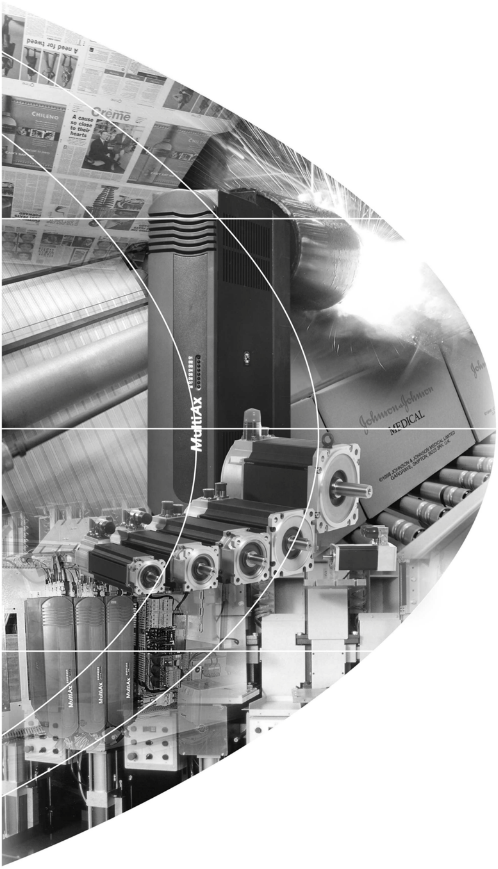
Nidec
All for dreams



User Guide

MultiAx

Compact high performance, 3-axis servo amplifier for brushless AC servo motors

Part Number: 0437-0005-07
Issue: 7

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 dive 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.

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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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Declaration of Conformity

Nidec Control Techniques Ltd
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MultiAx SAC
MultiAx HAC
MultiAx SDC
MultiAx HDC

The servo drive products listed above have been designed and manufactured in accordance with the following European harmonized, national and international standards:

EN 61800-5-1:2007	Adjustable speed electrical power drive systems - safety requirements - electrical, thermal and energy
EN 61800-3:2004	Adjustable speed electrical power drive systems. EMC product standard including specific test methods
EN 61000-6-2:2005	Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments
EN 61000-6-4:2007	Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments

These products comply with the Low Voltage Directive 2006/95/EC and the Electromagnetic Compatibility Directive 2004/108/EC..

T. Alexander
VP Technology
Date: 25th June 2009

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 assemblers who are familiar with requirements for safety and EMC. 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.
Refer to the User Guide for guidelines on installation. A MultiAx EMC Data Sheet is also available giving detailed EMC information.

1 Safety Information

1.1 Warnings, Cautions and Notes

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

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

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

1.2 Important safety information. Hazards. Competence of designers and installers

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 and Safe Torque Off functions of the drive do 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.

With the sole exception of the Safe Torque Off function, none of the drive functions must be used to ensure safety of personnel, i.e. they must not be used for safety-related functions.

The Safe Torque Off function may be used in a safety-related application. 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 Safe Torque Off function will only ensure the safety of a machine if it is correctly incorporated into a complete safety system. 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 Introduction

2.1 Important information about this User Guide

WARNING

Variable speed drives may be hazardous if misused. Carefully follow the instructions in this User Guide, especially those in Chapter 1 *Safety Information* on page 7.

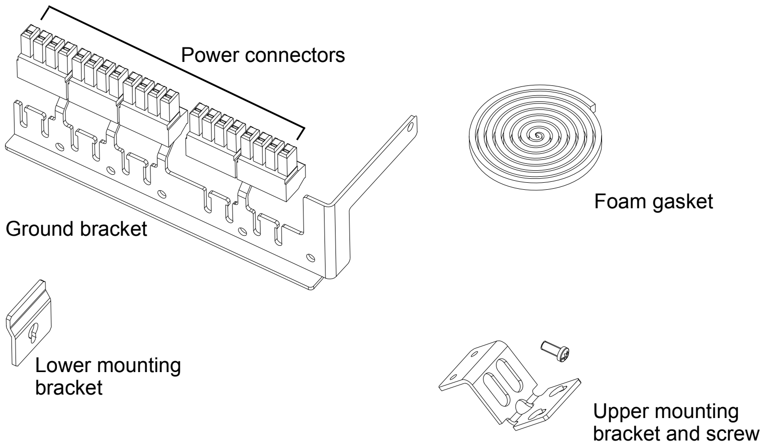
Read this User Guide before starting the installation or setting-up processes.

This User Guide is arranged as a series of topics, where each topic contains all the information and/or instructions on a specific subject. Consequently the information and instructions are not necessarily presented in the order of use.

Refer to this User Guide in conjunction with the instruction manual(s) for the motion controller for the following:

- Setting up the MultiAx and servo system
- Ensuring the user is made aware of all the related safety issues
- Making signal and data connections

Figure 2-1 Items supplied with the drive



2.2 Models and versions of the drive

The MultiAx is a high-performance three-axis servo amplifier for controlling permanent-magnet brushless motors that are fitted with a Control Techniques Speed Loop Module (SLM).

The MultiAx is available in several versions. In this User Guide, the term MultiAx is used to refer to all versions.

	Continuous operation	Overload for 2 s max
Maximum AC supply current	15.6A	31.2A
Maximum total output current	18.75A	37.5A
Maximum total output power	9.75kW	19.5kW

All models in the MultiAx range can be supplied in a number of versions, each possessing a variation in the functionality specific to a particular type of application. The version code is a suffix to the model number. Refer to Table 2-1and Table 2-2:

Table 2-1 Current rating

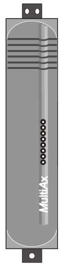
Model			Output current: Maximum continuous, Axis A	Output current: Maximum continuous, Axis B	Output current: Maximum continuous, Axis C	Output current: Maximumpeak (2 s max), Axis A	Output current: Maximumpeak (2 s max), Axis B	Output current: Maximumpeak (2 s max), Axis C
	MultiAx SAC / SDC	Default current mode	2.5			5.0		
		Full current scaling selected. Pin 6 & 7 on each axis connector linked	9.375			18.75		
	MultiAx HAC / HDC	Default current mode	2.5			5.0		
		Full current scaling selected. Pin 6 & 7 on each axis connector linked	15.0	9.375		30	18.75	

Table 2-2 refers to the individual axis current limits. The sum of all three axes can NOT exceed 18.75A continuous or 37A peak without the drive tripping.

Table 2-2 MultiAx versions

Suffix	Functionality
SAC	**S**tandard drive. For use with **AC** mains supply only.
HAC	**H**igh current drive. This only applies to axis A when configured to full current scaling (see *Current-scaling modes*). For use with **AC** mains supply only.
SDC	**S**tandard drive but with the AC mains loss detection disabled for use with AC or **DC** supplies.
HDC	**H**igh current drive (as per HAC above)but with the AC mains loss detection disabled for use with AC or **DC** supplies.

Current-scaling modes

The MultiAx is supplied with all three axes operating in the default current mode. By connecting a wire link in the related D-type signal connector, one or more axes can be operated in the full current-scaling mode. This can assist with matching the MultiAx to the current-ratings of the motor.

The link is only checked on power-up. Do NOT change without re-commissioning.

2.3 Automatic setting up of the drive for the motor

When the motor is fitted with an SLM*, the motion controller automatically reads the characteristics of the SLM and the motor each time the power is applied to the SLM and motion controller. This unique facility substantially reduces the time that is normally spent setting up a servo amplifier.

*This only applies for SLM versions 02.08.00 or higher.

A servo system consists of the following:

- Motion controller having an ***technology*** communications interface.
- One or more MultiAx servo amplifiers.
- Up to three SL-class servo motors driven by each MultiAx.
- A Control Techniques SLM fitted to each motor. The SLM samples the speed and position of the motor shaft every 125 ms to a resolution of one eight-millionth of a revolution.

The MultiAx contains the following main elements:

- For each axis, a PWM inverter
- ***technology*** data interface for each axis
- Input power stage supplying the three inverters
- Braking transistor common to the three inverters

2.4 *technology*

High system-performance is achieved by the use of A technology which is an EIA485 two-wire high-speed data communications network specially designed by Control Techniques for linking the elements of servo systems with minimal connections. By this means digital control and synchronisation are maintained between all the elements. Data, which consists of unit addresses, parameter numbers and values, is transferred at 125 ms intervals and at a rate of 2.5 Mbits/second.

The ***technology*** network carries the following data communications for servo control:

- The motion controller sends position and speed demands to each SLM.
- Each SLM sends position and speed feedback to the motion controller.
- The SLM sends a current/torque demand to each axis of the MultiAx in order to correct any position error.

2.5 External braking resistor

The braking-resistor circuit allows up to 20 kW to be dissipated into an external resistor of 30 Ω, which is the minimum permissible value. The braklng resistor must be protected from thermal overload (recommendations are given in Chapter 3 *Installation* on page 14).

2.6 Thermal protection of the motor

The SLM protects the motor from thermal overload without the need for an external thermistor. At power-up the SLM transmits to the motion controller the thermal characteristics of the motor as well as the value obtained from a thermistor embedded in the SLM.

When the motor is running, every 125 μs a thermal-modelling function in the SLM updates an accumulator whose value represents the temperature of the motor windings.

If the value of the accumulator reaches a level that indicates the motor windings are at the specified maximum safe working temperature, the output current is limited to a specified level and a motor thermal-overload alarm is produced. This alarm can be applied to, or read by, the system or motion controller to initiate reduction of demand, otherwise continued demand at this level will cause the drive to trip and cease controlling the motor.

Initial conditions are read by the drive, as follows:

- The thermal characteristics of the motor are obtained by the MC during setting-up (described in Automatic setting up of the drive for the motor).
- Each time the SLM is powered-up, the value of the initial motor temperature is obtained from a thermistor embedded in the SLM.
- Adjustments can be made to the motor-protection function, such that the drive provides an early warning to the host before it starts current limiting. Preventative action can then be made.

2.7 Motion-controller requirements

The motion controller must be able to perform the following functions:

- Writing, reading and verifying parameter values
- Setting motor flux angle for each axis
- Fault monitoring of the system
- Fail-safe operation.

3 Installation

3.1 Installation considerations

WARNING

Adhere to 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 MultiAx 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.

WARNING

Competence of the installer
The MultiAx must be installed only by professional assemblers who are familiar with the requirements for safety and EMC. 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.

CAUTION

Motor voltage
The motor must be suitable for use with a MultiAx drive and its required supply voltage

CAUTION

Flash / insulation testing
The MultiAx and RFI filter have internal electrical components connected between the AC-supply phases and ground. In order to avoid damaging these components when flash or insulation testing the AC-supply circuit and/or motor circuit, first disconnect the MultiAx completely from the circuit to be tested.

3.1.1 Authorized access

Only authorized, trained service personnel should be allowed access to the drive.

3.1.2 Installation in an enclosure

The MultiAx must be protected against water, condensation and electrically conductive contamination.

The MultiAx has ingress protection rated at IP20 (in accordance with IEC60529).

3.1.3 Fire enclosure

The MultiAx case is not classified as a fire enclosure.

When this protection is required, the MultiAx should be installed in a fire enclosure.

3.1.4 Hazardous areas

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

3.1.5 Environmental

Refer to Chapter 6 *Technical data* on page 55 for environmental requirements.

If condensation is likely to occur when the MultiAx is not in use, an anti-condensation heater must be installed. This heater must be switched off when the MultiAx is in use; automatic switching is recommended.

If the MultiAx is to be mounted directly above any heat-generating equipment (such as another MultiAx), the maximum temperature of the air immediately below the MultiAx should be taken as the ambient temperature for the MultiAx.

3.1.6 Electromagnetic compatibility

The MultiAx contains powerful electronic circuits which can cause electromagnetic interference. The information and instructions in this chapter include routine EMC precautions that will minimize the risk of disturbance to typical industrial control equipment. These include installing the MultiAx in an enclosure as well as careful attention to the layout of the connecting cables.

Additional precautions must be taken if any of the following apply:

- Strict compliance with emission standards is required
- It is known that electromagnetically sensitive equipment, such as radio receivers, is located nearby
- The MultiAx is to be operated in a residential environment

The information and instructions relating to these additional precautions are contained in the EMC emission standards sections later in this chapter.

These precautions include installing an RFI filter in the AC supply to each MultiAx and additional attention paid to cables and grounding.

NOTE

Dimensions
All dimension measurements are metric, all imperial measurements are in brackets and are calculated from the metric values.

3.2 AC supply protection

WARNING

The AC supply to the MultiAx must be fitted with suitable protection against overload and short-circuits. Failure to observe this recommendation will cause a risk of fire.

Include a fuse in each phase of the AC supply. Use of the following types of fuse are recommended:

- Europe: Type gG HRC to IEC 60269 (BS88)
- USA: CC 600 Vac

An MCB or MCCB having the correct thermal and magnetic trip ratings may be used in place of fuses, on condition the fault-current clearing capacity is sufficient for the installation.

Table 3-1 Fuse ratings

Model	Fuse Rating
MultiAx (all versions)	30 A

3.3 AC supply disturbances - use of line reactors

When a MultiAx is connected to an AC supply which is subject to severe disturbances – for example, if any of the following conditions apply...

- Capacity exceeds 200 kVA
- Fault current exceeds 5 kA
- Power-factor correction equipment is connected close to the MultiAx
- Large DC drives having no or ineffective line reactors are connected to the supply
- Direct-on-line started motor(s) are connected to the supply and, when any of these motors are started, a dip is produced in excess of 20 % of the actual supply voltage

Excessive peak current may flow in the input power circuit of the MultiAx. This may cause nuisance tripping or, in extreme cases, failure of the MultiAx.

A 2 % (0.9 mH) line reactor should then be connected in each phase of the supply to each MultiAx. Line reactor(s) add the required impedance to the AC supply in order to reduce current transients to a level that can be tolerated by the MultiAx.

Three individual reactors, or a single three-phase reactor should be used. Each MultiAx must have its own reactor(s).

CAUTION

RFI filters (for EMC purposes) do not give adequate protection against these conditions.

Table 3-2 Typical line-reactor values

Model Rating	Value
MultiAx (all versions)	1mH

Continuous RMS current: Not less than the continuous input current rating of the MultiAx.

Repetitive peak: Not less than 4 times the continuous input current rating of the MultiAx (this is to prevent magnetic saturation.)

3.4 Output current, Ambient temperature, Heat dissipation, De-rating

NOTE

The ambient temperature should be taken as the temperature of the air immediately under the drive. This is especially important when the drive is to be installed above heat-generating equipment.

The drive can supply the rated maximum continuous output current (FLC) as follows:

- All models: Up to an ambient temperature of 50 °C (122 °F)

If the drive is to be used at an altitude in excess of 2000 m (6600 ft), de-rating for altitude must be applied to the output current (refer to section 6.1.6 *Altitude* on page 56 in Chapter 6.

Make a note of the values that follow for the model to be used; you will need to know these later:

- Maximum intended ambient temperature (**$T_{AMB\ max}$**) (required for calculating the enclosure size later in this chapter)
- Maximum continuous output current (if this needs to be a de-rated value)
- Maximum heat dissipated into the enclosure

CAUTION

Current de-rating

When de-rating must be applied (for ambient temperature), it is essential that the appropriate value is entered in to the motion controller (see the motion controller user guide).
If this precaution is not taken, the current of the MultiAx can exceed the maximum permissible value.
This may result in loss of motor control due to excessive heatsink temperature causing the drive to trip.

3.4.1 Thermal protection

The power output stage (IGBT bridge) of the drive is protected as follows:

- If the heatsink temperature exceeds 85 °C (185 °F), the MultiAx trips; the status LED D5 will extinguish and LED D4 will light.

The maximum limits of current and heat that can be dissipated into the enclosure are shown in Table 3-3. These limits do not need to be de-rated for altitude.

Table 3-3 Maximum current and heat dissipated into the enclosure (These do not need to be de-rated for altitude)

Model	Output current			Heat dissipation	
	$T_{AMB\ max}$	Max continuous	Max. overload (2 s max)	Surface Mounting	Through-panel Mounting
MultiAx (all versions)	50 °C (122 °F)	18.75	37.5	350 W	40 W

3.5 When to use a braking resistor

When a motor is decelerated, or the drive is preventing the motor from gaining speed due to mechanical influences, energy is returned to the drive from the motor. When this energy is too great for the drive to absorb, the DC-bus voltage is raised, which increases the possibility of the drive tripping due to excessive DC-bus voltage.

Depending on the braking requirements, an external braking resistor can be used for absorbing the returned energy. The braking resistor is then switched into circuit by an internal transistor when the DC-bus voltage reaches 780 V.

The required value for the braking resistor is determined by the maximum required braking torque, while the required power rating is determined by the amount of energy to be dissipated, the duty cycle and repetition time, as well as the cooling available for the resistor.

CAUTION

It is important that the braking resistor is adequately rated otherwise the drive could trip due to excessive DC-bus voltage; braking will then cease, allowing the motor to coast uncontrolled.

3.5.1 Braking resistor data

The data for the braking resistor is shown in Table 3-4 .

Table 3-4 Braking resistor data

Minimum permissable value	30 Ω
Operating voltage	780V at switch-on 760V at switch-off
Maximum possible braking current (through 30 Ω) (I_{bMAX})	26.0 A
Peak power rating for 30 Ω	20 kW
Continuous power rating	See *Braking-resistor calculations* later in this chapter

The instantaneous power rating refers to the power dissipated during the conducting periods (milliseconds) of the braking transistor (this operates under a form of pulse width modulation during braking). Higher resistance values require proportionately lower instantaneous power ratings.

3.5.2 Braking resistor precautions

WARNING

Electric shock risk

The voltages present on the braking resistor, its associated components and terminals on the drive are capable of inflicting a severe electric shock and may be lethal.

WARNING

Thermal overload protection

When an external braking resistor is used, it is essential that a thermal overload protection device is incorporated in the braking-resistor circuit in order to minimise the risk of fire in the event of unexpectedly high current, or loss of control of the braking circuit. A typical protection circuit is shown in Figure 3-1.

WARNING

High temperatures

Braking resistors can attain high temperatures and should be segregated from temperature-sensitive equipment and personnel.

When a braking resistor is to be used, ensure the following:

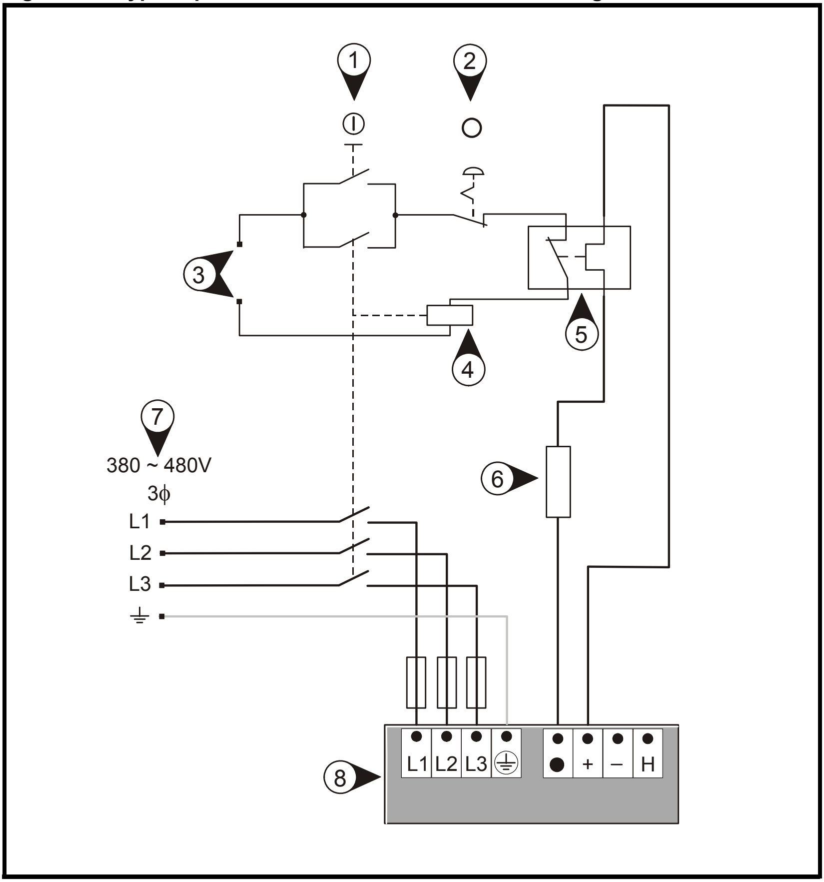
- Include a lock-out circuit that will prevent the AC supply from being re-connected to the drive until the cause of a trip has been fully investigated.
- An external braking resistor should be capable of tolerating thermal shock; pulse rated resistors are recommended.
- It is essential that the instantaneous and average power ratings of the braking resistor are sufficient for the most extreme braking duty that is likely to be encountered.
- When an external braking resistor is mounted inside the enclosure, the heat dissipated by the resistor will increase the ambient temperature inside the enclosure (The value of heat dissipation is used for calculating the enclosure size or ventilation which are described later in this chapter).
- Always use shielded or steel wire armoured cable for connecting an external braking resistor.

When an external braking resistor is used, a thermal-protection circuit must be added.

This must disconnect the AC supply from the drive if the braking resistor becomes overloaded.

For guidance, Figure 3-1 shows a typical circuit arrangement. Complete circuit diagrams for the power connections appear later in this chapter.

Figure 3-1 Typical protection circuit for an external braking resistor



Key

1. START/RESET switch (momentary)
2. STOP switch (latching)
3. Control-circuit supply
4. Contactor coil
5. Thermal overload protection relay
6. External braking resistor
7. 380 ~ 480 Vac supply to the drive
8. Drive power connectors.

3.5.3 Braking resistor example calculations

Conditions

- **Drive**
  Combined total peak ouput current (**Ipk**) from the drive (for 2 seconds): 37.5A
  Minimum permissible braking-resistor value: 30Ω
  Operating voltage ($\mathbf{V_R}$) at switch on: 780V.
- **Motors** (for this example all three motors are of the same type)
  Full-load rated speed (**n**) of motor: 3000 RPM
  Nominal torque ($\mathbf{T_{cs}}$): 8.9N m.
  Motor $\mathbf{K_T}$ = 1.6Nm/A.
  Motor inertia ($\mathbf{J_M}$): 1.66 x 10^{-3}kg m^2.
  Load inertia ($\mathbf{J_L}$): 8.3 x 10^{-3}kg m^2.
  Total combined inertia ($\mathbf{J_T}$ = 3 x [$\mathbf{J_M}$ + $\mathbf{J_L}$]): 29.88 x 10^{-3}kg m^2.
- **Braking**
  Required deceleration time for all axes simultaneously braking ($\mathbf{t_d}$): 0.5 seconds.
  Repeat cycle time for deceleration ($\mathbf{t_r}$): 15 seconds.

Minimum permissible deceleration time

The minimum permissible deceleration time is limited by the following:

- The peak current of the drive (**Ipk**)
- The intermittent torque limit of the motor (for the value of torque that the motor can deliver for a specified time, refer to the motor manufacturer's data)

1. Calculate the maximum total torque that the three motors would produce when the drive is delivering peak current (37.5A), as follows:
   $\mathbf{M_{bMAX} = I_{pk} \times K_T = 37.5 \times 1.6 = 60\ Nm}$
   The drive would cause this value of torque to be produced for up to two seconds.
2. Refer to the the motor manufacturer's data to obtain the permissible overload (continuous stall torque) for two seconds. Then use this figure to calculate the intermittent torque limit for the motor for a two second duration. For this example, three times the nominal torque rating is assumed for all three motors, as follows:
   $\mathbf{M_{bINT} = T_{CS} \times 3 \times 3 = 8.9 \times 3 \times 3 = 80.1Nm}$
3. For calculating the minimum permissible deceleration time ($\mathbf{t_{bMIN}}$), use the lower of the two calculated values, as follows:
   $\mathbf{M_{bMAX} = 60Nm}$
4. The following equation is used as the basis for the calculations:

$$\mathbf{M_b} = \frac{\mathbf{J_T n}}{\mathbf{t_b}} \times \frac{\pi}{\mathbf{30}} \quad \mathbf{(Nm)}$$

Use the following derivative of the equation to calculate the minimum permissible deceleration time ($\mathbf{t_{bMIN}}$) for stopping the motor from full-load speed:

$$\mathbf{t_{bmin}} = \frac{\mathbf{J_T \pi n}}{\mathbf{30 M_{bMAX}}}$$

$$\mathbf{t_{bmin}} = \frac{\mathbf{29.88 \times 10^{-3} \times \pi \times 3000}}{\mathbf{30 \times 60}} = \mathbf{0.16\ Seconds}$$

Check that t_{bMIN} is less than t_d. If it is then the system design must be reconsidered.

Resulting torque

Calculate the torque that results from the required deceleration time, as follows:

$$M_b = \frac{J_T n}{t_d} \times \frac{\pi}{30} \quad (Nm)$$

$$M_b = \frac{29.88 \times 10^{-3} \times \pi \times 3000}{0.5 \times 30} = 18.8 Nm$$

Power rating of the braking resistor

1. Calculate the kinetic energy (E_K) that will be dissipated in the braking resistor, as follows:

$$E_K = 0.5 \times J_T \times \left(\frac{n \times \pi}{30}\right)^2$$

$$E_K = 0.5 \times 29.88 \times 10^{-3} \times \left(\frac{3000 \times \pi}{30}\right)^2$$

$$E_K = 1.5 kJ$$

2. Calculate the average power over deceleration time (**td**):

$$P_{PK} = \frac{E_K}{td}$$

$$P_{PK} = \frac{1.5}{0.5} = 3 kW$$

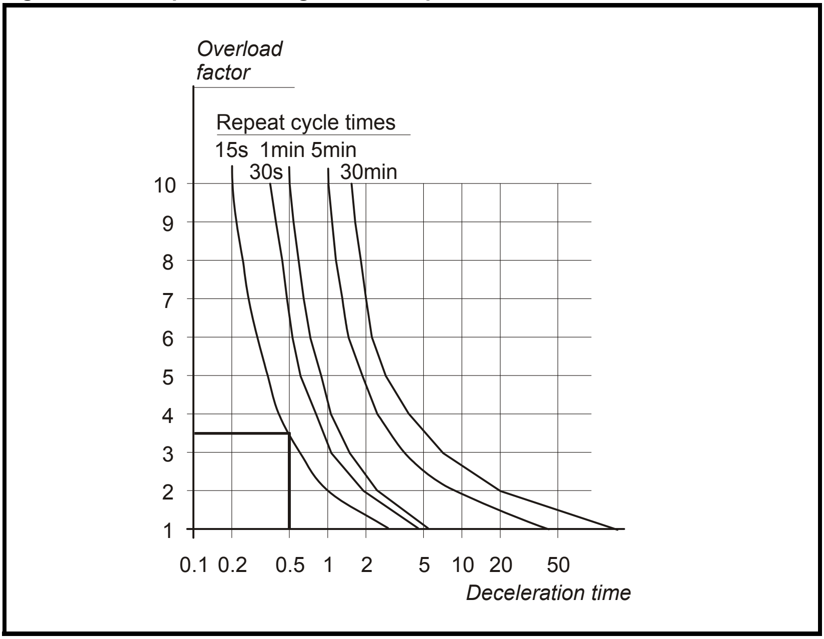
3. Calculate the average power (P_{av}) that will be dissipated over the whole cycle:

$$P_{av} = \frac{E_K}{tr}$$

$$P_{av} = \frac{3000}{15} = 200 W$$

4. Since braking is planned to occur intermittently, the resistor can be rated for intermittent rather than continuous power dissipation so that the overload factor of the resistor can be used. This factor can be obtained from cooling curves for the resistor, as shown in Figure 3-2. This graph shows an example of cooling curves for the power resistors. In practice, you must refer to the cooling curves for the resistor to be used.

Figure 3-2 Example of cooling curves for power resistors



5. The cooling curves indicate that for a braking time of 0.5 second and repeat cycle time of 15 seconds, the overload factor (F) is 3.5.
6. Calculate the minimum required power rating of the resistor, as follows:

$$\mathbf{P_{RMN}} = \frac{\mathbf{P_{PK}}}{\mathbf{F}} = \frac{\mathbf{3 \times 10^3}}{\mathbf{3.5}} = \mathbf{857W}$$

If the braking resistor is to be mounted inside the enclosure, make a note of this value; you will need it when calculating the enclosure size.

In practice, use a resistor having a power rating higher than the calculated value. For this example: $\mathbf{P_R = 1kW}$

3.5.4 Value of the braking resistor

1. Calculate the maximum suitable value for the braking resistor, as follows:

$$\mathbf{R_{MAX}} = \frac{(\mathbf{V_{MAX}})^2}{\mathbf{P_{PK}}} = \frac{\mathbf{780^2}}{\mathbf{3 \times 10^3}} = \mathbf{203\Omega}$$

2. In practice, use a resistor having a preferred value close to and lower than the calculated value. This is because the calculated value would cause the braking transistor to be switched on almost continuously during braking. In this case, the drive will not have full control of the DC-bus voltage. A lower value of braking resistor will cause the braking transistor to act as a chopper which will then allow the drive to control the DC-bus voltage more accurately.

The reduction in value does not increase the power dissipation since the average voltage across the resistor is reduced by the braking transistor operating as a chopper.

For this example: **R = 200**Ω.

3.5.5 Current setting for the thermal overload protection relay

1. Calculate the maximum permissible continuous current through the braking resistor that is to be used, as follows:

$$I_{RMAX} = \sqrt{\frac{P_R}{R}} = \sqrt{\frac{1000}{200}} = 2.2A$$

where:

- P_R is the continuous power rating of the resistor to be used (not the minimum required power rating)
- **R** is the actual value of the braking resistor (not the calculated value).

2. Select a model of thermal overload relay that can be set at **2.2A**
3. Calculate the maximum current that could flow through a resistor (e.g. due to the braking resistor becoming short circuit), as follows:

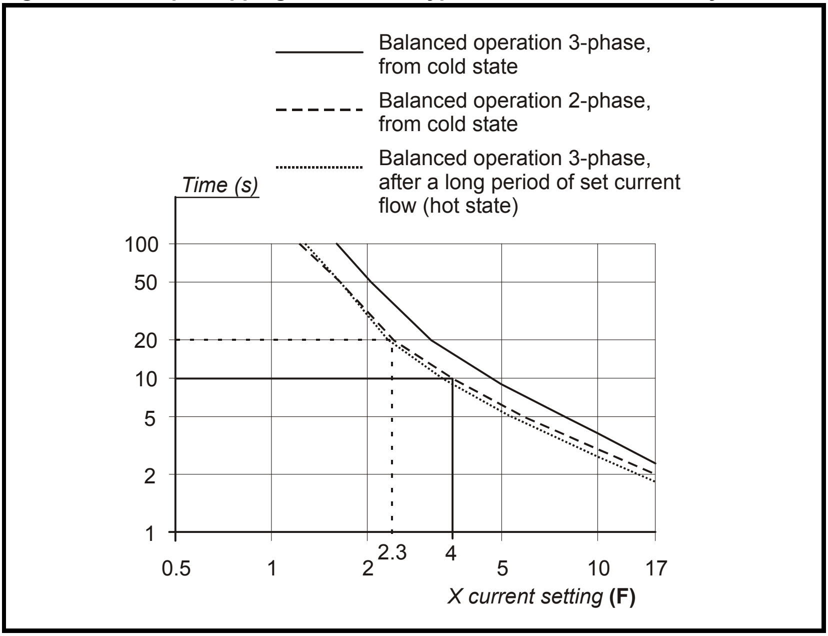
$$I_{Rpk} = \frac{V_R}{R} = \frac{780}{200} = 3.9A$$

4. Calculate the overload factor for this condition, as follows:

$$F_{S/C} = \frac{I_{Rpk}}{I_{SET}} = \frac{3.9}{2.2} = 1.8$$

5. Use the tripping curves to find the time that the thermal overload relay will take to trip (e.g. 40 seconds approximately).

Figure 3-3 Example tripping curves for a typical thermal overload relay



6. Check that the braking resistor can tolerate the overload current (I_{Rpk}) for this duration.

NOTE **Parallel connection of DC buses**
When a number of MultiAx units are used in a system, it is possible to connect their DC buses in parallel in order to allow energy sharing, especially when one or more motors are being braked.
Operation in this manner is not covered by this guide; cable sizes and other information can be obtained from the supplier of the MultiAx.

3.6 Method of Mounting

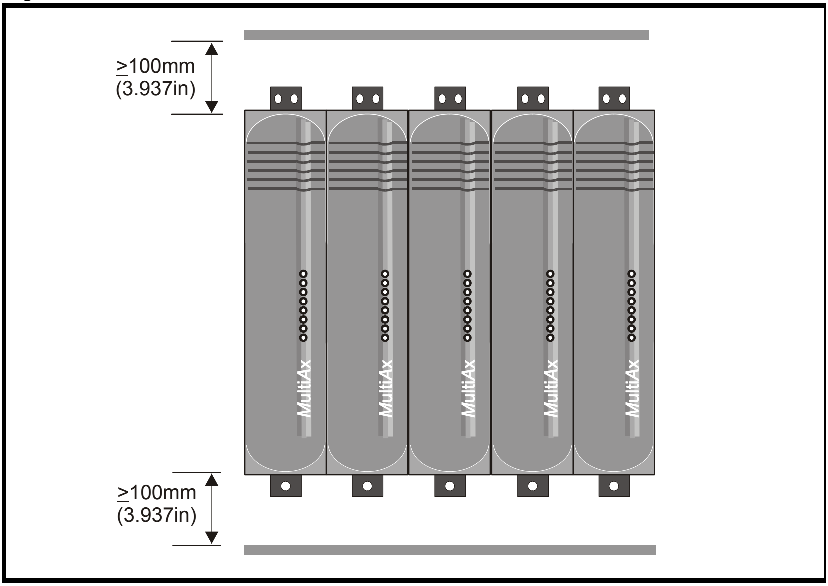
The two mounting brackets supplied with the drive are intended for mounting the drive on the back-plate of the enclosure. Exhaust heat from the drive is emitted in front of the back-plate (mounting instructions are given later in this chapter).

Alternatively the drive can be mounted through an aperture in the back-plate to allow the exhaust heat to be emitted behind the back-plate (mounting instructions are given later in this chapter).

3.7 Enclosure Layout

Refer to Figure 3-4. The bookcase format allows drives to be mounted in rows without need of horizontal spacing.

Figure 3-4 Minimum clearances above and below the drive



EMC compliance

When compliance with EMC emission standards is required, additional precautions must be taken; refer section section 3.16 *EMC emission standards – compliance information* on page 39.

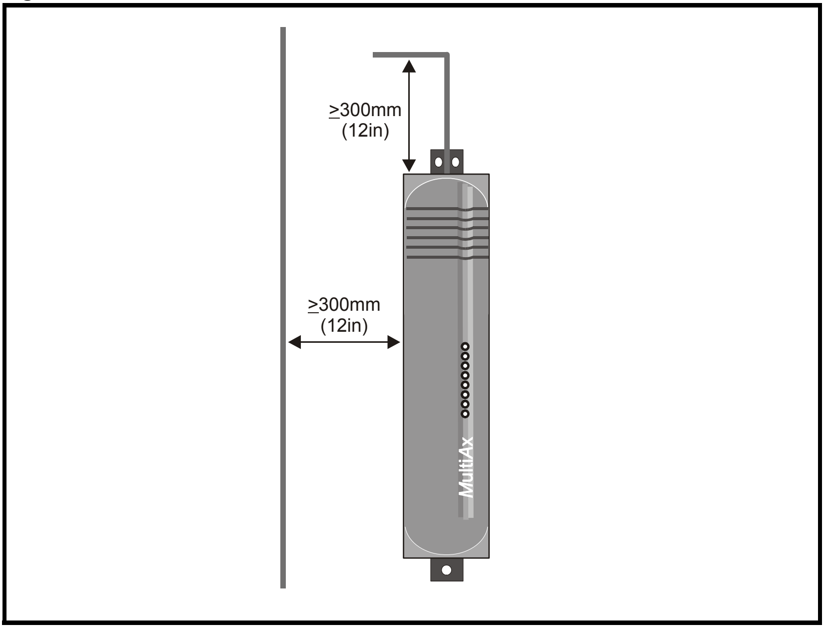
3.8 Clearances for the signal cables

Recommended clearances are shown overleaf; they are required for routine EMC precautions as well as for compliance with EMC emission standards.

3.8.1 Clearance from the MultiAx

Do not locate sensitive signal circuits or pass signal cables within 300mm (12in) of the MultiAx.

Figure 3-5 Clearance from the MultiAx



3.8.2 Clearance from power cables

Refer to Figure 3-6. Do not pass signal cables within 300mm (12 in) of:

- Motor cables
- Braking resistor cables
- AC supply cables

3.8.3 Crossing angle

Refer to Figure 3-7. When power and signal cables cross, the crossing angle must be 90°.

Figure 3-6 Clearance from power cables

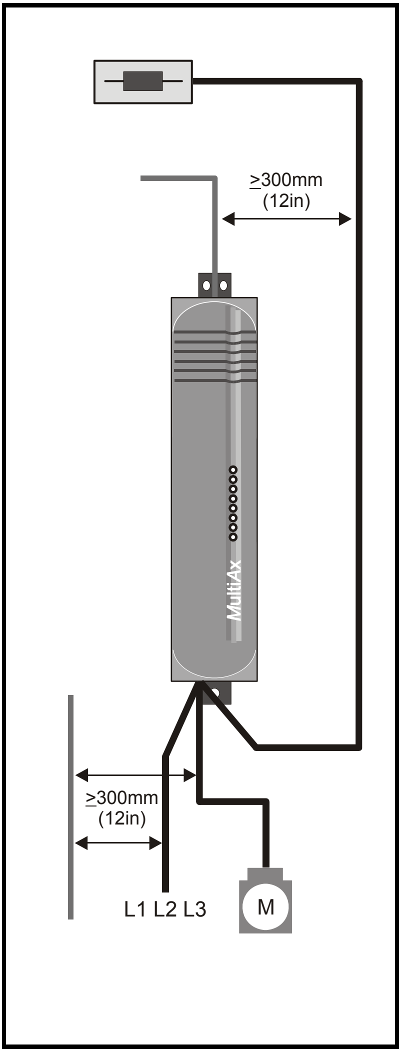
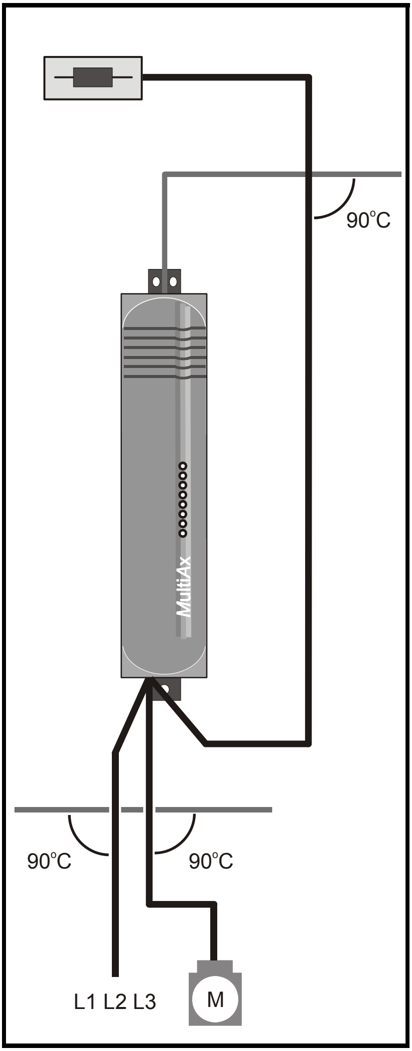


Figure 3-7 Crossing angle



3.9 Enclosure calculations for heat removal

Decide whether the enclosure is to be sealed or ventilated, as follows:

Sealed enclosure

A sealed enclosure can give a high ingress-protection rating, but with reduced heat removal capabilities. If possible, locate heat-generating equipment (other than braking resistors) in the lower part of the enclosure to encourage internal convection.

If necessary, a taller enclosure, and/or air-circulation fans inside the enclosure, can be used. For calculating the minimum size of sealed enclosure that will adequately cool the drive (and other drives), see section 3.9.2 *Calculating the size of a sealed enclosure* on page 27.

Ventilated enclosure

If a high ingress-protection rating is not required, a ventilated enclosure can be used with a fan to supply forced air cooling; this can give a lower ambient temperature than a sealed enclosure. For calculating the minimum required volume of cooling air, see section 3.9.3 *Calculating the air-flow in a ventilated enclosure* on page 29.

3.9.1 Total heat dissipation

1. Add the dissipation figures from section 3.4 *Output current, Ambient temperature, Heat dissipation, De-rating* on page 16) for each drive that is to be installed in the enclosure. Make a note of the total value.
2. If an RFI filter is to be used with each drive, add the dissipation figures from section 3.17.6 *Installing an RFI Filter* on page 40 for each RFI filter that is to be installed in the enclosure. Make a note of the total value.
3. If the braking resistor is to be mounted inside the enclosure, add the average power dissipation ($\mathbf{P_{av}}$) from section *Power rating of the braking resistor* on page 21 for each braking resistor that is to be installed in the enclosure. Make a note of the total value.
4. Make a note of the total heat dissipation (in Watts) of any other equipment to be installed in the enclosure.
5. Add the heat dissipation figures obtained (as appropriate) from lines 1, 2, 3 and 4 above. This gives a figure in Watts for the total heat that will be dissipated inside the enclosure. Make a note of this figure.

3.9.2 Calculating the size of a sealed enclosure

The enclosure transfers internally generated heat into the surrounding air by natural convection (or external forced air flow); the greater the surface area of the enclosure walls, the better is the dissipation capability. Only the surfaces of the enclosure that are unobstructed (not in contact with a wall or floor) can dissipate heat.

Calculate the minimum required unobstructed surface area Ae for the enclosure from:

$$\mathbf{A_e} = \frac{\mathbf{P}}{\mathbf{K}(\mathbf{T_i} - \mathbf{T_{amb}})}$$

Where:

$\mathbf{A_e}$	Unobstructed surface area in m^2 ($1m^2 = 10.8ft^2$)
$\mathbf{T_{amb}}$	Maximum expected ambient temperature in °C outside the enclosure
$\mathbf{T_i}$	Maximum intended ambient temperature in °C inside the enclosure
P	Power in Watts dissipated by all heat sources in the enclosure
k	Heat transmission coefficient of the enclosure material in $W/m^2/°C$

NOTE Take care when performing these calculations in order to ensure the ambient temperature inside the enclosure does not exceed 50°C (122°F) as appropriate, (see Table 3-3 on page 17).

Example

To calculate the size of an enclosure for the following:

- Two MultiAx SAC
- Each drive is to have an external braking resistor mounted inside the enclosure
- An RFI filter (model 4200-3258) to be used with each drive
- Maximum ambient temperature inside the enclosure: 50°C
- Maximum ambient temperature outside the enclosure: 30°C.

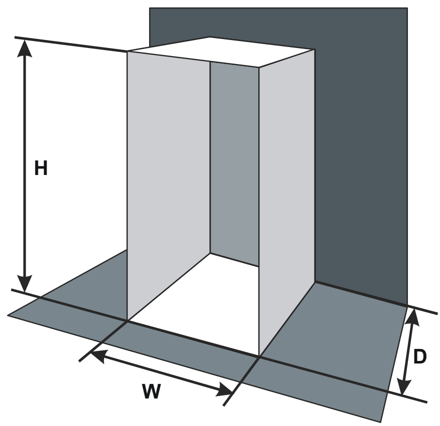
Enclosure calculations for heat removal:

- Dissipation of the drive: 350W (from Table 3-3 on page 17)
- Average dissipation from the braking resistor: 200W (from *Power rating of the braking resistor* on page 21)
- Dissipation of each RFI filter: 11.83W (max) (from section 3.17 *EMC emission standards – instructions* on page 39).

Total dissipation: 2 x (350 + 200 + 11.83) = 1124W.

The enclosure is to be made from painted 2mm (0.079in) sheet steel having a heat transmission coefficient **k** of 5.5W/m^2/°C. Only the top, front, and two sides of the enclosure are to be free to dissipate heat.

Figure 3-8 Enclosure having front, sides and top panels free to dissipate heat



Insert the following values:

$\mathbf{T_i}$	50°C
$\mathbf{T_{amb}}$	30°C
k	5.5
P	1124W

The minimum required heat conducting area is then:

$$A_e = \frac{1124}{5.5 \times (50 - 30)} = 10.2\text{m}^2 (111\text{ft}^2)$$

Estimate two of the enclosure dimensions - the height (H) and depth (D), for instance. Calculate the width (W) from:

$$\mathbf{W} = \frac{\mathbf{A_e - 2HD}}{\mathbf{H + D}}$$

Inserting H = 2m and D = 0.6m, obtain the minimum width:

$$\mathbf{W} = \frac{\mathbf{10.2 - (2 \times 2 \times 0.6)}}{\mathbf{2 + 0.6}} = \mathbf{3m(9ft10in)}$$

If the enclosure is too large for the space available, it can be made smaller only by attending to one or all of the following:

- Reducing the ambient temperature outside the enclosure, and/or applying forced-air cooling to the outside of the enclosure
- Removing other heat-generating equipment, e.g. braking resistors
- Reducing the number of drives in the enclosure
- Add air circulating fans inside the enclosure.

3.9.3 Calculating the air-flow in a ventilated enclosure

The dimensions of the enclosure are required only for accommodating the equipment. The equipment is cooled by the forced air flow.

Calculate the minimum required volume of ventilating air from:

$$\mathbf{V} = \frac{\mathbf{3k_a k_p P}}{\mathbf{T_i - T_{amb}}}$$

Where:

V Air-flow in m^3 per hour

$\mathbf{T_{amb}}$ Maximum ambient temperature in °C outside the enclosure

$\mathbf{T_i}$ Maximum ambient temperature in °C inside the enclosure

P Power in Watts dissipated by all heat sources in the enclosure

$\mathbf{k_p}$ Ratio of $\frac{\mathbf{P_0}}{\mathbf{P_1}}$

Where:

$\mathbf{P_0}$ is the air pressure at sea level

$\mathbf{P_1}$ is the air pressure at the installation

Typically use a factor $\mathbf{k_a}$ of 1.2 to 1.3, to allow also for pressure-drops in dirty air-filters.

Example

To calculate the required air flow in an enclosure for the following:

- Two MultiAx SAC
- Each drive is to have an external braking resistor mounted outside the enclosure
- Maximum ambient temperature inside the enclosure: 50°C
- Maximum ambient temperature outside the enclosure: 30°C
- At sea level ($\mathbf{k_p}$ = 1 for the example).

Dissipation of each drive: 350W (from Table 3-3 *Maximum current and heat dissipated into the enclosure (These do not need to be de-rated for altitude)* on page 17).

Total dissipation: 2 x 350 = 700W.

Insert the following values:

$\mathbf{T_i}$	50°C
$\mathbf{T_{amb}}$	30°C
$\mathbf{k_a}$	1.3
P	700W

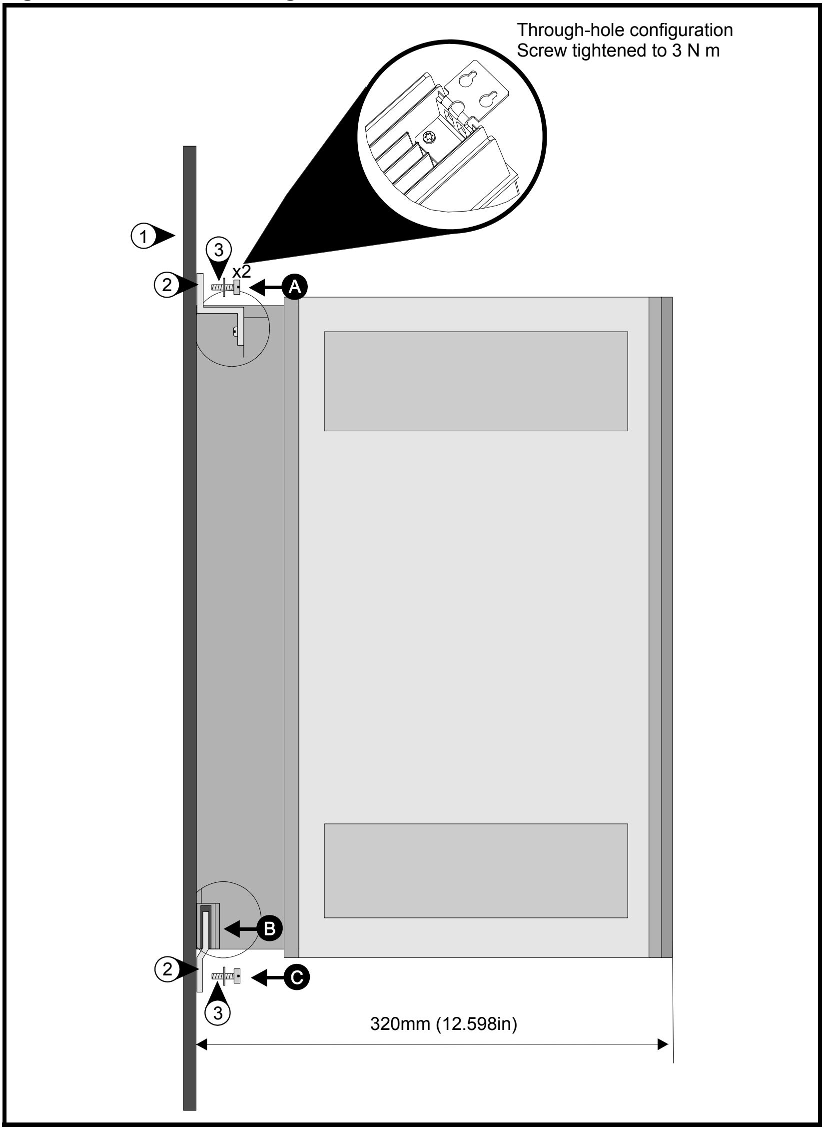
Then:

$$\mathbf{V} = \frac{\mathbf{3 \times 1.3 \times 700}}{\mathbf{50 - 30}} = \mathbf{136.5m^3/hr(81ft^3/min)}$$

($1m^3/hr = 0.59ft^3/min$)

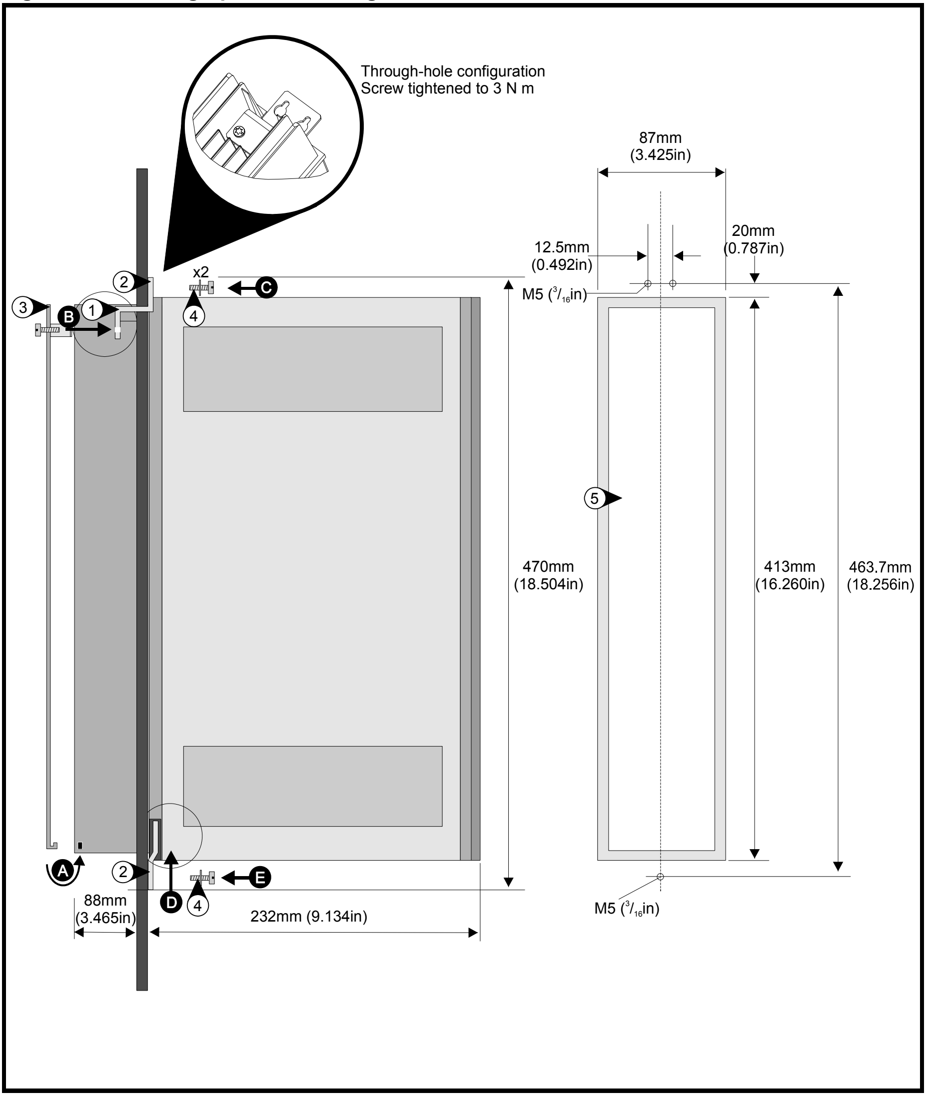
3.10 Mounting the MultiAx

Figure 3-9 Surface-mounting details for the MultiAx



1. Back-plate to form a continuous duct in conjunction with the heatsink fins.
2. If compliance with EMC emission standards is required, both brackets must make direct electrical contact with the back-plate; the screw holes should be threaded.
3. M5 (3/16 in) screws and washers.
4. Area occupied by the MultiAx.
5. Fitting order: (A) to (C).

Figure 3-10 Through-panel mounting details for the MultiAx



Key

1. Reverse the upper bracket.
2. If compliance with EMC emission standards is required, both brackets must make direct electrical contact with the back-plate; the screw holes should be threaded.
3. Baffle-plate (part no. 6521-0321) must be fitted to form a continuous duct in conjunction with the heatsink fins.
4. M5 (3/16 in) screws and washers.
5. Area to be cut out of the back-plate.
6. Fitting order: (A) to (E).

3.11 Precaution for making power connections

WARNING	**Electric shock risk** The voltages present in the following locations can cause severe electric shock and may be lethal: AC supply cables and connections Output cables and connections Many internal parts of the drive An auxiliary back-up supply when connected in addition to the AC supply.

WARNING	**Isolation device** The AC supply must be disconnected from the MultiAx using an approved isolation device before any cover is removed from the MultiAx 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 five minutes before work may continue.

WARNING	**AC supply by plug and socket** Special attention must be given if the MultiAx is installed in equipment which is connected to the AC supply by a plug and socket. The AC supply terminals of the MultiAx are connected to the internal capacitors through rectifier diodes which do not give 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 MultiAx must be used (eg. a latching relay).

WARNING	**ENABLE function** Disabling the ENABLE function does not remove dangerous voltages from the MultiAx.

WARNING	**Safety ground connection** The ground loop impedance must conform to the requirements of local safety regulations. The electrical safety of the installation depends on the correct fitting and use of the ground bracket supplied with the MultiAx. All ground connections to the MultiAx must be made to this ground bracket. The ground bracket must be grounded by a connection capable of carrying the prospective fault current until the protective device (fuse, etc) disconnects the AC supply. The ground connections must be inspected and tested at appropriate intervals.

3.12 Terminal sizes and tightening torques

WARNING

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

Table 3-11 Terminal sizes and tightening torques

Unit	Power terminals		Ground terminal	
	Size / Type	**Torque**	**Size / Type**	**Torque**
MultiAx	Plug-in terminal block	0.5Nm (4.4 lb.in)	M5 (Torx / slot-head screw)	2.5Nm (22.1 lb.in)
RFI Filter	Screw terminals	0.7Nm (6 lb.in)	Screw terminals	0.7Nm (6 lb.in)
Torque reference	±10%		±10%	

3.13 Power cables

WARNING

Wiring must be in accordance with local regulations and codes of practice. The table below shows typical cable sizes for power input and output wiring. In the event of a conflict, local regulations prevail.

3.13.1 Cable type and sizes

Use 105°C (221°F) PVC or PUR insulated cable of suitable voltage rating and having copper conductors.

For the following, use shielded cable or steel wire armoured cable having the appropriate number of conductors:

- MultiAx to motors (3 core + optional ground)
- MultiAx to braking resistor (2 core + optional ground).

3.13.2 Ground conductors

A ground conductor can be included in the motor and braking resistor cables, or a separate wire external to these cables can be used.

3.13.3 Typical cable sizes

Table 3-5 Power cable sizes

Connection	Typical cable size	
	MultiAx SAC MultiAx SDC	**MultiAx HAC MultiAx HDC**
AC supply to MultiAx (or RFI filter when used)	6mm^2 (10AWG)	6mm^2 (10AWG)
MultiAx to motor, axis A	2.5mm^2 (14AWG)	4mm^2 (12AWG)
MultiAx to motor, axis B	2.5mm^2 (14AWG)	2.5mm^2 (14AWG)
MultiAx to motor, axis C	2.5mm^2 (14AWG)	2.5mm^2 (14AWG)
MultiAx to braking resistor	4mm^2 (12AWG)	4mm^2 (12AWG)

> **WARNING**
> To avoid a fire hazard, 4mm^2 motor cable must used when a MultiAx HAC / HDC unit is operating with full current selected on Axis A.

3.13.4 Cable terminations

In order to meet UL508C requirements, the power cable cores must be managed so as to prevent loose conductor strands from contacting other uninsulated live parts or metal parts. It is recommended that suitable insulated ferrules should be used at least on the power and ground cores.

3.13.5 Motor cable

Most cables have an insulating jacket between the cores and the armour or shield; these cables have a relatively low capacitance. When using a cable of this type, observe the recommended maximum lengths stated in the following table.

Table 3-6 Maximum cable lengths

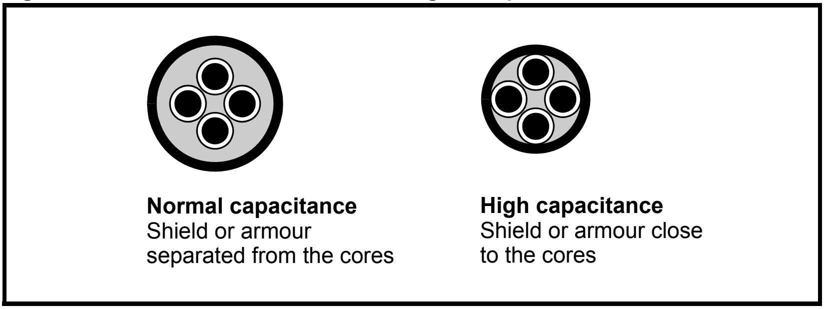
Model	Maximum cable length*	
	m	ft
MultiAx (all versions)	50	165

* Cable lengths in excess of the specified values may be used only when special techniques are adopted; refer to the supplier of the drive.

Typical capacitance for normal cable: 130pF/m (refer to section 3.13.6 *Cable capacitance* on page 35).

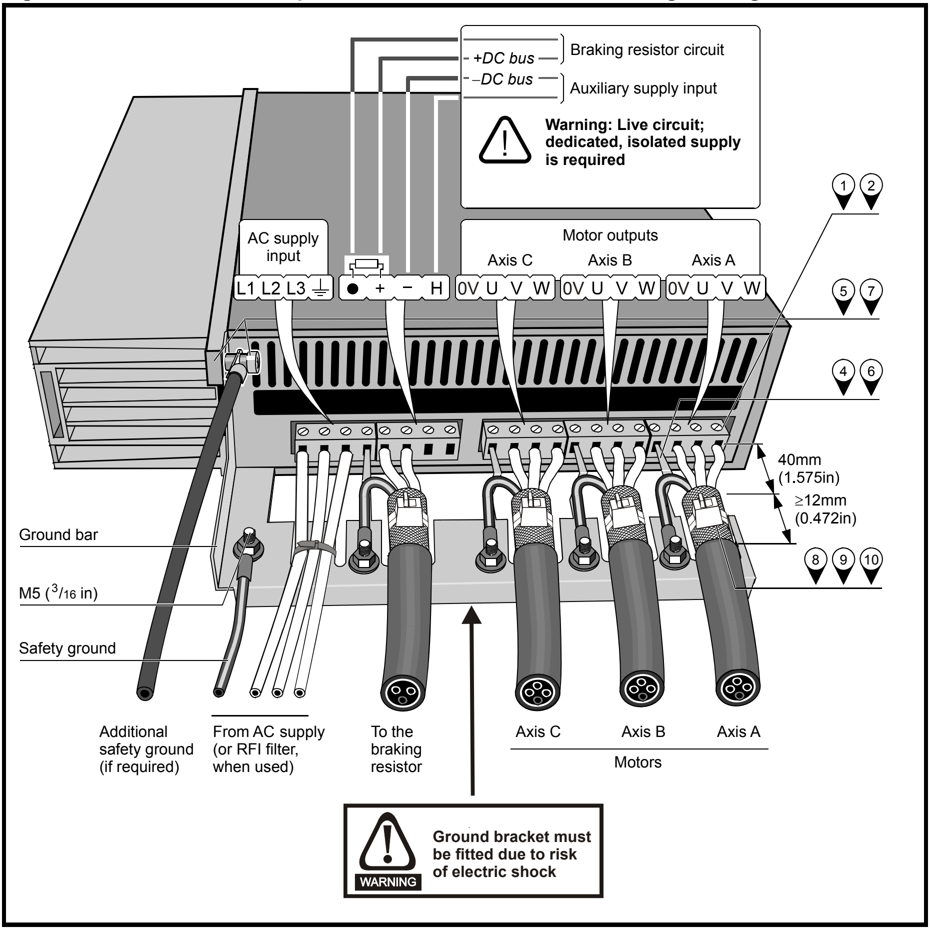
3.13.6 Cable capacitance

Figure 3-12 Cable construction influencing the capacitance



3.14 Method of connecting power cables

Figure 3-13 Locations of the power connections and correct fitting of the ground bracket



For electrical safety, the ground bracket must be fitted as shown. See also section 3.15 *Circuit diagram for the power connections* on page 38 and section 3.12 *Terminal sizes and tightening torques* on page 34.

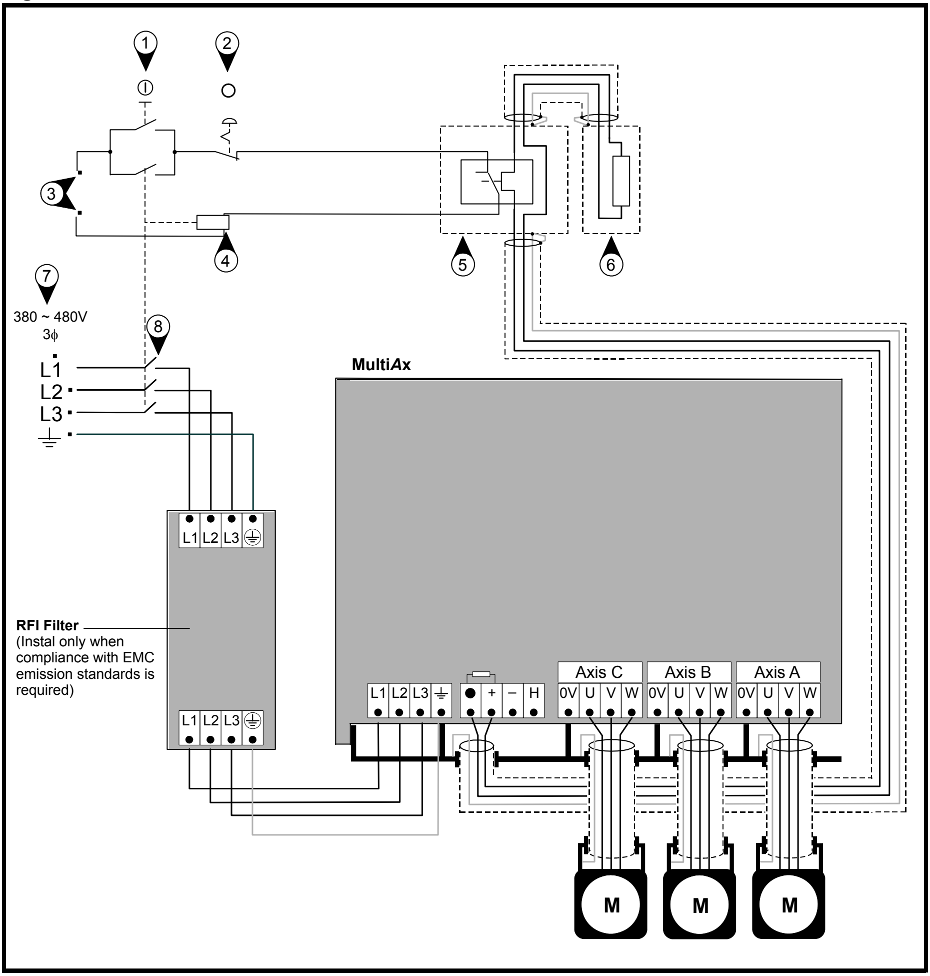
Perform the following:

1. Fit a plug-in multi-way connector into each of the five 4-way sockets on the underside of the MultiAx.
2. Loosen the screw for each of the ground terminals of the 4-way connectors.
3. Taking care not to lose the recessed nut, remove the screw in the tab at the bottom of the heatsink flange.
4. Fit the four tongues of the ground bracket in the ground terminals of the 4-way connectors and align the hole in the ground bracket with the hole in the heatsink tab.
5. If an additional safety ground is required, fit an adequately rated safety-ground wire to the screw and fit the screw loosely in the tab in order to retain the ground bracket.
6. Tighten the screws in the four ground terminals to the specified torque.
7. Tighten the screw in the heatsink tab to the specified torque.
8. Strip back the insulating sheath on the shielded cables to expose at least 12mm (0.472in) of shield and 40mm (1.575in) of inner conductors.
9. Fit a hose clip over each cable shield to clamp it to the ground bracket. Ensure the hose clip makes good electrical contact with the shield or armour.
10. For the motor and braking resistor cables, connect each ground wire to the ground bracket using the related hole at the position shown. This applies whether the ground wire is inside or outside the cable.

3.15 Circuit diagram for the power connections

Figure 3-14 shows the power connections to be made, including a typical protection circuit for the braking resistor.

Figure 3-14 Power connections



Key

1. START/RESET switch
2. STOP switch
3. Control supply
4. Contactor coil
5. Thermal overload protection relay
6. Braking resistor
7. AC supply to the MultiAx
8. AC supply Isolator.

3.16 EMC emission standards – compliance information

NOTE **Conditions for EMC compliance**
The installer of the drive is responsible for ensuring compliance with the EMC regulations that apply where the drive is to be used.
The drive will comply with the standards for emission, such as EN50081–2, only when the instructions given in this section are adhered to closely.

NOTE **Special note for EN61800-3 (EMC Power Drive Systems)**
For installation in the "second environment", ie, where the low voltage supply network does not supply domestic premises, and where the rated input current of the drive system exceeds 100A, no filter is required in order to meet IEC61800-3 (EN61800-3).

CAUTION
Operating the drive in this environment without an RFI filter may cause interference to nearby electronic equipment whose sensitivity has not been appreciated. The user must take remedial measures if this situation arises.
If the consequences of unexpected disturbances are severe, it is recommended that the emission limits of EN61000-6-4 be adhered to. In any other case adhere to the precautions described in this section.

When the drive is used in the "first environment", i.e. where the low voltage supply network also supplies domestic premises, the following warning applies:

WARNING
This is a product of the restricted distribution class according to IEC 61800-3.
In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

3.17 EMC emission standards – instructions

Follow these instructions in addition to those given earlier in this chapter.

3.17.1 Enclosure

The enclosure must be made of metal but does not require special EMC features.

3.17.2 Back-plate

Ensure the enclosure back-plate is unpainted, but it may be zinc plated.

3.17.3 Mounting brackets electrically connected to the back-plate

Ensure the mounting brackets for the drive and RFI filter make direct electrical connection with the back-plate.

3.17.4 Grounding

For compliance with EMC emission standards, employ the grounding arrangements shown in this section. These arrangements are in addition to (not instead of) the safety requirements.

The fitting of an additional safety ground will not reduce the EMC performance.

3.17.5 External braking resistor

When an external braking resistor is to be mounted outside the enclosure, ensure the following:

- The resistor housing will give electromagnetic shielding (without compromising ventilation)
- The braking-resistor wiring must be shielded/armoured.

3.17.6 Installing an RFI Filter

For compliance with emission standards such as EN61000-6-3 or EN61000-6-4, use an RFI filter for each drive, as shown in the table below. Standards that are met are specified in section 6.2 *Optional RFI filter* on page 59.

Table 3-7 RFI Filter

Model	RFI Filter		
	Part Number	**Maximum power dissipation**	**Ingress Protection**
MultiAx (all versions)	4200-3258	11.83W	IP20

Make a note of the following for each RFI filter to be used:

- Part number
- Maximum power dissipation figure
- IP rating.

Figure 3-15 Dimensions of the RFI filter

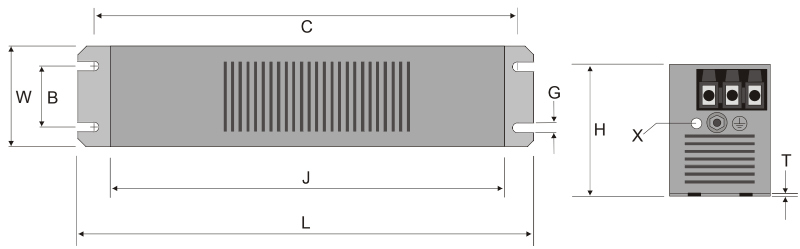
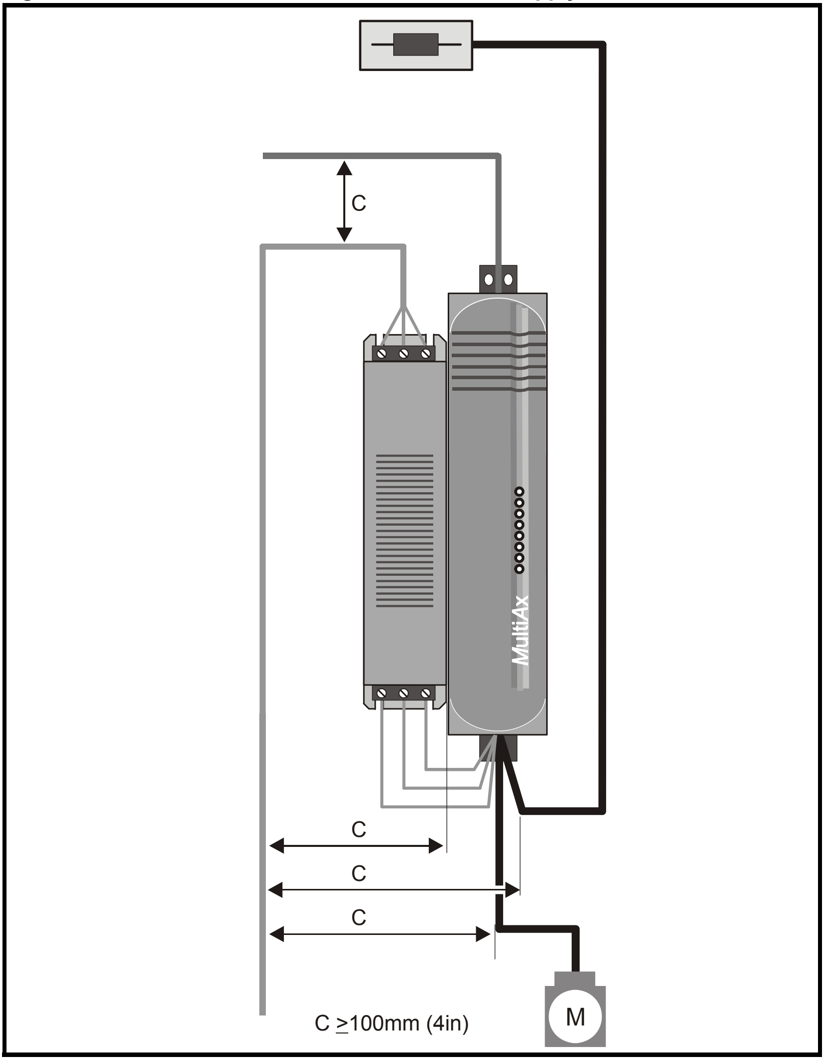


Table 3-8 Dimensions of the RFI filter

L	W	H	J	B	C	G	T		X
270	50	85	240	30	255	5.4	1.0	MM	M5
10.63	0.969	3.346	9.449	1.181	10.039	0.213	0.039	in	

3.17.7 Clearances from the RFI filter and AC supply cables

Figure 3-16 Clearances from the RFI filter and AC supply cables



Mount the RFI filter as close as possible to the drive. No clearance is required either side of the RFI filter or the drive.

Make the wires connecting the RFI filter to the drive as short as possible.

Allow at least 100mm (4in) clearance (C) between the AC supply cable and the following:

- Signal cables
- Drive
- Braking resistors and cables
- Motors and cables.

3.18 Additional ground connections for the signal cables

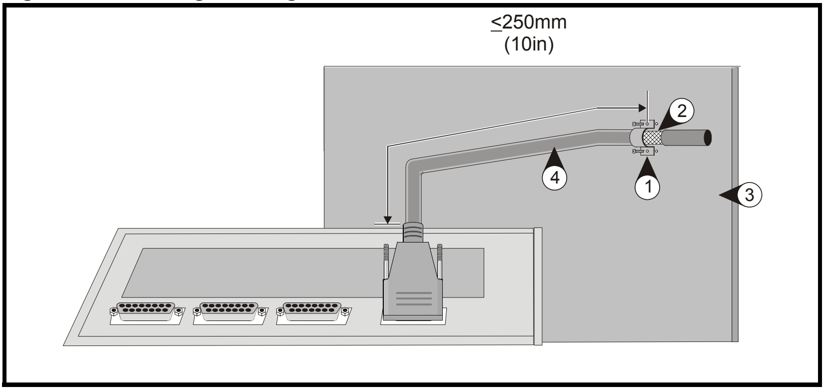
Electrically bond the shields of all the signal cables to the back-plate by direct grounding unless ground-loop currents cause problems. In this case, indirect grounding can be used to ground all the cables. Refer to section 3.18.1 *Direct grounding* and section 3.18.2 *Indirect grounding* for more information.

3.18.1 Direct grounding

1. Using an uninsulated metal cable-clamp (1), electrically bond the shield (2) of the cable to the back-plate (3).
2. Ensure there is no more than 250mm (10in) of cable length (4) between the clamp and the drive.

For clarity, the upper mounting bracket has been omitted from this view.

Figure 3-17 Direct grounding

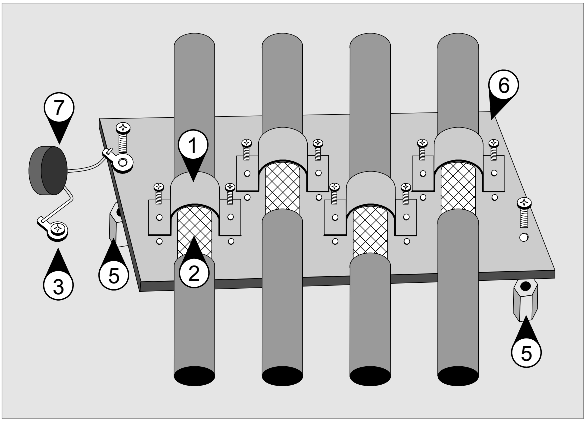


3.18.2 Indirect grounding

Indirect grounding uses a 10nF capacitor to prevent low-frequency ground-loop currents from occurring. Low-frequency ground-loop currents these can cause problems in systems controlled by analog signals.

1. Use insulating studs (5) to mount an uninsulated metal plate (6) on the back-plate (3); the plate (6) must be insulated from the back-plate.
2. Using uninsulated metal cable-clamps (1), electrically bond the shield (2) of each cable to the metal plate (6).
3. Ensure there is no more than 250mm (10in) of cable length (4) between each clamp and the drive. (Refer to the preceding diagram.)
4. Connect a 10nF 2kV ceramic disc capacitor (7) between the metal plate (6) and the back-plate (3). Maximum permissible length of each lead-out wire is 20mm (0.787in).

Figure 3-18 Indirect grounding

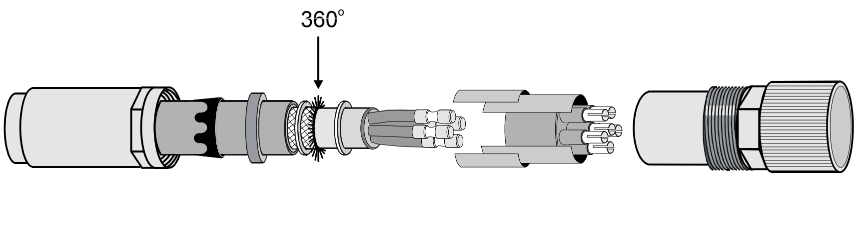


3.19 Bonding the cable shield to the motor frame

The shield of the motor cable must be electrically bonded to the motor frame. The preferred method of achieving this is to connect the shield to the ground terminal of the motor, as shown in Figure 3-19 and Figure 3-20.

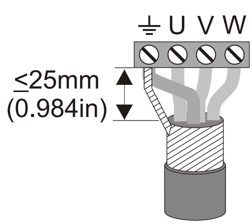
For motors that have a power input socket, a metal cable plug should be used and the cable shield make contact with the shell throughout its entire circumference (full 360° termination). (A typical plug is shown aside.)

Figure 3-19 Bonding the cable shield to the motor frame



If a full 360° termination is not possible (due to a plastic plug being used, or the motor having separate terminals and cable glands), a link no longer than 25mm (0.984in) between the shield and the terminal should be used.

Figure 3-20 Link between the shield and the terminal



4 Drive connections

Follow the instructions in this chapter for product familiarisation as well as permanent installation.

WARNING	**Personnel requirements** The drive must be installed and operated only by personnel having the necessary training or experience.

WARNING	**Motor safety** If this is the first time the drive has been operated, ensure that no damage or safety hazard could arise from the motor starting unexpectedly. For product familiarisation as well as full installation, the motor must be fixed down and the shaft guarded against inadvertent contact.

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 five minutes before work may continue.

4.1 Making electrical connections

4.1.1 Setting up the drive without an AC supply

If it is required, the drive can be set up for the application without connection to an AC supply. To do this an auxiliary supply must be connected to the drive. Before this can be done, refer to section 4.7 *Back-up supplies* on page 50 for more information.

4.1.2 Permanent installation

To make permanent connections to the drive, refer to these sections that follow:

- Chapter 1 *Safety Information* on page 7
- Chapter 3 *Installation* on page 14
- Chapter 7 *Signal connections* on page 61
- The remainder pages of this chapter.

4.1.3 Product familiarisation

For operation make temporary connections power and signal connections to the MultiAx refer to section 4.3 *Functions of the signal connectors* on page 45. Then follow the instructions in Chapter 5 *Setting up* on page 55.

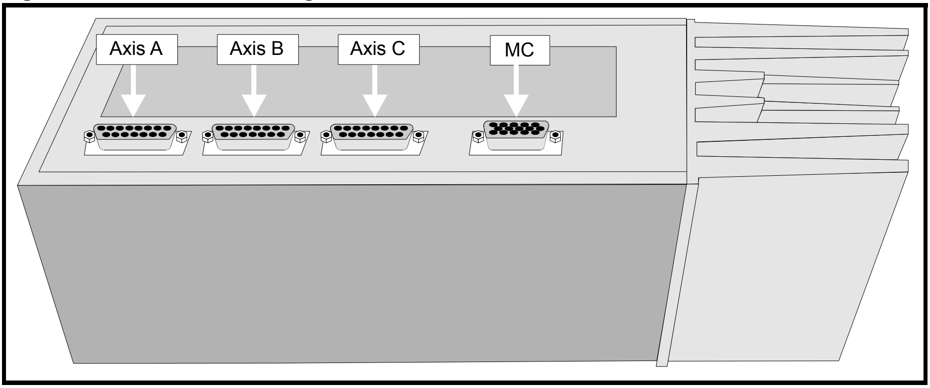
For making the power connections, refer to Chapter 1 *Safety Information* on page 7 before using the following sections in Chapter 3 *Installation* on page 14:

- AC supply protection
- Power cables
- Signal cables and connectors
- Precautions for making power connections
- Terminal sizes and tightening torques
- Method of connecting the power cables
- Circuit diagrams for the power connections

Refer to the remainder of this chapter, for making signal connections, and Chapter 7 *Signal connections* on page 61.

4.2 Locations of the signal connectors

Figure 4-1 Locations of the signal connectors on the MultiAx



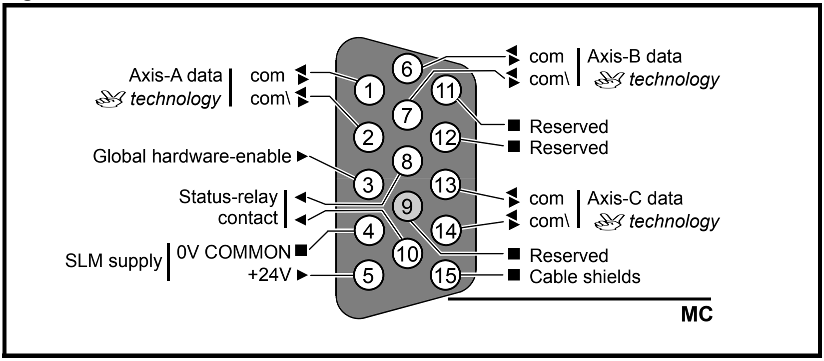
4.3 Functions of the signal connectors

4.3.1 D-type connector

MC signal connections

- ***technology*** I/O to a motion controller for all axes
- **Global Hardware enable** input (electrical signal from a system or motion controller for all axes
- **Status-relay** contact
- **SLM supply** input can be applied when the drive is powered-down to retain position (see section 4.7 *Back-up supplies* on page 50).

Figure 4-2 MC

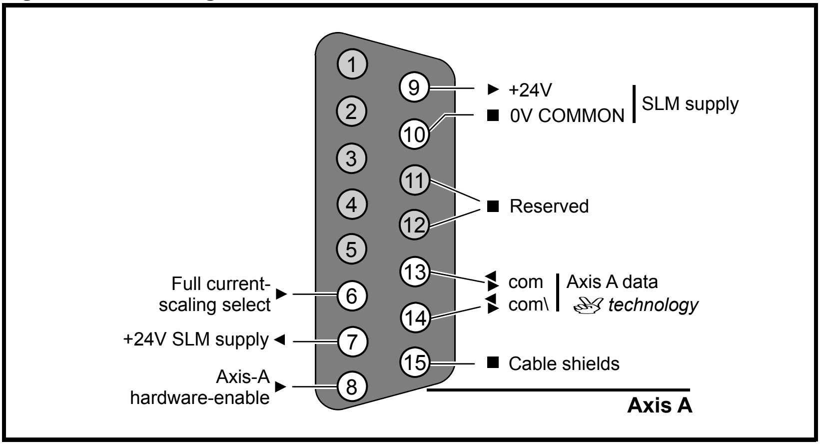


Axis A signal connections

- ***technology*** I/O to a axis A **SLM**
- **Hardware enable** input (electrical signal from a system or motion controller for axis A)
- 24Vdc supply to the **SLM**

Full current-scaling input. The electrical signal used to set the full scale current limit of axis A.

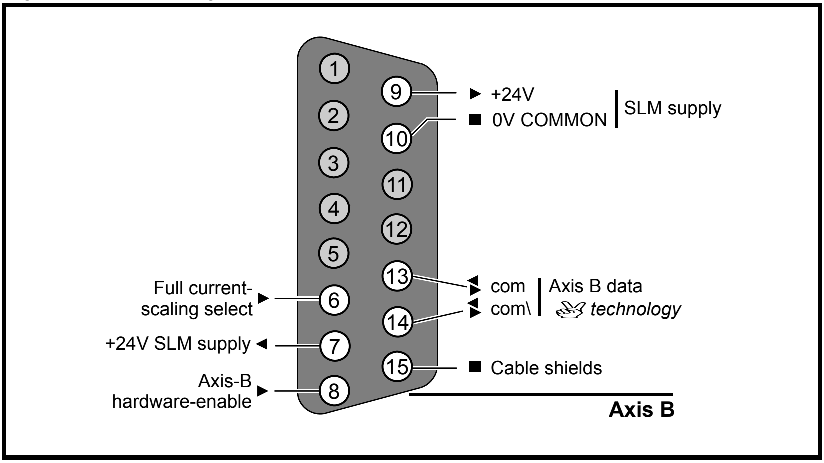
Figure 4-3 Axis A signal connections



Axis B signal connections

- *technology* I/O to axis B **SLM**
- **Hardware enable** input (electrical signal from a system or motion controller for axis B)
- 24Vdc supply to the **SLM**
- **Full current-scaling** input. The electrical signal used to set the full scale current limit of axis B.

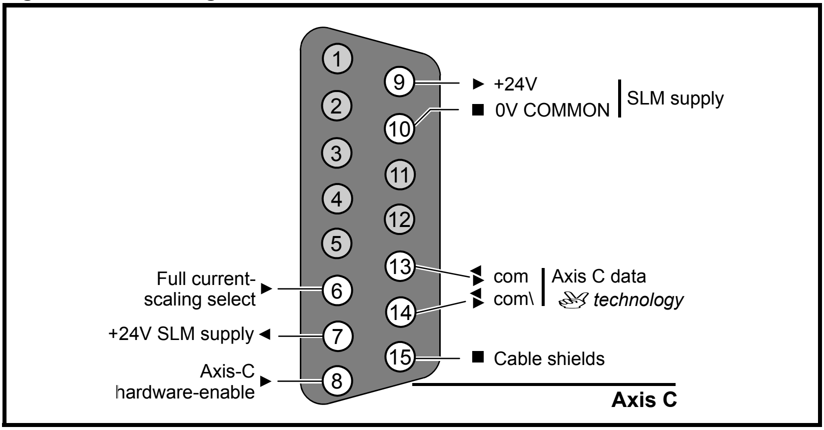
Figure 4-4 Axis B signal connections



Axis C signal connections

- *technology* I/O to axis C SLM
- **Hardware enable** input (electrical signal from a system or motion controller for axis C)
- 24Vdc supply to the **SLM**
- **Full current-scaling** input (electrical signal used to set the full scale current limit of axis C).

Figure 4-5 Axis C signal connections



NOTE The link is only checked on power-up. Do NOT change without re-commissioning.

NOTE The MultiAx will not respond to any enable / disable software commands via the SLM until the drive sees a rising edge on the Hardware enable signal after a drive power-up. The host controller must guarantee that the Hardware enable signal is not present at the drive power-up or toggle it afterwards. This is a safety feature to prevent any unintentional live power stage at drive power-up.

CAUTION Wait 30 seconds after removing power to the drive before inserting or removing control cables as 'hot plugging' cables can result in damage to the drive or SLM.

4.3.2 Parallel and multiple connections

The following functions are available on more than one connector (the related terminals are connected in parallel in the drive):

0V COMMON

+24V SLM supply

Axis-A data ***technology***

Axis-B data ***technology***

Axis-C data ***technology***

4.3.3 Hardware enable

For the MultiAx to run, **Hardware enable** and **Software enable** (described in Chapter 5 *Setting up* on page 55) must both be applied.

Since the hardware-enable function in the MultiAx is edge-triggered, **Hardware enable** signal(s) must be applied after the MultiAx has been powered-up.

4.3.4 Global or axis enable

When a **Global Hardware enable** is applied, it will simultaneously enable all three axes (each axis will also require a software enable, see section 4.3.3 *Hardware enable*). It is also possible to apply a **Hardware enable** signal to individual axes if required. It is not necessary to apply global as well as axis hardware-enable signals.

4.3.5 Current-scaling modes

The MultiAx is supplied with all three axes operating in the default current-scaling mode. By connecting a wire link in the related D-type signal connector, one or more axes can be operated in the full current-scaling mode. This can assist with matching the MultiAx to the current-ratings of the motor.

NOTE The correct cable MUST be used. Monitor (VDU) signal cables are NOT suitable for use with the MC connector.

4.3.6 D-type connectors

For connection to the MC connectors on the MultiAx use the following:

Cables

- Multi-core cables having tinned-copper stranded twisted pair conductors, overall braided shield and braided outer sheath. Maximum overall diameter: depends on the D-type connector being used.

Connectors

- 15-way High density D-type male / plug connector.

For connection to the Axis A, Axis B and Axis C connectors on the MultiAx use the following:

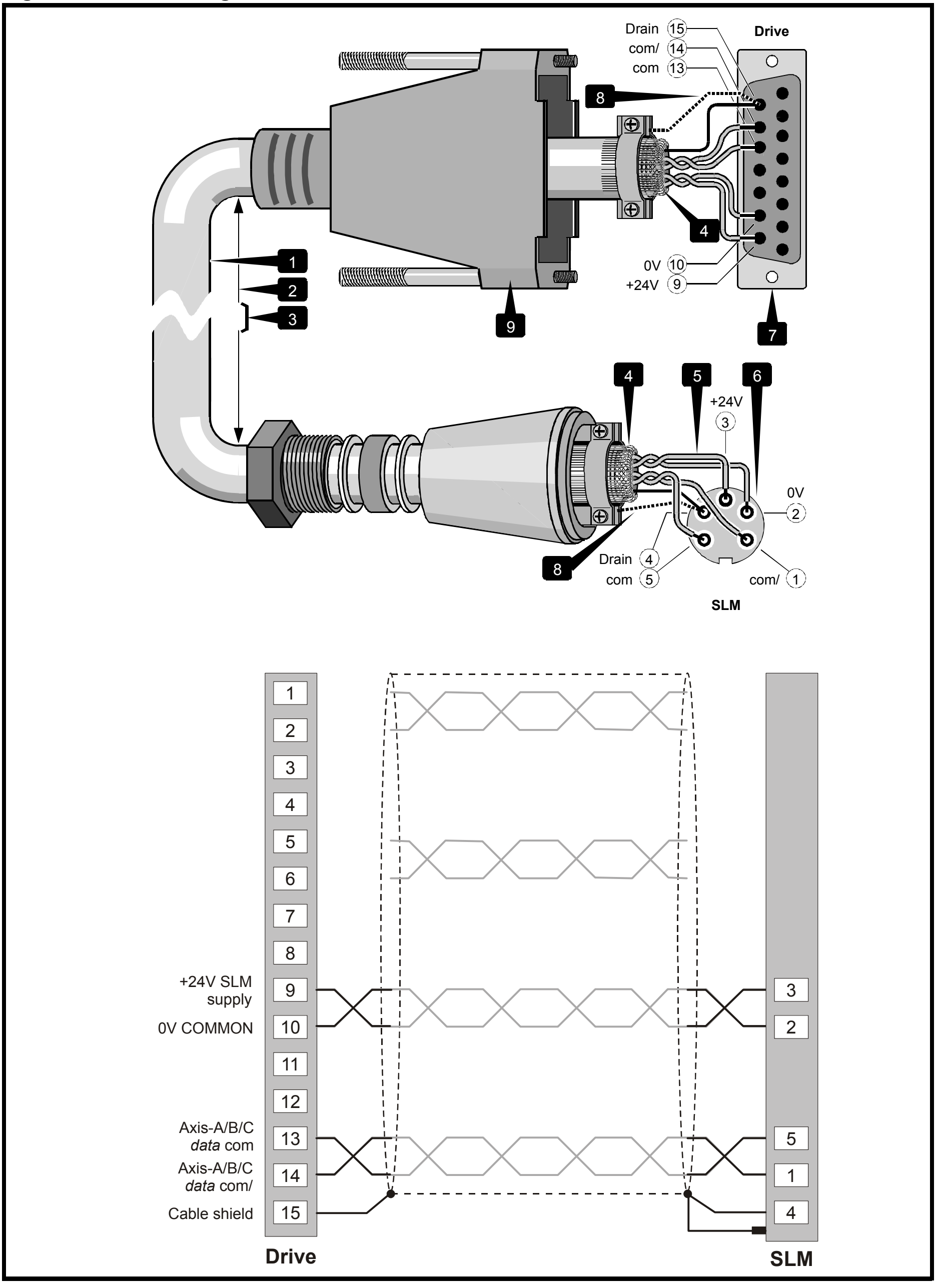
Cables

- Up to four twisted-pairs having an overall shield (unused wires must not be connected to pins at the other end)
- Maximum length: 50m (165ft)
- Maximum overall diameter: depends on the D-type and SLM connector being used.
- Static installations: for example, use BICC type S-FTP patch, four twisted pairs, 5.33mm diameter
- Dynamic installations: for example, use Intercond type **3MBM 26P 02P**, 2 twisted pairs, 5.5mm diameter.

4.4 SLM connections

To make the connections of the SLM cable refer to Figure 4-6 and Figure 4.5 on page 50.

Figure 4-6 Connecting the SLM cable to the connectors



1. Two twisted-pairs having an overall shielded braid
2. Maximum length: 50m (165ft)
3. Route the cable by the shortest convenient path and so that it is no closer than 300mm (12in) from any power cable.
4. Overall shield of tinned copper braid. Comb out the braid at both ends, fold the strands back and trap them under the cable clamp to ensure good electrical contact with the connector shell.
5. Make the wire ends as short as possible (this affects performance).
6. 5-way screw-locking DIN connector meeting IP67.
7. Shielded high-density 15-way D-type male connector.
8. Drain connection between cable shielded braid and 0V (0V COMMON)
9. Metalised or diecast D-type connector shell.

4.5 +24Vdc Supplies

The +24V SLM supply should be obtained from the motion controller and applied to the +24V SLM supply input (MC connector, pin 5). It is then passed direct to the +24V SLM supply outputs (Axis A, B, C connectors, pins 7, 9). The +24V SLM supply should also be used to supply the Hardware enable and Global Hardware enable inputs, and the Full current scale select inputs (see Chapter 7 *Signal connections* on page 61).

Permissible voltage for all inputs: 21.6Vdc to 26.4Vdc.

4.6 Planning the signal-current consumption

Table 4-1 Digital input current requirements at 24V

Circuit	Current drawn
SLM	65mA each
Hardware enable input	6mA each
Global Hardware enable input	18mA
Full current select	13mA each

4.7 Back-up supplies

The SLM supply and the Auxiliary supply are the two types of back-up supply that can be applied individually or concurrently to the drive.

SLM supply

This supply is totally independent of the drive at all times, which ensures that the position information is not lost in the SLM when the drive is powered-down for any reason.

The low current demand of an SLM (65mA each) makes it practical for a battery to be used for this back-up supply.

Auxiliary supply

The auxiliary supply supplies the control circuits in the drive.

Parameters can be accessed by the motion controller.

This supply can be used also for setting up the drive without an AC supply being connected. See section 4.7.3 *Auxiliary supply* on page 52.

4.7.1 SLM supply

Functions

The features of the SLM supply are:

- It maintains the 24V supply to the SLM
- Low-current requirements (65mA per SLM)
- The back-up supply can be at ground potential
- The back-up supply can supply one or more drives, and their SLMs, on condition that the total current entering any one drive does not exceed 500mA.

4.7.2 Requirements

CAUTION

The current from the back-up supply to each drive must be limited to 500mA by a fuse or other protection means.

The requirements to manage the current from the back-up supply (unregulated power supply or battery) are:

- Maximum permissible voltage: 28Vdc average (30Vdc peak including AC ripple peak)
- Minimum permissible voltage: 17V (including AC ripple troughs)
- Maximum current: 500mA
- Maximum fuse I^2t-rating: $5A^2/_s$

CAUTION

Ensure that the motion controller used is suitable or compatable with a back-up or battery supply (Refer to the user guide for the motion controller). See Figure 4-7

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Setting up
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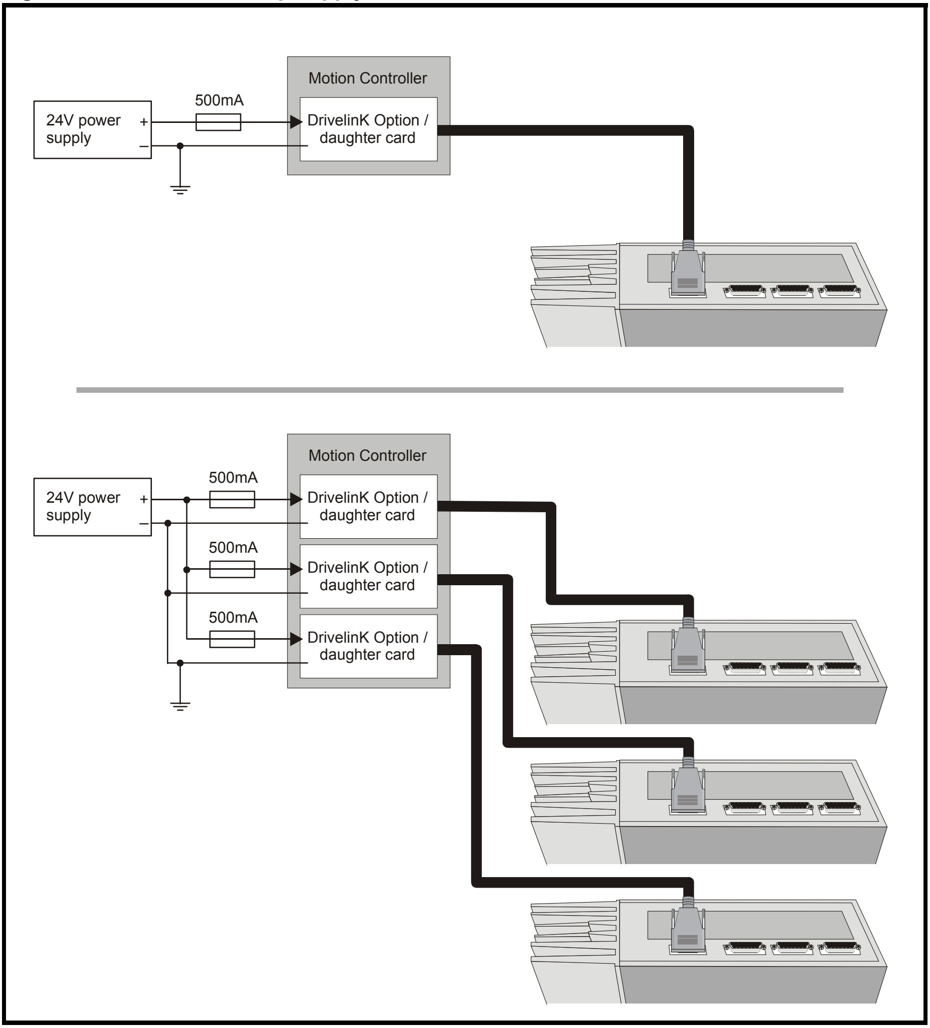
Signal connections

Figure 4-7 SLM and back-up supply connections



4.7.3 Auxiliary supply

WARNING

The Auxiliary supply MUST be supplied using an isolating transformer.

CAUTION

Isolation

The Auxiliary supply must be isolated from ground since it is referenced to –DC of the DC bus. It must also be isolated from any other auxiliary supply except when the DC-buses of the drives are connected in parallel.

Failure to observe these requirements will result in damage to the back-up supplies and drive(s).

4.7.4 Functions

The function of the auxiliary supply is to maintain the DC supply to the control circuits of the drive.

NOTE The drive will be in a tripped state (undervolts) when using just the Auxiliary supply.

4.7.5 Requirements

The requirements for the auxiliary supply are:

- Voltage: 28Vdc ~ 32Vdc
- Maximum current to the control circuits (of each drive): 2A

In addition to the appropriate connections, the connections for the auxiliary power supplies are shown in Figure 4-8 and Figure 4-9. Refer to the key data for explanations of the symbols.

Figure 4-8 Auxiliary supply connnections (contactor circuits)

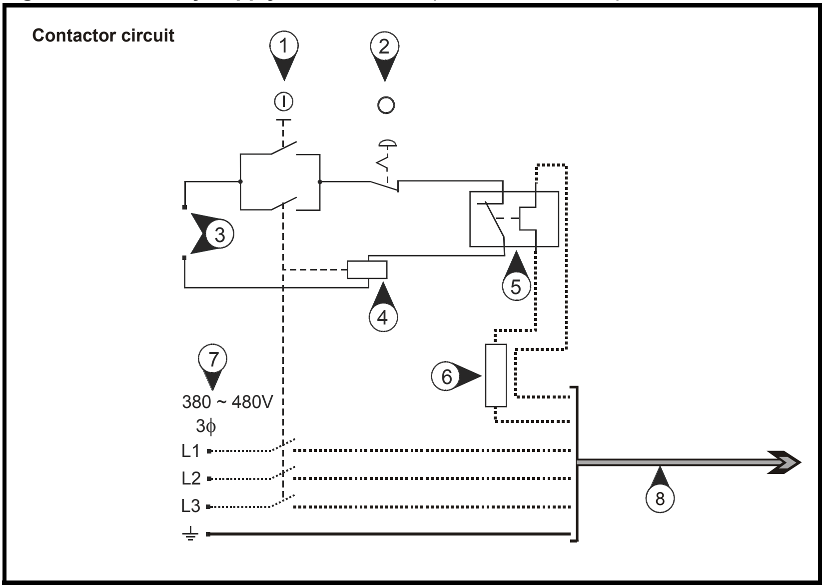
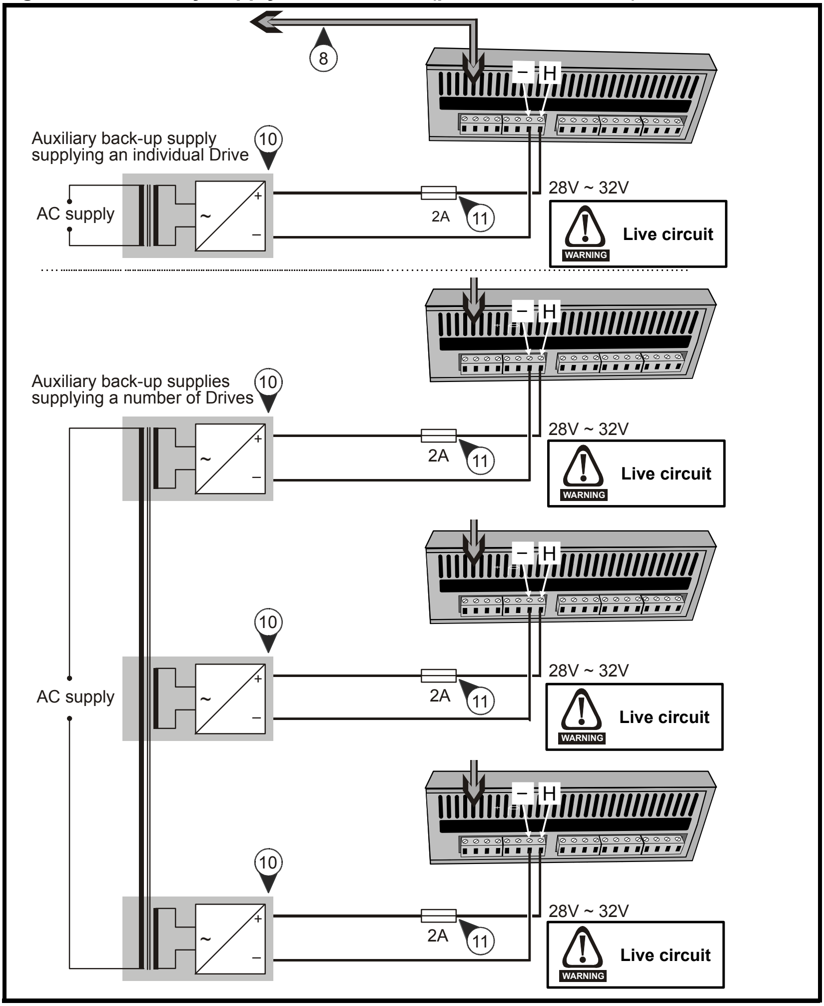


Figure 4-9 Auxiliary supply connnections (power connections)



Key data

1. START/RESET switch (momentary)
2. STOP switch (latching)
3. Control-circuit supply
4. Contactor coil
5. Thermal-overload protection relay for braking resistor
6. Optional external braking resistor
7. 380 ~ 480Vac supply to the drive
8. Power connectors from the contactor circuits to the drive
9. Interlock relay in contactor circuit
10. Isolated power supply
11. 2A fuse to protect the control circuits.

5 Setting up

CAUTION

Read Chapter 1 *Safety Information* on page 7 before applying AC power to the MultiAx or any associated equipment.

NOTE Since the MultiAx can be used with different types of motion controller, the setting-up instructions and information in this chapter are not specific to operation with any type of controller; for certain controllers additional instructions and information may be required. Refer also to the documentation for the motion controller.

5.1 Commissioning

To commission the MultiAx refer to the user guide for the machine, system or motion controller user guide.

5.2 Primary axis

The MultiAx can be used to run a maximum of three motors. For applications that use a MultiAx with only one or two axes, Axis-A MUST always be configured for use i.e. Axis-A must NOT be the redundant axis.

5.3 Diagnostics

WARNING

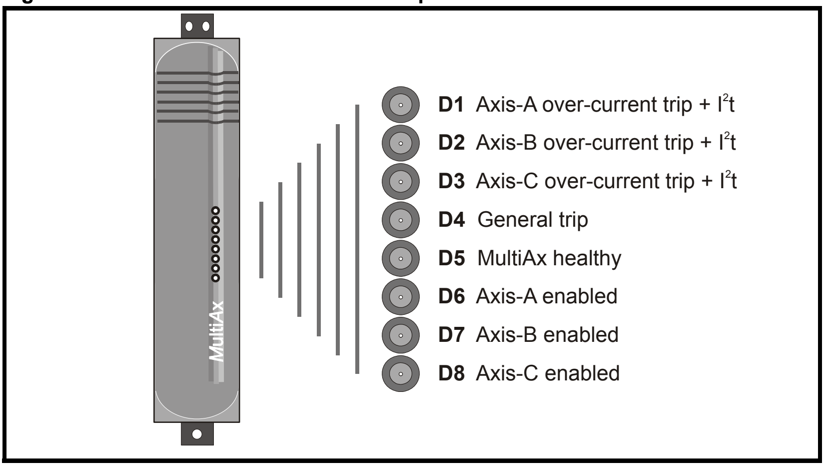
Users must not attempt to repair a drive if it is faulty. They must not carry out fault diagnosis other than through the use of the diagnostic features described in this section. Under no circumstances must the casing of the drive be opened when the AC supply is connected.

If a drive is faulty, it must be returned to an authorised Control Techniques distributor for repair.

Status indicators

The meaning of each of the status indicators is shown in Figure 5-1.

Figure 5-1 Status indicators on the front panel of the MultiAx



When the MultiAx is operating normally, indicator **D5** is continuously lit. If the MultiAx trips, **D5** is extinguished and other indicator(s) are lit, as follows:

D1, D2, D3

- Excessive instantaneous output current
- The value of I^2t for the related axis has reached the trip level

D4

- The trip has been caused by a fault other than those above (see controller fault finding guide)

D6, D7, D8

- D6, D7, D8 are lit when their related axis has received a **Hardware enable** (global or axis) plus a **Software enable**. If an SLM trips, the axis becomes disabled (the **Software enable** is removed) and the related indicator becomes extinguished.

5.4 Clearing trips

1. Remove the cause of the trip (refer to Section 5.5).
2. Reset the MultiAx using the motion controller or by removing and re-applying the AC supply
3. Re-position the motor shafts, as required.

5.5 Fault finding

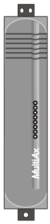
Refer to the user guide for the machine or the system for information to do with fault codes and their meanings.

6 Technical data

6.1 MultiAx Data

6.1.1 Output current ratings

Table 6-1 Current rating

<table>
<tr><th colspan="3" rowspan="4">Model</th><th colspan="6">Output current</th></tr>
<tr><th colspan="3">Maximum continuous</th><th colspan="3">Maximum peak (2 s max)</th></tr>
<tr><th colspan="3">Axis</th><th colspan="3">Axis</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>A</th><th>B</th><th>C</th></tr>
<tr><td rowspan="4"></td><td rowspan="2">MultiAx SAC / SDC</td><td>Default current mode</td><td colspan="3">2.5</td><td colspan="3">5.0</td></tr>
<tr><td>Full current scaling selected. Pin 6 & 7 on each axis connector linked</td><td colspan="3">9.375</td><td colspan="3">18.75</td></tr>
<tr><td rowspan="2">MultiAx HAC / HDC</td><td>Default current mode</td><td colspan="3">2.5</td><td colspan="3">5.0</td></tr>
<tr><td>Full current scaling selected. Pin 6 & 7 on each axis connector linked</td><td>15.0</td><td colspan="2">9.375</td><td>30</td><td colspan="2">18.75</td></tr>
</table>

NOTE All MultiAx are supplied in a default state where all axis are configured to 2.5A continuous and 5.0A overload. (See Chapter 7 *Signal connections* on page 61 for configuration).

NOTE Table 6-1 refers to the individual axis current limits. The sum of all three axes can NOT exceed 18.75A continuous or 37A peak without the drive tripping.

6.1.2 Supply currents

Table 6-2 Supply currents

Model	Typical total supply current	Maximum total supply current
All MultiAx Models	15.6A	31.2A

NOTE Typical supply currents apply to a balanced AC supply having a fault current of no greater than 5kA. Maximum supply currents apply to an AC supply having 2% negative phase-sequence and a fault current of 16kA.

6.1.3 AC supply requirements

380V to 480V ±10%

3-phase

48 to 62Hz

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

6.1.4 Over-voltage categories

The drive can be operated on AC supplies in these (or better) over-voltage categories:

- Grounded star supply:
- Over-voltage category 3
- Grounded delta and IT supplies:
- Over-voltage category 2

For operation on an AC supply in a poorer category, refer to the supplier of the drive for advice on suitable varistors to connect to the AC supply.

Also refer to section 6.1.6 *Altitude* .

6.1.5 Temperature, humidity and cooling method

Temperature

1. The ambient temperature range through which all models of MultiAx can be used is: 0°C to 50°C (32°F to 122°F) at rated maximum continuous output current (FLC). (see section 6.1.1 *Output current ratings* on page 57).
2. The storage temperature range for all models of MultiAx is: –40°C to 55°C (–40°F to 131°F).

Storage

The maximum period that a MultiAx dive can be put in storage is: 12 months.

Humidity

The maximum humidity range for all models of MultiAx is: 95% non-condensing at 50°C (122°F).

Cooling

An internal fan is used to keep the MultiAx drives cool.

6.1.6 Altitude

The effective altitude to which the MultiAx can be used, without derating, is: 0 to 2000m (6600ft).

When additional precautions are taken, the drive can be operated at altitudes from 2000m to 4000m (13000ft). For more information contact the supplier of the drive.

6.1.7 Vibration

The random vibration applicabl to the MultiAx is rated according to IEC 68–2–34. This is set as being: 0.01g2/Hz over 5 to 20 Hz, reducing at –3dB/octave from 20 to 500 Hz (0.89g RMS) when applied for 30 minutes in each orthogonal axis.

6.1.8 Ingress protection

IP20. It is suitable for use in a Pollution Degree 2 environment.

6.1.9 Overall dimensions

The overall dimensions of the MultiAx are listed in Table 6-3.

Table 6-3 Overall dimensions

Description	Measurement (imperial)	Mearsurement (metric)
Height including mounting brackets	18.504in	470mm
Width	3.622in	92mm
Projection forward of panel when surface mounted	12.598in	320mm
Projection forward of the front surface of the panel when through-panel mounted	9.134in	232mm
Projection rear of the front surface of the panel when through-panel mounted	3.465in	88mm

6.1.10 Weight

The weight of all models of MultiAx is: 10kg (22lb).

6.1.11 Dissipation

The dissapation rates are listed in Table 6-4.

Table 6-4 Dissapation

Model	Output current			Heat dissipation	
	$T_{AMB\ max}$	Maximum continuous	Maximum overload (2 s max)	Surface Mounting	Through-panel Mounting
MultiAx (all versions)	50°C (122°F)	18.75	37.5	350W	40W

6.1.12 Starts per hour

The number of starts llowed per hour of the drive is limited to:

- By electronic control: unlimited
- By interrupting the AC supply: <20.

6.1.13 SLM supply input

- Voltage: 17V to 28V
- Maximum current: 500mA.

CAUTION

A current limit in excess of 500mA can result in damage to the MultiAx.

6.1.14 Auxiliary supply input

- Voltage: 28Vdc ~ 32Vdc
- Maximum current: 2A

This supply is referenced to –DC. For isolation requirements, see section 4.7 *Back-up supplies* on page 50.

CAUTION

An Auxiliary supply must be isolated from ground and any other auxiliary back-up supply. Failure to observe these requirements will result in damage

6.1.15 Braking resistor

The rated values of the external resistor are shown in Table 6-5.

Table 6-5 External resistor

External resistor	Value
Minimum permissible value	30Ω
Operating voltage (**V_R**)	780V at switch-on 760V at switch-off
Maximum possible braking current (through 30Ω) (**I_{bMAX}**)	26.0A
Peak power rating for 30Ω	20kW
Continuous power rating	(See section 3.5.3 *Braking resistor example calculations* on page 20)

6.1.16 Electromagnetic compatibility (EMC)

This is a summary of the EMC performance of the drive when installed in accordance with the instructions given in Chapter 3 *Installation* on page 14. For full details, refer to the *MultiAx EMC Data Sheet* which can be obtained from the drive supplier.

Immunity

Compliance with immunity standards does not depend on installation details. The drive meets EN50082–2 (generic immunity standard for the industrial environment) and the following specifications from the IEC61000–4 group (derived from IEC801):

- Part 2, Electrostatic discharge: Level 3
- Part 3, Radio frequency field: Level 3
- Part 4, Transient burst:
- Level 4, at the control terminals
- Level 3, at the power terminals
- Part 5, Surge (at the AC supply terminals):
- Level 4, line-to-ground
- Level 3, line-to-line (as specified by EN50082–2 informative annex)
- Part 6, Conducted radio frequency: Level 3

Emission

Compliance with emission standards depends on rigorous adherence to the installation guidelines, including the use of the specified RFI filter in the AC supply circuit. Compliance also depends on the length of the motor cable. For full details, refer to the *MultiAx EMC Data Sheet* which can be obtained from the drive supplier.

Summary

Conducted and radiated emission meet EN50081–2 (generic emission standard for the industrial environment) over a wide range of conditions. This is similar to CISPR11 and EN55011 Class A.

The optional RFI filter, part number 4200-3258, must be used.

Compliance with EN61800-3 (standard for Power Drive Systems)

Meeting the requirements of this standard depends on the environment that the drive is to be operated in, as follows:

1. **Operation in the first environment**

   Observe the wiring guidelines given in the whole of Installation, including the Compliance with EMC emission standards sections. Refer to the Warning at the top of section 3.16 *EMC emission standards – compliance information* on page 39.

2. **Operation in the second environment**

   Where the rated input current of the drive system is less than 100A:

   Observe the wiring guidelines given in the whole of Chapter 3 *Installation* on page 14, including the Compliance with EMC emission standards sections.

   Where the rated input current of the drive system exceeds 100A:

   Observe the wiring guidelines given in Chapter 3 *Installation* on page 14, excluding the section 3.16 *EMC emission standards – compliance information* on page 39.

6.2 Optional RFI filter

6.2.1 Main ratings

The main ratings for the optional RFI filter (part number 4200-3258) are shown in Table 6-6:

Table 6-6 Main ratings

Optional RFI filter (part number 4200-3258)	
Max. continuous current	30A
Power dissipation at rated current	11.83W

The maximum ambient temperature of the optional RFI filter (part number 4200-3258) in the rated current and frequency range is: 50°C (122°F).

The ingress protection of the optional RFI filter (part number 4200-3258) is rated at: IP20.

6.2.2 AC supply ratings

The maximum operating voltage of the optional RFI filter (part number 4200-3258) is rated at: 480V +10% at up to 50°C (122°F).

The AC supply frequency of the optional RFI filter (part number 4200-3258) is rated between: 48 to 62 Hz.

6.2.3 Ground leakage current

The ground-leakage current, phase-to-phase and phases-to-ground, is rated as follows:

- Balanced supply, all phases present: 33mA
- Two phases disconnected: 192mA

These figures apply for an AC supply of 400V at 50Hz. For other AC supply voltages and currents, scale the values of leakage current proportionally.

6.2.4 Discharge resistors

The discharge resistors are formed in a 330KΩ star network between the AC supply phases. The star point is connected by a 1MW resistor to ground. These resistors are fitted internally.

6.2.5 Maximum current overload

The maximum current overload is rated at: 150% of rated current for 60 seconds.

6.2.6 Overall dimensions

Table 6-7 Overall dimensions

Part Number	Dimension		
	Height	Width	Depth
4200-3258	270mm (10.63in)	50mm (1.969in)	85mm (3.346in)

6.2.7 Weight

Table 6-8 Weight

Part Number	kg	lb oz
4200-3258	1.2	2lb 10oz

7 Signal connections

WARNING

Isolation

All the signal connections are isolated from the power circuits by basic insulation only. Ensure that all external control circuits are separated from human contact by at least one layer of insulation rated for use at the AC supply voltage.

7.1 Digital inputs

7.1.1 Digital inputs

The four digital inputs to the drive ate listed in Figure 7-1.

Table 7-1 Digital inputs to the drive.

Input	Value
Logic sense	Positive
Voltage range	–0.3V to +30V
Isolation	Optical
Input current	6-18mA at 24V

7.1.2 Current-scaling modes

The MultiAx is supplied with all three axes operating in the default current mode. By connecting a wire link in the related D-type signal connector, one or more axes can be operated in the full current-scaling mode. This can assist with matching the MultiAx to the current-ratings of the motor.

NOTE The link is only checked on power-up. Do NOT change without re-commissioning.

Hardware enable

Hardware enable is a positive-logic input. Time delays are as follows:

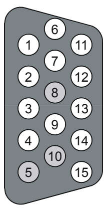
- Enable time: <250μs
- Disable time: <500μs.

7.2 Functions of the terminal

7.2.1 MC

Name	Pin	I/O	Function	Specification
Axis-A *data* com	1	I/O	SLM ***technology*** port for bi-directional communications with a motion controller	2-wire EIA485 Connecting cable: Shielded twisted pair
Axis-A *data* com\	2			
Global Hardware-enable	3	I		See section 4.3 *Functions of the signal connectors* on page 45
0V COMMON	4		For use with: SLM ***technology*** com and com\ Hardware-enables Global hardware-enable 24V SLM supply	0V COMMON must not be interchanged with 0V
+24V SLM supply input	5	I	+24Vdc supply for the SLMs and Hardware-enable inputs	
Axis-B *data* com	6	I/O	SLM ***technology*** port for bi-directional communications with a motion controller	2-wire EIA485 Connecting cable: Shielded twisted pair
Axis-B *data* com\	7			
Status relay contact	8 10	O	DRIVE HEALTHY Relay contact opens if the drive trips	Voltage rating: 50V AC/DC category 2 Current rating: 0.5A resistive Isolation: 500V Update period: 1ms
Reserved	9 11 12		Do not use	Do not connect
Axis-C *data* com	13	I/O	SLM ***technology*** port for bi-directional communications with a motion controller	2-wire EIA485 Connecting cable: Shielded twisted pair
Axis-C *data* com\	14			
Cable shield	15 Shell		Connect all the cable shields to the connector shell	

Figure 7-1 Female D-type connector pin locations (seen from the top of the drive)

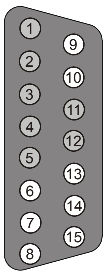


NOTE The MultiAx will not respond to any enable / disable software commands via the SLM until the drive sees a rising edge on the Hardware enable signal after a drive power-up. The host controller must guarantee that the Hardware enable signal is not present at the drive power-up or toggle it afterwards. This is a safety feature to prevent any unintentional live power stage at drive power-up.

7.2.2 Axis A, B and C

Name	Pin	I/O	Function	Specification
(No connection)	1 2 3 4 5			
Full current-scaling select	6	I	Connect to pin 7 to select high current scaling	See section 7.1 *Digital inputs* on page 63
+24V SLM supply	7 9	O		
Axis-A/B/C hardware-enable	8	I	Connect to pin 7 to select axis	See section 4.3 *Functions of the signal connectors* on page 45
0V COMMON	10		For use with: SLM ***technology*** com and com\ Hardware-enables Global hardware-enable 24V SLM supply	0V COMMON must not be interchanged with 0V
Reserved	11 12		Do not use	Do not connect
Axis-A/B/C *data* com	13	I/O	SLM ***technology*** port for bi-directional communications with a motion controller	2-wire EIA485 Connecting cable: Shielded twisted pair
Axis-A/B/C *data* com\	14			
Cable shield	15 Shell		Connect all the cable shields to the connector shell	

Figure 7-2 Female D-type connector pin locations (seen from the top of the drive)



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