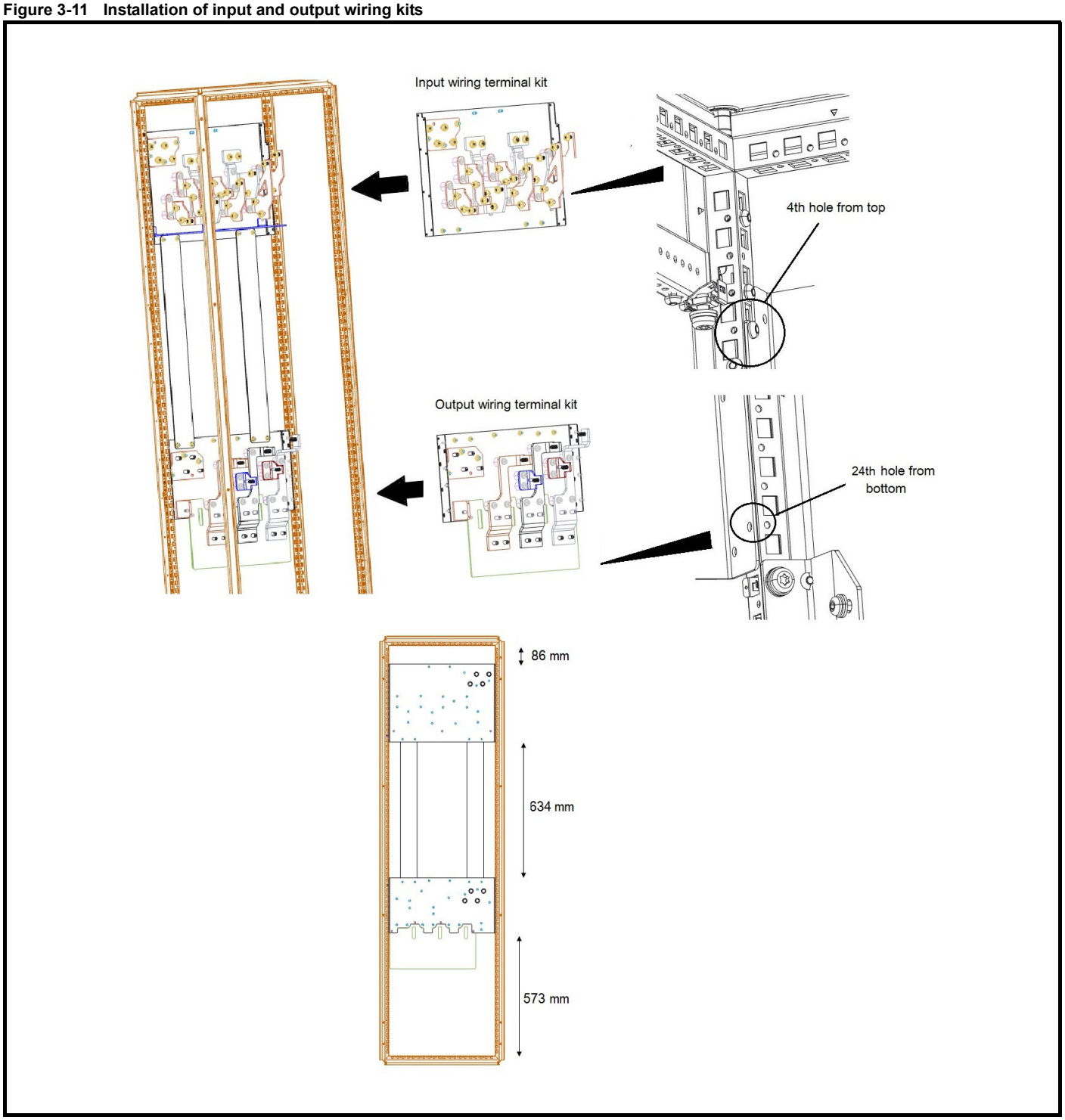
3.7.1 Fit braces to the cubicle for support

Figure 3-10 Fit the support braces to the upper and lower ends of the right side of the cubicle



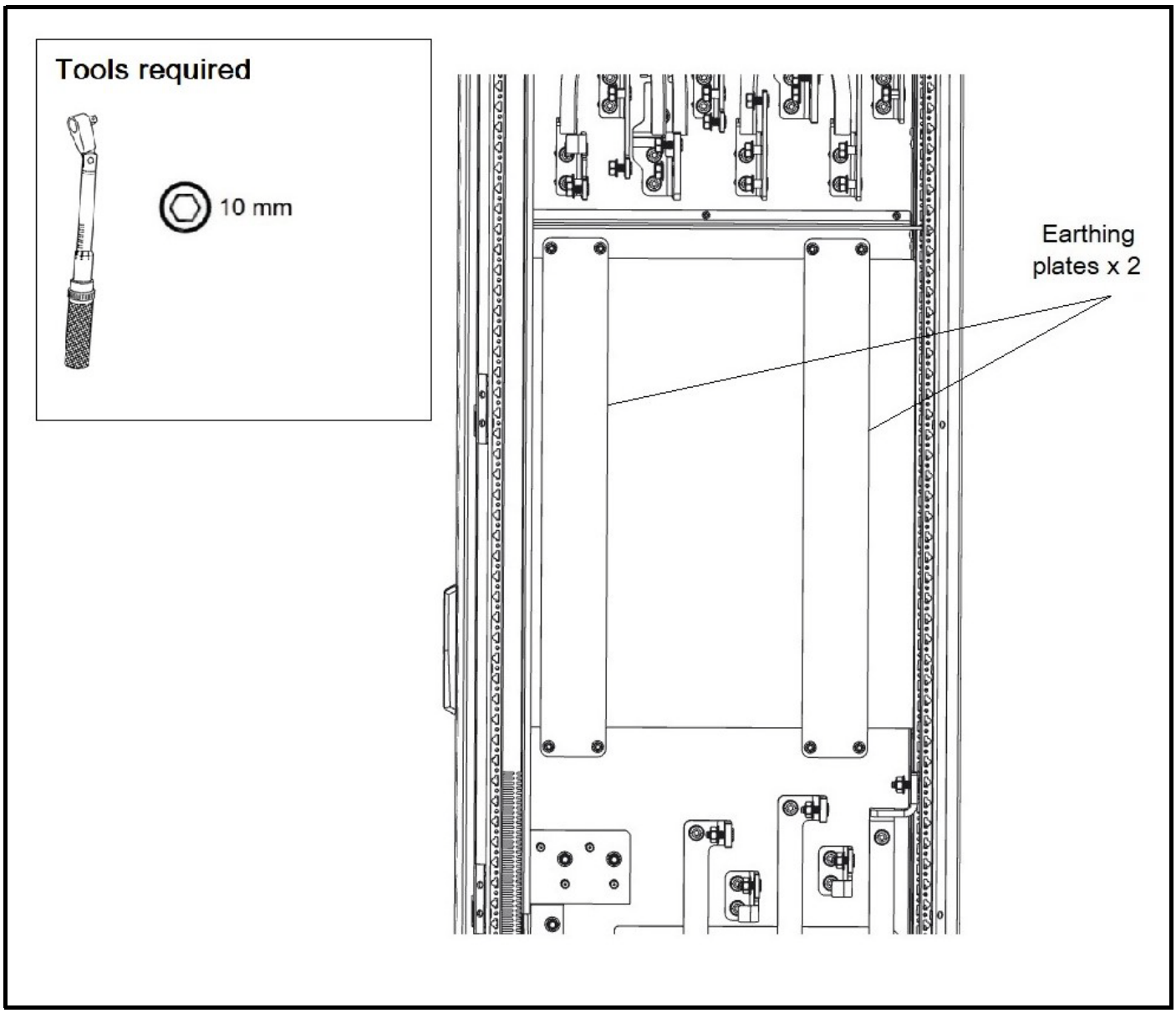
3.7.2 Install input and output wiring terminal kits to the cubicle as defined in the specified dimensions below.

Figure 3-11 Installation of input and output wiring kits



3.7.3 Install earthing plates between the wiring kits. Fasten using 8 off M6 nuts and tighten to 6 Nm.

Figure 3-12 Installation of earthing plates



3.7.4 Connect input, output and earth cables to wiring terminal kits.

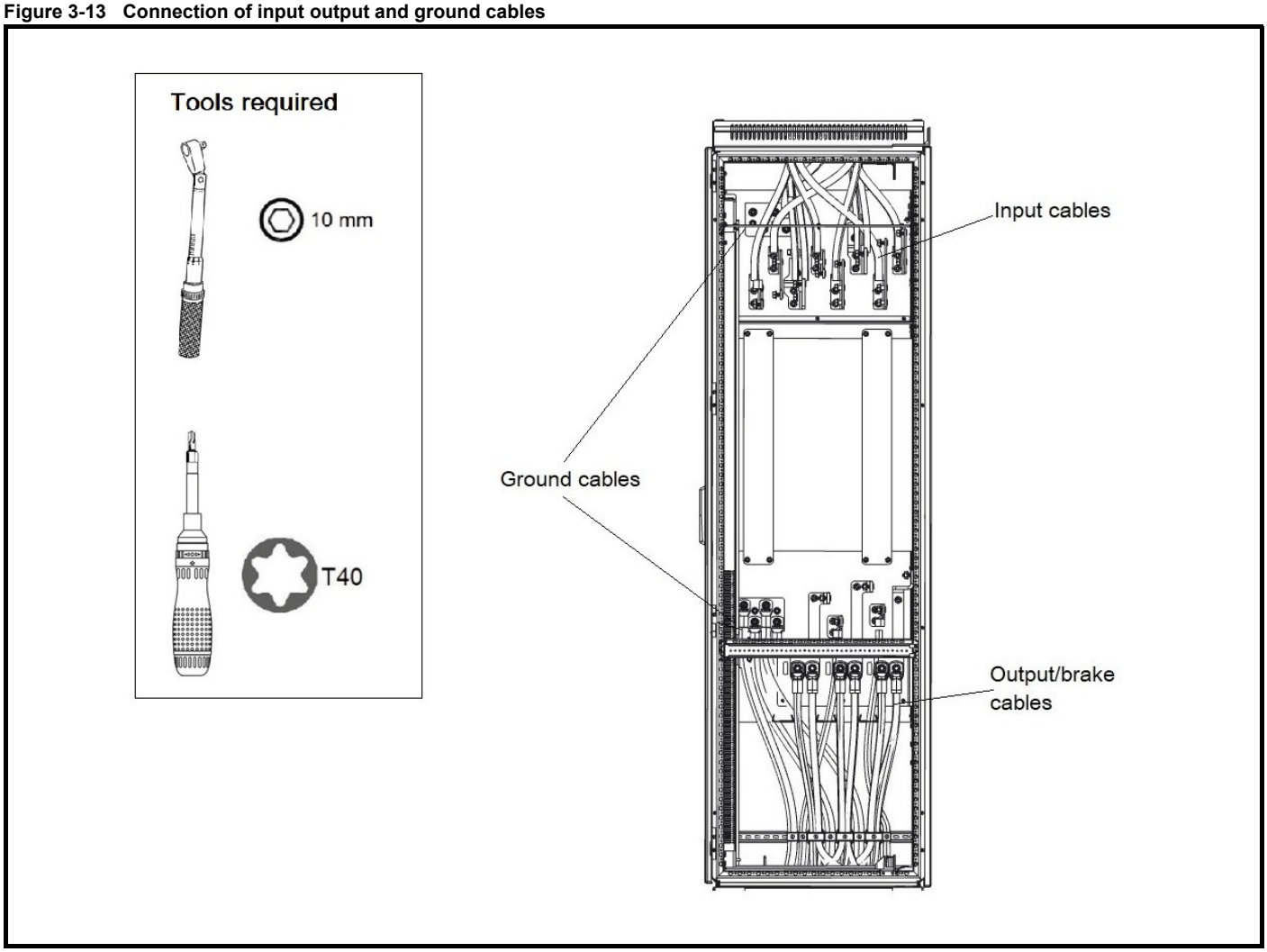
NOTE

To aid cable installation, the input phase busbars are supplied loose on the input wiring kit.

- Position L3B busbar to the position furthest back on the wiring plate
- Tighten 2 off M8 screws to 12 Nm
- Attach the L3B supply cables using suitably sized ring tongue terminals with M10 nuts
- Tighten the M10 nuts to 30 Nm
- Repeat for each input busbar in turn in order L3A, *(DC-), L2B, L2A, *(DC+), L1B, L1A.

* If the DC +/- busbars are required then the above process should be followed.

Figure 3-13 Connection of input output and ground cables



NOTE

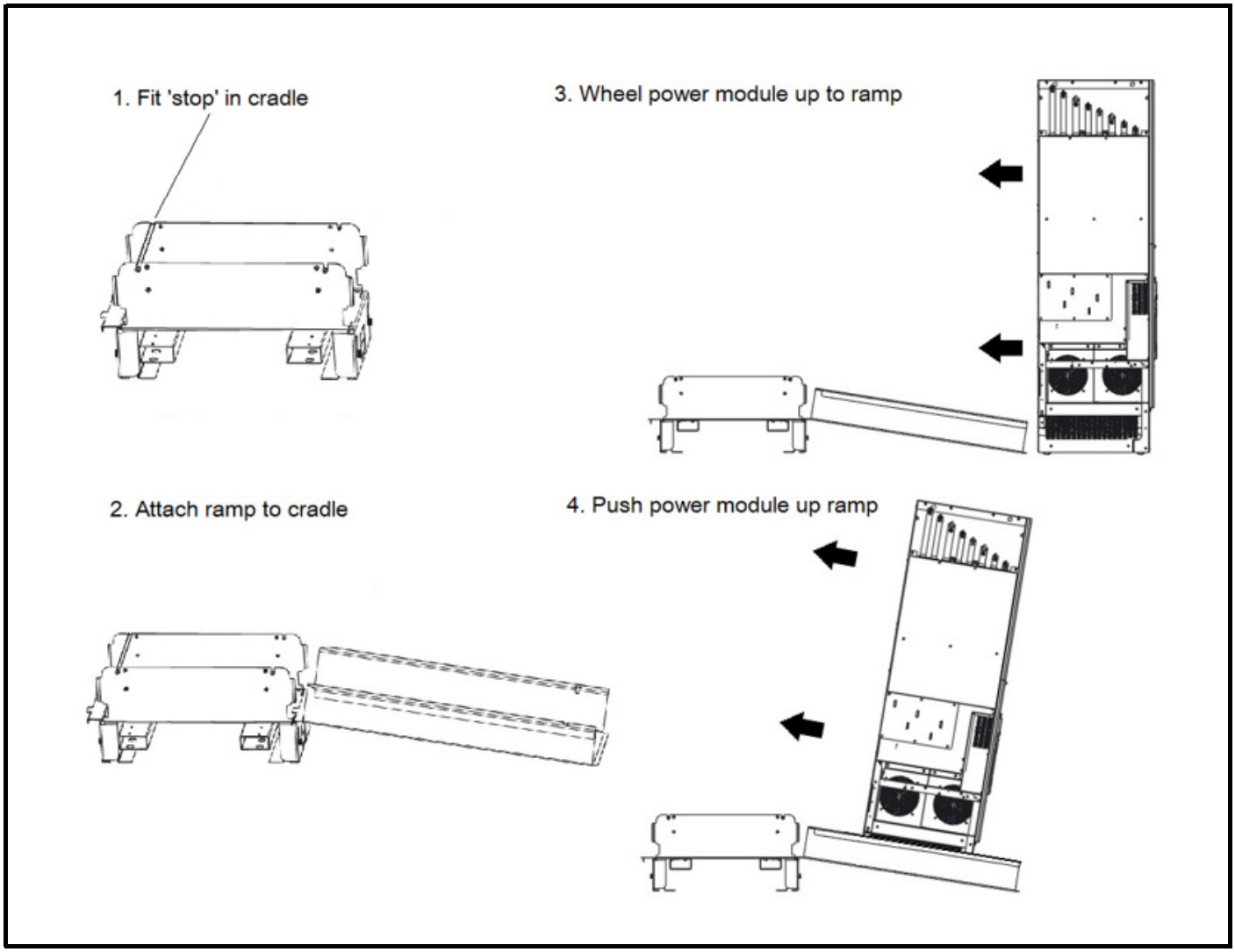
Wiring configurations marked on terminal kit busbars to aid installation.

NOTE

Selected roof, glands and associated parts to be fitted at this stage.

3.7.5 If the power module requires transporting to the cubicle, fit the power module into the cradle. If the power module does not require transportation the ramp can be connected directly to the cubicle. See section 3.7.9 for details.

Figure 3-14 Mounting the drive on the pallet truck lifting kit

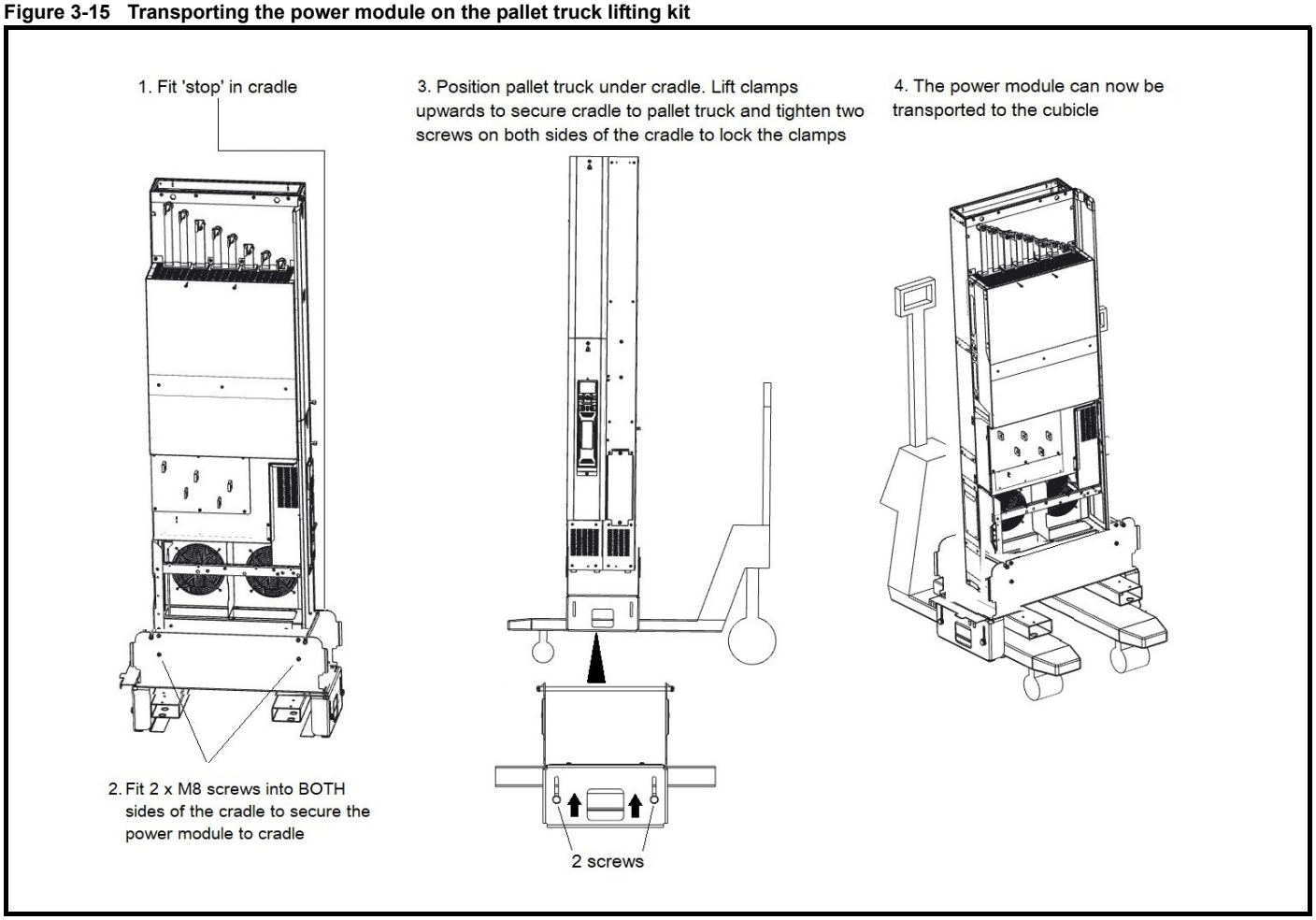


WARNING Push power module slowly up the ramp. Ensure that it is held firmly at all times. The use of gloves is recommended.

WARNING Wear safety shoes when transporting the power module.

3.7.6 Wheel the power module into the cubicle, ensuring alignment of all busbar threaded connections during the final part of movement.

Figure 3-15 Transporting the power module on the pallet truck lifting kit



NOTE

The pallet truck forks are intended to fit underneath the fork supports as shown in part 4 of Figure 3-15.

WARNING

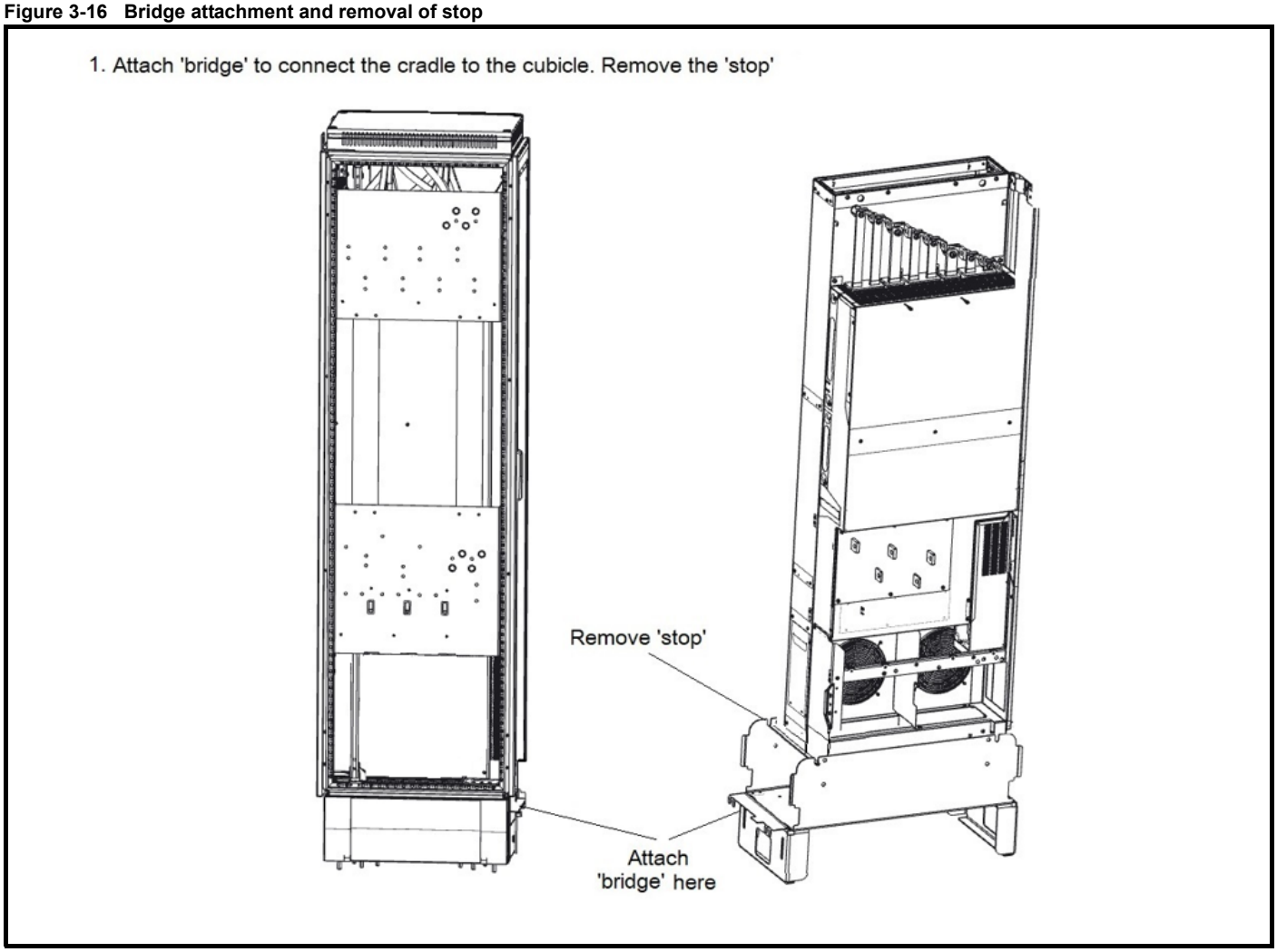
Check that ‘stop’ is firmly located at both ends. Failure to correctly fit the ‘stop’ could cause the power module to fall from the cradle.

WARNING

Ensure that the screws are fitted through the cradle into the power module on both sides and the screws are fitted to the cradle to lock it against the pallet truck forks.

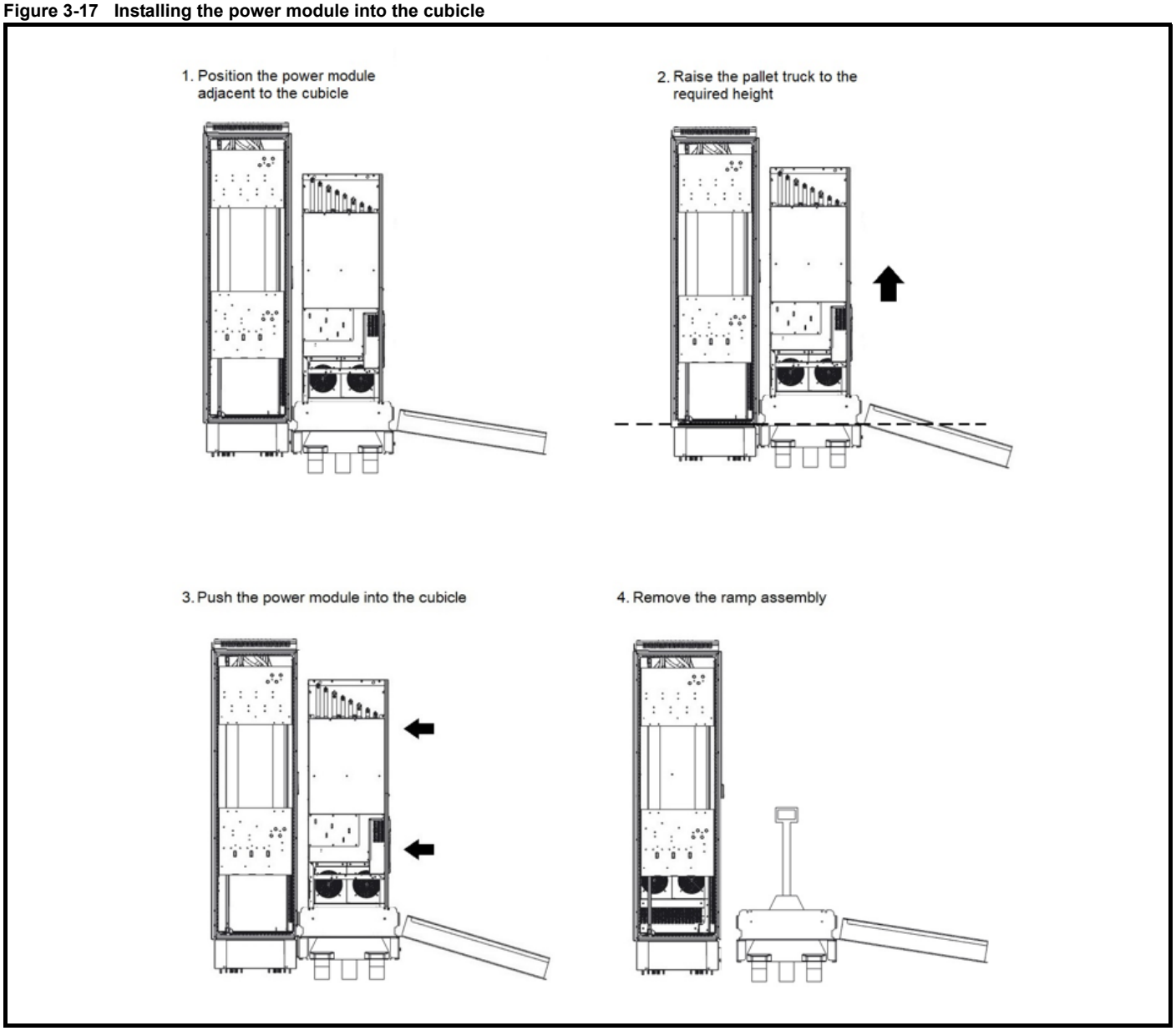
3.7.7 Attach the bridge between the cradle and the cubicle.

Figure 3-16 Bridge attachment and removal of stop



3.7.8 Fit the power module into the cubicle. Ensure terminal busbar alignment is correct.

Figure 3-17 Installing the power module into the cubicle

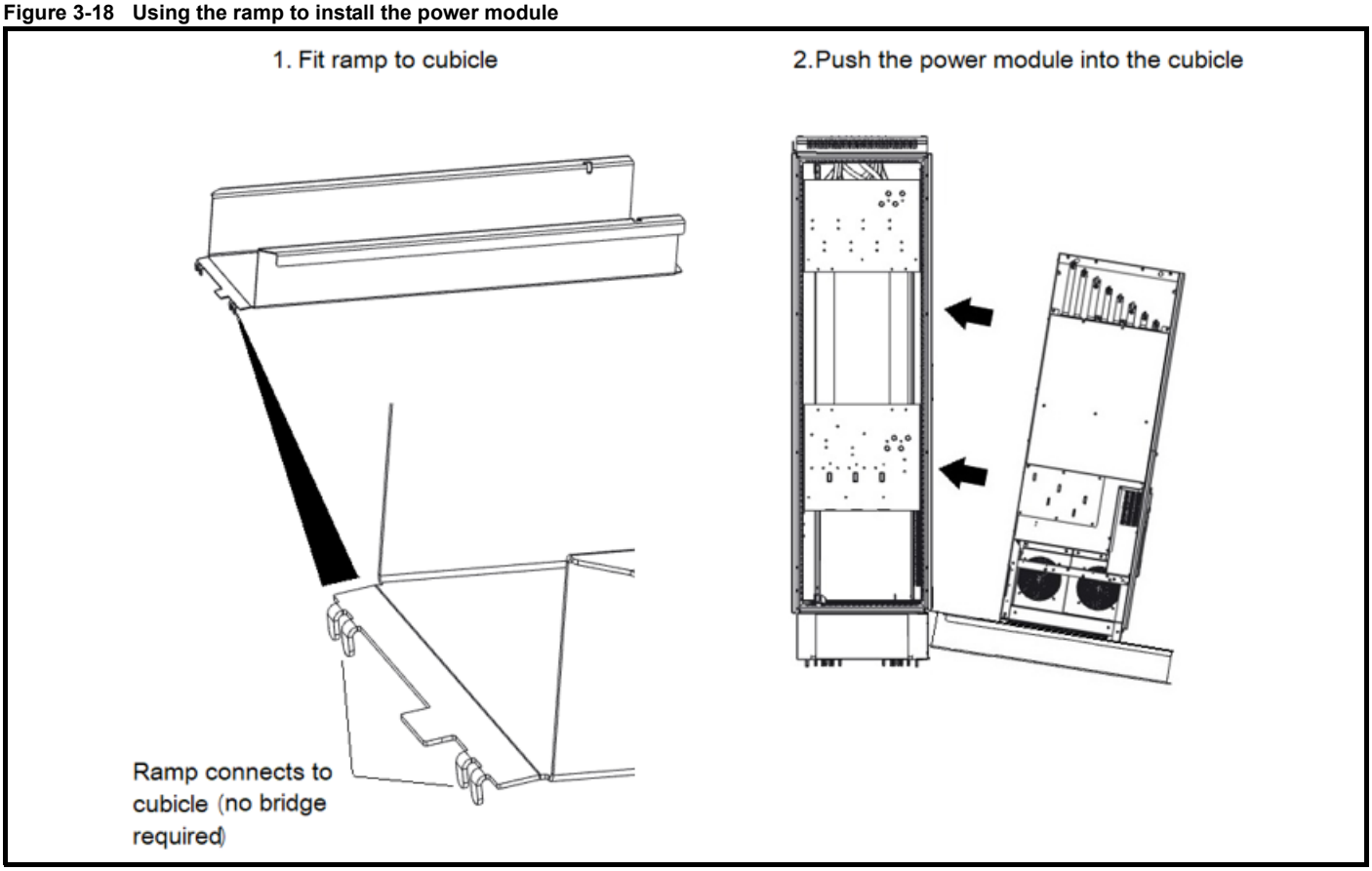


WARNING Keep fingers clear of front of cubicle when sliding power module.

CAUTION Ensure correct alignment of busbars when locating power module to prevent damage to threads.

3.7.9 Installing the cubicle using the ramp only. Ensure terminal busbar alignment is correct.

Figure 3-18 Using the ramp to install the power module



WARNING

Push power module slowly up the ramp. Ensure that it is held firmly at all times. The use of gloves is recommended.

WARNING

Wear safety shoes when transporting the power module.

WARNING

Keep fingers clear of front of cubicle when sliding power module.

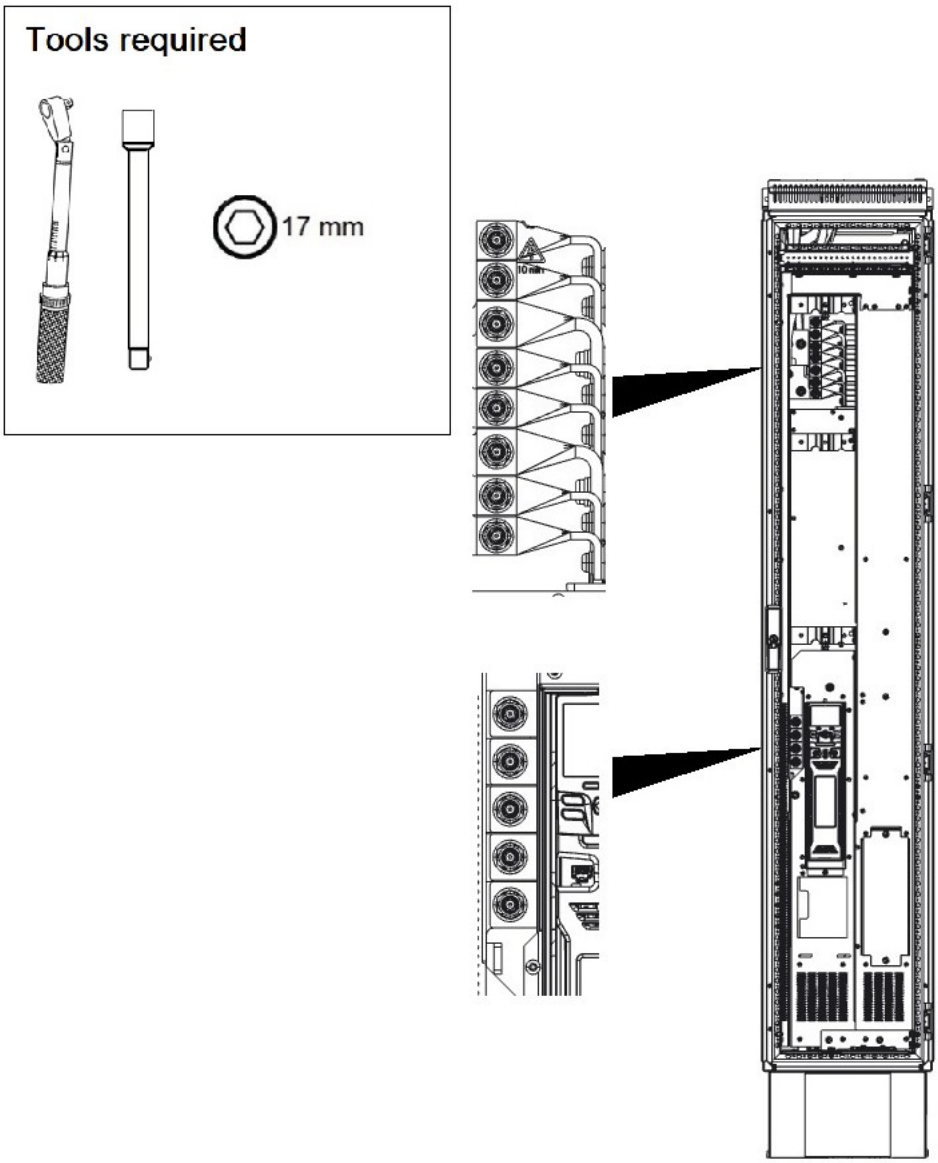
CAUTION

Ensure correct alignment of busbars when locating power module to prevent damage to threads.

3.7.10 Fit 15 x M10 nuts to the main input and output power terminals and ground connections. See section 3.11.5 for location of ground connections.

Tighten loosely to ensure that alignment of terminals is achieved.

Figure 3-19 Fitting the nuts to the power terminals

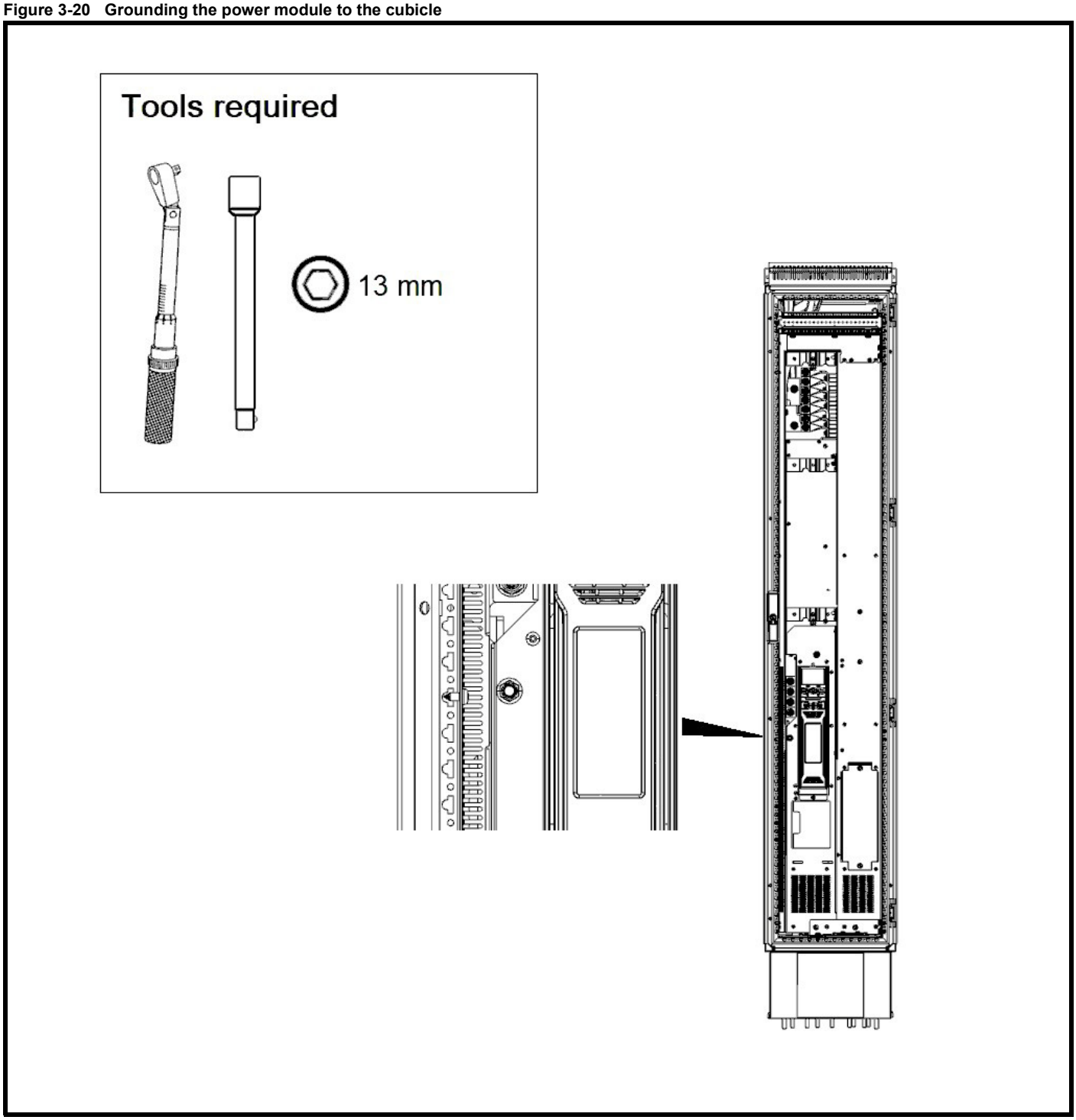


CAUTION

Care must be taken to prevent the fasteners from falling into the cubicle.

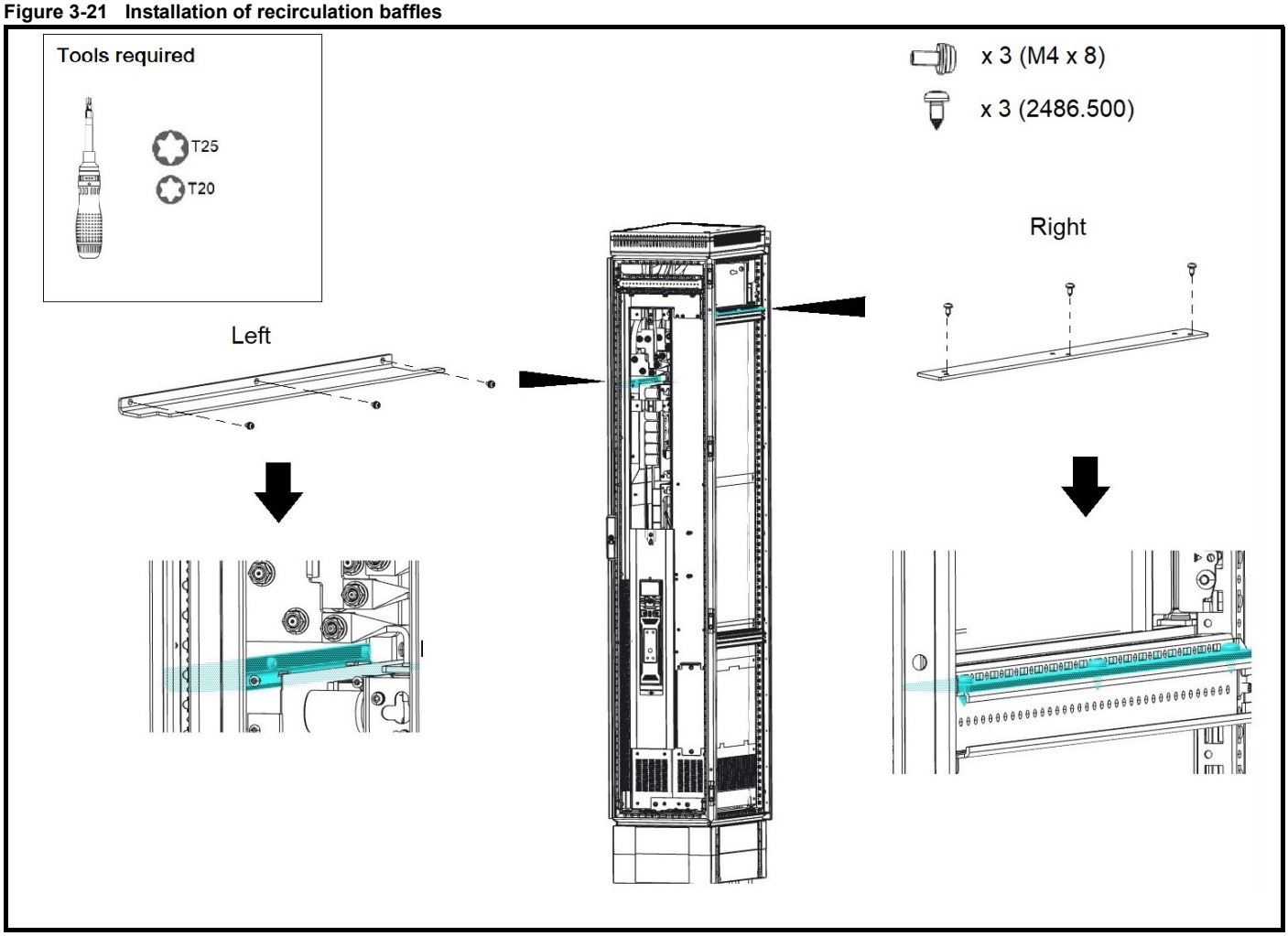
3.7.11 With the power module in the cubicle, fit M8 nut over ground stud and tighten to 2 Nm. This connects the chassis of the power module to ground.

Figure 3-20 Grounding the power module to the cubicle



3.7.12 Install recirculation baffles to upper right and upper left sides. Insert 3 off M4 x 8 screws into left baffle and tighten to 2 Nm. Insert 3 of Rittal multi-tooth 2486.500 screws in right baffle and tighten to 6 Nm.

Figure 3-21 Installation of recirculation baffles

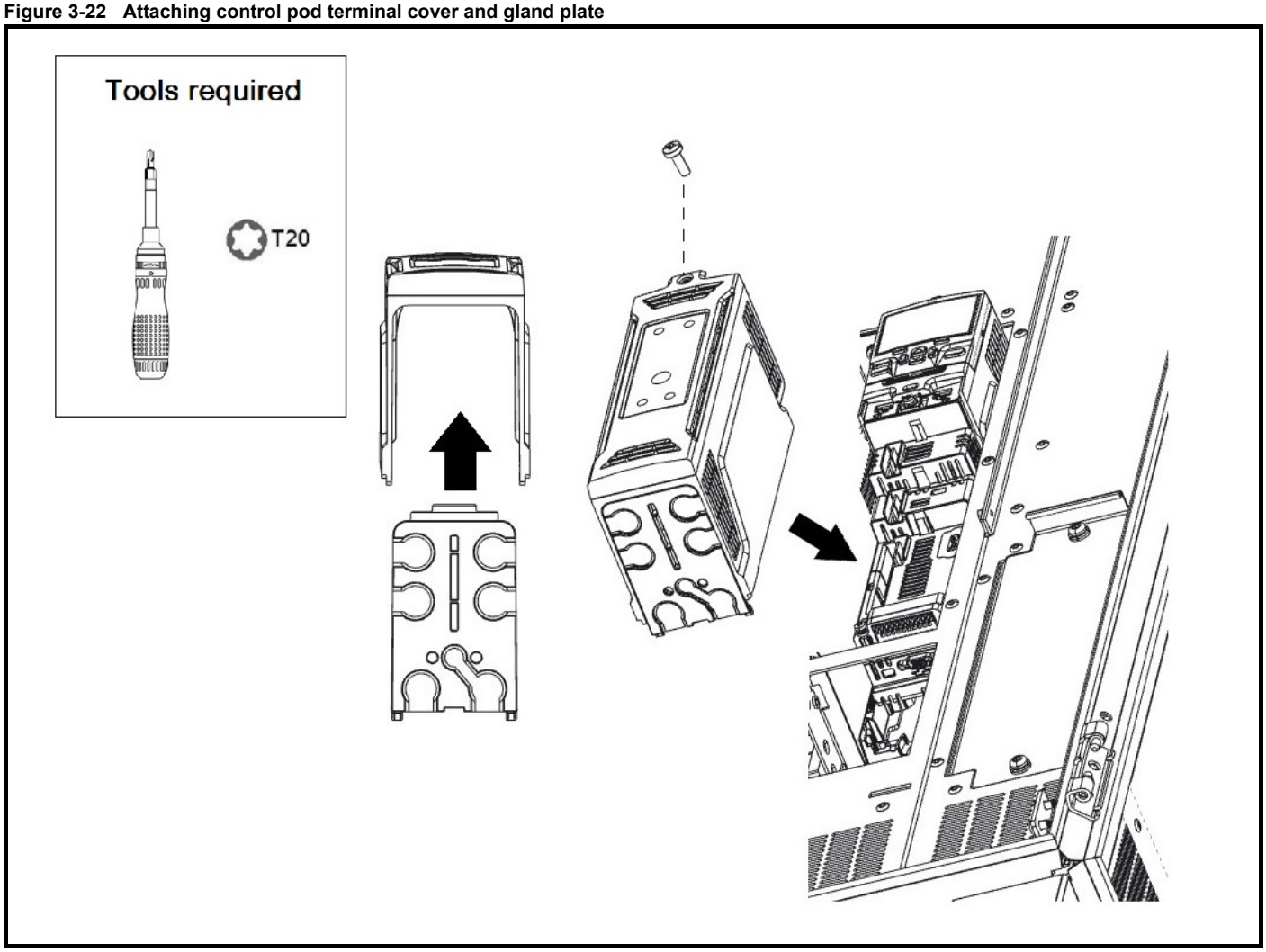


CAUTION

Care must be taken to prevent the fasteners from falling into the cubicle.

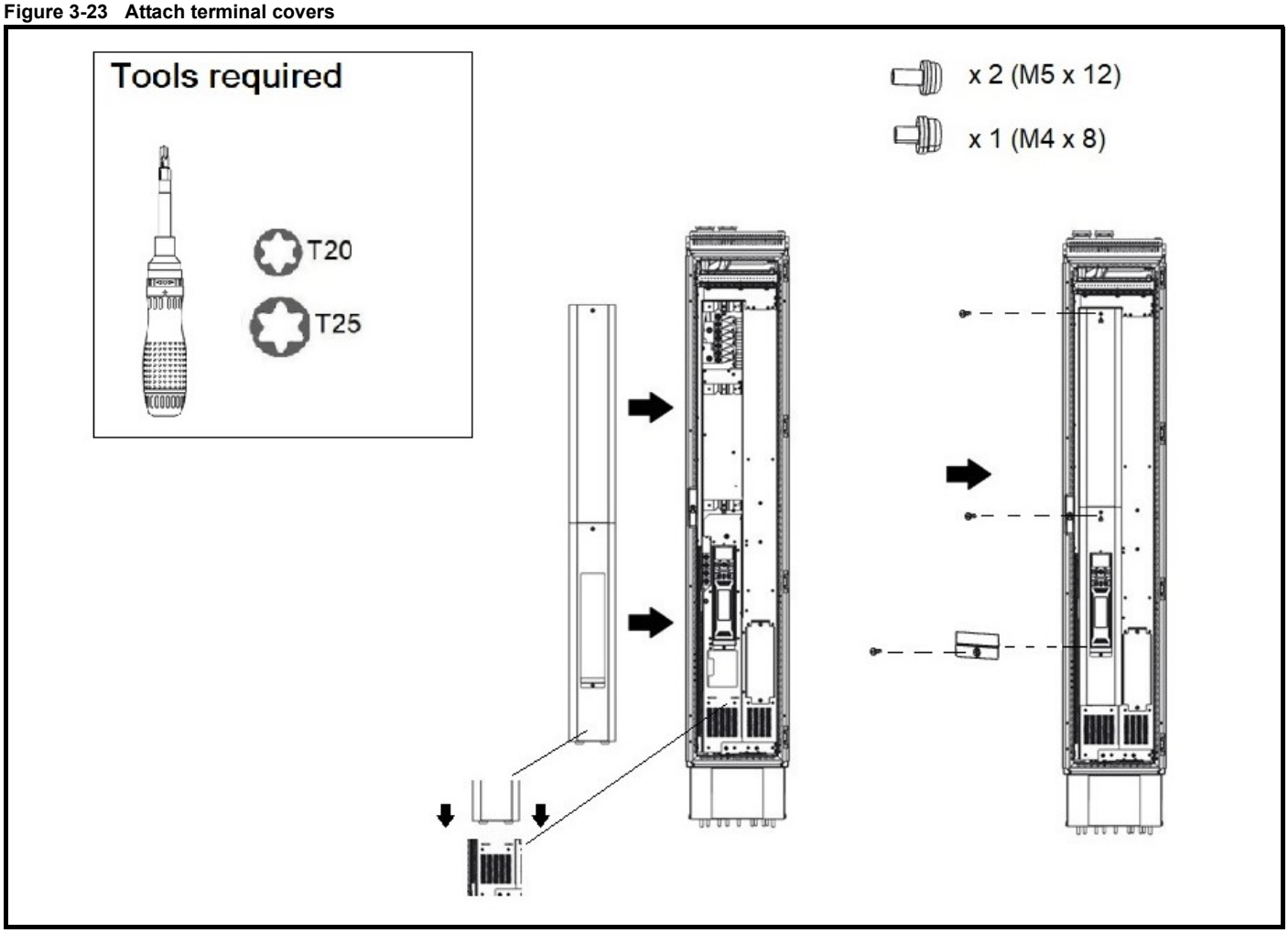
3.7.13 Attach control pod terminal cover and gland plate. Tighten M4 x 12 screw to 2 Nm.

Figure 3-22 Attaching control pod terminal cover and gland plate



3.7.14 Attach terminal covers and fit 2 off M5 x 12 screws. Tighten to 4 Nm. Insert the control pod panel and fit one M4 x 8 screw. Tighten to 2 Nm.

Figure 3-23 Attach terminal covers



3.8 Terminal cover removal

WARNING

Isolation of the cubicle
The AC supply must be disconnected from the drive using the supply isolator before any cover is removed from the drive or before any servicing work is performed.

WARNING

Stored charge
The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may commence.
Normally, the capacitors are discharged by an internal resistor. Under certain, unusual fault conditions, it is possible that the capacitors may fail to discharge or be prevented from being discharged by a voltage applied to the output terminals. If the drive has failed in a manner that causes the display to go blank immediately, it is possible the capacitors will not be discharged. In this case, consult Control Techniques or their authorized distributor.

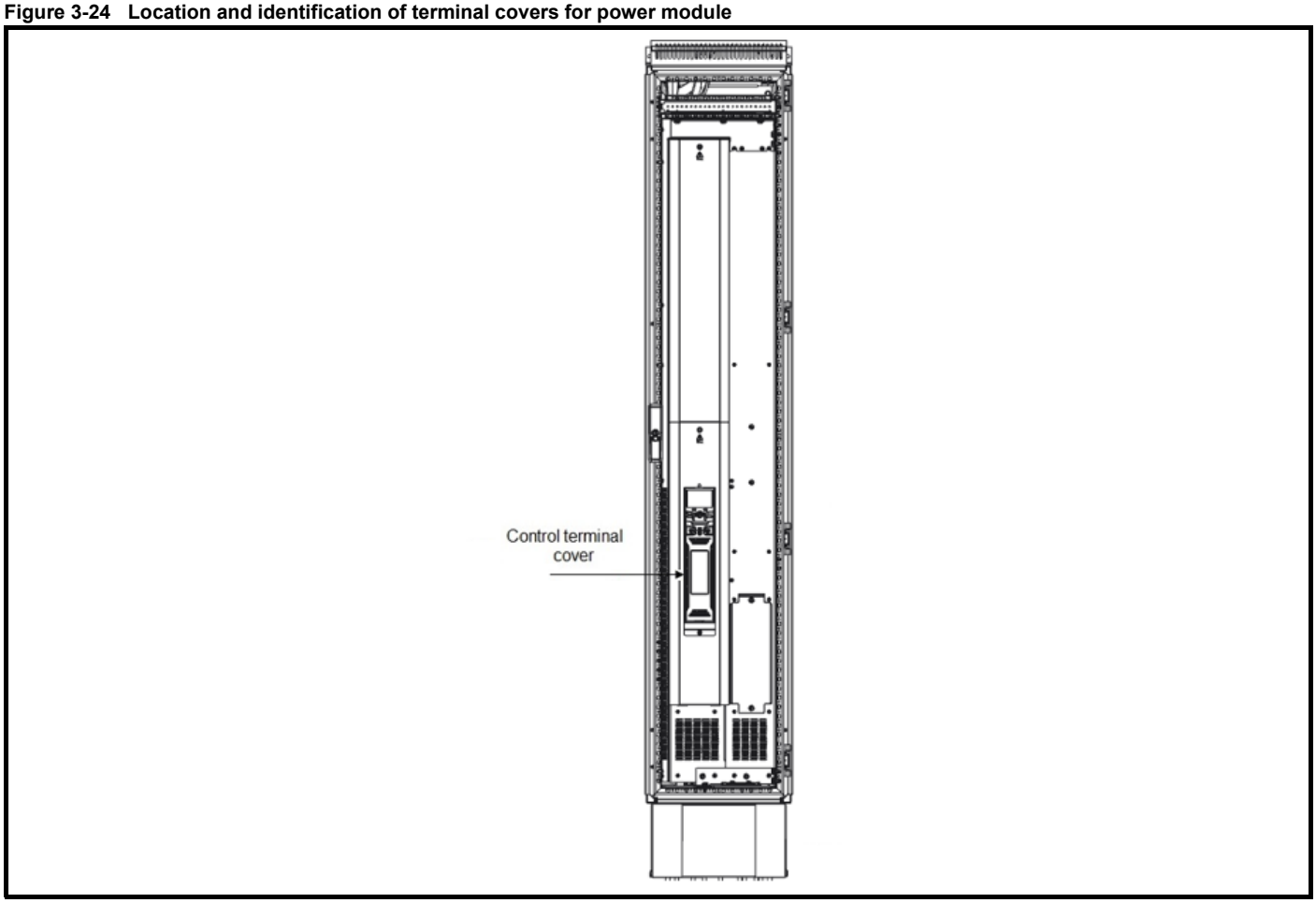
3.8.1 Removing the drive control terminal covers

The power module control terminals are fitted with terminal covers. The terminal covers must be removed to gain access to the control terminals.

NOTE

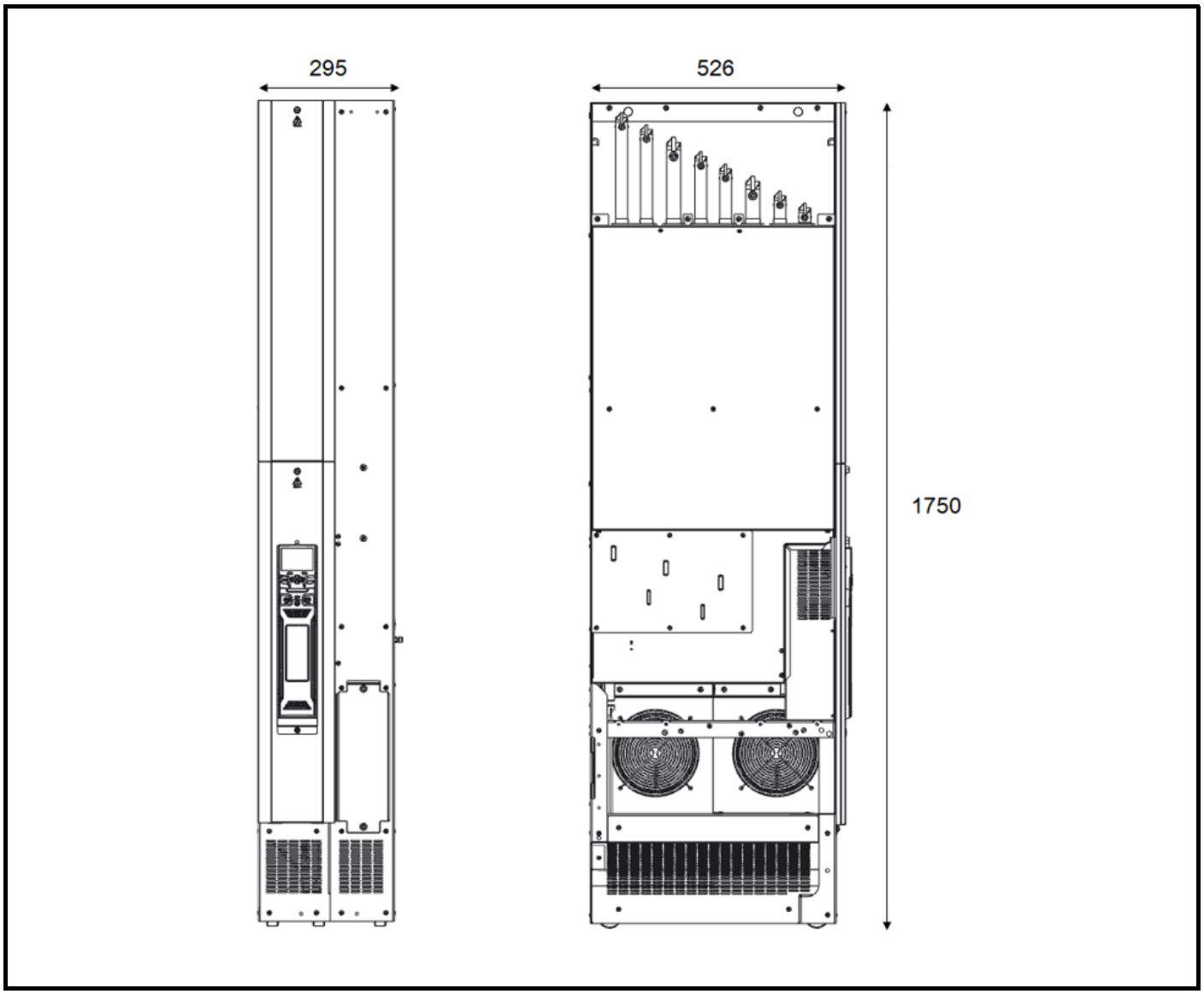
Refer to the relevant control user guide for details on the control terminal layout, functionality and option modules.

Figure 3-24 Location and identification of terminal covers for power module



3.9 Dimensions

Figure 3-25 Power Module dimensions (shown in mm)



3.10 External EMC filter

To provide customers with a degree of flexibility, external EMC filters have been sourced from two manufacturers: Schaffner and Block. Filter details for each drive rating are provided in the tables below.

NOTE

If an external EMC filter is to be installed, it must be installed in an incomer cabinet.

Table 3-2 Drive EMC filter details

Drive	Schaffner		Block	
	Part number	Weight	Part number	Weight
12404800T	FN 3311-1000-99-C16-R55	5.5 kg (12.1 lb)	HLD 103-500/1000	22.5 kg (49.6 lb)
12405660				
12406600				
12407200				

Figure 3-26 Schaffner external EMC filter

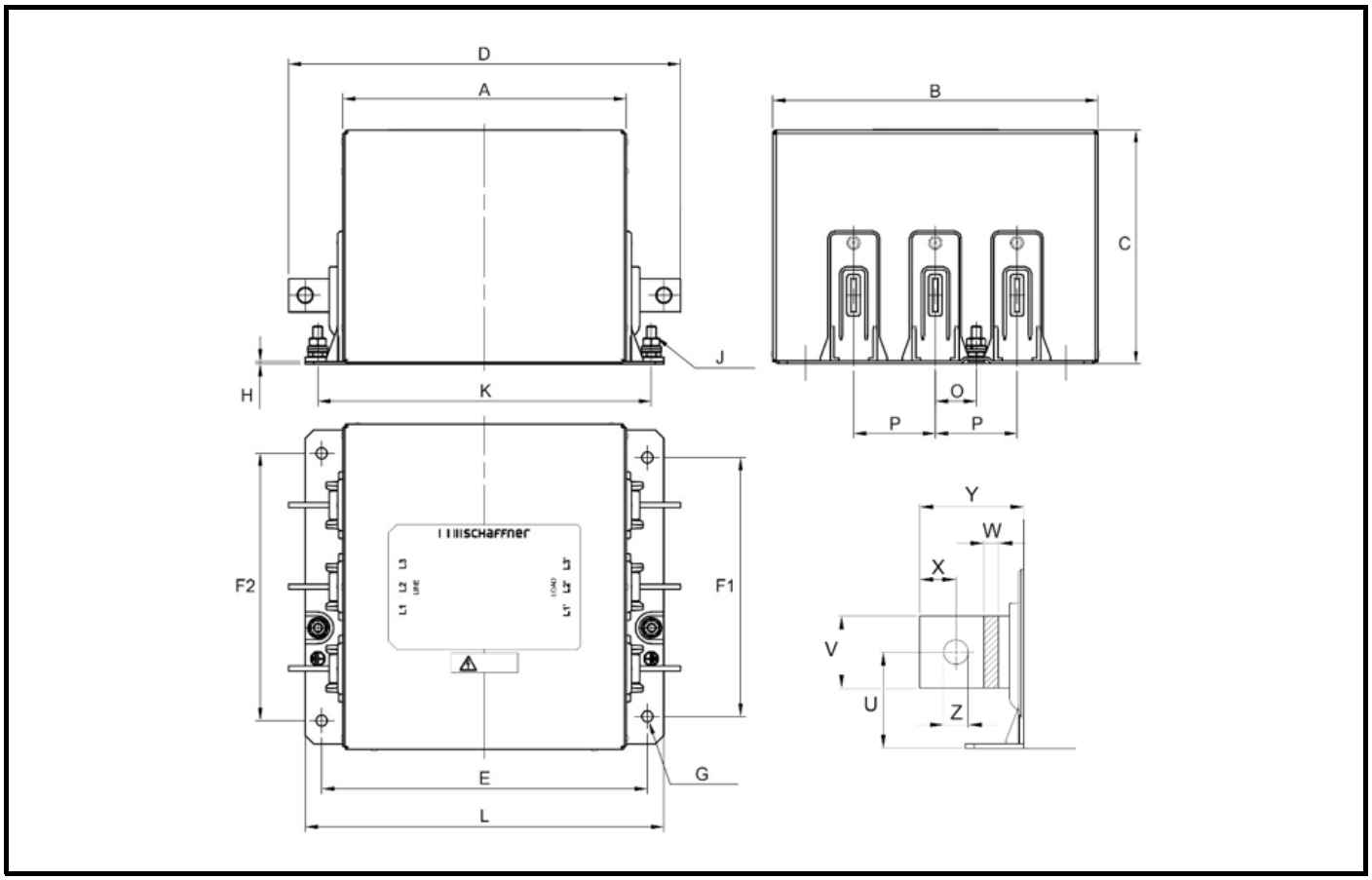


Table 3-3 Schaffner External EMC filter dimensions

Part number	A	B	C	D	E	F1	F2	G	H	J	K	L	O	P	U	V	W	X	Y	Z
FN 3311-1000-99-C16-R55	190	220	140	305	220	180	185	Ø 9	2.5	M8	225 ±1	245	30	59 ±0.5	53	40	8	20	58	Ø 13.5

Figure 3-27 Block external EMC filter

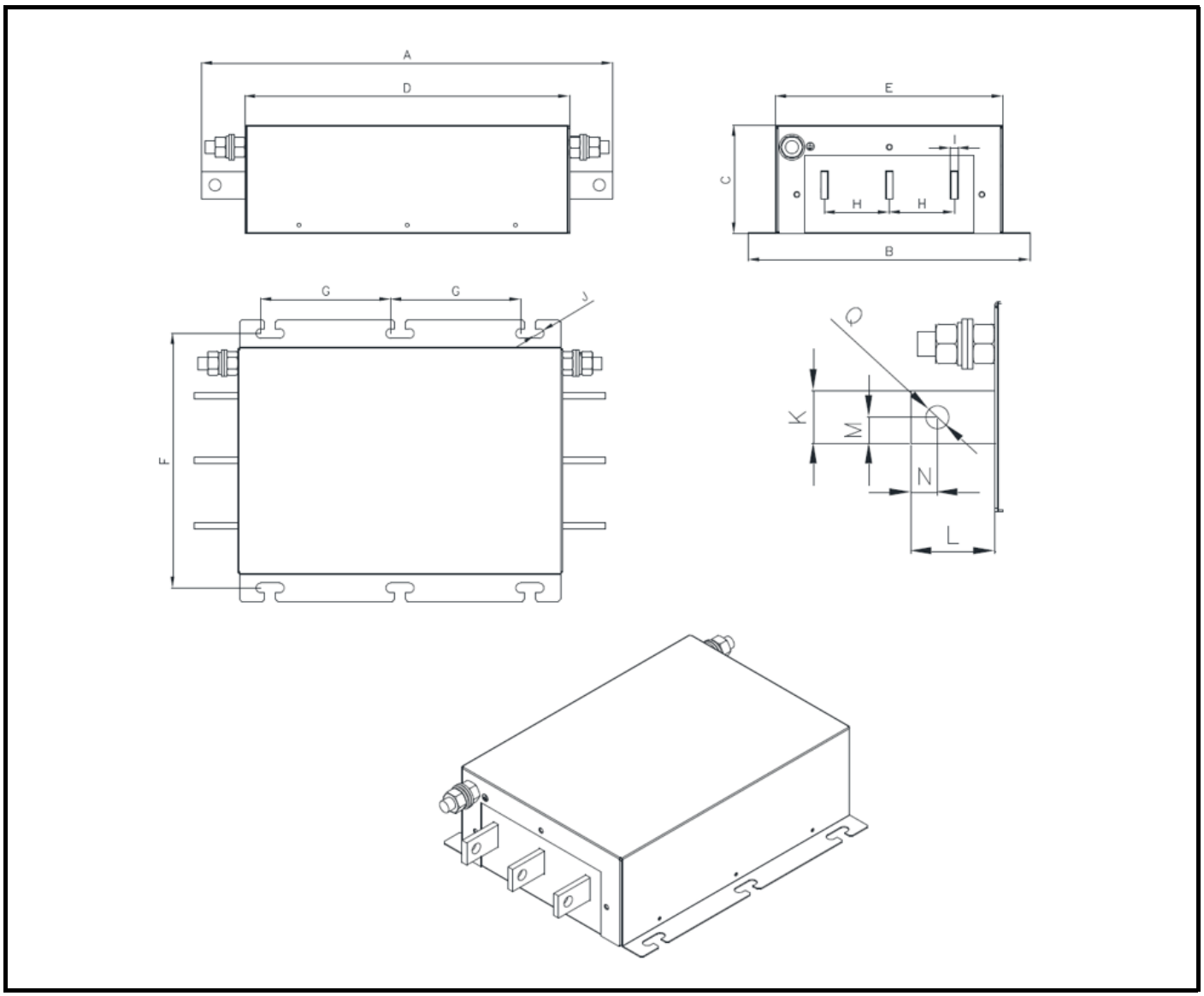


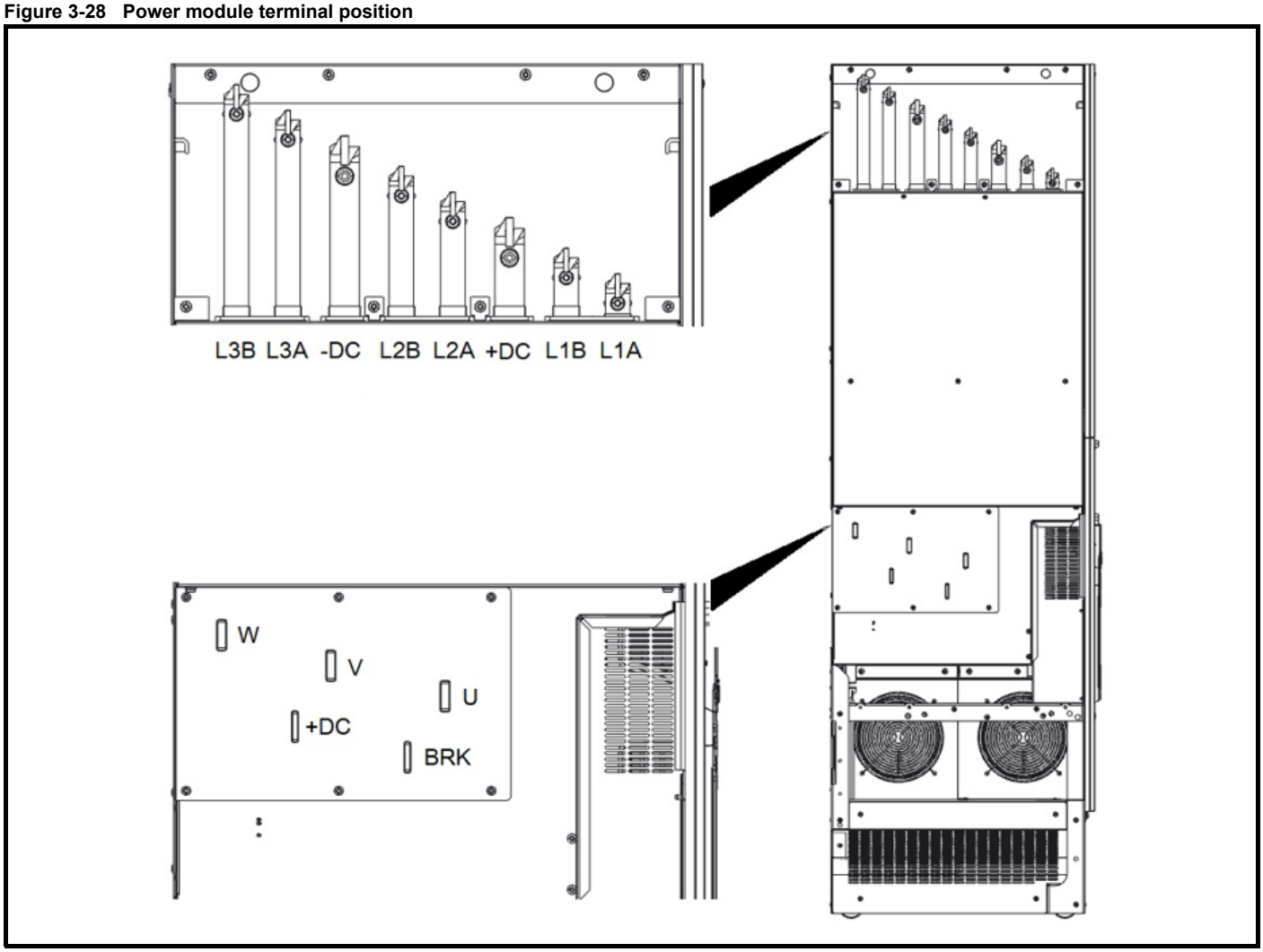
Table 3-4 Block external EMC filter dimensions

Part number	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Q
HLD 103-500/1000	460	280	130	350	230	255	145	60	8	M8	40	55	20	20	Ø 14

3.11 Electrical terminals

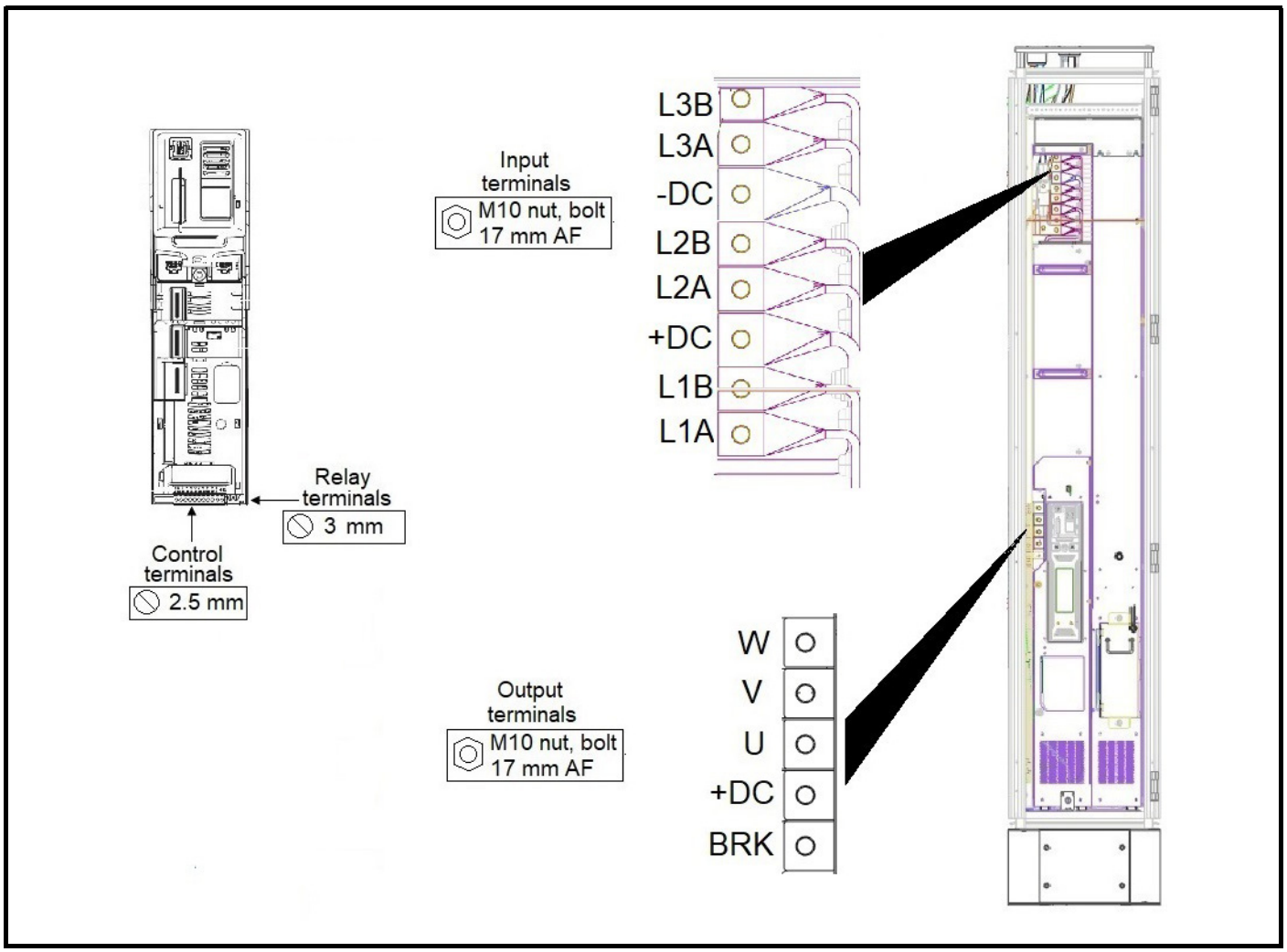
3.11.1 Power module terminals

Figure 3-28 Power module terminal position



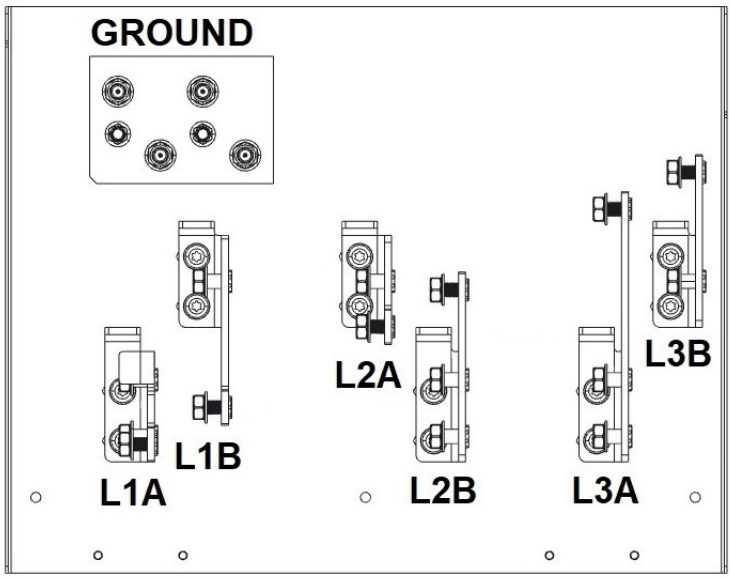
3.11.2 Location of the power and control terminals

Figure 3-29 Location of power and control terminals



3.11.3 Input wiring kit terminal identification for 6 and 12 pulse configurations

Figure 3-30 Terminal identification for input wiring kit.

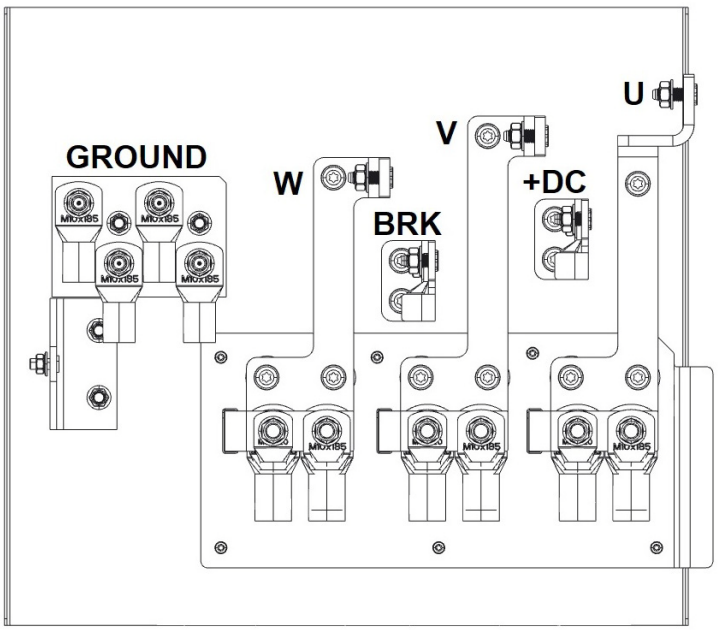


NOTE

The +DC and -DC input busbars are supplied separately. See Page 13, Table 2-4 for further details.

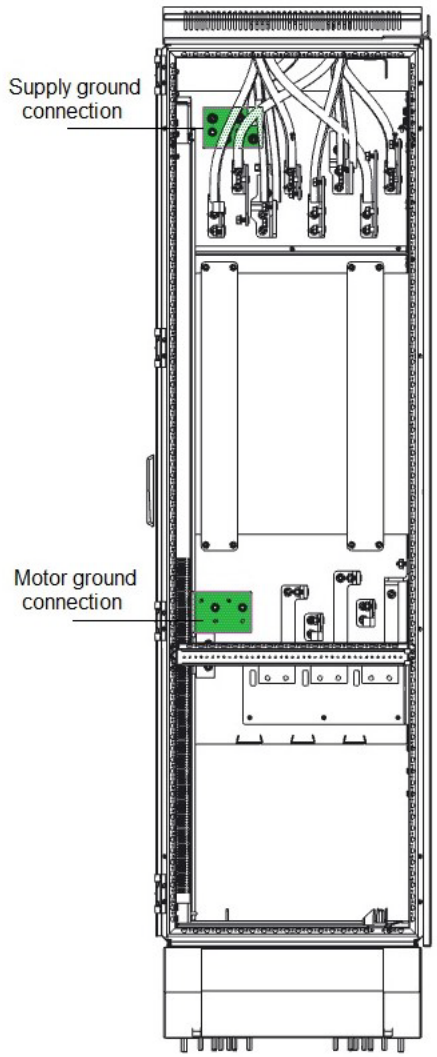
3.11.4 Output wiring kit terminal identification

Figure 3-31 Terminal identification for output wiring kit



3.11.5 Location of ground terminals

Figure 3-32 Location of ground terminals



Ground connections
The equipment must be grounded (earthed). The wiring must conform to local regulations and codes of practice. This is the responsibility of the installer.
The ground loop impedance must conform to the requirements of local safety regulations. The grounded connection must be capable of carrying the prospective fault current until the protective device (fuse, etc.) disconnects the AC supply. The cross-sectional area of the Ground (Earth) conductor must be not less than half the cross-sectional area of the input phase conductors.
The ground connections must be inspected and tested at appropriate intervals.

WARNING

Electrochemical corrosion of grounding terminals
Ensure that grounding terminals are protected against contamination, for example, caused by condensation.

WARNING

Table 3-5 Protective ground cable ratings

Input phase conductor size	Minimum ground conductor size
> 35 mm²	Half of the cross-sectional area of the input phase conductor

3.12 Terminal sizes and torque settings

WARNING

To avoid a fire hazard, adhere to the specified tightening torques for the power and ground terminals. Refer to the following tables.

Table 3-6 Drive control and relay terminal data

Terminal	Connection size	Torque setting
Control and user relay	Plug-in terminal block	0.5 Nm (0.4 lb ft)
Motor output	3 x M10 x 17 AF nut	30 Nm (22.1 lb ft)
Brake	2 x M10 x 17 AF nut	30 Nm (22.1 lb ft)
Earth (ground)	1 x M8 x 13 AF nut	12 Nm (8.9 lb ft)
AC Supply and DC bus	8 x M10 x 17 AF nut	30 Nm (22.1 lb ft)

Table 3-7 Schaffner external EMC filter terminal data

Part number	Power connections	Ground connections	
	Max torque	Ground stud size	Max torque
FN 3311-1000-99-C16-R55	93 Nm (68.6 lb ft)	M8	9 Nm (6.6 lb ft)

Table 3-8 Block external EMC filter terminal data

Part number	Power connections	Ground connections	
	Max torque	Ground stud size	Max torque
HLD 103-500/1000	30 Nm (22.1 lb ft)	M12	30 Nm (22.1 lb ft)

WARNING

Stored charge

The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.

Normally, the capacitors are discharged by an internal resistor. Under certain, unusual fault conditions, it is possible that the capacitors may fail to discharge or be prevented from being discharged by a voltage applied to the output terminals. If the drive has failed in a manner that causes the display to go blank immediately, it is possible the capacitors will not be discharged. In this case, consult Control Techniques or their authorized distributor.

3.13 Routine maintenance

The drive should be installed in a cool, clean, well ventilated location. Contact of moisture and dust with the drive should be prevented.
Regular checks of the following should be carried out to ensure drive / installation reliability are maximized:

Environment	
Ambient temperature	Ensure the enclosure temperature remains at or below maximum specified.
Dust	Ensure the drive remains dust free – check that the heatsink and drive fan are not gathering dust. The lifetime of the fan is reduced in dusty environments.
Moisture	Ensure the drive enclosure shows no signs of condensation.
Electrical	
Screw connections	Ensure all screw terminals remain tight.
Crimp terminals	Ensure all crimp terminals remains tight – check for any discoloration which could indicate overheating.
Cables	Check all cables for signs of damage.

3.14 Replacement of serviceable parts

The drives main components are made up of serviceable sub-assemblies (Inverter, rectifier, SMPS, Power control PCB, fans). Instructions for removal and replacement can be found in the *Frame 12 Service Guide*.

4 Electrical Installation

Electric shock risk
The voltages present in the following locations can cause severe electric shock and may be lethal:

- AC supply cables and connections
- DC and brake cables, and connections
- Output cables and connections
- Many internal parts of the drive, and external option units

Unless otherwise indicated, control terminals are single insulated and must not be touched.

Stored charge
The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.
Normally, the capacitors are discharged by an internal resistor. Under certain, unusual fault conditions, it is possible that the capacitors may fail to discharge or be prevented from being discharged by a voltage applied to the output terminals. If the drive has failed in a manner that causes the display to go blank immediately, it is possible the capacitors will not be discharged. In this case, consult Control Techniques or their authorized distributor.

STOP function
The STOP function does not remove dangerous voltages from the drive, the motor or any external option units.

Equipment supplied by plug and socket
Special attention must be given if the drive is installed in equipment which is connected to the AC supply by a plug and socket. The AC supply terminals of the drive are connected to the internal capacitors through rectifier diodes which are not intended to give safety isolation. If the plug terminals can be touched when the plug is disconnected from the socket, a means of automatically isolating the plug from the drive must be used (e.g. a latching relay).

Permanent magnet motors
Permanent magnet motors generate electrical power if they are rotated, even when the supply to the drive is disconnected. If that happens then the drive will become energized through its motor terminals.
If the motor load is capable of rotating the motor when the supply is disconnected, then the motor must be isolated from the drive before gaining access to any live parts.

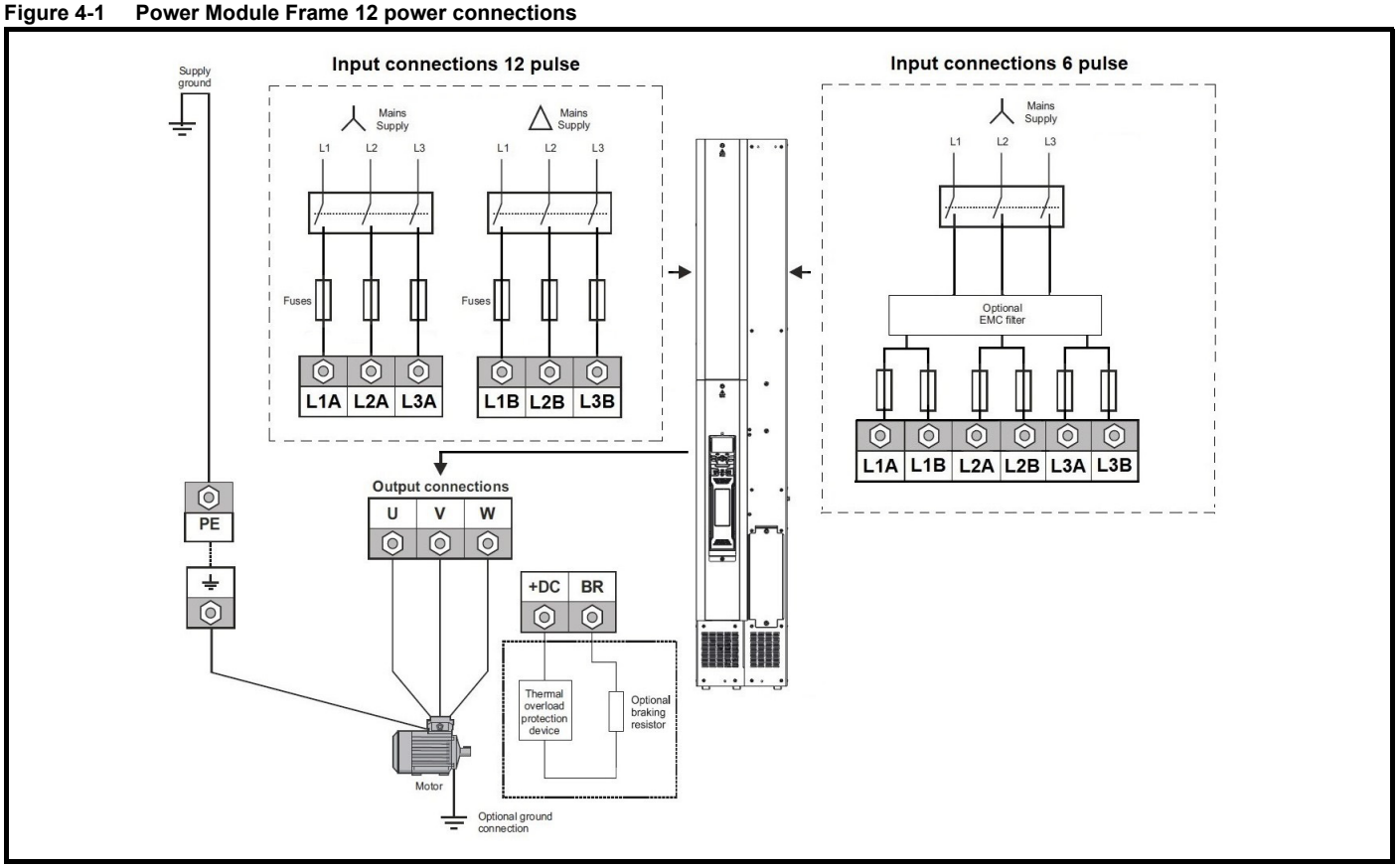
Fuses
The AC supply to the drive must be installed with suitable protection against overload and short circuits. Table 4-10 on page 51 show the recommended fuse ratings.
Failure to observe this requirement will increase the risk of fire.

Isolation device
The AC supply must be disconnected from the drive using an approved isolation device before any cover is removed from the drive or before any servicing work is performed.

4.1 Power connections

4.1.1 AC and DC and brake connections

Figure 4-1 Power Module Frame 12 power connections



4.2 Output short circuit protection

The drive modules are provided with fast-acting electronic short-circuit protection which limits the fault current to typically no more than five times the rated output current and interrupts the current in approximately 20 µs. No additional short-circuit protection devices are required. Refer to the Unidrive M700, M701, M702 Control User Guide. CT Part Number: 0478-0353.

4.3 Motor overload protection

The drive modules are provided with overload protection for the motor and the motor cable.

For this to be effective, the drive overload protection parameter 'Rated Current (00.046)' must be set to the rated motor current as marked on the motor rating plate. For details of how to adjust the drive parameters, refer to the Unidrive M700, M701, M702 Control User Guide. CT Part Number: 0478-0353.

WARNING

Parameter Pr **00.046** '*Motor Rated Current*' must be set correctly to avoid a risk of fire in the event of motor overload.

Table 4-1 Typical motor overload limits

Operating mode	RFC from cold	RFC from 100 %	Open loop from cold	Open loop from 100 %
Normal Duty overload with motor rated current = drive rated current	110 % for 180 s	110 % for 10 s *	110 % for 180 s	110 % for 10 s *
Heavy Duty overload with motor rated current = drive rated current	140 % for 60 s	140 % for 10 s	140 % for 60 s	140 % for 10 s

* 1240720T rating provides 110 % for 3 s from rated normal duty current. 110 % is available for 10 s when limited to 850 A continuous.

12406600T and 12405660T support 110 % for 10 s.

Generally, the drive rated current is higher than the matching motor rated current allowing a higher level of overload than the default setting. The time allowed in the overload region is proportionally reduced at very low output frequency on some drive ratings.

NOTE

The maximum overload level which can be attained is independent of the speed.

4.4 Use of a residual current device (RCD)

There are three common types of ELCB / RCD:

- AC - detects AC fault currents
- A - detects AC and pulsating DC fault currents (provided the DC current reaches zero at least once every half cycle)
- B - detects AC, pulsating DC and smooth DC fault currents

Type AC should not be used with variable speed drives.

Type A can only be used with single phase drives

Type B is the only type suitable for use with three phase, variable speed drives

RCD types
Only type B ELCB / RCD are suitable for use with 3 phase inverter drives.

If an external EMC filter is used, a delay of at least 50 ms should be incorporated to prevent spurious tripping. The leakage current is likely to exceed the trip level if all phases are not energized simultaneously.

NOTE

RCD's with trip levels of less than 100 mA are not supported with this product.

4.5 Supply requirements

4.5.1 AC to AC operation (AC supply to AC motor)

Table 4-2 AC Supply voltage ranges

Voltage range	400 V
Number of supply phases	3
Rated supply	400 V
Max nominal supply	480 V
Tolerance	10 %
Max supply AC rms	528 V
Min nominal supply	380 V
Tolerance	-10 %
Min supply AC rms	342 V

Maximum supply imbalance: 2 % negative phase sequence (equivalent to 3 % voltage imbalance between phases).

Frequency range: 45 to 66 Hz

For UL compliance only, the maximum supply symmetrical fault current must be limited to 100 kA.

4.5.2 Types of AC supply configuration

The types of AC supply shown in Table 4-3 of can be used.

Table 4-3 Types of AC supply

Voltage rating	400 V
Star (Y) connected supply	
Earth system: any TN, TT, neutral earthed	✓
Earth system: IT (floating supply)	✓
Delta connected supply	
Earth system: any TN, TT, corner earthed	✓
Earth system: IT (floating supply)	✓
Centre of one side of delta grounded	✓
Corner earthed (grounded) in regen mode	✘

4.5.3 DC Supply

Table 4-4 DC to AC operation

Voltage range	400 V
Rated supply	565 V
Max supply DC	743 V
Min supply DC	485 V

4.5.4 Supply types

Drives rated for supply voltage up to 575 V are suitable for use with any supply type, i.e. TN-S, TN-C-S, TT, IT, with grounding at any potential, i.e. neutral, centre or corner ("grounded-delta"). Grounded delta supplies > 575 V are not permitted.

Drives are suitable for use on supplies of installation category III and lower, according to IEC60664-1. This means they may be connected permanently to the supply at its origin in a building, but for outdoor installation additional over-voltage suppression (transient voltage surge suppression) must be provided to reduce category IV to category III.

WARNING

Operation with IT (ungrounded) supplies:
Special attention is required when using internal or external EMC filters with ungrounded supplies, because in the event of a ground (earth) fault in the motor circuit the drive may not trip and the filter could be over-stressed. In this case, either the filter must not be used (removed) or additional independent motor ground fault protection must be provided. Refer to Table 4-5.
For details of ground fault protection contact the supplier of the drive.

Table 4-5 Behaviour of the drive in the event of a motor circuit ground (earth) fault with an IT supply

Internal filter only	External filter (in addition to internal filter)
May not trip – precautions required • Remove the EMC filter • Use ground leakage relay	May not trip – precautions required • Do not use EMC filter • Use ground leakage relay

4.5.5 Line reactors

The Power Module Frame 12 input has two rectifiers to enable 6 pulse or 12 pulse operation as standard. The rectifier and DC link are designed such that an external input line reactor is not required.

6 pulse operation is created by connecting the inputs of the two rectifiers to a 3 phase 3 wire (+ PE) supply.

Lower harmonics 12 pulse operation is created by feeding the two rectifiers with two secondary windings; one Δ and one Y.

For 6 pulse operation

- The design assumes an input impedance of 1 % for base power of 500 kVA. To put this in context, a typical cost-effective installation will have a supply transformer not bigger than 3 MVA, with a typical impedance of 6 % and will provide the 1 % impedance at 500 kVA base.
- In rare low voltage (± 690 V) systems with transformer power > 3 MVA and input cables greater than 15 meters from transformer to drive, the minimum impedance will satisfy the requirements of the drive input stage.
- From a harmonics emission perspective, at public low-voltage system, there are no compliance requirements in IEC61000-3-12 for drives rated at over 75 A.
- Input line reactors (INL's) may be installed to reduce the total input RMS current and the harmonics content. If an input line reactor is required, a standard 1 % reactor can be sourced locally. Should the harmonics requirement be strict, an active front end is recommended.
- Laboratory measurements have been performed using a low impedance transformer (1 MVA Dyn11 2.45 %) with approximately 25 metres of cable from transformer to power distribution (PD2) panel and 30 metres of cable from PD2 to point of load. The results with a 500 kVA load indicated < 7 % THDv at the point of load and THDv < 2 % at the PD2 when the THDi =~ 57 %.

For 12 Pulse operation

- For 12 pulse operation, a phase shift Ddy transformer, an equivalent isolating transformer, an auto transformer type, such as the Line Interphase Transformer (LIT), or other partial power differential types are available.
- In this operation mode, not only are the harmonics reduced but also the input stage stresses. As a result, the DC capacitors lifetime is greatly extended.

For individual harmonic data for the above conditions listed above please refer to the EMC datasheet.

If current harmonic compliance is required to IEEE519 an active front end solution is recommended.

4.5.6 24 Vdc supply

The 24 Vdc supply connected to control terminals provides the following functions:

It can be used to supplement the drive's own internal 24 V supply when multiple option modules are being used and the current drawn by these modules is greater than the drive can supply.

It can be used as a back-up power supply to keep the control circuits of the drive powered up when the line power supply is removed. This allows any fieldbus modules, application modules, encoder or serial communications to continue to operate.

It can be used to commission the drive when the line power supply is not available, as the display operates correctly. However, the drive will be in the Under Voltage trip state unless either line power supply or low voltage DC operation is enabled, therefore diagnostics may not be possible.

(Power down save parameters are not saved when using the 24 V back-up power supply input)

If the DC bus voltage is too low to run the main SMPS in the drive, then the 24 V supply can be used to supply all the low voltage power requirements of the drive. *Low Under Voltage Threshold Select* (06.067) must also be enabled for this to happen.

Table 4-6 24 Vdc supply connections

Function	Frame 12
Supplement the drive's internal supply	Terminal 1, 2*
Back-up supply for the control circuit	Terminal 51, 52

* Terminal 9 on *Unidrive M702*

Table 4-7 Working range of the control 24 Vdc power supply

1	**0 V common**
2	**+24 Vdc**
Nominal operating voltage	24.0 Vdc
Minimum continuous operating voltage	19.2 V
Maximum continuous operating voltage	28.0 V
Minimum startup voltage	21.6 V
Maximum power supply requirement at 24 V	40 W
Recommended fuse	3 A, 50 Vdc

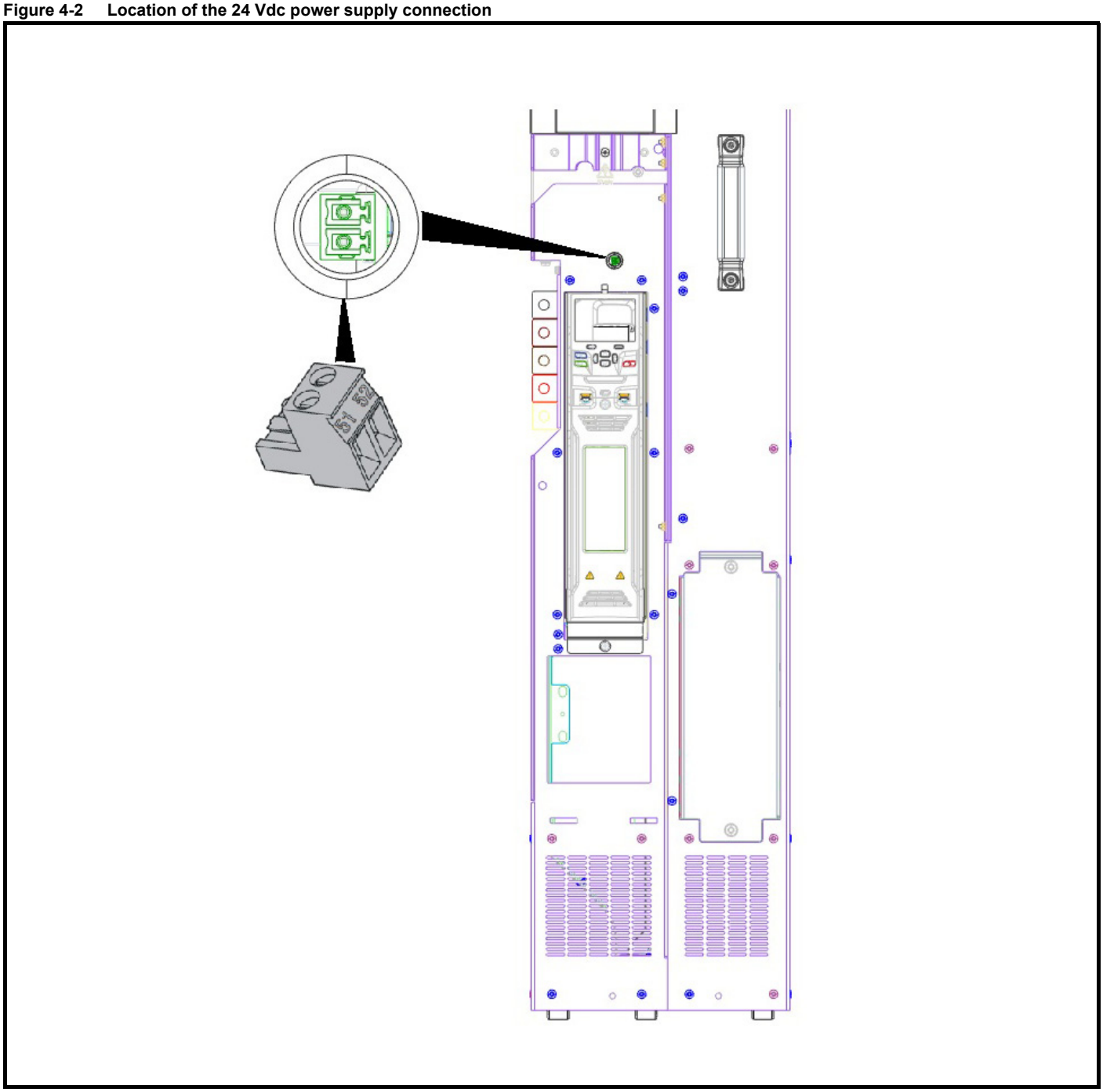
Table 4-8 Working range of the 24 Vdc power supply

51	**0 V common**
52	**+24 Vdc**
Nominal operating voltage	24.0 Vdc
Minimum continuous operating voltage	18.6 V
Maximum continuous operating voltage	28.0 V
Minimum startup voltage	18.4 V
Maximum power supply requirement at 24 V	40 W
Recommended fuse	3 A, 50 Vdc

NOTE

If the 24 Vdc supply is not connected none of the above-mentioned functions can be used and "Waiting For Power Systems" will be displayed on the keypad. The location of the power 24 Vdc can be identified from Figure 4-2.

Figure 4-2 Location of the 24 Vdc power supply connection



4.6 Low voltage operation

With the addition of a 24 Vdc power supply to supply the control circuits, the drive is able to operate from a low voltage DC supply with a range from 24 Vdc to the maximum DC volts. It is possible for the drive to go from operating on a normal line power supply to operating on a much lower supply voltage without interruption.

Going from low voltage operation to normal mains operation requires the inrush current to be controlled. This may be provided externally.

If not, the drive supply can be interrupted to utilize the normal soft starting method in the drive.

To fully exploit the low voltage mode of operation, the under voltage trip level is now user programmable. For application data, contact the supplier of the drive.

The working voltage range of the low voltage DC power supply is as follows:

Minimum continuous operating voltage: 26 V

Minimum start up voltage: 32 V

Maximum over voltage trip threshold: 415 V

4.7 Ratings

The input current is affected by the supply voltage and impedance.

Typical input current

The values of typical input current are given to aid calculations for power flow and power loss. The values of typical input current are stated for a balanced supply.

Maximum continuous input current

The values of maximum continuous input current are given to aid the selection of cables and fuses. These values are stated for the worst case condition with the unusual combination of stiff supply with bad balance. The value stated for the maximum continuous input current would only be seen in one of the input phases. The current in the other two phases would be significantly lower.

The values of maximum input current are stated for a supply with a 2 % negative phase-sequence imbalance and rated at the supply fault current given in Table 4-9.

Table 4-9 Supply fault current used to calculate maximum input currents

Model	Symmetrical fault level (kA)
All	100

WARNING

Fuses
The AC supply to the drive must be installed with suitable protection against overload and short-circuits. Table 4-10 shows the recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

Table 4-10 400 V Drive input current, fuse and cable size rating

Model	Maximum continuous input current	Fuse (6 per drive)		Nominal cable size (European) mm^2				Nominal cable size (USA)		
		IEC		Input 6 pulse	Input 12 pulse	Output	Cable type (input & output)	Input 6 pulse	Input 12 pulse	Output
	3 ph	Nom	Class							
	A	A		mm^2	mm^2	mm^2		kcmil	kcmil	kcmil
12404800T	720	400	gR	4 x 120	2 x 120	3 x 150	XLPE/EPR	4 x 250	2 x 250	4 x 250
12405660T	777	450		4 x 150	2 x 150	4 x 120		4 x 300	2 x 300	4 x 300
12406600T	845	500				3 x 185		4 x 400	2 x 400	4 x 350
12407200T	995	550		4 x 185	2 x 185	4 x 150		4 x 500	2 x 500	3 x 500

NOTE

Cable sizes are from IEC60364-5-52:2009 table B.52.3 with correction factor for 40 °C ambient of 0.91 (from table B52.14) for cable installation method B2 (multicore cable in conduit).

Cable size may be reduced if a different installation method is used, or if the ambient temperature is lower.

The recommended cable sizes above are only a guide. The mounting and grouping of cables affects their current-carrying capacity, in some cases smaller cables may be acceptable but in other cases a larger cable is required to avoid excessive temperature or voltage drop. Refer to local wiring regulations for the correct size of cables.

NOTE

Cable sizes indicated are PVC insulated.

NOTE

The recommended output cable sizes assume that the motor maximum current matches that of the drive. Where a motor of reduced rating is used the cable rating may be chosen to match that of the motor. To ensure that the motor and cable are protected against overload, the drive must be programmed with the correct motor rated current.

A fuse or other protection must be included in all live connections to the AC supply.

NOTE

Fuse types

The fuse voltage rating must be suitable for the drive supply voltage.

Ground connections

The drive must be connected to the system ground of the AC supply. The ground wiring must conform to local regulations and codes of practice.

Table 4-11 Protective ground cable ratings

Input phase conductor size	Minimum ground conductor size
>35 mm^2	Half of the cross-sectional area of the input phase conductor

4.7.1 Main AC supply contactor

The recommended AC supply contactor type is AC1.

4.8 Output circuit and motor protection

The output circuit has fast-acting electronic short-circuit protection which limits the fault current to typically no more than five times the rated output current and interrupts the current in approximately 20 µs. No additional short-circuit protection devices are required.

The drive provides overload protection for the motor and its cable. For this to be effective, Pr **0.046** *Motor rated current* must be set to suit the motor.

Pr **0.046** *Motor rated current* must be set correctly to avoid a risk of fire in the event of motor overload.

There is also provision for the use of a motor thermistor to prevent over-heating of the motor, e.g. due to loss of cooling.

4.8.1 Cable types and lengths

Since capacitance in the motor cable causes loading on the output of the drive, ensure the cable length does not exceed the values given in Table 4-12.

Use 105 °C (221 °F) (UL 60/75 °C temp rise) PVC-insulated cable with copper conductors having a suitable voltage rating, for the following power connections:

- AC supply to external EMC filter (when used)
- AC supply (or external EMC filter) to drive
- Drive to motor
- Drive to braking resistor
- Cable lengths in excess of the specified values may be used only when special techniques are adopted; refer to the supplier of the drive.
- The default switching frequency is 3 kHz for open-loop and closed-loop vector and 6 kHz for servo.

Table 4-12 Maximum motor cable lengths

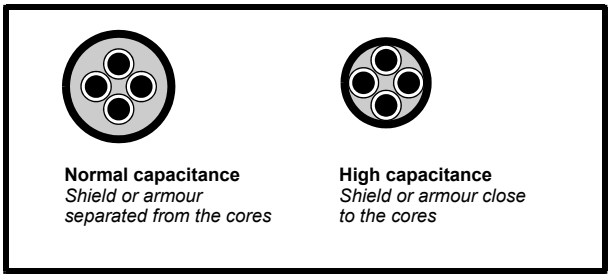
Voltage rating	Maximum Permissible motor cable length				
	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz
400 V	250 m (820 ft)	250 m (820 ft)	187 m (614 ft)	125 m (410 ft)	93 m (305 ft)

High-capacitance cables

The maximum cable length is reduced from that shown in Table 4-10, if high capacitance motor cables are used.

Most cables have an insulating jacket between the cores and the armor or shield; these cables have a low capacitance and are recommended. Cables that do not have an insulating jacket tend to have high capacitance; if a cable of this type is used, the maximum cable length is half that quoted in the tables. (Figure 4-3 shows how to identify the two types).

Figure 4-3 Cable construction influencing the capacitance



The cable used for Table 4-10 is shielded and contains four cores. Typical capacitance for this type of cable is 130 pF/m (i.e. from one core to all others and the shield connected together).

4.8.2 Motor winding voltage

The PWM output voltage can adversely affect the inter-turn insulation in the motor. This is because of the high rate of change of voltage, in conjunction with the impedance of the motor cable and the distributed nature of the motor winding.

For normal operation with AC supplies up to 500 Vac and a standard motor with a good quality insulation system, there is no need for any special precautions. In case of doubt the motor supplier should be consulted.

Special precautions are recommended under the following conditions, but only if the motor cable length exceeds 10 m:

- AC supply voltage exceeds 500 V
- Operation of 400 V drive with continuous or very frequent sustained braking
- Multiple motors connected to a single drive

For multiple motors, the precautions given in section 4.8.3 *Multiple motors* should be followed.

For the other cases listed, it is recommended that an inverter-rated motor be used. This has a reinforced insulation system intended by the manufacturer for repetitive fast-rising pulsed voltage operation.

Users of 575 V NEMA rated motors should note that the specification for inverter-rated motors given in NEMA MG1 section 31 is sufficient for motoring operation but not where the motor spends significant periods braking. In that case an insulation peak voltage rating of 2.2 kV is recommended.

If it is not practical to use an inverter-rated motor, an output choke (inductor) should be used. The recommended type is a simple iron-cored component with a reactance of about 2 %. The exact value is not critical. This operates in conjunction with the capacitance of the motor cable to increase the rise-time of the motor terminal voltage and prevent excessive electrical stress.

4.8.3 Multiple motors

Open-loop only

If the drive is to control more than one motor, one of the fixed V/F modes should be selected (Pr **5.014** = Fd or SrE). Make the motor connections as shown in Figure 4-4 and Figure 4-5. The maximum cable lengths in Table 4-10 apply to the sum of the total cable lengths from the drive to each motor.

It is recommended that each motor is connected through a protection relay since the drive cannot protect each motor individually. For ⅄ connection, a sinusoidal filter or an output inductor must be connected as shown in Figure 4-5, even when the cable lengths are less than the maximum permissible. For details of inductor sizes refer to the supplier of the drive.

Figure 4-4 Preferred chain connection for multiple motors

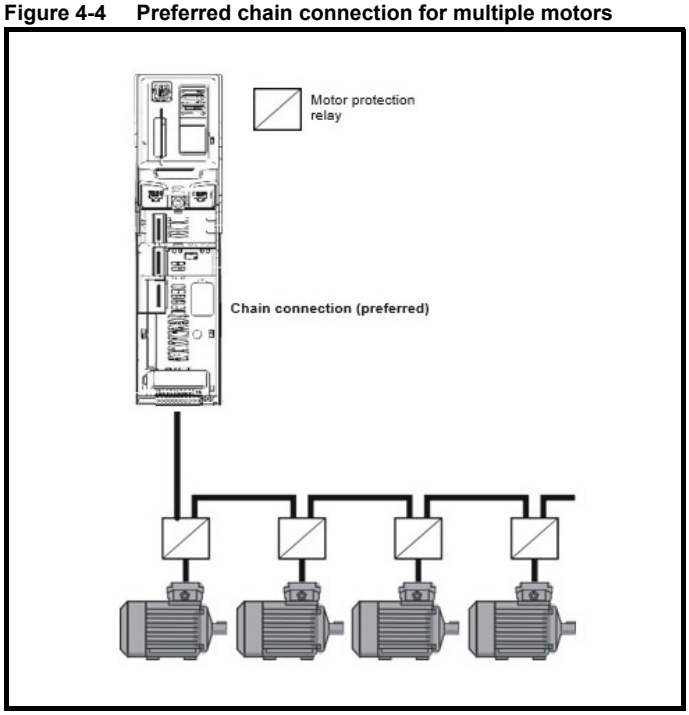
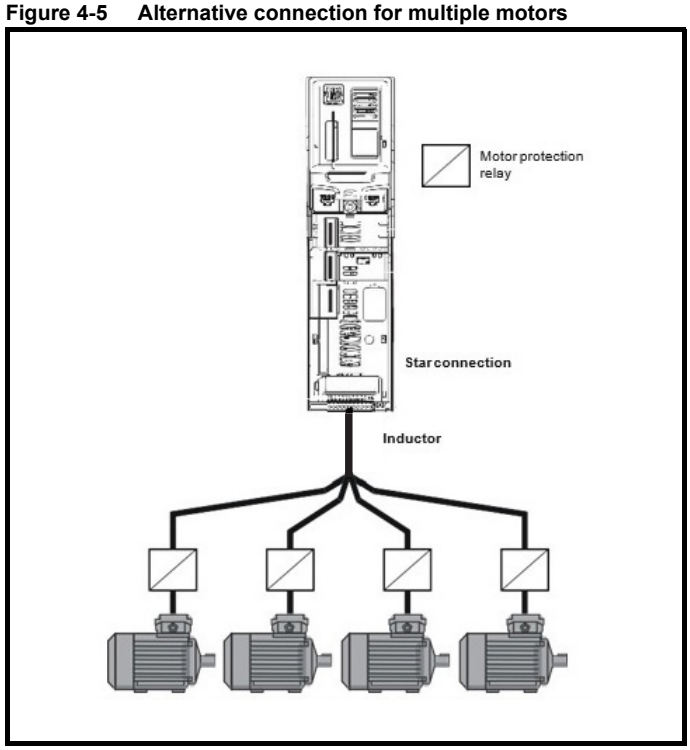


Figure 4-5 Alternative connection for multiple motors



4.8.4 ⅄ / Δ motor operation

The voltage rating for ⅄ and Δ connections of the motor should always be checked before attempting to run the motor.

The default setting of the motor rated voltage parameter is the same as the drive rated voltage, i.e.

400 V drive 400 V rated voltage

A typical 3 phase motor would be connected in ⅄ for 400 V operation or Δ for 200 V operation, however, variations on this are common e.g. ⅄ 690 V Δ 400 V.

Incorrect connection of the windings will cause severe under or over fluxing of the motor, leading to a very poor output torque or motor saturation and overheating respectively.

4.8.5 Output contactor

WARNING

If the cable between the drive and the motor is to be interrupted by a contactor or circuit breaker, ensure that the drive is disabled before the contactor or circuit breaker is opened or closed. Severe arcing may occur if this circuit is interrupted with the motor running at high current and low speed.

A contactor is sometimes required to be installed between the drive and motor for safety purposes.

The recommended motor contactor is the AC3 type.

Switching of an output contactor should only occur when the output of the drive is disabled.

Opening or closing of the contactor with the drive enabled will lead to:

1. OI.AC trips (which cannot be reset for 10 seconds)
2. High levels of radio frequency noise emission
3. Increased contactor wear and tear

The Drive Enable terminal (T31) when opened provides a function. This can in many cases replace output contactors.

4.9 Braking

Braking occurs when the drive is decelerating the motor, or is preventing the motor from gaining speed due to mechanical influences. During braking, energy is returned to the drive from the motor.

When the motor is being braked by the drive, the maximum regenerated power that the drive can absorb is equal to the power dissipation (losses) of the drive.

When the regenerated power is likely to exceed these losses, the DC bus voltage of the drive increases. Under default conditions, the drive brakes the motor under PI control, which extends the deceleration time as necessary in order to prevent the DC bus voltage from rising above a user defined set-point.

If the drive is expected to rapidly decelerate a load, or to hold back an overhauling load, a braking resistor must be installed.

Table 4-13 shows the DC voltage level at which the drive turns on the braking transistor.

Table 4-13 Braking transistor turn on voltage

Drive voltage rating	DC bus voltage levels
400 V	780 V

NOTE

When a braking resistor is used, Pr **02.004** should be set to FASt ramp mode.

WARNING

High temperatures
Braking resistors can reach high temperatures. Locate braking resistors so that damage cannot result. Use cable having insulation capable of withstanding high temperatures.

4.9.1 Braking resistor

WARNING

Overload protection
When a braking resistor is used, it is essential that an overload protection device is incorporated in the braking resistor circuit; this is described in Figure 4-6 on page 54.

Ensure that the braking resistor is mounted in a ventilated metal housing that will perform the following functions:

- Prevent inadvertent contact with the resistor
- Allow adequate ventilation for the resistor

When compliance with EMC emission standards is required, external connection requires the cable to be armored or shielded, since it is not fully contained in a metal enclosure.

Internal connection does not require the cable to be armored or shielded.

Minimum resistances and power ratings

Table 4-14 Minimum resistance values and peak power rating for the braking resistor at 40 °C (104 °F)

Voltage range	Minimum resistance* Ω	Instantaneous Power Rating (kW)	Average Power for 60 s (kW)
400	2.6	234	209

* Resistor tolerance: ±10 %

NOTE

Connections from the brake resistor should be kept separate.
The resistor tolerance should not be more than ±10 % and the resistor should be matched to within ±5 %.

For high-inertia loads or under continuous braking, the *continuous power* dissipated in the braking resistor may be as high as the power rating of the drive. The total *energy* dissipated in the braking resistor is dependent on the amount of energy to be extracted from the load.

The instantaneous power rating refers to the short-term maximum power dissipated during the on intervals of the pulse width modulated braking control cycle. The braking resistor must be able to withstand this dissipation for short intervals (milliseconds). Higher resistance values require proportionately lower instantaneous power ratings.

In most applications, braking occurs only occasionally. This allows the continuous power rating of the braking resistor to be much lower than the power rating of the drive. It is essential, though, that the instantaneous power rating and energy rating of the braking resistor are sufficient for the most extreme braking duty that is likely to be encountered.

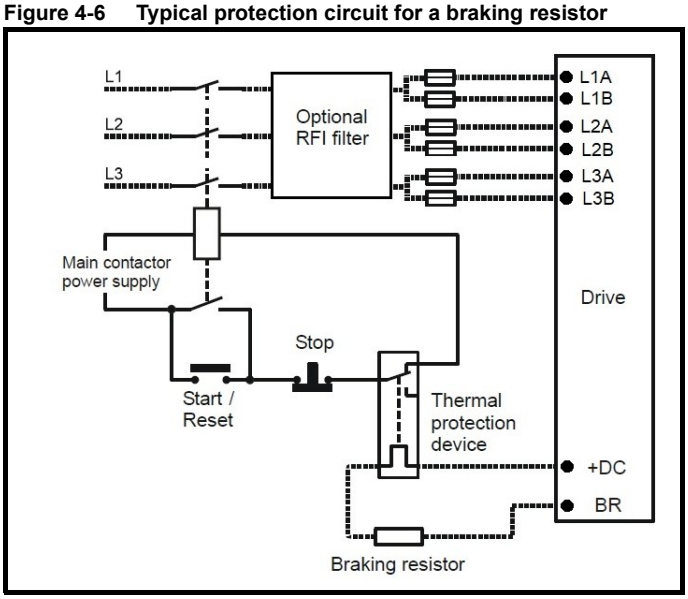
Optimization of the braking resistor requires a careful consideration of the braking duty.

Select a value of resistance for the braking resistor that is not less than the specified minimum resistance. Larger resistance values may give a cost saving, as well as a safety benefit in the event of a fault in the braking system. Braking capability will then be reduced, which could cause the drive to trip during braking if the value chosen is too large.

Thermal protection circuit for the braking resistor

The thermal protection circuit must disconnect the AC supply from the drive if the resistor becomes overloaded due to a fault. Figure 4-6 shows a typical circuit arrangement.

Figure 4-6 Typical protection circuit for a braking resistor



4.9.2 Braking resistor software overload protection

The drive software contains an overload protection function for a braking resistor. In order to enable and set-up this function, it is necessary to enter two values into the drive:

- Resistor short-time overload time (Pr **10.030**)
- Resistor minimum time between repeated short-time overloads (Pr **10.031**)

This data should be obtained from the manufacturer of the braking resistors.

Pr **10.039** gives an indication of braking resistor temperature based on a simple thermal model. Zero indicates the resistor is close to ambient and 100% is the maximum temperature the resistor can withstand. A 'Brake resistor alarm is given if this parameter is above 75 % and the braking IGBT is active. A 'Brake R too hot' trip will occur if Pr **10.039** reaches 100 %, when Pr **10.037** is set to 0 (default value) or 1.

If Pr **10.037** is equal to 2 or 3 a 'Brake R too hot' trip will not occur when Pr **10.039** reaches 100%, but instead the braking IGBT will be disabled until Pr **10.039** falls below 95 %. This option is intended for applications with parallel connected DC buses where there are several braking resistors, each of which cannot withstand full DC bus voltage continuously. With this type of application it is unlikely the braking energy will be shared equally between the resistors because of voltage measurement tolerances within the individual drives.

Therefore, with Pr **10.037** set to 2 or 3, then as soon as a resistor has reached its maximum temperature the drive will disable the braking IGBT, and another resistor on another drive will take up the braking energy. Once Pr **10.039** has fallen below 95 % the drive will allow the braking IGBT to operate again.

See the *Unidrive M Control User Guide* for more information on Pr **10.030**, Pr **10.031**, Pr **10.037** and Pr **10.039**.

This software overload protection should be used in addition to an external overload protection device.

4.10 Ground leakage

The ground leakage current is dependant on whether the internal EMC filter is fitted or not. The drive is supplied with the filter installed.

Instructions for removing the internal filter are given in section 4.11.4 *Disconnection of the internal EMC filter and line to earth varistors* on page 58.

With internal filter installed:

18 mA* AC at 400 V 50 Hz

* Proportional to the supply voltage and frequency.

With internal filter removed: < 63 mA

NOTE

In both cases there is an internal voltage surge protection device connected to ground. Under normal circumstances this carries negligible current.

4.11 EMC (Electromagnetic compatibility)

4.11.1 Immunity

This is a summary of the EMC performance of the drive. For full details, refer to the *EMC Data Sheet* which can be obtained from the supplier of the drive.

Table 4-15 Immunity compliance

Standard	Type of immunity	Test specification	Application	Level
IEC 61000-4-2	Electrostatic discharge	6 kV contact discharge 8 kV air discharge	Module enclosure	Level 3 (industrial)
IEC 61000-4-3	Radio frequency radiated field	Prior to modulation: 10 V/m 80 - 1000 MHz 3 V/m 1.4 - 2.0 GHz 1 V/m 2.0 - 2.7 GHz 80 % AM (1 kHz) modulation	Module enclosure	Level 3 (industrial)
IEC 61000-4-4	Fast transient burst	5 / 50 ns 2 kV transient at 5 kHz repetition frequency via coupling clamp	Control lines	Level 4 (industrial harsh)
		5 / 50 ns, 2 kV transient at 5 kHz repetition frequency by direct injection	Power lines	Level 3 (industrial)
IEC 61000-4-5	Surges	Common mode 4 kV 1.2 / 50 µs wave shape	AC supply lines: line to earth	Level 4
		Differential mode 2 kV	AC supply lines: line to line	Level 3
		Common mode 1 kV	Control lines	(Note:1)
IEC 61000-4-6	Conducted radio frequency	10 V prior to modulation 0.15 - 80 MHz 80 % AM (1 kHz) modulation	Control and power lines	Level 3 (industrial)
IEC 61000-4-11	Voltage dips, short interruptions & variations	All durations	AC supply lines	
IEC 61000-4-8	Power frequency magnetic field	1700 A/m RMS. 2400 A/m peak (2.1 mT RMS 3 mT peak) continuous at 50 Hz	Module enclosure	Exceeds level 5 (Note: 2)
IEC 61000-6-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
IEC 61000-6-2	Generic immunity standard for the industrial environment			Complies
IEC 61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

1 Applies to ports where connections may exceed 30 m length. Special provisions may be required in some cases, see additional information below

2 Limited by test equipment capability

Unless stated otherwise, immunity is achieved without any additional measures such as filters or suppressors. To ensure correct operation, the wiring guidelines specified in this Installation Guide must be followed. All inductive components such as relays, contactors, electromagnetic brakes must be fitted with appropriate suppression.

4.11.2 Conducted Emissions

Radio frequency emission in the range from 150 kHz to 30 MHz is generated by the switching action of the main power devices (IGBTs) and is mainly conducted out of the equipment through the electrical power wiring.

Switching frequency

Conducted emissions increase with switching frequency. The switching frequency should be chosen to optimise the balance between motor losses and electromagnetic emissions. A switching frequency of 2 kHz to 3 kHz is the most appropriate for low conducted emissions.

Motor cable length

Conducted emissions increase with the length of the motor cable. The drive should be placed as close to the motor as possible and the length of the motor cable should be kept to a minimum.

Screened motor cable

Use either four-core cable or shielded (screened) cable to connect the variable speed drive to the motor. Most types of shielded cable can be used provided that the cable has an overall screen that is continuous for its entire length. For example, steel wire armoured cable is acceptable.

Ground (earth) connections

The motor cable ground conductor (or shield) must be terminated at the output terminal wiring plate.

Cable layout

The input and output cables should be kept separate. A separation of at least 100 mm is recommended.

Sensitive signal circuits should be routed away from the drive module. A minimum separation of 300 mm (12 in) is recommended.

Any signal cables which are carried inside the motor cable (motor thermistor, motor brake) will pick up large pulse currents via the cable capacitance. The shield of these signal cables must be connected to ground close to the motor cable, to avoid noise current spreading through the control system.

Internal EMC filter

The drive contains a cost-effective internal EMC filter which gives a reduction of about 30 dB in the level of conducted emission at the supply terminals.

With the internal EMC filter connected, the drive meets the conducted radio-frequency emission limits in EN/ IEC 61800-3, Equipment Category C3 for motor cable lengths up to 5.5 m, at a switching frequency of 2 kHz.

For longer motor cables the filter continues to provide a useful reduction in emission level. When used with any length of shielded motor cable up to the limit for the drive, it is unlikely that nearby industrial equipment will be disturbed.

It is recommended that the filter is used in all applications unless the ground leakage current is unacceptable, or the power drive system is installed on an ungrounded (IT) supply.

Ground leakage current due to internal EMC filter

WARNING

High ground leakage current
When an EMC filter is used, a permanent fixed ground connection must be provided which does not pass through a connector or flexible power cord.

Use of EMC filters on ungrounded (IT) supplies

WARNING

When the drive is used with ungrounded (IT) supplies the internal EMC filter must be removed unless additional motor ground fault protection is installed.

Instructions showing how to disconnect the EMC filter are shown below.

Unusual hazards can occur on ungrounded supplies with more than one source, for example on ships. For details of ground fault protection contact the supplier of the drive.

4.11.3 Compliance with EN/ IEC 61800-3 (EMC standard for Power Drive Systems)

External EMC filters

With both the internal and external EMC filters connected, the power drive system is capable of meeting the conducted radio-frequency emission limits in EN/ IEC 61800-3, Equipment Category C3 for motor cable lengths up to 100 m, at a switching frequency of 2 kHz.

The filter should be mounted as close as possible to the drive module, ideally on the same earthing plate or back panel.

The interconnecting cables should be kept as short as possible. A good quality radio frequency ground must exist between the drive module and the filter.

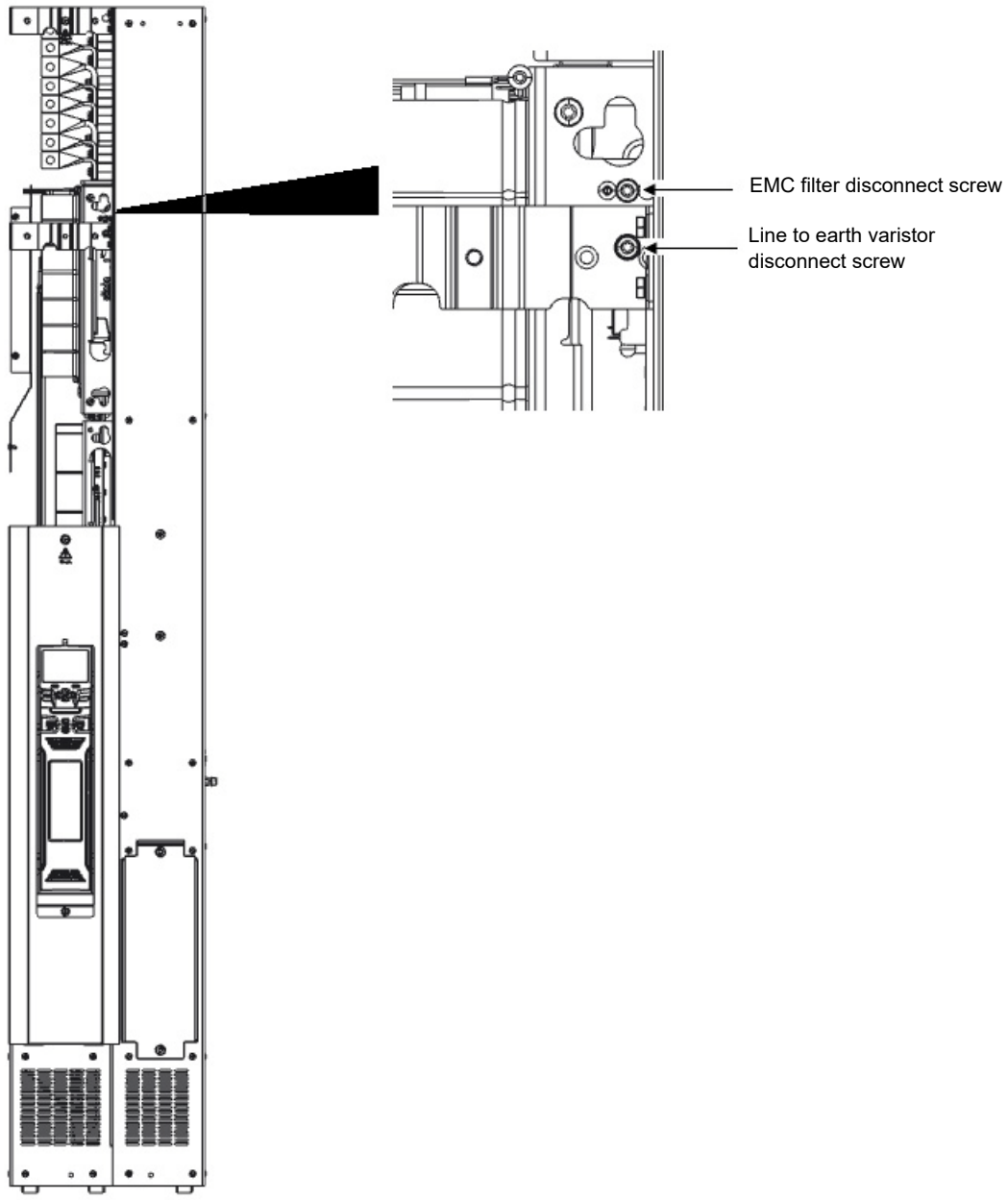
For further details on external EMC filters refer to section 3.10 *External EMC filter*.

4.11.4 Disconnection of the internal EMC filter and line to earth varistors

The power module is fitted with an internal EMC filter and three line to earth varistors. These can be disconnected by removing the applicable screw as shown in Figure 4-7.

1. Remove the applicable screw using a T20 torx bit.
2. If the filter or line to earth varistors are to be connected, insert the screw and tighten to 2 Nm (1.48 lb ft)

Figure 4-7 Remove the EMC filter and line to earth varistor mounting screws



CAUTION

Ensure care is taken when removing the screws to avoid the risk of the screw falling into the power module.

4.11.5 General requirements for EMC

Ground (earth) connections

If ground connections are made using a separate cable, they should run parallel to the appropriate power cable to minimize emissions.

The incoming supply ground should be connected to the earth/ground terminal inside the enclosure.

Use four core cable to connect the motor to the drive. The ground conductor in the motor cable must be connected directly to the earth/ground terminal of the drive and motor. It must not be connected directly to the power earth/ground busbar.

Cable layout

Do not place sensitive (unscreened) signal circuits in a zone extending 300 mm (12 in) all around the drive, motor cable, input cable from EMC filter and unscreened braking resistor cable (if used).

NOTE

Any signal cables which are carried inside the motor cable (i.e. motor thermistor, motor brake) will pick up large pulse currents via the cable capacitance. The shield of these signal cables must be connected to ground close to the motor cable, to avoid this noise current spreading through the control system.

Feedback device cable shielding

Shielding considerations are important for PWM drive installations due to the high voltages and currents present in the output (motor) circuit with a very wide frequency spectrum, typically from 0 to 20 MHz.

The following guidance is divided into two parts:

1. Ensuring correct transfer of data without disturbance from electrical noise originating either within the drive or from external sources.
2. Additional measures to prevent unwanted emission of radio frequency noise. These are optional and only required where the installation is subject to specific requirements for radio frequency emission control.

To ensure correct transfer of data, observe the following:
Resolver connections:

- Use a cable with an overall shield and twisted pairs for the resolver signals.
- Connect the cable shield to the drive 0 V connection by the shortest possible link ("pigtail").
- It is generally preferable not to connect the cable shield to the resolver. However, in cases where there is an exceptional level of common-mode noise voltage present on the resolver body, it may be helpful to connect the shield there. If this is done then it becomes essential to ensure the absolute minimum length of "pigtails" at both shield connections, and possibly to clamp the cable shield directly to the resolver body and to the drive grounding bracket.
- The cable should preferably not be interrupted. If interruptions are unavoidable, ensure the absolute minimum length of "pigtail" in the shield connections at each interruption.

Encoder connections:

- Use a cable with the correct impedance.
- Use a cable with individually shielded twisted pairs.
- Connect the cable shields to 0 V at both the drive and the encoder, using the shortest possible links ("pigtails").
- The cable should preferably not be interrupted. If interruptions are unavoidable, ensure the absolute minimum length of "pigtail" in the shield connections at each interruption. Preferably, use a connection method which provides substantial metallic clamps for the cable shield terminations.

The above applies where the encoder body is isolated from the motor and where the encoder circuit is isolated from the encoder body. Where there is no isolation between the encoder circuits and the motor body, and in case of doubt, the following additional requirement must be observed to provide the best possible noise immunity.

- The shields must be directly clamped to the encoder body (no pigtail) and to the drive grounding bracket. This may be achieved by clamping of the individual shields or by providing an additional overall shield which is clamped.

NOTE

The recommendations of the encoder manufacturer must also be adhered to for the encoder connections.

NOTE

In order to guarantee maximum noise immunity for any application double shielded cable as shown should be used.

In some cases single shielding of each pair of differential signals cables, or a single overall shield with individual shield on the thermistor connections is sufficient. In these cases all the shields should be connected to ground and 0 V at both ends.

Figure 4-8 and Figure 4-9 illustrate the preferred construction of cable and the method of clamping. The outer sheath of the cable should be stripped back enough to allow the clamp to be installed. The shield must not be broken or opened at this point. The clamps should be installed close to the drive or feedback device, with the ground connections made to a ground plate or similar metallic ground surface.

Figure 4-8 Feedback cable, twisted pair

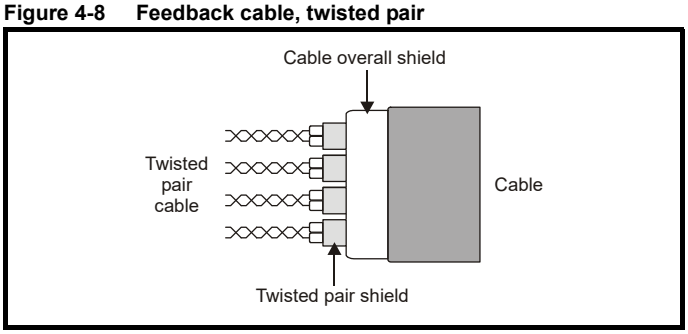
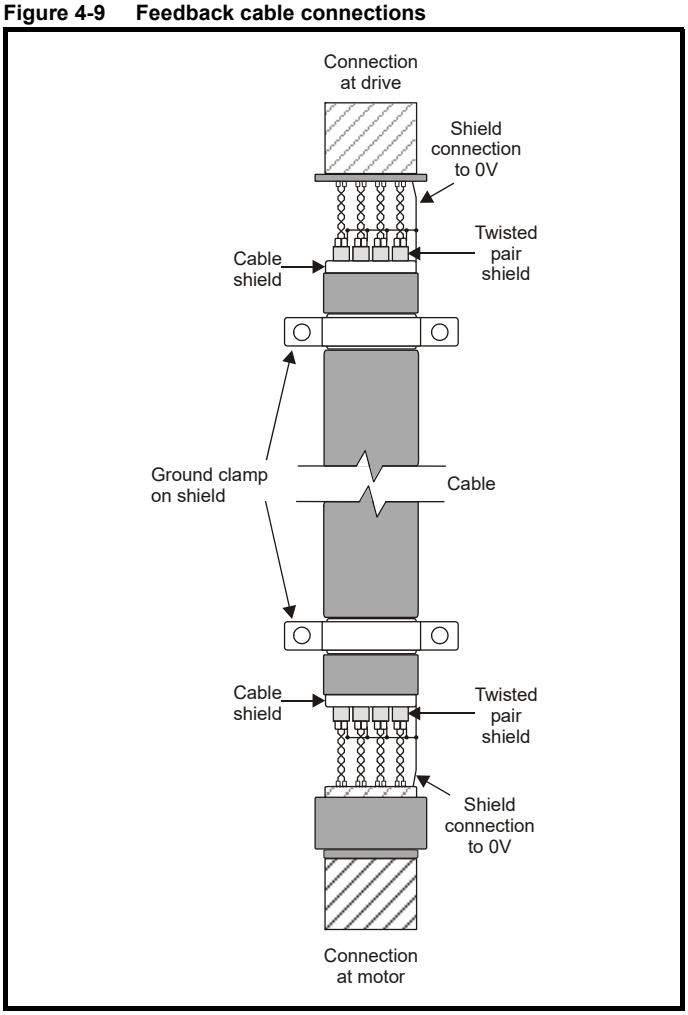


Figure 4-9 Feedback cable connections



To ensure suppression of radio frequency emission, observe the following:

- Use a cable with an overall shield.
- Clamp the overall shield to grounded metallic surfaces at both the encoder and the drive, as illustrated in Figure 4-9 above.

4.11.6 Compliance with EN 61800-3 (standard for Power Drive Systems)

External EMC filters

With both the internal and external EMC filters connected, the power drive system is capable of meeting the conducted radio-frequency emission limits in EN/ IEC 61800-3, Equipment Category C3 for motor cable lengths up to 100 m, at a switching frequency of 2 kHz.

The filter should be mounted as close as possible to the drive module, ideally on the same earthing plate or back panel.

The interconnecting cables should be kept as short as possible. A good quality radio frequency ground must exist between the drive module and the filter.

4.11.7 Compliance with generic emission standards

Use the recommended filter and shielded motor cable. Ensure the AC supply and ground cables are at least 100 mm from the drive and motor cable.

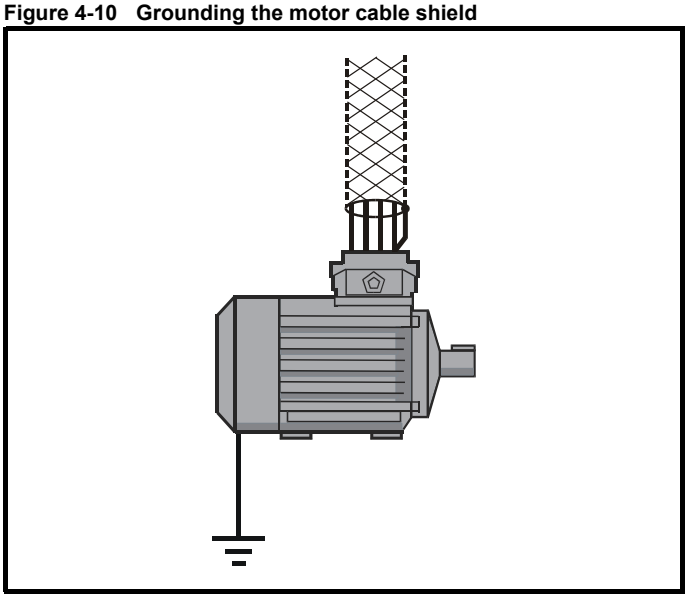
Avoid placing sensitive signal circuits in a zone 300 mm (12 in) all around the drive.

Ensure good EMC grounding.

Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50 mm (2 in) long. A full 360° termination of the shield to the terminal housing of the motor is beneficial.

It is unimportant for EMC purposes whether the motor cable contains an internal (safety) ground core, or there is a separate external ground conductor, or grounding is through the shield alone. An internal ground core will carry a high noise current and therefore it must be terminated as close as possible to the shield termination.

Figure 4-10 Grounding the motor cable shield

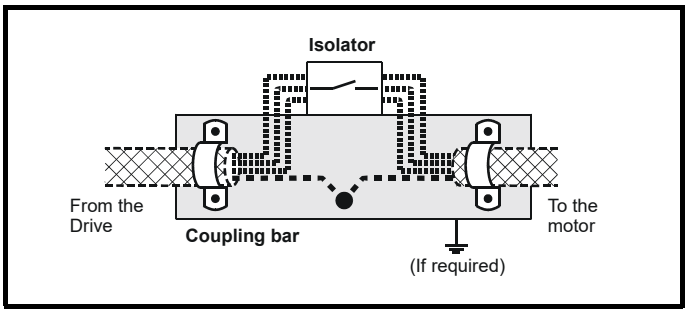


Wiring to the optional braking resistor(s) must be shielded.

If the control wiring is to leave the enclosure, it must be shielded and the shield(s) clamped to the drive using the grounding bracket as shown in Figure 4-10 above. Remove the outer insulating cover of the cable to ensure the shield(s) make contact with the bracket, making sure to keep the shield(s) intact and as close to the terminals as possible.

Alternatively, wiring may be passed through a ferrite ring, part no. 3225-1004.

Figure 4-11 Connecting the motor cable to an isolator / disconnect switch



Surge immunity of control circuits - long cables and connections outside a building

The input/output ports for the control circuits are designed for general use within machines and small systems without any special precautions.

These circuits meet the requirements of EN61000-6-2 (1 kV surge) provided the 0 V connection is not grounded. In applications where they may be exposed to high-energy voltage surges, some special measures may be required to prevent malfunction or damage. Surges may be caused by lightning or severe power faults in association with grounding arrangements which permit high transient voltages between nominally grounded points. This is a particular risk where the circuits extend outside the protection of a building.

As a general rule, if the circuits are to pass outside the building where the drive is located, or if cable runs within a building exceed 30 m (98.5 ft), some additional precautions are advisable. One of the following techniques should be used:

1. Galvanic isolation, i.e. do not connect the control 0 V terminal to ground. Avoid loops in the control wiring, i.e. ensure every control wire is accompanied by its return (0 V) wire.
2. Screened cable. The cable shield may be connected to ground at both ends, but in addition the ground conductors at both ends of the cable must be bonded together by a power ground cable (equipotential bonding cable) with cross-sectional area of at least 10 mm², or 10 times the area of the signal cable shield, or to suit the electrical safety requirements of the plant. This ensures that fault or surge current passes mainly through the ground cable and not in the signal cable shield. If the building or plant has a well-designed common bonded network this precaution is not necessary.
3. Additional over-voltage suppression - for the analog and digital inputs and outputs, a Zener diode network or a commercially available surge suppressor may be connected in parallel with the input circuit as shown in Figure 4-12 and Figure 4-13. If a digital port experiences a severe surge its protective trip may operate.

For continued operation after such an event, the trip can be reset automatically by setting Pr **10.034** to a value of 5.

Figure 4-12 Surge suppression for digital and unipolar inputs and outputs

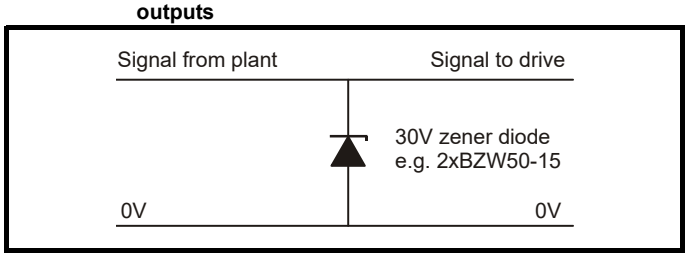
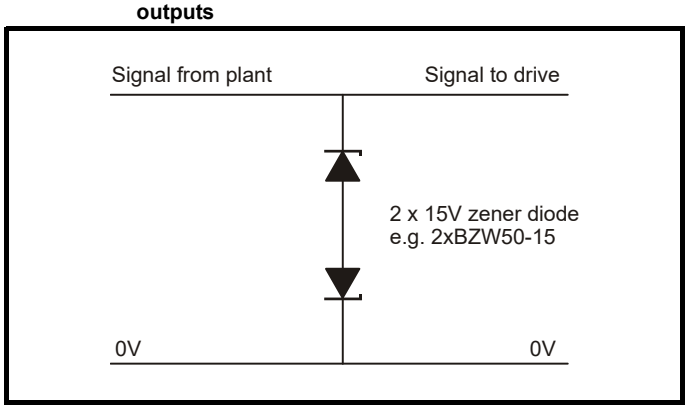


Figure 4-13 Surge suppression for analog and bipolar inputs and outputs



Surge suppression devices are available as rail-mounting modules, e.g. from Phoenix Contact:

Unipolar TT-UKK5-D/24 DC Bipolar TT-UKK5-D/24 AC

These devices are not suitable for encoder signals or fast digital data networks because the capacitance of the diodes adversely affects the signal. Most encoders have galvanic isolation of the signal circuit from the motor frame, in which case no precautions are required. For data networks, follow the specific recommendations for the particular network.

4.11.8 Emissions

AC Supply

The drive modules covered by this Installation Guide are intended to be connected to an industrial supply network with a dedicated distribution transformer, located adjacent to or inside the premises which supplies only industrial customers.

These products are not intended for use in domestic premises or establishments directly connected without an intermediate transformer to a low-voltage power supply network which supplies buildings used for domestic purposes.

WARNING

In a residential environment, these products may cause radio interference in which case supplementary mitigation measures may be required.

Electromagnetic Emission occurs over a wide range of frequencies. The effects are divided into three main categories:

- Low frequency effects, such as supply harmonics and notching.
- High frequency emission below 30 MHz where emission is predominantly by conduction.
- High frequency emission above 30 MHz where emission is predominantly by radiation.

4.11.9 Low Frequency Emissions

Supply voltage notching

The drives do not cause notching of the supply voltage.

Voltage fluctuations and flicker

When running at constant load the drive does not generate voltage fluctuations or flicker. Care must be taken to ensure that the application does not cause the load to vary rapidly, resulting in flicker. Cyclical variations with frequency in the region of 2 Hz to 20 Hz are likely to cause irritating lighting flicker and should be avoided.

When power is first applied the drive draws an inrush current which is lower than the rated input current. This meets the requirements of IEC 61000-3-3.

Common mode harmonic emissions (crosstalk)

The drives generate switching waveforms with frequency components in the audible range as well as the frequency range commonly used by telephone and data systems. The installation instructions include recommendations for segregation and shielding of power and signal cables.

Supply harmonics

The drive input current contains harmonics of the supply frequency. The harmonic levels are affected to some extent by the supply impedance (fault current level).

4.11.10 Radiated Emissions

When installed in a standard metal enclosure according to the wiring guidelines in this Installation Guide, the power drive system is capable of meeting the radiated emission limits required by EN/ IEC 61800-3 (EMC standard for Power Drive Systems) for Equipment Category C3.

Table 4-16 Radiated emissions limits in EN/ IEC 61800-3

Frequency range (MHz)	Category C3	Units
30 - 230	50	dBµV/m Quasi peak
230 - 1000	60	

NOTE

The limits apply at a measuring distance of 10 m. The measurements may be made at 3 m with the limits increased by 10 dB.

Both the internal and external EMC filters must be fitted, and all power and control wiring must be shielded with the shields connected to ground using a good quality RF ground connection. Ungrounded, unscreened cables act as antennae leading to increased levels of radiated emissions.

5 Technical data

5.1 Drive technical data

5.1.1 Power and current ratings (Derating for switching frequency and temperature)

Table 5-1 Maximum permissible continuous output current @ 40 ºC (104 ºF) ambient temperature

Model	Normal Duty							Heavy Duty						
	Nominal rating		Maximum Permissible continuous output current (A)					Nominal rating		Maximum permissible continuous output current (A)				
	kW	hp	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	kW	hp	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz
12404800														
12405660	355	476	660	660	660	580	466	315	422	566	566	566	493	399
12406600	400	536	755	755	703	580	466	355	476	660	646	595	493	399
12407200	500	670	865	770	703	580	466	400	536	720	646	595	493	399

Table 5-2 Maximum permissible continuous output current @ 50 ºC (122 ºF) ambient temperature

Model	Normal Duty					Heavy Duty				
	Maximum permissible continuous output current (A)					Maximum permissible continuous output current (A)				
	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz
12404800										
12405660	660	660	655	532	427	566	566	553	459	374
12406600	755	722	655	532	427	660	612	553	459	374
12407200	798	722	655	532	427	672	612	553	459	374

5.1.2 Power dissipation

Table 5-3 Losses @ 40 ºC (104 ºF) ambient for docked (rectifier and inverter) drive

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz
12404800										
12405660	5491	6044	6615	6697	6306	5491	6044	6615	6697	6306
12406600	7860	8598	8546	7969	7302	6635	7078	7076	6697	6306
12407200	9785	8884	8617	8033	7359	7478	7139	7065	6750	6354

5.1.3 Supply requirements

Voltage:

400 V drive 380 V to 480 V ±10 %

Number of phases: 3

Maximum supply imbalance: 2 % negative phase sequence (equivalent to 3 % voltage imbalance between phases).

Frequency range: 48 to 65 Hz

5.1.4 Temperature, humidity and cooling method

Ambient temperature operating range:

-20 °C to 40 °C (-4 °F to 104 °F).

Output current derating must be applied at ambient temperatures > 50 °C (122 °F).

Minimum temperature at power-up:

-20 °C (-4 °F), the supply must be cycled when the drive has warmed up to 0 °C (32 °F).

Cooling method: Forced convection

Maximum humidity: 90 % at 50 °C (122 °F). Non-condensing 95 % at 40 °C (104 °F)

Operation with lower AC supplies is possible but the output power from the drive will be reduced. For example, a 400 V drive powered on a 200 V single phase supply will operate but not at the rated output power.

5.1.5 Storage

-40 °C (-40 °F) to +40 °C (104 °F) for long term storage, or to +70 °C (158 °F) for short term storage.

Electrolytic capacitors in any electronic product have a storage period after which they require reforming or replacing.

The DC bus capacitors have a storage period of 10 years.

The low voltage capacitors on the control supplies typically have a storage period of 2 years and are thus the limiting factor.

Low voltage capacitors cannot be reformed due to their location in the circuit and thus may require replacing if the drive is stored for a period of 2 years or greater without power being applied.

It is therefore recommended that drives are powered up for a minimum of 1 hour after every 2 years of storage. This process allows the drive to be stored for a further 2 years.

5.1.6 Altitude

Altitude range: 0 to 3,000 m (9,900 ft), subject to the following conditions:

1,000 m to 3,000 m (3,300 ft to 9,900 ft) above sea level: de-rate the maximum output current from the specified figure by 1 % per 100 m (330 ft) above 1,000 m (3,300 ft)
For example at 3,000 m (9,900 ft) the output current of the drive would have to be de-rated by 20 %.

5.1.7 IP / UL Rating

The power module is rated to IP00. Once installed in the cubicle the IP rating can be IP21 or IP54 depending on the installation design.

The IP rating of a product is a measure of protection against ingress and contact to foreign bodies and water. It is stated as IP XX, where the two digits (xx) indicate the degree of protection provided as shown in Table 5-4.

Table 5-4 IP Rating degrees of protection

First digit		Second digit	
Protection against contact and ingress of foreign bodies		Protection against ingress of water	
0	No protection	0	No protection
1	Protection against large foreign bodies ϕ > 50 mm (large area contact with the hand)	1	Protection against vertically falling drops of water
2	Protection against medium size foreign bodies ϕ > 12 mm (finger)	2	Protection against spraywater (up to 15° from the vertical)
3	Protection against small foreign bodies ϕ > 2.5 mm (tools, wires)	3	Protection against spraywater (up to 60° from the vertical)
4	Protection against granular foreign bodies ϕ > 1 mm (tools, wires)	4	Protection against splashwater (from all directions)
5	Protection against dust deposit, complete protection against accidental contact.	5	Protection against heavy splash water (from all directions, at high pressure)
6	Protection against dust ingress, complete protection against accidental contact.	6	Protection against deckwater (e.g. in heavy seas)
7		7	Protection against immersion
8		8	Protection against submersion

5.1.8 Corrosive gasses

Concentrations of corrosive gases must not exceed the levels given in:

- Table A2 of EN 50178:1998
- Class 3C2 of IEC 60721-3-3

This corresponds to the levels typical of urban areas with industrial activities and/or heavy traffic, but not in the immediate neighborhood of industrial sources with chemical emissions.

5.1.9 Vibration

Maximum recommended continuous vibration level 0.14 g r.m.s. broad-band 5 to 200 Hz.

NOTE

This is the limit for broad-band (random) vibration. Narrow-band vibration at this level which coincides with a structural resonance could result in premature failure.

Random Vibration Test

Testing all specimens in each of three mutually perpendicular axes in turn.

Referenced standard: IEC 60068-2-64: Test Fh:

Severity: 1.0 m^2/s^3 (0.01 g^2/Hz) ASD from 5 - 20 Hz

- 3 dB/octave from 20 - 200 Hz

Duration: 30* minutes in each of 3 mutually perpendicular axes.

Shock Bump Test

Testing all specimens together in each of three mutually perpendicular axes in turn.

Referenced standard: IEC 60068-2-29: Test Eb:

Severity: 10 g, 11 ms, half sine

No. of Bumps: 600 (100 in each direction of each axis)

Instrumentation: 3 off additional response accelerometers

Sinusoidal Vibration Test

Testing all specimens together in each of three mutually perpendicular axes in turn.

Referenced standard: In accordance to IEC 60068-2-6: Test Fc.

Severity: 3.5 mm peak displacement from 2 to 8.5 Hz

10 m/s^2 peak acceleration from 9 to 200 Hz

15 m/s^2 peak acceleration from 200 to 500 Hz

Sweep Rate: 1 octave/minute

Frequency Range: 2* to 500 Hz (*or lowest achievable on an electromagnetic shaker)

Duration: 15 minutes

5.1.10 Starts per hour

By electronic control: unlimited

By interrupting the AC supply: ≤ 20 (equally spaced)

5.1.11 Start up time

This is the time taken from the moment of applying power to the drive, to the drive being ready to run the motor:

All variant: 5 s

5.1.12 Output frequency / speed range

Open-loop frequency range: 0 to 599 Hz

Closed-loop speed range: 0 to 40,000 rpm

Closed-loop frequency range: 0 to 550 Hz

5.1.13 Accuracy and resolution

Speed:

The absolute frequency and speed accuracy depends on the accuracy of the crystal used with the drive microprocessor. The accuracy of the crystal is 100 ppm, and so the absolute frequency/speed accuracy is 100 ppm (0.01 %) of the reference, when a preset speed is used. If an analog input is used the absolute accuracy is further limited by the absolute accuracy of the analog input.

The following data applies to the drive only; it does not include the performance of the source of the control signals.

Open loop resolution:

Preset frequency reference: 0.1 Hz
Precision frequency reference: 0.001 Hz

Closed loop resolution

Preset speed reference: 0.1 rpm
Precision speed reference: 0.001 rpm
Analog input 1: 11 bit plus sign
Analog input 2: 11 bit plus sign

Current:

The resolution of the current feedback is 10 bit plus sign.

The typical accuracy of the current feedback is typically 0 % and worst case 5 %.

5.1.14 Acoustic noise

The cooling fans generate the majority of the acoustic noise produced by the drive. The power modules in the drive contain cooling fans. The power modules control the speed at which the fans run at based on the temperature of the power modules and the drive's thermal model system.

Table 5-5 gives the acoustic noise produced by the drive for the heatsink fan running at the maximum and minimum speeds.

Table 5-5 Acoustic noise data

Max speed dBA	Min speed dBA
73	51

NOTE

These figures are worst case as they include some low-level background noise due to the location of the measurement.

5.1.15 Airflow

Number of fans per drive	Airflow rate per fan (m^3/h)
2	1580

5.1.16 Overall dimensions

H Height

W Width

D Depth

Table 5-6 Overall power module dimensions

	Dimension mm		
	H	**W**	**D**
Power module	1750	295	526

5.1.17 Weights

Table 5-7 Overall power module weights

Model	kg	lb
Power module	130	287

5.1.18 Input current, fuse and cable size ratings

The input current is affected by the supply voltage and impedance.

Typical input current

The values of typical input current are given to aid calculations for power flow and power loss.

The values of typical input current are stated for a balanced supply.

Maximum continuous input current

The values of maximum continuous input current are given to aid the selection of cables and fuses. These values are stated for the worst case condition with the unusual combination of stiff supply with bad balance.

The value stated for the maximum continuous input current would only be seen in one of the input phases. The current in the other two phases would be significantly lower.

The values of maximum input current are stated for a supply with a 2 % negative phase-sequence imbalance and rated at the maximum supply fault current given in Table 5-8.

Table 5-8 Supply fault current used to calculate maximum input currents

Model	Symmetrical fault level (kA)
All	100

NOTE

Cable sizes are from IEC60364-5-52:2001 table A.52.C with correction factor for 40 °C ambient of 0.87 (from table A52.14) for cable installation method B2 (multicore cable in conduit).

Cable size may be reduced if a different installation method is used, or if the ambient temperature is lower.

The recommended cable sizes above are only a guide. The mounting and grouping of cables affects their current-carrying capacity, in some cases smaller cables may be acceptable but in other cases a larger cable is required to avoid excessive temperature or voltage drop. Refer to local wiring regulations for the correct size of cables.

5.1.19 Fuses and cable size

WARNING

Fuses
The AC supply to the drive must be installed with suitable protection against overload and short-circuits. Table 5-9 shows recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

Table 5-9 400 V Drive input current, fuse and cable size rating

Model	Maximum continuous input current	Fuse (6 per drive)		Nominal cable size (European)			
		IEC		Input 6 pulse	Input 12 pulse	Output	Cable type (input & output)
	3 ph	Nom	Class				
	A	A		mm²	mm²	mm²	
12404800T	720	400	gR	4 x 120	2 x 120	3 x 150	XLPE/EPR
12405660T	777	450		4 x 150	2 x 150	4 x 120	
12406600T	845	500					
12407200T	995	550		4 x 185	2 x 185	4 x 150	

Table 5-10 Installation class

Key to the cable installation method (ref: IEC60364-5-52:2009)	
B1	Separate Cables in Conduit
B2	Multi-core cable in conduit
C	Multi-core cable in free-air
E	On perforated tray
F	Separate cables bunched in groups of three, in free air
G	Individual cables separated vertically in free air

NOTE

Cable sizes are from IEC60364-5-52:2009.

Cable size may be reduced if a different installation method is used, or if the ambient temperature is lower.

The recommended cable sizes above are only a guide. The mounting and grouping of cables affects their current-carrying capacity, in some cases smaller cables may be acceptable but in other cases a larger cable is required to avoid excessive temperature or voltage drop. Refer to local wiring regulations for the correct size of cables.

5.2 Optional external EMC filters

Table 5-11 EMC filter details (all models)

Drive	Schaffner		Block	
	Part number	Weight	Part number	Weight
12404800T	FN 3311-1000-99-C16-R55	5.5 kg (12.1 lb)	HLD 103-500/1000	22.5 kg (49.6 lb)
12405660T				
12406600T				
12407200T				

Table 5-12 Optional external EMC filter

Part number	Manufacturer	Maximum continuous current (A)		Voltage rating (V)	IP rating	Power dissipation at rated current (W)	Ground leakage (mA)		Discharge resistors
		@40 ºC (104 ºF)	@50 ºC (122 ºF)				Phase to ground leakage (with balanced supply)	1 Phase open circuit	
FN 3311-1000-99-C16-R55	Schaffner	1095	1000	530	00	70	61	455	See note 1
HLD 103-500/1000	Block	1100	1000	520	00	130	570	60	Included

NOTE

1. 1 M Ω in Y connection between phases

Table 5-13 Optional external EMC Filter dimensions

Part number	Manufacturer	H	W	D
FN 3311-1000-99-C16-R55	Schaffner	140 mm	245 mm	220 mm
HLD 103-500/1000	Block	130 mm	280 mm	460 mm

Table 5-14 Optional external EMC Filter terminal data

Part number	Manufacturer	Power connections	Ground connections	
		Max torque	Ground stud size	Max torque
FN 3311-1000-99-C16-R55	Schaffner	93 Nm	M8	9 Nm
HLD 103-500/1000	Block	30 Nm	M12	30 Nm

Index

0478-0613-02