

*User Guide*

# **Dinverter 2B**

Variable Speed Drive  
for three-phase induction motors  
0.75kW to 4.0kW  
1.0HP to 5.3HP

Part Number: 0444-0014

Issue Number: 6

## General information

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the optional operating parameters of the equipment or from mismatching the variable speed drive (Drive) with the motor.

The contents of this User Guide are believed to be correct at the time of printing. In the interests of a commitment to a policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance, or the contents of the User Guide, without notice.

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## Important...

### Drive software version

This product is supplied with the latest version of user-interface and machine-control software. If this product is to be used in a new or existing system with other Dinverter 2B Drives, there may be some differences between their software and the software in this product. These differences may cause this product to function differently. This may also apply to Drives returned from a Control Techniques Service Centre.

If there is any doubt, contact a Control Techniques Drive Centre.

## Use within the European Union, etc

The following information applies where the end use of the Drive is within the European Union, the European Economic Area, or other regions which have implemented Directives of the European Council or equivalent measures.

The Drive complies with the Low Voltage Directive 73/23/EEC.

The installer is responsible for ensuring that the equipment into which the Drive is incorporated complies with all relevant Directives.

The complete equipment into which the Drive is incorporated must comply with the EMC Directive 89/336/EEC.

If the Drive is incorporated into a machine, the manufacturer is responsible for ensuring that the machine complies with the Machinery Directive 98/37/EC. In particular, the electrical equipment should generally comply with European Harmonised Standard EN60204-1.

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Control Techniques Drives Ltd  
Author: RFD  
Issue Code: d2lu6  
Issue Date: November 1998  
S/W Version: V01.02.07 onward

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# Declaration of Conformity

**Control Techniques plc**  
**The Gro**  
**Newtown**  
**Powys**  
**UK**  
**SY16 3BE**

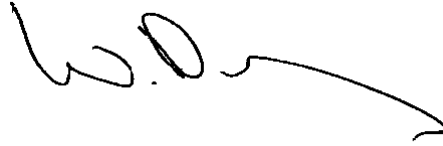
DIN 1220075B	DIN 1220150B	DIN 1220220B
DIN 3220075B	DIN 3220150B	DIN 3220220B
DIN 3380075B	DIN 3380110B	DIN 3380150B
DIN 3380220B	DIN 3380300B	DIN 3380400B

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

EN60249	Base materials for printed circuits
IEC326-1	Printed boards: general information for the specification writer
IEC326-5	Printed boards: specification for single- and double-sided printed boards with plated-through holes
IEC326-6	Printed boards: specification for multilayer printed boards
IEC664-1	Insulation co-ordination for equipment within low-voltage systems: principles, requirements and tests
EN60529	Degrees of protection provided by enclosures (IP code)
UL94	Flammability rating of plastic materials
UL508C	Standard for power conversion equipment
EN50081-1 *	Generic emission standard for the residential, commercial and light industrial environment
EN50081-2	Generic emission standard for the industrial environment
EN50082-2	Generic immunity standard for the industrial environment
EN61800-3	Adjustable speed electrical power drive systems – Part 3: EMC product standard including specific test methods

\* Met in part (see *Electromagnetic compatibility (EMC)* in Chapter 3 *Data*, or the *Dinverter 2B EMC Data Sheet*).

These products comply with the Low Voltage Directive 73/23/EEC, the Electromagnetic Compatibility (EMC) Directive 89/336/EEC and the CE Marking Directive 93/68/EEC.



**W. Drury**  
**Technical Director**  
**Newtown**

**Date: 24th November 1998**

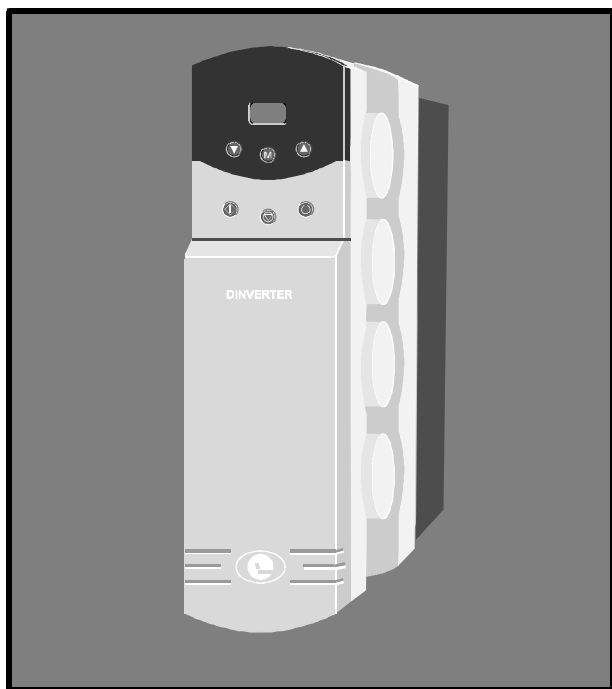
**These electronic Drive products are intended to be used with appropriate motors, controllers, electrical protection components and other equipment to form complete end products or systems. Compliance with safety and EMC regulations depends upon installing and configuring Drives correctly, including 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. The *Dinverter 2B EMC Data Sheet* is also available giving detailed EMC information.**



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# 1 Introduction

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**Figure 1–1 The Dinverter B Drive**

## 1.1 Features

- For use with single-phase, three-phase low-voltage, and three-phase high-voltage AC supplies
- Motor power range: 0.75kW (1HP) to 4.0kW (5.3HP)
- Fully EMC compliant with optional external RFI filter
- DIN-rail, surface mounting or through-panel mounting
- Plug-in signal connectors
- Full digital control
- Seven preset speeds
- Automatic reset
- Skip frequencies to avoid mechanical resonances in the machine
- Synchronization to a spinning motor
- Coast to stop, deceleration ramp, DC injection braking or dynamic braking
- Analog output signals as voltage or current
- Display of output frequency or load
- Terminal or keypad control
- Voltage or current-loop speed reference signal
- Adjustable PWM switching frequency

## 1.2 Method of operation

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### Power circuits

The AC supply is rectified and smoothed to apply a constant voltage to a DC bus. This DC bus supplies an IGBT power stage that delivers AC power at variable frequency and voltage to the motor.

The AC power output of the Drive is synthesized by a pattern of on–off switching applied to the gates of the IGBT bridge. This method of producing an alternating output from a DC source is Pulse Width Modulation (PWM). The pulsed switching pattern is generated by an Application Specific Integrated Circuit (ASIC) which is controlled by a microprocessor.

Enhanced braking can be obtained using DC injection braking or using an external braking resistor.

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### Controlling and monitoring the Drive

Operation of the Drive is controlled by programming software parameters. These parameters have default values that enable the Drive to be run without initial programming.

The parameters can be programmed in two ways, as follows:

- Using the keypad on the Drive
- Using a host PC connected by serial communications

The operation of the Drive can be monitored by reading values of parameters using the display on the Drive or a host PC.

## 1.3 How to use this User Guide

This User Guide is arranged logically: reading from beginning to end will take you in the correct order through the basic steps of installing the Drive and getting it running with a motor.

To make subsequent adjustments to the parameters, refer to Chapter 10 *List of Parameters*.





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## 2 Safety Information

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### 2.1 Warnings, Cautions and Notes

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

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

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

### 2.2 Electrical safety – general warning

The voltages used in the Drive can cause severe electric shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to the Drive.

Specific warnings are given at the relevant places in this User Guide.

The installation must comply with all relevant safety legislation in the country of use.

### 2.3 System design

The Drive is intended as a component for professional incorporation into complete equipment or systems. If installed incorrectly the Drive 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 mechanical 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 and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this User Guide carefully.

To ensure mechanical safety, additional safety devices such as electro-mechanical interlocks may be required. The Drive must not be used in a safety-critical application without additional high-integrity protection against hazards arising from a malfunction.

### 2.4 Environmental limits

Instructions in this User Guide regarding transport, storage, installation and use of Drives must be complied with, including the specified environmental limits. Drives must not be subjected to excessive physical force.

### 2.5 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 earth (ground) connections.

This User Guide contains instructions for achieving compliance with specific EMC standards.

Within the European Union, all machinery in which this product is used must comply with the following directives:

98/37/EC: Safety of Machinery

89/336/EEC: Electromagnetic Compatibility.

### 2.6 Safety of personnel

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

The Stop and Start controls or electrical inputs of the Drive should not be relied upon to ensure safety of personnel. If a safety hazard could exist from unexpected starting of the Drive, an interlock that electrically isolates the Drive from the AC supply must be installed to prevent the motor being inadvertently started.

Careful consideration must be given to the functions of the Drive which might result in a hazard, either through their intended functions (eg. Auto-start) or through incorrect operation due to a fault or trip (eg. stop/start, forward/reverse, maximum speed).

Under certain conditions, the Drive can suddenly discontinue control of the motor. If the load on the motor could cause the motor speed to be increased (eg. hoists and cranes), a separate method of braking and stopping the motor must be used (eg. a mechanical brake).

Before connecting the AC supply to the Drive, it is important that you understand the operating controls and their operation. If in doubt, do not adjust the Drive. Damage may occur, or lives put at risk. Carefully follow the instructions in this User Guide.

Before making adjustments to the Drive, ensure all personnel in the area are warned. Make notes of all adjustments that are made.

## 2.7 Risk analysis

In any application where a malfunction of the Drive could lead to damage, loss or injury, a risk analysis must be carried out, and where necessary, further measures taken to reduce the risk. This would normally be an appropriate form of independent safety back-up system using simple electro-mechanical components.

## 2.8 Motor

Ensure the motor is installed in accordance with the manufacturer's recommendations. Ensure the motor shaft is not exposed.

Standard squirrel-cage induction motors are designed for single-speed operation. If it is intended to use the capability of the Drive to run a motor at speeds above its designed maximum, it is strongly recommended that the manufacturer is consulted first.

Low speeds may cause the motor to over-heat because the cooling fan becomes less effective. The motor should then be fitted with a protection thermistor. If necessary, a separate cooling fan should be used.

## 2.9 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.

## 3 Data

### 3.1 Models and ratings

Model	AC supply		Motor power		100% RMS AC input current *	AC input power †	100% RMS output current	150% overload current for 60 secs	Inrush current ‡
	V (±10%)	φ	kW	HP	A	kVA	A	A	A
DIN1220075B	200 ~ 240	1	0.75	1.0	11.3	2.6	4.3	6.5	270
DIN1220150B	200 ~ 240	1	1.5	2.0	18.5	4.2	7.0	10.5	270
DIN1220220B	200 ~ 240	1	2.2	3.0	26.0	6.0	10.0	15.0	270
DIN3220075B	200 ~ 240	3	0.75	1.0	6.9	2.4	4.3	6.5	270
DIN3220150B	200 ~ 240	3	1.5	2.0	11.3	3.9	7.0	10.5	270
DIN3220220B	200 ~ 240	3	2.2	3.0	15.4	5.3	10.0	15.0	270
DIN3380075B	380 ~ 480	3	0.75	1.0	4.2	2.8	2.1	3.2	250
DIN3380110B	380 ~ 480	3	1.1	1.5	5.0	3.3	2.8	4.2	250
DIN3380150B	380 ~ 480	3	1.5	2.0	5.8	3.8	3.8	5.7	250
DIN3380220B	380 ~ 480	3	2.2	3.0	9.0	5.9	5.6	8.4	250
DIN3380300B	380 ~ 480	3	3.0	4.0	11.6	7.6	7.6	11.4	250
DIN3380400B	380 ~ 480	3	4.0	5.3	13.9	9.2	9.5	14.3	250

#### Notes

##### \* AC supply impedance

Source impedance: 0.014Ω  
(supply having 16000 Amp short-circuit capability)

##### † AC supply kVA calculation

Single-phase models (200V to 240V):  
[100% RMS supply current] x 230V

Three-phase models (200V to 240V):  
[100% RMS supply current] x √3 x 230V

Three-phase models (380V to 480V):  
[100% RMS supply current] x √3 x 400V

##### ‡ Inrush current

Maximum amplitude

Inrush currents were measured at the peak of the first AC supply half-cycle that was applied to a Drive having fully discharged DC-bus capacitors. The following conditions applied:

Internal temperature of the Drive:  
50°C (122°F) (typical)

AC supply voltage as shown opposite

Models	AC supply voltage
200 ~ 240V single-phase and three-phase	250VRMS
380 ~ 480V three-phase	440VRMS

Typical duration

Duration of inrush current: 1 ~ 2 ms

Temperature effects

When the power circuits of the Drive are cold, inrush currents are lower than the specified values (ie. the inrush current at the first start-up after a long period of non-use will be lower than at subsequent start-ups when the Drive has become warmer).

### 3.2 AC supply frequency

All models: 48 ~ 62 Hz

### 3.3 Maximum supply imbalance

2% negative phase sequence (equivalent to 3% voltage imbalance between phases)

### 3.4 Altitude

Reduce the normal full-load current by 1% for each 100m above 1000m above sea-level.

Maximum altitude: 4000m above sea level

### 3.5 Ambient temperature and humidity

Ambient temperature range:

–10°C to 50°C (14°F to 122°F) non-condensing

Storage temperature range:

–40°C to +50°C (-40°F to 122°F) non-condensing  
12 months maximum

### 3.6 Environmental protection

Ingress Protection rating: IP20

The Drive is to be mounted in an enclosure which provides protection from the environment, and prevents access by unskilled personnel.

### 3.7 Materials

Flammability rating of all plastics used: UL94 V0

### 3.8 Vibration and shock

Random vibration tests: In accordance with BS2011, part 2.1, test Fd (IEC 68-2-34)

Frequency Bandwidth: 5 to 150Hz

Acceleration spectral density: 0.01g<sup>2</sup> / Hz

Test duration: 1 hour per axis

Tested in the three mutually perpendicular axes

Shock tests: In accordance with BS2011, part 2.1, test Ea (IEC 68-2-27)

Pulse shape: Half sinewave

Pulse duration: 11ms

Peak acceleration: 50g

Test duration: Three shocks in each direction of each axis (total 18)

Tested in the three mutual perpendicular axes

### 3.9 Electromagnetic compatibility (EMC)

The following is a summary of the EMC performance of the Drive. For full details, refer to the *Dinverter B EMC Data Sheet* which can be obtained from a Drive Centre or distributor listed at the end of this User Guide.

Standard	Part	Type	Level or conditions
EN50082-2		Generic standard for the industrial environment	
IEC1800-3 EN61800-3		Product standard for adjustable-speed power drive systems	First and second environments
IEC1000-4 EN61000-4	2	Electrostatic discharge	Level 3
	3	Radio frequency field	Level 3
	4	Fast transient burst	Level 4 at the control terminals Level 3 at the power terminals
	5	Surge	Level 4 line-to-ground Level 3 line-to-line
	6	Conducted radio frequency	Level 3
	11	Supply voltage dips and interruptions	All cases *

\* The Drive may stop when energy stored in the Drive is depleted, but will behave as programmed when the power returns.

## Immunity

Compliance with immunity standards does not depend on installation details. The Drive meets the standards shown in the table above.

## Emission

The Drive complies with the requirements of IEC1800-3 and EN61800-3 for emission in the second environment subject to the special provisions given in that standard.

Compliance with more severe 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 PWM switching frequency used in the output stage of the Drive, and the length of the motor cable. For full details, refer to the *Inverter B EMC Data Sheet* which can be obtained from a Drive Centre or distributor listed at the end of this User Guide.

### In summary...

When an RFI filter is used, conducted and radiated emissions meet EN50081-2 (generic emission standard for the industrial environment) and IEC1800-3 / EN61800-3 (first environment, restricted distribution) over a wide range of conditions. This is similar to CISPR11 and EN55011 Class A.

Under restricted conditions, the conducted emission meets EN50081-1 (generic emission standard for the residential, commercial and light industrial environment). This is similar to CISPR11 and EN55011 Class B.

### 3.10 Frequency accuracy

±0.01% full-scale  
(crystal control of frequency)

### 3.11 Resolution

#### Digital frequency control

0.001Hz when using serial communications

#### Parameter values

The resolution of parameter values is affected by the value, as follows:

Values	Resolution
0 to 100	0.1
>100	1

The resolution of the acceleration and deceleration settings becomes more coarse towards 600 and 999 seconds.

For the following parameters...

**p0, p1, p7, p10 to p15, p20 to p27**

...the resolution is as follows:

0.3 Hz when Upper Limit Frequency (ULF) = 480 Hz

0.5 Hz when Upper Limit Frequency (ULF) = 960 Hz

For parameter **p6**, the resolution is 0.4 Hz.

### 3.12 Starts per hour

#### Drive

#### By interrupting the AC supply

20 starts per hour maximum (3 minutes interval between starts).

#### Maximum stabilizing time after connecting the AC supply

3 seconds (wait at least 3 seconds before monitoring the state of the status-relay contacts, etc.).

#### Electronic control using the DRIVE ENABLE input

Unlimited.

#### Motor

Refer to the motor manufacturer.

### 3.13 Heat dissipation and cooling

Model	Power dissipation in Watts at specified switching frequency				Fan air flow
	2.9 kHz	5.9 kHz	8.8 kHz	11.7 kHz	m <sup>3</sup> /min
DIN1220075B	64	70	88	90	None
DIN1220150B	67	73	93	114	0.72
DIN1220220B	82	115	131	140	0.72
DIN3220075B	52	61	67	71	None
DIN3220150B	62	72	80	85	0.72
DIN3220220B	81	93	108	124	0.72
DIN3380075B	41	44	49	61	None
DIN3380110B	46	57	65	72	None
DIN3380150B	55	67	73	89	0.72
DIN3380220B	75	89	97	119	0.72
DIN3380300B	90	105	120	138	0.72
DIN3380400B	110	120	135	148	0.72

The dissipation was measured as follows:

#### Single-phase models (200V to 240V)

240V AC supply voltage

41Hz output frequency (worst case)

100% output current

#### Three-phase models (200V to 240V)

225V AC supply voltage

41Hz output frequency (worst case)

100% output current

#### Three-phase models (380V to 480V)

440V AC supply voltage

41Hz output frequency (worst case)

100% output current

### 3.14 PWM switching frequencies

The following PWM switching frequencies and Upper Limit Frequencies (ULF) can be selected:

Upper Limit Frequency	Minimum PWM frequency
120Hz	2.9kHz
240Hz	2.9kHz
480Hz	5.9kHz
960Hz	11.7kHz

The table shows the maximum ULF that can be used for each PWM switching frequency.

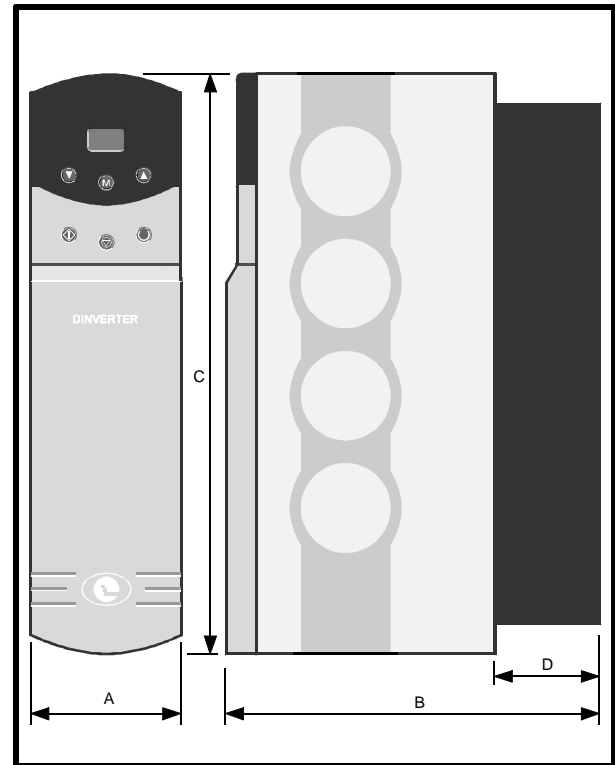
### 3.15 Serial communications

Four-wire RS422 or RS485  
 Protocol: ANSI × 3.28–2.5–A4  
 Baud rate: 4800 or 9600  
 See Chapter 12 Serial Communications.

### 3.16 Weights

Model	Weight	
	kg	lb
DIN1220075B	3.1	7
DIN1220150B	3.3	7 <sup>1</sup> / <sub>2</sub>
DIN1220220B	3.4	7 <sup>3</sup> / <sub>4</sub>
DIN3220075B	3.1	7
DIN3220150B	3.3	7 <sup>1</sup> / <sub>2</sub>
DIN3220220B	3.4	7 <sup>3</sup> / <sub>4</sub>
DIN3380075B	3.1	7
DIN3380110B	3.1	7
DIN3380150B	3.1	7
DIN3380220B	3.1	7
DIN3380300B	3.4	7 <sup>3</sup> / <sub>4</sub>
DIN3380400B	3.4	7 <sup>3</sup> / <sub>4</sub>

### 3.17 Overall dimensions



Dimension	mm	in
A	91	3 <sup>9</sup> / <sub>16</sub>
B	200	7 <sup>7</sup> / <sub>8</sub>
C	293	11 <sup>1</sup> / <sub>2</sub>
D	56	2 <sup>1</sup> / <sub>8</sub>

Figure 3–1 Overall dimensions of the Drive





## 4 Installing the Drive



### 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 Drive and any external option unit, and the way in which they are operated and maintained, comply with the requirements of the Health and Safety at Work Act in the United Kingdom or applicable legislation and regulations and codes of practice in the country in which the equipment is used.



### Warning

#### Installation in an enclosure

The Drive case is classified as IP20 according to IEC529 (see Chapter 3 *Data*). The Drive is listed by UL as an *Enclosed type AC motor controller*.

The Drive is designed for installation in an enclosure to prevent unauthorized access and to avoid contamination from conductive dust or condensation.



### Warning

#### Authorized access

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



### Warning

#### Fire enclosure

The Drive case is not classified as a fire enclosure. To meet this requirement, the Drive must be installed in a fire enclosure.



### 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, and external option units



### Warning

#### Isolation device

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



### 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 15 minutes before work may continue.

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



**Warning**

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



**Warning**

**Water ingress**  
**The Drive has no protection against water ingress.**



**Warning**

**STOP function**  
**The STOP function does not remove dangerous voltages from the Drive or any external option units.**

Depending on the requirements of the installation, one of the following levels of electromagnetic compatibility (EMC) should be adopted:

### **Routine EMC precautions**

These precautions are recommended when strict compliance with emission standards is not required. The risk of disturbing adjacent electronic equipment is minimized by adopting these precautions.

### **Compliance with EMC emission standards**

These precautions are recommended when strict compliance with emission standards is required. In addition, it is recommended that these precautions are taken when the Drive is installed in a residential area, or adjacent to sensitive electronic equipment such as radio receivers or similar.

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

Meeting the requirements of this standard depends on the environment that the Drive is intended to operate in, as follows:

#### **Operation in the first environment**

Observe the guidelines given in *Compliance with EMC emission standards*. An RFI filter will always be required. Some model sizes may require additional filtering techniques to be applied.

#### **Operation in the second environment**

An RFI filter may not be required. Follow the guidelines given in *Routine EMC precautions* or *Compliance with EMC emission standards* depending on the requirements of the end user.



**Caution**

**The second environment typically includes an industrial low-voltage power supply network which does not supply buildings used for domestic purposes. 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 EN50081-2 be adhered to.**

## 4.1 EMC considerations

### Installation and use

The Drive is 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 the Drive being installed and configured correctly, including the use of the specified RFI filter.

The Drive 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. Detailed EMC information is given in the *Inverter B EMC Data Sheet* which is available from the Drive Centres listed at the end of this User Guide.

Instructions are given later in this chapter for these levels of EMC. Refer to Chapter 3 *Data* for further information on compliance with EMC standards and definitions of environments.

Detailed instructions and EMC information are given in the *Dinverter 2B EMC Data Sheet* which is available from the Drive Centres and distributors listed at the end of this *User Guide*.

Compliance data is given in Chapter 3 *Data*.

#### **Note**

**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 *Planning the installation and Wiring recommendations* later in this chapter are followed closely.**

---

## 4.2 Declaration of conformity

The specification of the Drive includes compliance with specific EMC standards. The Drive carries a **CE** mark and has a manufacturer's Declaration of Conformity with the EMC Directive of the European Union.

The Drive is a complex component which has been designed for incorporation into a complete product, system or installation, the details of which are beyond the control of Control Techniques, but which will affect the EMC behaviour of the installed Drive. Furthermore, other equipment installed in the same system may affect the overall EMC behaviour. Therefore, the declaration of conformity applies only to the Drive when installed in a typical assembly in accordance with the instructions given in this chapter.

#### **Note**

**The installer of the Drive is responsible for ensuring that the complete system or installation meets the prevailing regulations for EMC.**

---

## 4.3 Environmental requirements

1. The environment must be acceptable (see Chapter 3 *Data*).
2. In accordance with the IP20 rating of the Drive, the Drive must be located in an environment that is free from dust, corrosive vapours, gases and all liquids, including condensation of atmospheric moisture.
3. If condensation is likely to occur when the Drive is not in use, an anti-condensation heater must be installed. This heater must be switched off when the Drive is in use; automatic switching is recommended.
4. The Drive must not be located in a classified hazardous area unless the Drive is installed in an approved enclosure and the complete installation is certified.
5. The maximum permissible ambient temperature of the Drive must not be exceeded. Take into account heat generated by nearby equipment.

## 4.4 Type of enclosure

The recommendations are based on the use of a standard industrial metal enclosure. A special EMC enclosure is not required unless more stringent EMC standards must be met.

If no enclosure is used, a considerable benefit can be achieved by mounting the Drive, RFI filter and motor-cable shield on a metal back-plate in the same way as shown in Figures 4-15 and 4-16. In this case, some increase in radiated emission in the 30 to 60MHz range may occur.

## 4.5 Installation parts supplied

The following are supplied with the Drive:

- DIN-rail mounting bracket
- Mounting bracket
- Mounting foot

## 4.6 RFI filter and ferrite rings

### EMC requirements

For compliance with EMC emissions standards, use the recommended RFI filter and ferrite rings, as shown in the following table. Use one RFI filter and (when required) two ferrite rings for each Drive.

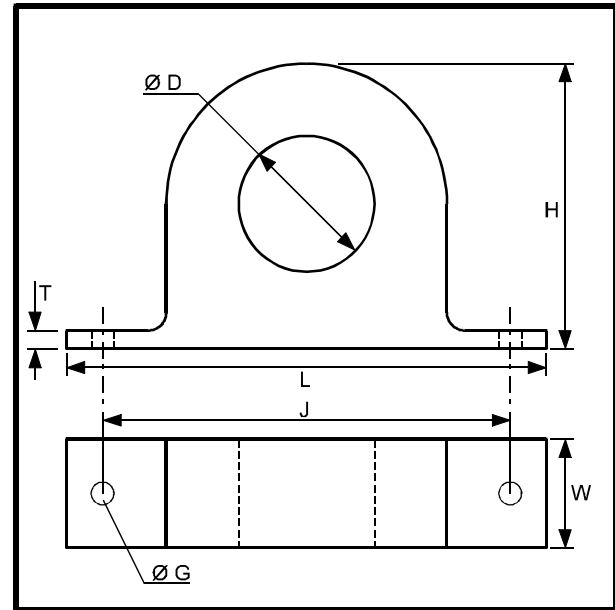
Model	Part numbers	
	RFI filter (x1)	Ferrite rings (x2)
DIN 122075B	4200-2515	Not required
DIN 1220150B	4200-2425	Not required
DIN 1220220B	4200-2425	Not required
DIN 3220075B	4200-4810 *	4200-0000
DIN 3220150B	4200-4820 *	4200-0000
DIN 3220220B	4200-4820 *	4200-0000
DIN 3380075B	4200-4810 *	4200-0000
DIN 3380110B	4200-4810 *	4200-0000
DIN 3380150B	4200-4810 *	4200-0000
DIN 3380220B	4200-4810 *	4200-0000
DIN 3380300B	4200-4820 *	4200-0000
DIN 3380400B	4200-4820 *	4200-0000

\* When the length of motor cable exceeds 50 metres (165 feet), use RFI filter part number 4200-4830.

### Length of motor cable

Ensure that the motor cable is shielded and its length does not exceed 150 metres (465 feet). (See the *Inverter B EMC Data Sheet* for further information.)

### Ferrite ring

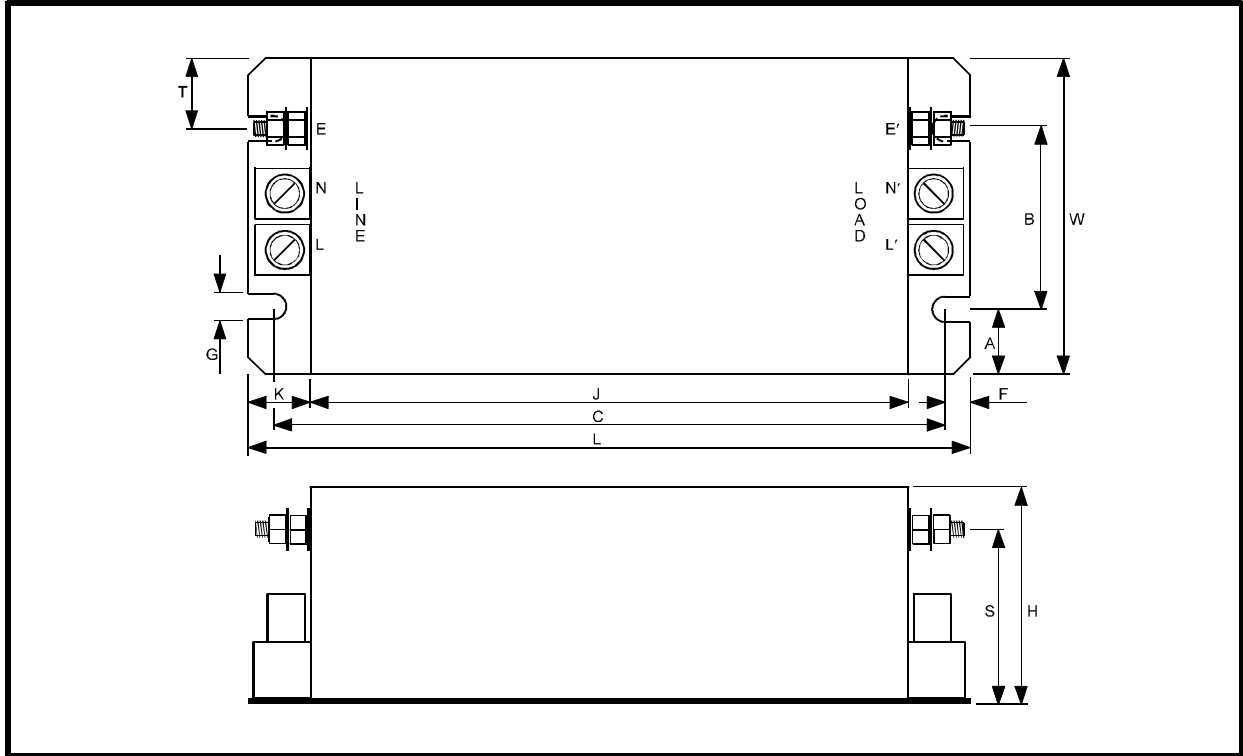


Dimension	mm	in
L	105	$4\frac{3}{16}$
W	24	1
H	62	$2\frac{1}{2}$
T	5	$\frac{3}{16}$
D	28	$1\frac{1}{8}$
J	90	$3\frac{5}{8}$
G	5	$\frac{3}{16}$

Figure 4-1 Dimensions of the ferrite ring

## RFI filters

### Single-phase models



**Figure 4-2** Dimensions of the RFI filters for the single-phase models

Drive model	DIN1220075B		DIN1220150B DIN1220220B	
Filter part number	4200-2515		4200-2425	
Dimension	mm	in	mm	in
L	170	6 <sup>11</sup> / <sub>16</sub>	170	6 <sup>11</sup> / <sub>16</sub>
W	75	2 <sup>15</sup> / <sub>16</sub>	75	2 <sup>15</sup> / <sub>16</sub>
H	50	2	50	2
C	158	6 <sup>1</sup> / <sub>4</sub>	158	6 <sup>1</sup> / <sub>4</sub>
B	41	1 <sup>5</sup> / <sub>8</sub>	41	1 <sup>5</sup> / <sub>8</sub>
F	6	1/4	6	1/4
A	17	5/8	17	5/8
G	7	1/4	7	1/4
J	142	5 <sup>5</sup> / <sub>8</sub>	142	5 <sup>5</sup> / <sub>8</sub>
K	14	9/16	14	9/16
S	35	1 <sup>3</sup> / <sub>8</sub>	35	1 <sup>3</sup> / <sub>8</sub>
T	16	5/8	16	5/8
Ground stud	M5 x 15mm			

## Three-phase models

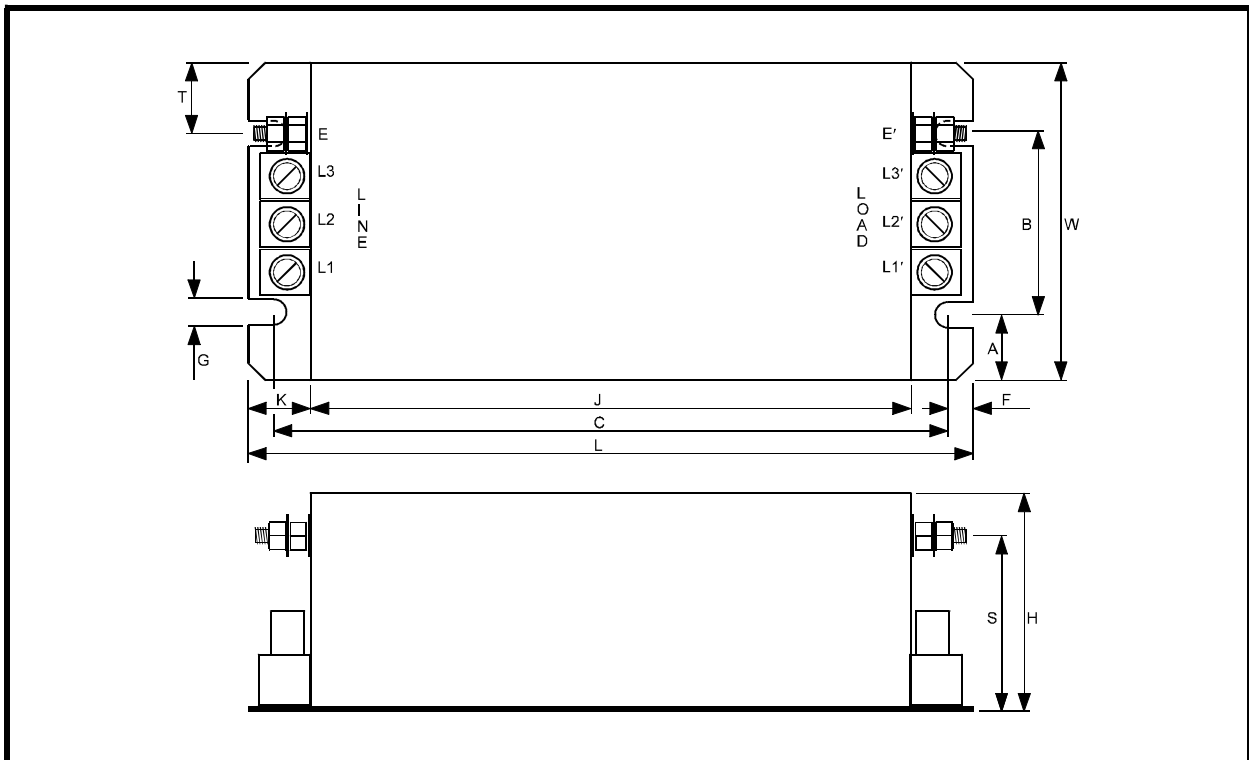


Figure 4–3 Dimensions of the RFI filters for the three-phase models

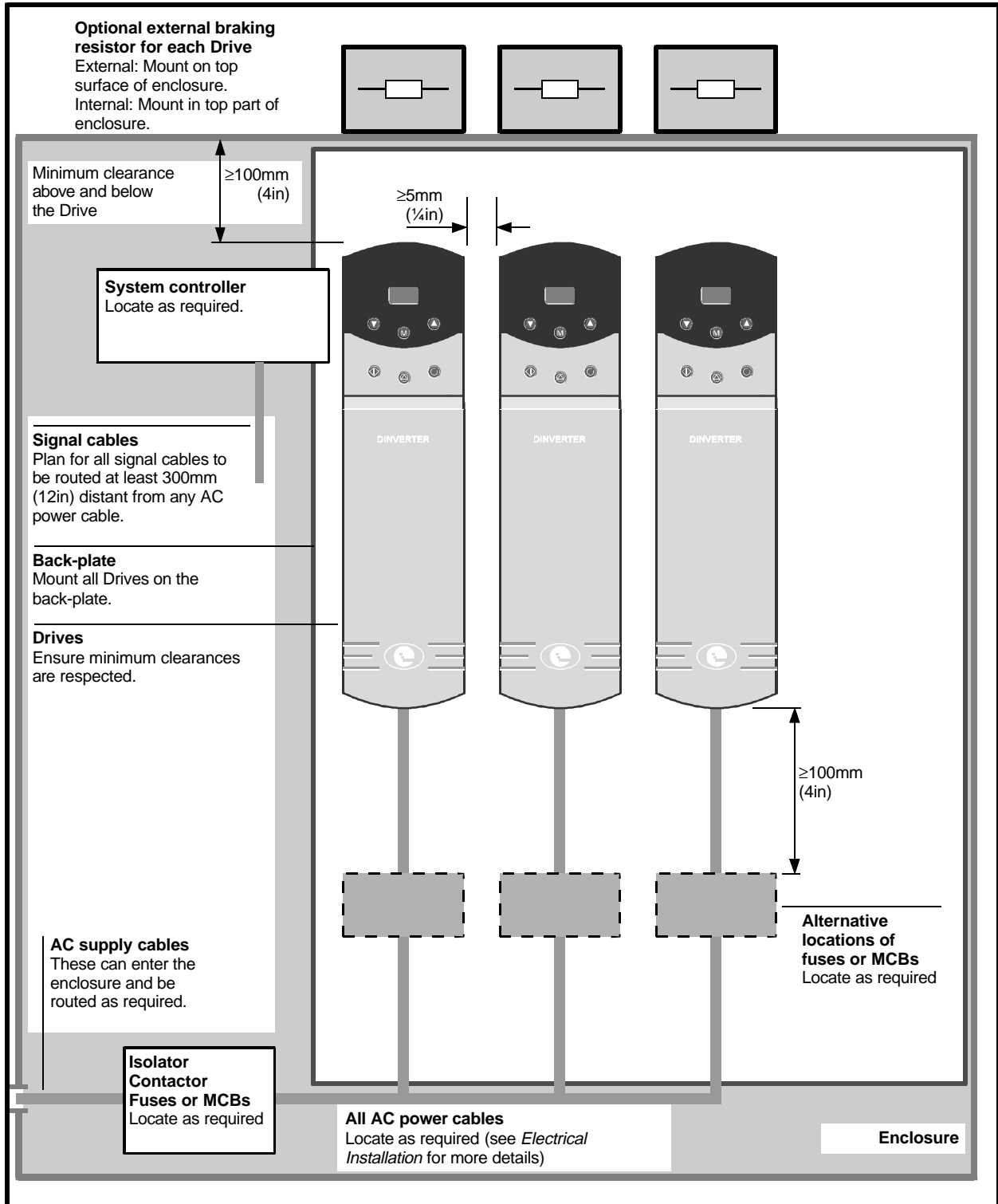
<b>Drive model</b>	<b>DIN3220075B DIN3380075B DIN3380110B DIN3380150B DIN3380220B</b>	<b>DIN3220150B DIN3220220B DIN3380300B DIN3380400B</b>
<b>Filter part number</b>	<b>4200–4810</b>	<b>4200–4820 4200–4830</b>

<b>Dimension</b>	<b>mm</b>	<b>in</b>	<b>mm</b>	<b>in</b>
L	250	9 <sup>13</sup> / <sub>16</sub>	270	10 <sup>5</sup> / <sub>8</sub>
W	110	4 <sup>5</sup> / <sub>16</sub>	140	5 <sup>1</sup> / <sub>2</sub>
H	60	2 <sup>3</sup> / <sub>8</sub>	60	2 <sup>3</sup> / <sub>8</sub>
C	238	9 <sup>3</sup> / <sub>8</sub>	258	10 <sup>3</sup> / <sub>16</sub>
B	76	3	106	4 <sup>3</sup> / <sub>16</sub>
F	6	1/4	6	1/4
A	17	5/8	17	5/8
G	7	1/4	7	1/4
J	220	8 <sup>5</sup> / <sub>8</sub>	240	9 <sup>7</sup> / <sub>16</sub>
K	15	9/16	15	9/16
S	47	1 <sup>3</sup> / <sub>8</sub>	47	1 <sup>3</sup> / <sub>8</sub>
T	17	5/8	17	5/8
Ground stud	M5 x 15mm			

## 4.7 Planning the installation

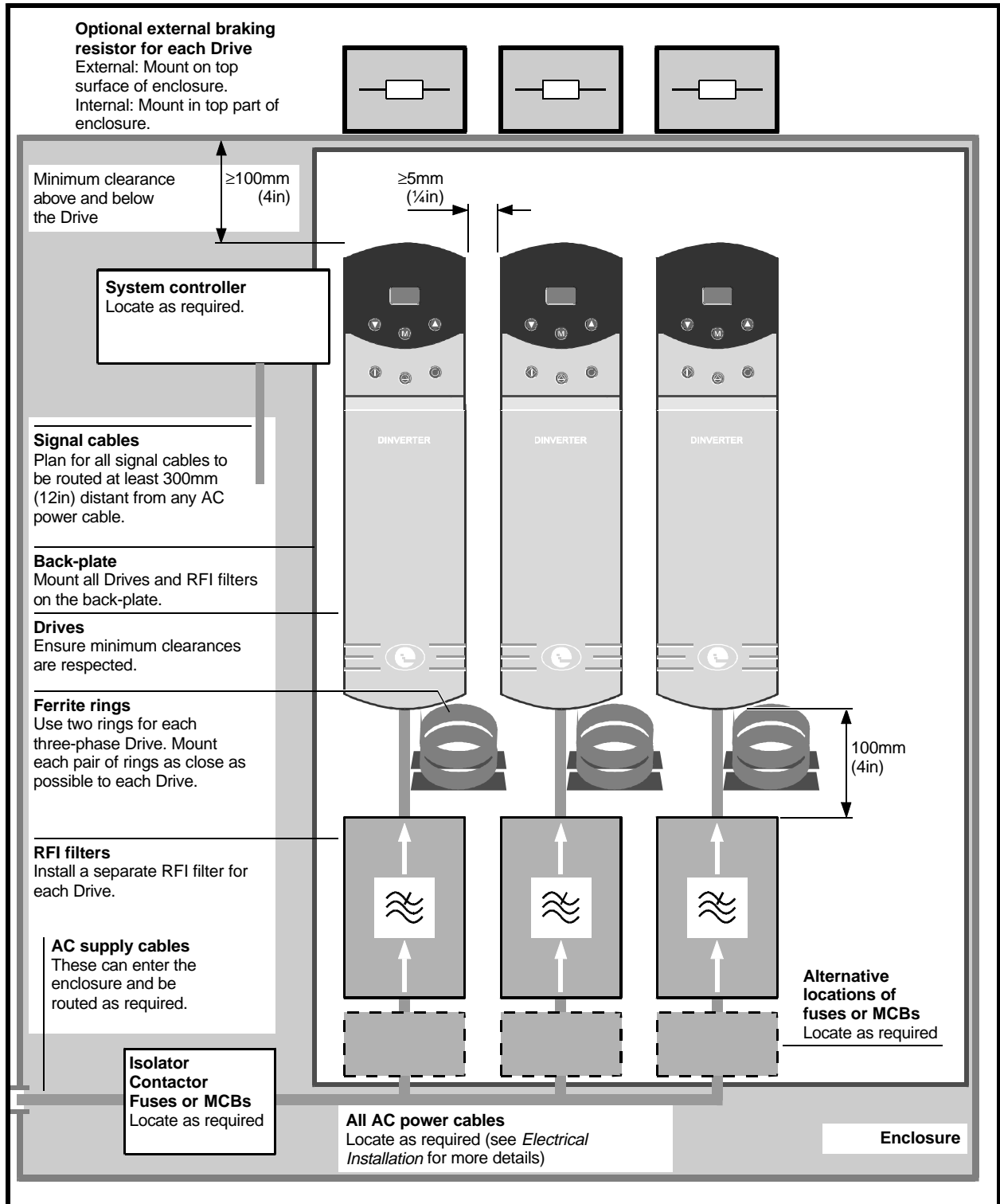
The following conditions must be met when planning the installation of the Drive or a number of Drives in an enclosure:

- The conditions stated in *Environmental requirements*
  - The appropriate EMC requirements
  - Electrical safety requirements for the installation as specified by the end-user
  - The planned size of the installation does not exceed the space available
1. Use one of the following enclosure layout diagrams, depending on the requirements of the installation:  
**Routine EMC precautions** Refer to Figure 4–4 which shows the recommended layout for three Drives, and the signal and power cables.  
**Compliance with EMC emission standards** Refer to Figure 4–5 which shows three Drives, three RFI filters, ferrite rings, and the signal and power cables.
  2. When compliance with EMC emissions standards is required, the enclosure must be made of metal but does not require special EMC features.
  3. Ensure the enclosure is fitted with an un-insulated metal back-plate for mounting the Drive, RFI filters and (when required) the ferrite rings.
  4. The Drive must be installed vertically for best flow of cooling air.
  5. The Drive should be installed as low as possible in the enclosure without contravening EMC requirements (when applicable).
  6. Allow at least 100mm (4in) clearance above and below the Drive.
  7. Allow at least 5mm ( $\frac{1}{4}$ in) clearance each side of the Drive.
  8. When compliance with EMC emissions standards is required, mount an RFI filter at the left side of the Drive in order to minimize the cable length between the Drive and filter.
  9. Decide how the Drives are to be mounted in the enclosure, as follows:
    - DIN-rail mounted
    - Surface-mounted
    - Through-panel mountedDIN-rail and surface mounting give:
    - Better ingress protection
    - Heat dissipated inside the enclosureThrough-panel mounting gives:
    - Heat dissipated outside the enclosure
    - Reduced ingress protection
  10. If the Drives are to be surface or DIN-rail mounted in the enclosure, refer to either of the following:
    - If the enclosure is to be sealed, perform the calculations in *Heat dissipation in a sealed enclosure* (later in this chapter) in order to determine the minimum permissible size of enclosure for heat dissipation.
    - If the enclosure is to be ventilated, perform the calculation in *Heat dissipation in a ventilated enclosure* (later in this chapter) in order to determine the required volume of air-flow.
  11. If necessary, adjust the size of the enclosure, and re-plan the internal equipment accordingly. Repeat these instructions as many times as required to meet all the requirements.



**Figure 4-4 Recommended layout for routine EMC precautions (wiring recommendations are shown in Figure 4-14)**





**Figure 4-5 Recommended layout for compliance with EMC emission standards (wiring recommendations are shown in Figures 4-15 and 4-16)**

## 4.8 Heat dissipation in a sealed enclosure

If possible, locate heat-generating equipment in the lower part of the enclosure to encourage internal convection. Otherwise, use a taller enclosure or install stirrer fans.

To maintain sufficient cooling of the Drive when it is installed inside a sealed enclosure, heat generated by all the equipment in the enclosure must be taken into account, and the enclosure must be of adequate size.

To calculate the minimum acceptable size of enclosure, use the following procedure:

Calculate the minimum required surface area **A<sub>e</sub>** for the enclosure from:

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

Where:

<b>T<sub>amb</sub></b>	Maximum ambient temperature in °C outside the enclosure
<b>A<sub>e</sub></b>	Unobstructed heat-conducting area in m <sup>2</sup>
<b>k</b>	Heat transmission coefficient of the enclosure material
<b>T<sub>i</sub></b>	Maximum permissible ambient temperature in °C inside the enclosure
<b>P</b>	Power in Watts dissipated by all heat sources in the enclosure

### Example

To calculate the size of an enclosure for model DIN1220150B (1.5kW, 2HP).

The following conditions are assumed:

- The Drive is surface-mounted inside the enclosure
- Only the top, front, and two sides of the enclosure are free to dissipate heat
- The enclosure is made from painted 2mm (<sup>3</sup>/<sub>32</sub>in) sheet steel
- Maximum external air temperature: 30°C (86°F)
- Drive PWM frequency: 5.9kHz

Insert the following values:

<b>T<sub>i</sub></b>	=	50°C
<b>T<sub>amb</sub></b>	=	30°C
<b>k</b>	=	5.5 (typical for painted 2mm ( <sup>3</sup> / <sub>32</sub> in) sheet steel)
<b>P</b>	=	73 (from <i>Heat dissipation and cooling</i> in Chapter 3 <i>Data</i> )

### Note

**It is essential to include any other heat sources in the value of P.**

The minimum required heat conducting area is then:

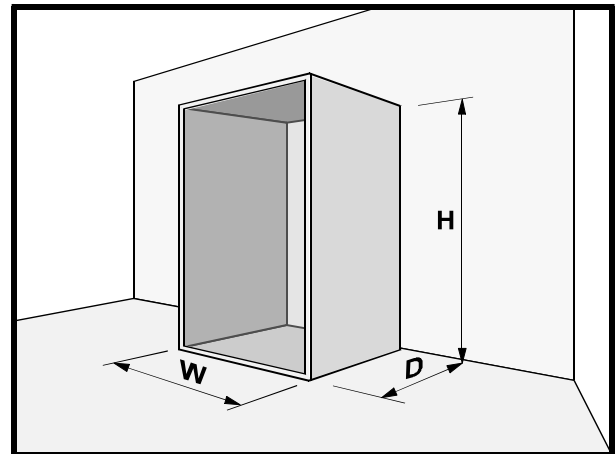
$$A_e = \frac{73}{5.5(50 - 30)} = 0.67\text{m}^2$$

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

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

Inserting **H = D = 0.5m**, obtain the minimum width:

$$W = \frac{0.67 - (2 \times 0.5 \times 0.5)}{0.5 + 0.5} = 0.42\text{m}$$



**Figure 4–6 Enclosure having front, sides and top panels free to dissipate heat**

## 4.9 Heat dissipation in a ventilated enclosure

If a high ingress protection rating is not required, the enclosure may be smaller. A ventilating fan can be used to exchange air between the inside and outside of the enclosure.

To calculate the volume of ventilating air, use the following equation:

$$V = \frac{3.1P}{T_i - T_{amb}}$$

Where V = Air-flow in m<sup>3</sup> per hour

### Example

$$\begin{aligned} P &= 73 \\ T_i &= 50^\circ\text{C} \\ T_{amb} &= 30^\circ\text{C} \end{aligned}$$

Then:

$$V = \frac{3.1 \times 73}{50 - 30} = 11.3\text{m}^3 / \text{hr}$$

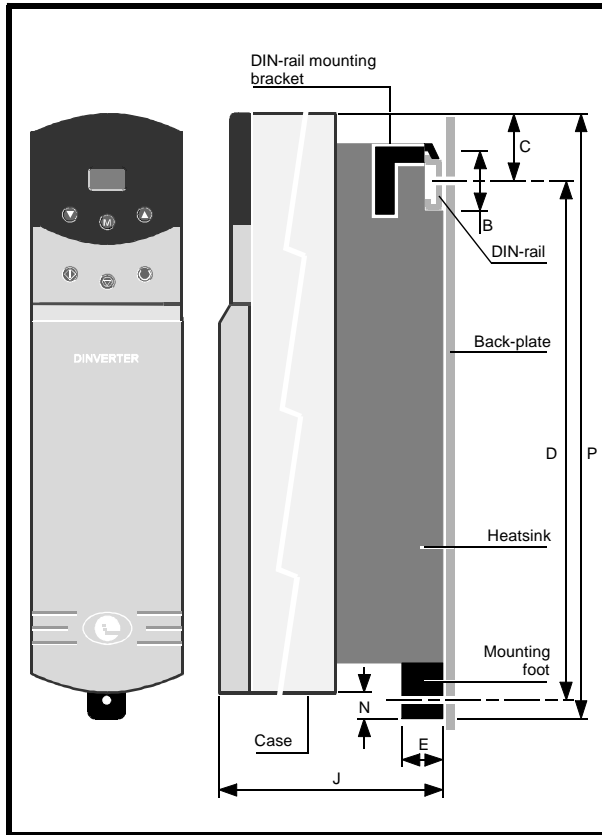
## 4.10 Motor cooling

When a motor is driven at low speed, its internal cooling fan becomes less effective. If necessary, provide it with additional cooling (such as forced ventilation).

## 4.11 Grounding the Drive heatsink

For compliance with EMC emission standards, the heatsink of the Drive is required to make a good direct electrical connection to the metal back-plate on which the Drive is to be mounted. The metal mounting brackets supplied with the Drive must be used for achieving this.

## 4.12 DIN-rail mounting



1. Slide the DIN-rail mounting bracket into the square recess in the top of the heatsink.
2. Retain the mounting bracket to the heatsink with the M5 self-tap slot-head screw supplied.
3. Locate the Drive on the DIN-rail.
4. Slide the mounting foot into the flanged recess in the bottom of the heatsink.
5. The DIN-rail mounting bracket and mounting foot supplied with the Drive are manufactured from metal. Ensure the mounting foot and DIN-rail make direct electrical contact with the back-plate; for example, tap threaded holes in the back-plate to accept the mounting screws.

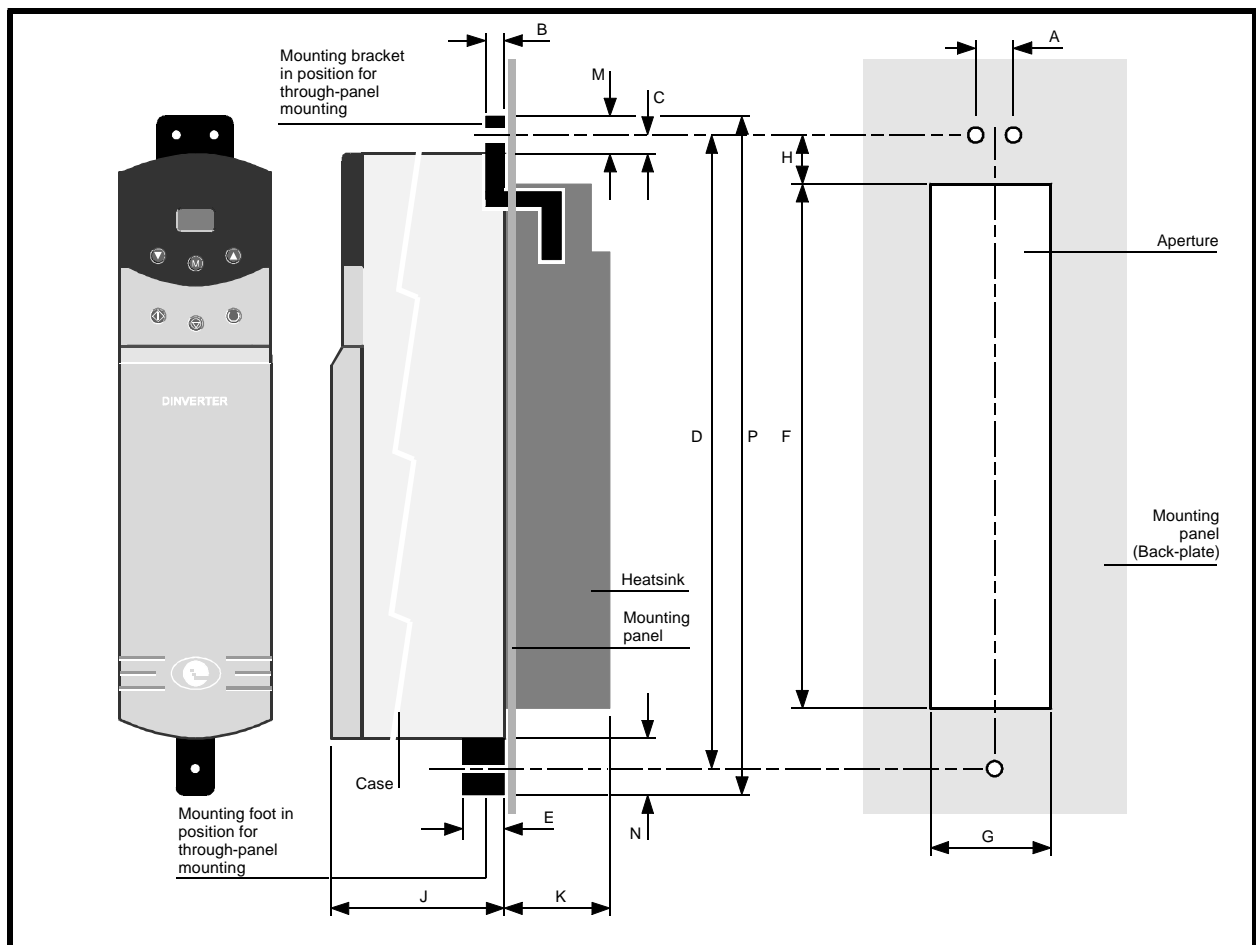
Dimension	mm	in
B	35	1 <sup>3</sup> / <sub>8</sub>
C	37.5	1 <sup>1</sup> / <sub>2</sub>
D	258	10 <sup>3</sup> / <sub>16</sub>
E	15	<sup>9</sup> / <sub>16</sub>
F	200	7 <sup>7</sup> / <sub>8</sub>
J	200	7 <sup>7</sup> / <sub>8</sub>
N	8	<sup>5</sup> / <sub>16</sub>
P	301	11 <sup>7</sup> / <sub>8</sub>
Hole diameter	5.5	<sup>3</sup> / <sub>16</sub>

**Figure 4–7 Mounting the Drive on a DIN-rail**

### 4.13 Through-panel mounting

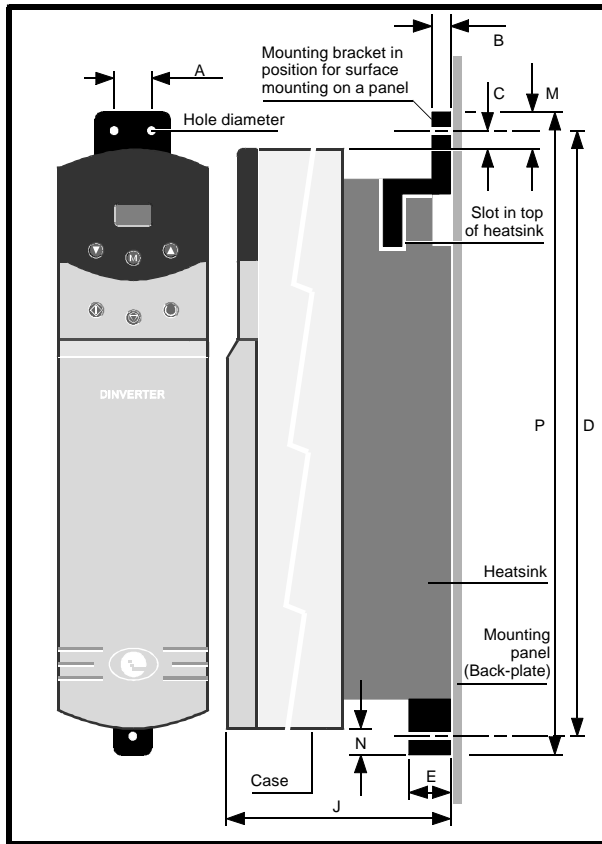
1. Cut an aperture in the panel of the dimensions given in Figure 4–8.
2. Prepare the panel as required for mounting the Drive.
3. Orientate the mounting bracket as shown in Figure 4–8 and slide the mounting bracket into the rectangular recess in the top of the heatsink.
4. Retain the mounting bracket to the heatsink with the M5 self-tap slot-head screw supplied.
5. Slide the mounting foot into the T-shape hole in the bottom of the case.
6. The mounting bracket and mounting foot supplied with the Drive are manufactured from metal. Ensure the bracket and foot make direct electrical contact with the back-plate; for example, tap threaded holes in the back-plate to accept the mounting screws.

Dimension	mm	in
A	16	$\frac{5}{8}$
B	6.5	$\frac{1}{4}$
C	7.5	$\frac{5}{16}$
D	321	$11\frac{15}{16}$
E	15	$\frac{9}{16}$
F	269	$10\frac{9}{16}$
G	78	$3\frac{1}{16}$
H	20	$\frac{3}{4}$
J	244	$9\frac{5}{8}$
K	56	$2\frac{1}{8}$
M	15	$\frac{5}{8}$
N	26	1
P	334	$13\frac{1}{8}$
Hole diameter	5.5	$\frac{3}{16}$



**Figure 4–8 Through-panel mounting of the Drive**

## 4.14 Surface mounting on a panel

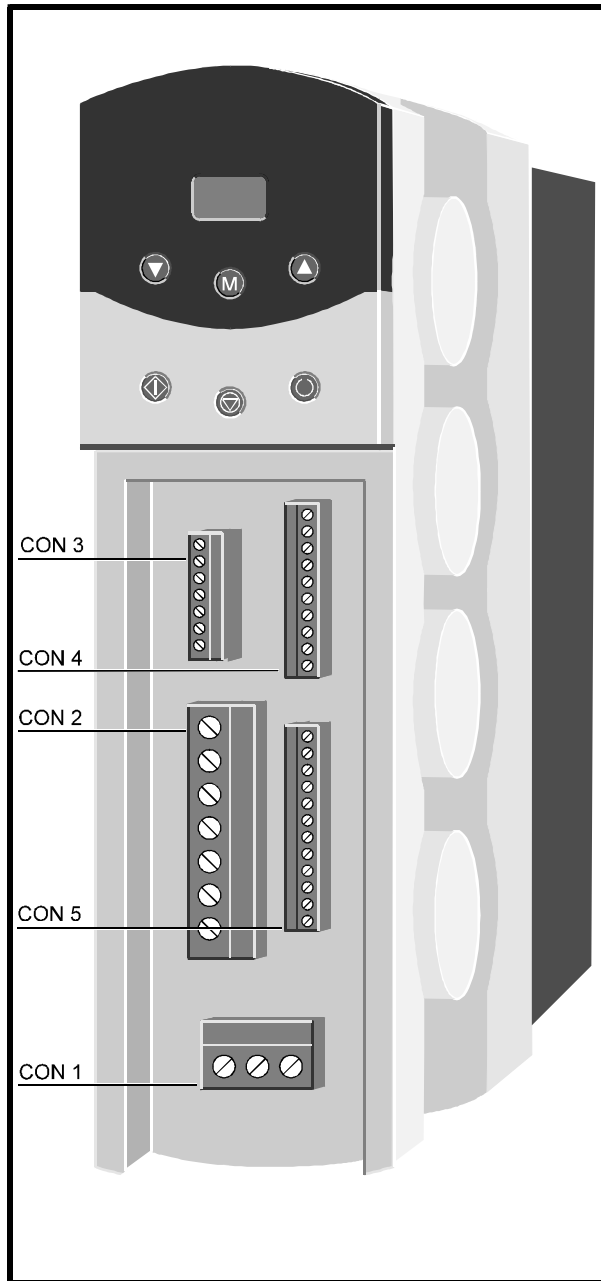


1. Prepare the panel as required for mounting the Drive.
2. Orientate the mounting bracket as shown in Figure 4–9, then slide the mounting bracket into the rectangular recess in the top of the heatsink.
3. Retain the mounting bracket to the heatsink with the M5 self-tap slot-head screw supplied.
4. Slide the mounting foot into the flanged recess in the bottom of the heatsink.
5. The mounting bracket and mounting foot supplied with the Drive are manufactured from metal. Ensure the bracket and foot make direct electrical contact with the back-plate; for example, tap threaded holes in the back-plate to accept the mounting screws.

Dimension	mm	in
A	16	$\frac{5}{8}$
B	6.5	$\frac{1}{4}$
C	7.5	$\frac{5}{16}$
D	303	$11\frac{7}{8}$
E	15	$\frac{9}{16}$
J	200	$7\frac{7}{8}$
M	15	$\frac{5}{8}$
N	8	$\frac{5}{16}$
P	316	$12\frac{7}{16}$
Hole diameter	5.5	$\frac{3}{16}$

**Figure 4–9** Surface mounting the Drive on a panel

## 4.15 Access to the connectors



**Figure 4-10** Locations of the connectors

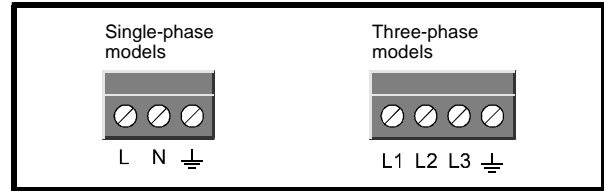
Remove the front clip-on cover to gain access to the connectors.

The following signal connectors are in two parts allowing the wiring to be unplugged from the Drive:

- CON 3
- CON 4
- CON 5

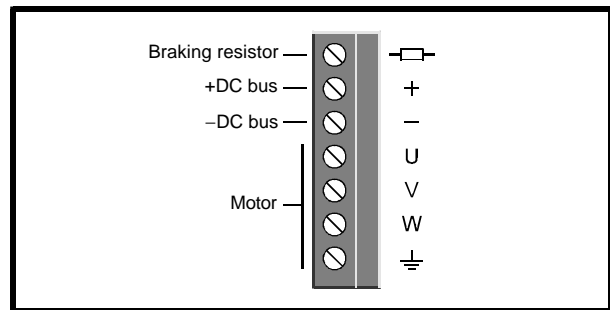
## 4.16 Power connections

### AC supply connections



**Figure 4-11** CON 1 connections

### Motor and braking-resistor connections



**Figure 4-12** CON 2 connections (all models)

## 4.17 AC supply requirements

### Single-phase models

Use either of the following types of AC supply of the correct voltage:

- Single-phase (ie. between one phase and neutral of a star-connected three-phase supply)
- Between two phases of a delta-connected three-phase supply (one phase can be grounded)

### Three-phase models

Use a three-phase star or delta supply of the correct voltage.

## 4.18 Cables and fuses



### Warning

**The AC supply to the Drive must be fitted with suitable protection against overload and short circuits. The table shows recommended fuse ratings. Failure to observe this recommendation will cause a risk of fire.**

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

For the following power connections...

AC supply to the RFI filter (when used)

RFI filter (when used) or AC supply to the Drive

Drive to the motor

Drive to external braking resistor (when used)

... use pvc-insulated cable having a voltage rating shown in the following table and having copper conductors rated at 105°C (221°F).

Cable sizes must be selected for 100% of the RMS currents.

The table below is only a guide to cable sizes. Refer to local wiring regulations for the correct size of cables.

When EMC emission requirements are to be met, shielded cable or steel-wire armoured cable may be required for the following:

AC supply to the enclosure

Drive to the motor

Drive to external braking resistor (when used and when part of the cable is outside the enclosure)

Since a current surge can occur when AC power is applied to the Drive, the use of slow-blow fuses is recommended. In a single-phase system, a fuse of the specified rating should be included in the live connection of the AC supply. In a three-phase system, a fuse of the specified rating should be included in each phase of the AC supply.

### Fuse types

Use the following type of fuse:

Europe: Type gG HRC industrial fuses to IEC269 (BS88)

USA: RK1 600VAC

As an alternative to fuses, an MCB or MCCB may be used if equipped with adjustable thermal and magnetic trip devices of a suitable rating.

Model	Fuse rating A	AC supply cables			Motor cables			Braking resistor cables		
		mm <sup>2</sup>	AWG	Voltage rating	mm <sup>2</sup>	AWG	Voltage rating	mm <sup>2</sup>	AWG	Voltage rating
DIN1220075B	16	1.0	18	300VAC	1.0	18	300VAC	1.0	18	500VDC
DIN1220150B	20	1.5	16	300VAC	1.0	18	300VAC	1.0	18	500VDC
DIN1220220B	32	2.5	14	300VAC	1.0	18	300VAC	1.0	18	500VDC
DIN3220075B	10	1.0	18	300VAC	1.0	18	300VAC	1.0	18	500VDC
DIN3220150B	16	1.0	18	300VAC	1.0	18	300VAC	1.0	18	500VDC
DIN3220220B	16	1.5	16	300VAC	1.0	18	300VAC	1.0	18	500VDC
DIN3380075B	6	1.0	18	600VAC	1.0	18	600VAC	1.0	18	1000VDC
DIN3380110B	6	1.0	18	600VAC	1.0	18	600VAC	1.0	18	1000VDC
DIN3380150B	6	1.0	18	600VAC	1.0	18	600VAC	1.0	18	1000VDC
DIN3380220B	10	1.0	18	600VAC	1.0	18	600VAC	1.0	18	1000VDC
DIN3380300B	16	1.5	16	600VAC	1.0	18	600VAC	1.0	18	1000VDC
DIN3380400B	16	1.5	16	600VAC	1.0	18	600VAC	1.0	18	1000VDC



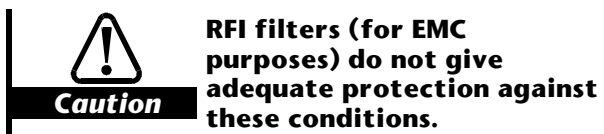
## 4.19 Protecting the Drive with line reactors

When a DInverter 2B is connected to an AC supply which is subject to severe disturbances, as a result of the following for example...

- Capacity is at least 200kVA
- Fault current is at least 5kA
- Power-factor correction equipment is connected close to the Drive
- 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 Drive. This may cause nuisance tripping or, in extreme cases, failure of the Drive.

A line reactor should be connected in each phase of the supply to each Drive. 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 Drive.



For single-phase Drives, one line reactor is adequate; for three-phase Drives, three individual reactors, or a single three-phase reactor should be used. Each Drive must have its own reactor(s).

### Typical values

Model	Value mH	Model	Value mH
DIN1220075B	2.0	DIN3380075B	6.0
DIN1220150B	1.5	DIN3380110B	5.0
DIN1220220B	1.0	DIN3380150B	4.5
DIN3220075B	5.0	DIN3380220B	3.0
DIN3220150B	3.0	DIN3380300B	2.0
DIN3220220B	2.0	DIN3380400B	2.0

## Current ratings

Continuous: Not less than the continuous current rating of the Drive

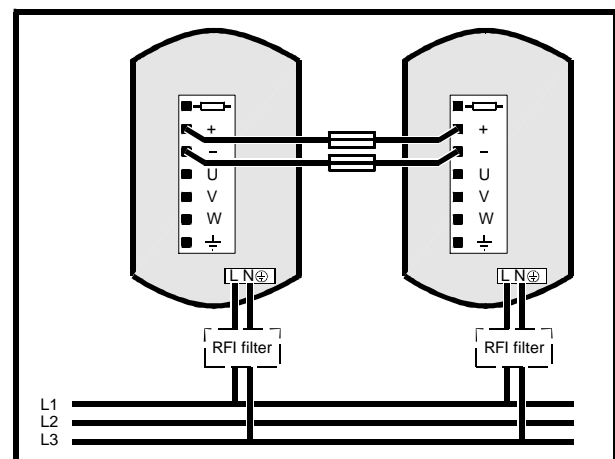
Repetitive peak: Not less than *twice* the continuous current rating of the Drive

## 4.20 Parallel connection of DC buses

When two or more Drives are to be used in an application, it is possible to connect their DC buses in parallel. This allows the braking resistor on one Drive to be shared by a number of Drives.

For fuse ratings, see *Connecting an external supply to the DC bus* (below).

Although any two phases can be used when supplying single-phase models from two phases of a low-voltage three-phase supply, ensure the same two phases are used for each Drive in a paralleled system (see Figure 4–13).



**Figure 4–13 Using the same AC supply phase connections for single-phase models supplied by a low-voltage three-phase supply and having their DC buses connected in parallel**

## 4.21 Connecting an external supply to the DC bus

The Drive can be powered by applying a DC voltage to the DC bus instead of using an AC supply. The applied voltage must be as shown in the following table.



### Warning

**Do not allow the maximum permissible voltage to be exceeded. Exceeding this voltage will cause the braking transistor in the Drive to be permanently conducting. A risk of fire would be caused if the Drive (or any other Drive on the dc supply) has a braking resistor connected.**

Model	Minimum permissible voltage	Maximum permissible voltage	DC supply fuse (A)
DIN1220075B	250	370	10A, 500VDC
DIN1220150B	250	370	16A, 500VDC
DIN1220220B	250	370	20A, 500VDC
DIN3220075B	250	370	10A, 500VDC
DIN3220150B	250	370	16A, 500VDC
DIN3220220B	250	370	20A, 500VDC
DIN3380075B	440	740	5A, 1000VDC
DIN3380110B	440	740	5A, 1000VDC
DIN3380150B	440	740	6A, 1000VDC
DIN3380220B	440	740	10A, 1000VDC
DIN3380300B	440	740	12A, 1000VDC
DIN3380400B	440	740	16A, 1000VDC

## 4.22 Motor-cable driving capability

Model	Maximum permissible length	
	metres	feet
DIN1220075B	250	775
DIN1220150B	200	660
DIN1220220B	100	330
DIN3220075B	250	775
DIN3220150B	200	660
DIN3220220B	100	330
DIN3380075B	75	250
DIN3380110B	75	250
DIN3380150B	75	250
DIN3380220B	75	250
DIN3380300B	125	410
DIN3380400B	125	410

Cable lengths are based on a torque overload capability of 125%.

Cable lengths stated in the table are typical values. Using greater cable lengths may cause the Drive to trip on overcurrent (trip **OL**), or to reduce the output frequency.

## 4.23 Ground connections

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

Refer to *Wiring recommendations* later in this chapter.



### Warning

**The ground loop impedance must conform to the requirements of local safety regulations. The ground connections must be inspected and tested at appropriate intervals.**

## 4.24 Electromagnetic compatibility (EMC)

This section outlines the main considerations for ensuring that the installation meets the requirements for electromagnetic compatibility. Further information is given in *Wiring recommendations* (later in this chapter) and in the *Dinverter B EMC Data Sheet*, which is available from the Drive Centres and distributors listed at the end of this User Guide.

### Emission

---

PWM inverter Drives produce significant levels of radio frequency energy from the PWM switching frequency up to about 30MHz. This frequency range is below the frequency bands used by television and personal communications systems, but can affect radio equipment working in the long, medium, and short wavebands. Also, if the emissions are carried along unscreened wiring or inadequate ground wiring, they can be coupled into other possibly sensitive electronic circuits and may cause disturbance. This disturbance can be prevented by a combination of appropriate shielding and filtering.

Figures 4–15 and 4–16 show the full precautions which must be taken where very low emission levels are required in order to comply with specific emission standards.

Figure 4–14 shows simplified precautions where no special EMC requirements apply. Most modern industrial electrical and electronic equipment has good immunity from disturbance. If this is the only equipment located near to the Drive, the simplified precautions should be sufficient.

Where sensitive equipment is located near to the Drive (particularly radio equipment) or where residential areas are within a distance of 30 metres (100 feet) from any part of the Drive and motor installation, it is recommended that the full EMC precautions be applied.

Some examples of industrial equipment which have been found to be particularly sensitive are:

- Proximity detectors using capacitance techniques
- Strain-gauge amplifiers
- Thermocouple amplifiers
- Equipment using a radio-based time clock
- Digital data communications systems, only where there are unscreened runs of data lines or the screens have been terminated incorrectly

### Immunity

---

The immunity of the Drive meets severe industrial standards and is sufficient for most practical applications. Under exceptional circumstances, the Drive may be disturbed by emissions from external sources. The following possible sources of disturbance should be avoided by the fitting of suitable suppression:

- Relay and contactor-coil circuits where wiring runs close to the Drive control wiring
- Other inductive DC circuits – for example, solenoid-operated brakes
- Control wiring which runs outside buildings, even when the wiring is underground, because there may be a risk of high-voltage surges from lightning strikes.

In all cases the local laws on EMC and RFI must be complied with.

## 4.25 Wiring recommendations

### Note

**This section contains instructions which relate to the shielding of some signal connections. This shielding is needed for ensuring correct operation of the Drive. Where strict compliance with EN50081-2 or similar is required, the guidance given in *Electromagnetic compatibility* (earlier in this chapter) must also be followed.**

---

Wiring recommendations are given for the following:

- Routine precautions where full compliance with EMC standards is not required
- Compliance with EMC emission standards

The recommendations are given in the following sections:

- Routine EMC precautions
- Compliance with EMC emission standards

Observe the wiring guidelines given in this chapter. The details of individual installations may vary, but details which are indicated in the guidelines to be important for EMC must be adhered to closely.

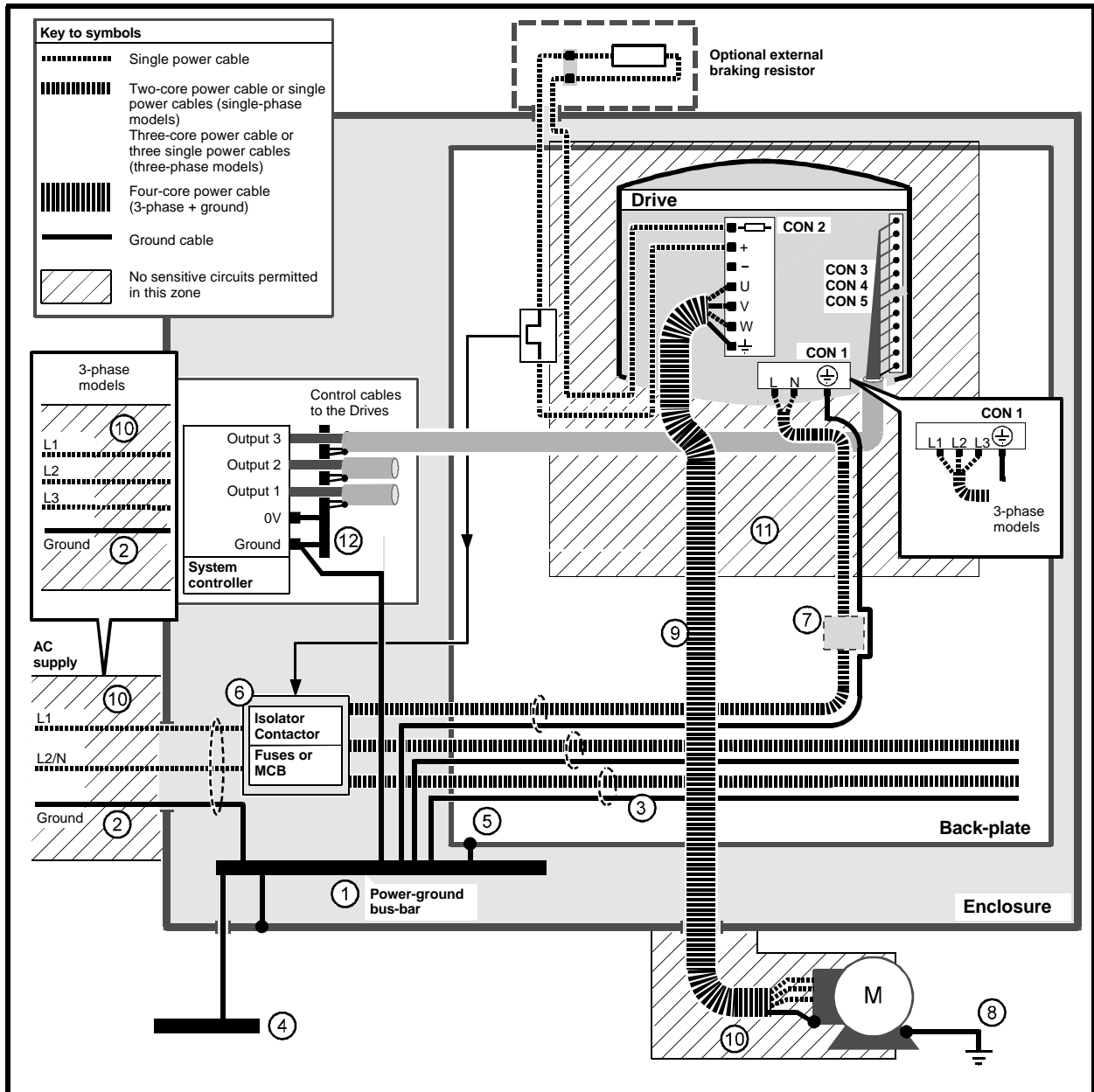


Figure 4-14 Wiring guidelines for routine EMC precautions

## Routine EMC precautions for single- and three-phase models (Figure 4–14)

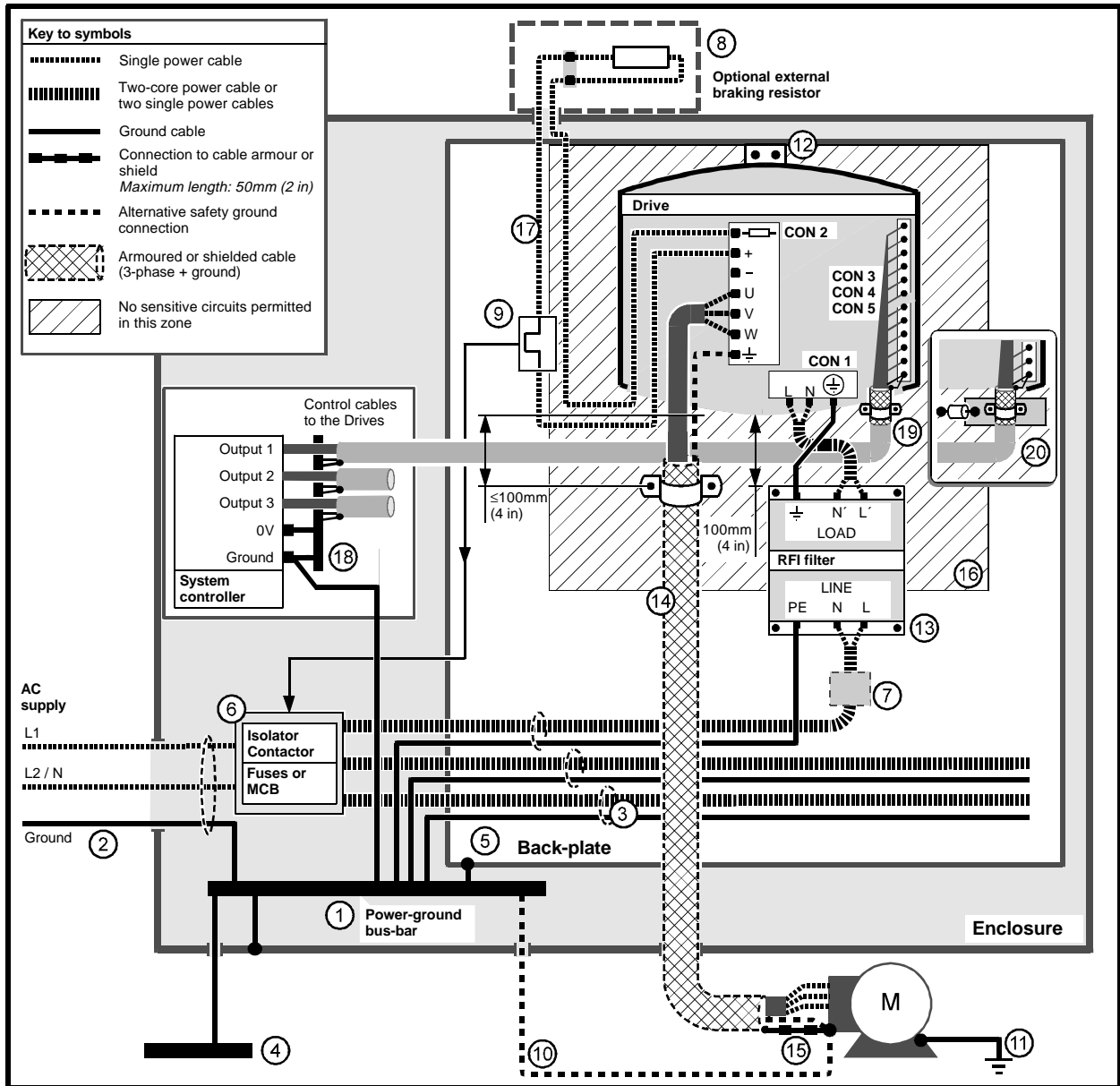
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### General features

1. Single power-ground bus-bar, or low-impedance ground terminal.
2. Incoming AC supply ground connected to the power ground bus-bar.
3. Connect grounds of any other circuits to the power ground bus-bar.
4. Site ground, if required.
5. Metal back-plate, safety bonded to the power ground bus-bar.
6. System isolator, circuit contactors and fuses/MCB.
7. Alternative position for Drive fuses/MCB.
8. Motor-frame ground connection, if required.

### Routine EMC precautions

9. Use four-core cable to connect the motor to the Drive as shown. The ground conductor in the motor cable must be connected only to the ground terminals of the Drive and motor; it must not be connected directly to the power-ground bus-bar.
10. If the wiring for sensitive signal circuits is to be parallel to an unshielded motor cable (or cables for an unfiltered power supply) for more than 1 metre (3 feet), ensure the separation is at least 0.3m (12 in).  
If the parallel run is to exceed 10 metres (30 feet), increase the separation proportionally. For example, if the parallel run is to be 40 metres, the spacing must be:  $0.3 \times 40 \div 10 = 1.2$  metres.  
When a motor-thermistor is used, this constraint does not apply to the cable connecting the thermistor to the Drive. The motor-thermistor cable must be shielded (as shown in Figure 4-20).
11. Do not place sensitive signal circuits in a zone extending 0.3m (12 in) all around the Drive.
12. If the control circuit 0V is to be grounded, this should be done at the system controller (eg. PLC) and not at the Drive. This is to avoid injecting noise currents into the 0V circuit.



**Figure 4-15 Single-phase models – Wiring guidelines for compliance with EMC emission standards**

## Compliance with EMC emission standards for the single-phase models (Figure 4–15)

---

Model numbers: DIN1220075B to 1220220B

### General features

1. Single power ground bus-bar, or low-impedance ground terminal.
2. Incoming AC supply ground connected to the power ground bus-bar.
3. Connect grounds of any other circuits to the power ground bus-bar.
4. Site ground if required.
5. Metal back-plate, safety bonded to the power ground bus-bar. Ensure that the grounding arrangement prevents high-frequency noise currents circulating in the back-plate.
6. System isolator, circuit contactors and fuses/MCB.
7. Alternative position for Drive fuses/MCB.
8. Optional braking resistor mounted externally, protected and shielded by a metal grille.
9. Thermal overload device to protect the braking resistor.
10. Alternative safety ground for the motor.
11. Motor-frame ground connection, if required.
15. Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50mm (2 in) in length.
16. Avoid sensitive signal circuits in a zone extending 0.3m (12 in) all around Drive.
17. Unshielded wiring to the optional braking resistor(s) may be used, provided the resistor is either in the same enclosure as the Drive or the wiring does not run external to the enclosure. When the braking-resistor wiring is unshielded, ensure a minimum spacing of 0.3m (12 in) from signal wiring and the AC supply wiring to the RFI filters.
18. At the controller, connect the shield of the control signal cable(s) to 0V.

The following two points may be omitted only if slightly increased radiated emission is acceptable.

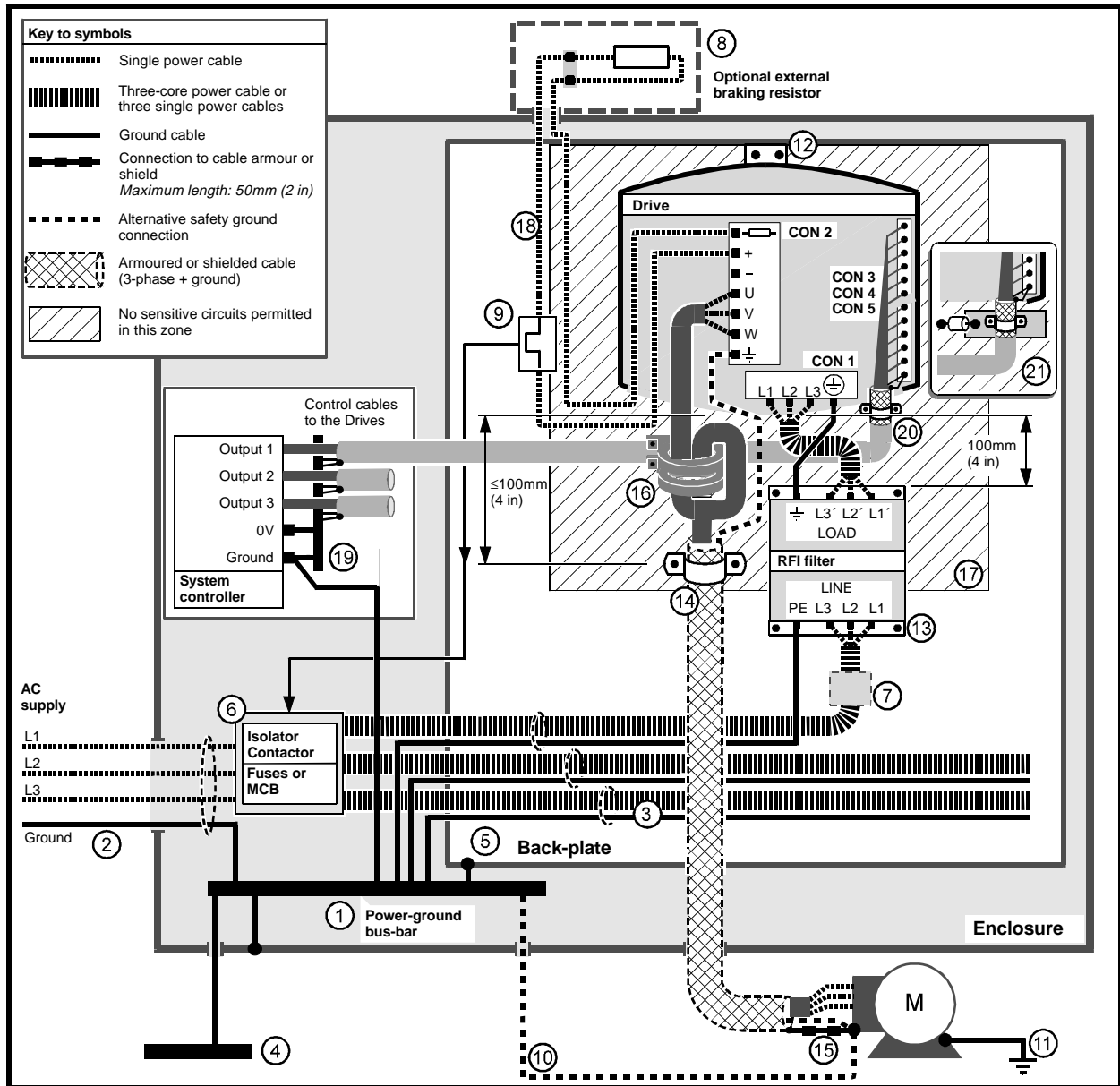
### Special features for EMC

12. Drive heatsink directly connected to the back-plate by the mounting bracket(s). Ensure that the screws make a good electrical connection between the mounting bracket(s) and the back-plate.
13. RFI filter mounted 100mm (4 in) from the Drive. The RFI filter casing is directly grounded to the back-plate by the fixing screws. Minimize the length of cables between the Drive and RFI filter.
14. A shielded (screened) or steel-wire armoured cable must be used to connect the Drive to the motor. The shield must be bonded to the back-plate using an uninsulated metal cable-clamp. The clamp must be positioned no further than 100mm (4 in) from the Drive.
19. At the Drive, connect the shield of the control signal cable(s) to 0V as well as directly to the back-plate.
20. Alternative connections to avoid low-frequency ground-loop currents (see step 19). Instead of connecting the shield of the control signal cable(s) directly to the back-plate, connect the shield to a metal bar that is insulated from the back-plate. Connect a 1nF capacitor between the metal bar and a stud on the back-plate. Ensure the capacitor leads are as short as possible.

#### Note

**The shield must cover *all* the control wiring. The status-relay wiring must also be contained in this shield or in a separate shield.**

---



**Figure 4-16 Three-phase models – Wiring guidelines for compliance with EMC emission standards**



## Compliance with EMC emission standards for the three-phase models (Figure 4–16)

---

Model numbers: DIN3220075B to 3220220B and DIN3380075B to 3380400B

### General features

1. Single power ground bus-bar, or low-impedance ground terminal.
2. Incoming AC supply ground connected to the power ground bus-bar.
3. Connect grounds of any other circuits to the power ground bus-bar.
4. Site ground if required.
5. Metal back-plate, safety bonded to the power ground bus-bar. Ensure that the grounding arrangement prevents high-frequency noise currents circulating in the back-plate.
6. System isolator, circuit contactors and fuses/MCB.
7. Alternative position for Drive fuses/MCB.
8. Optional braking resistor mounted externally, protected and shielded by a metal grille.
9. Thermal overload device to protect the braking resistor.
10. Alternative safety ground for the motor.
11. Motor-frame ground connection, if required.
16. Where ferrite rings are specified, pass 2 turns of the output phases (UVW) around the rings as shown. See *RFI filter and ferrite rings* earlier in this chapter.
17. Avoid placing sensitive signal circuits in a zone extending 0.3m (12 in) all around the Drive.
18. Unshielded wiring to the optional braking resistor(s) may be used, provided the resistor is either in the same enclosure as the Drive or the wiring does not run external to the enclosure. When the braking-resistor wiring is unshielded, ensure a minimum spacing of 0.3m (12 in) from signal wiring and the AC supply wiring to the RFI filters.
19. At the controller, connect the shield of the control signal cable(s) to 0V.

The following two points may be omitted only if slightly increased radiated emission is acceptable.

### Special features for EMC

12. Drive heatsink directly connected to the back-plate by the mounting bracket(s). Ensure that the screws make a good electrical connection between the mounting bracket(s) and the back-plate.
13. RFI filter mounted 100mm (4 in) from the Drive. The RFI filter casing is directly grounded to the back-plate by the fixing screws. Minimize the length of cables between the Drive and RFI filter.
14. A shielded (screened) or steel-wire armoured cable must be used to connect the Drive to the motor. The shield must be bonded to the back-plate using an uninsulated metal cable-clamp. The clamp must be positioned no further than 100mm (4 in) from the Drive.
15. Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50mm (2 in) in length.
20. At the Drive, connect the shield of the control signal cable(s) to 0V as well as directly to the back-plate.
21. Alternative connections to avoid low-frequency ground-loop currents (see step 20). Instead of connecting the shield of the control signal cable(s) directly to the back-plate, connect the shield to a metal bar that is insulated from the back-plate. Connect a 1nF capacitor between the metal bar and a stud on the back-plate. Ensure the capacitor leads are as short as possible.

#### Note

**The shield must cover *all* the control wiring. The status-relay wiring must also be contained in this shield or in a separate shield.**

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## Variations

### Interruptions to the motor cable

The motor cable should ideally be a single piece of shielded or armoured cable having no interruptions. In some situations it may be necessary to interrupt the cable, as in the following examples:

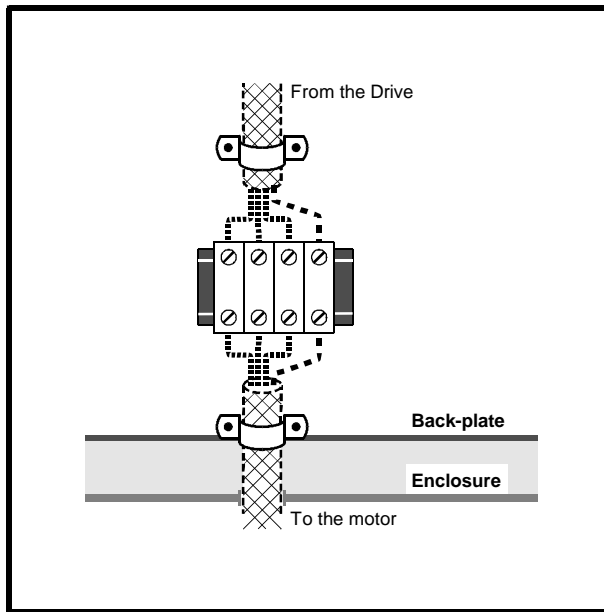
Connecting the motor cable to a terminal block in the Drive enclosure

Fitting a motor isolator switch for safety when work is done on the motor

In these cases the following guidelines should be followed.

### Terminal block in the enclosure

The motor cable shields should be bonded to the back-plate using uninsulated metal cable-clamps which should be positioned as close as possible to the terminal block. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away from the terminal block.



(Refer to Key to symbols in Figure 4–15)

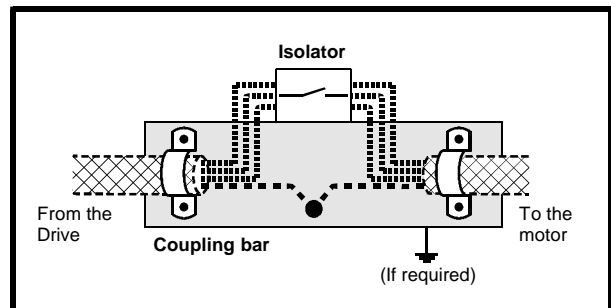
**Figure 4–17** Connecting the motor cable to a terminal block in the enclosure

### Using a motor isolator-switch

The motor cable shields should be connected by a very short conductor having a low inductance. The use of a flat metal coupling-bar is recommended; conventional wire is not suitable.

The shields should be bonded directly to the coupling-bar using uninsulated metal cable-clamps. Keep the length of the exposed power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away.

The coupling-bar may be grounded to a known low-impedance ground nearby, for example a large metallic structure which is connected closely to the Drive ground.



(Refer to Key to symbols in Figure 4–15)

**Figure 4–18** Connecting the motor cable to an isolator switch

## 4.26 External braking resistor

### Connecting the resistor



#### High temperatures

#### Warning

Braking resistors can reach high temperatures. Locate braking resistors so that damage cannot result.

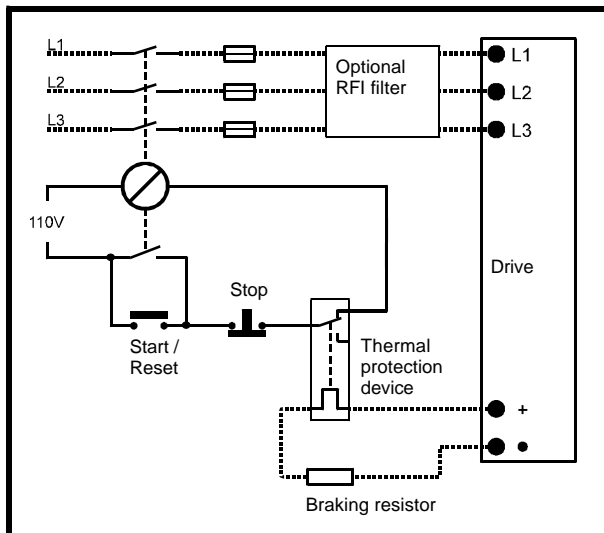
Use cable having insulation capable of withstanding high temperatures.



#### Overload protection

#### Warning

It is essential that an overload protection device is incorporated in the braking resistor circuit; see below.



**Figure 4-19 External braking resistor connections**

Connect an external braking resistor in series with a thermal protection device. The thermal protection device is used to avoid the resistor causing a fire hazard if the braking transistor in the Drive becomes permanently switched on or short-circuit. The thermal protection device must disconnect the AC supply from the Drive.

### Resistor value

Calculate the maximum peak power ( $P_{max}$ ) to be dissipated in the braking resistor from:

$$P_{max} = \left( \frac{ULF}{t_{min}} \right) J \left( \frac{4\pi}{p} \right)^2 \times f_{max}$$

Where:

- J** Load inertia in kg.m<sup>2</sup>
- f<sub>max</sub>** Maximum operating frequency of the Drive in Hz
- p** Number of motor poles (2, 4, 6, 8 etc)
- t<sub>min</sub>** The lowest value for parameter **p3** that will be used in the application
- ULF** Upper Limit Frequency set in parameter **b14**

#### Note

**$P_{max}$  must be less than 1.5 times the Drive rating to ensure that the Drive can tolerate the braking duty.**

Use the following equation to calculate the maximum suitable value for the braking resistor:

$$R \leq \frac{V_R^2}{P_{max}}$$

Where:

- V<sub>R</sub>** Voltage across the braking resistor (Low-voltage models: 377V) (High-voltage models: Value set in parameter **p64**)
- P<sub>max</sub>** Maximum peak power to be dissipated

#### Minimum values

Model	Minimum value of external braking resistor
Low-voltage (200V to 240V)	33Ω
High-voltage (380V to 480V)	82Ω

## Average power dissipation

---

Calculate the maximum energy to be dissipated in the braking resistor from:

$$E_{\text{Loss}} = (0.5) J \left( \frac{4\pi}{p} \right)^2 \times [f1^2 - f2^2]$$

Where:

- E<sub>loss</sub>** Energy to be removed
- J** Inertia in kgm<sup>2</sup>
- f1** Highest operating frequency
- f2** Minimum frequency after deceleration

For repetitive deceleration, the average power dissipation is as follows:

$$P_{\text{avloss}} = \frac{E_{\text{loss}}}{t1 + t2}$$

Where:

- t1** Length of a braking period
- t2** Interval between braking periods

## Peak power rating

---

Check that the resistor has a peak power dissipation rating as follows:

$$P_{\text{PK}} > 1.15 \left( \frac{V_R^2}{R} \right)$$

## 4.27 Signal connections



### Warning

#### Isolation

**The control circuits and terminals are isolated from the power circuits only by basic insulation. The installer must 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.**

**If the control circuits are to be connected to circuits classified as Safety Extra Low Voltage (SELV), an additional isolating barrier must be included in order to maintain the SELV classification.**

**If the control signal connections are to be accessible to personnel, a 0V-common terminal (A1, B1 or C1) must be connected to a safety ground by a wire which is capable of carrying the fault current before the AC supply fuse disconnects the supply. Alternatively, a second isolation barrier must be used for making signal connections to the signal connectors.**

## Control signal wire size

---

Recommended size:

0.5mm<sup>2</sup> (20AWG) with overall shield where required

## Shielding

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Analog signal wiring must be shielded unless it is totally contained in the enclosure. Refer to Figures 4-14 to 4-16 as appropriate for connecting each end of the shield.

## Logic sense

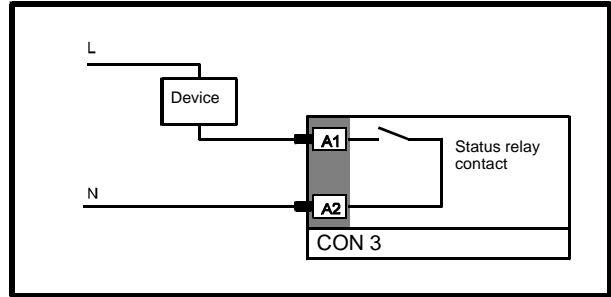
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The Drive is supplied operating in negative logic. The logic signal connections described in this section apply to negative logic.

The setting may be changed to positive logic using parameter **b5** *Logic selector*. Refer to **b5** in Chapter 10 *List of Parameters*.

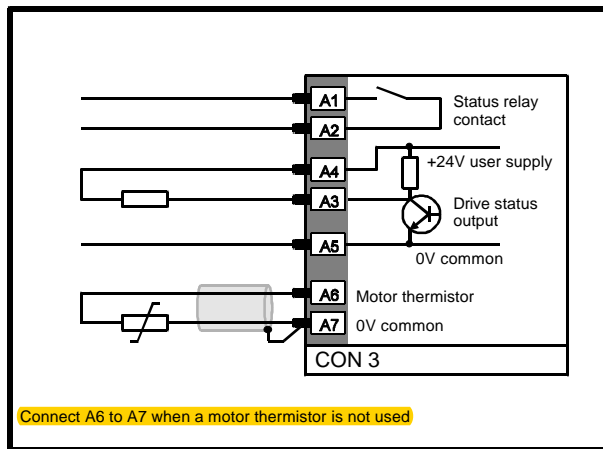
**Warning**

**Connecting a Drive configured in negative logic to a positive-logic PLC could cause the Drive to start the motor automatically when power is connected to the Drive.**



**Figure 4-21** Arrangement for connecting a device operating on the AC supply

**CON 3**



**Figure 4-20** Signal connections to CON 3

A1 A2	<b>Status relay contact</b>
----------	-----------------------------

Contact rating: 240VAC, 4A resistive  
Update time: 65ms

**Warning**

**The Status relay must not be connected to an AC supply of overvoltage category greater than II, as defined in IEC664-1 *Insulation co-ordination for equipment within low voltage systems, section 2.2.2.1.1.***

When the Status relay contact is used to switch a device operating on the AC supply, it is recommended that the contact is connected as shown in Figure 4-21.

The function of the Status relay is controlled by parameter **b50** *Status relay selector*.

**b50 set at 0**

When the Drive is in **normal** operation, the status relay contact connects terminal A1 to terminal A2 (relay energized).

When the Drive is tripped, or when AC power is removed from the Drive, the status relay contact is open.

**b50 set at 1**

When the Drive is **at speed**, the status relay contacts connect terminal A1 to terminal A2 (relay energized).

When any of the following conditions occurs, the status relay contact is open:

- The Drive is not at speed
- The Drive is tripped
- AC power is removed from the Drive

### A3 DRIVE STATUS output

Open-collector output  
Internal pull-up resistor to +24V: 6kΩ  
Output voltage range: 0V to +24V  
Maximum sink current: 100mA  
Maximum source current: 4mA  
Update time: 65ms

The output may be used to energize an external relay connected between terminals A3 and A4 (+24V).

The function of this output is controlled by the settings of parameters **b53** *Status output selector* and **b5** *Logic selector*.

#### Negative logic (b5 set at 1)

##### b53 set at 0

When the Drive is running, the transistor is on.  
When the Drive is not running, the transistor is off.

##### b53 set at 1

When the Drive is above **Minimum speed**, the transistor is on. When the Drive is at or below **Minimum speed**, the transistor is off.

#### Positive logic (b5 set at 0)

##### b53 set at 0

When the Drive is running, the transistor is off.  
When the Drive is not running, the transistor is on.

##### b53 set at 1

When the Drive is above **Minimum speed**, the transistor is off. When the Drive is at or below **Minimum speed**, the transistor is on.

### A4 +24V user supply

Voltage tolerance: ±10%  
Maximum output current: 100mA  
Short-circuit protected  
Supply for external devices.

### A5 0V common

### A6 Motor thermistor

Voltage applied to thermistor: 2.5V  
Trip resistance: 3kΩ  
Reset resistance: 1.8kΩ

A positive temperature co-efficient thermistor may be used to protect the motor. Connect the thermistor between terminals A6 and A7 (0V common). A motor thermal-switch may instead be used.

When a motor thermistor is not used, connect terminal A6 to terminal A7 (0V).

#### Note

**Do not connect the shield of the thermistor cable to the motor frame, or to the ground point for the motor.**

### A7 0V common

## CON 4



#### Warning

**The RS485 serial communications connections in the Drive are not isolated from the other control circuits and are separated from the live parts by basic insulation; if the serial communications circuit is to be accessible to personnel, an isolation unit must be used. When multiple RS485 networks are to be used, each network will require its own isolation unit.**

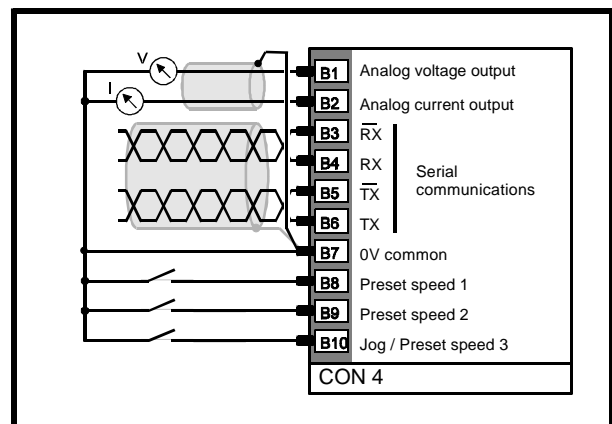


Figure 4–22 Signal connections to CON 4

**B1 Analog voltage output**

Output voltage range: 0 to  $\pm 10V$   
 Maximum output current: 5mA  
 Accuracy:  $\pm 5\%$  of full-scale  
 Update time: 65ms

The function of this output is controlled by the settings of the following parameters:

**b24** and **b25** Analog output selector

**Frequency signal**  
**b24 = 0 b25 = 0**

An analog voltage signal proportional to the **output frequency** of the Drive is produced on terminal B1. The signal is as follows:

0V when the frequency is 0Hz  
 +10V when the frequency is at the value of **+p1**  
 -10V when the frequency is at the value of **-p1**

**Load signal**  
**b24 = 0 b25 = 1**

An analog voltage signal proportional to the **load** on the motor is produced on terminal B1. The signal is as follows:

0V at 0% full load current (FLC)  
 +10V at 150% FLC motoring  
 -10V at 150% FLC regenerating

**Load detection**  
**b24 = 1 b25 = 0 or 1**

A signal of +10V is produced on terminal B1 when the **maximum continuous current** set in parameter **p5** is reached. When the current is below this level, the output signal is 0V.

**B2 Analog current output**

Output current range: 4mA to 20mA  
 Accuracy:  $\pm 5\%$  of full-scale  
 Update time: 65ms

The function of this output is controlled by the settings of the following parameters:

**b24** and **b25** Analog output selector

**Load signal**  
**b24 = 0 or 1 b25 = 0**

An analog current signal proportional to the **load** on the motor is produced on terminal B2. The signal is as follows:

4mA at 0% FLC  
 20mA at 150% FLC motoring or regenerating  
 (FLC = Full-load current)

**Frequency signal**  
**b24 = 0 or 1 b25 = 1**

An analog current signal proportional to the **output frequency** of the Drive is produced on terminal B2. The signal is as follows:

4mA at 0Hz  
 20mA when the frequency is at the value of  **$\pm p1$**  Maximum frequency

**B3 RX input**  
**B4 RX input**

Serial communications differential inputs.

Signal level: 0V to +5V  
 Differential input impedance: 3.7k $\Omega$   
 Logic high: (RX to  $\overline{RX}$ ) > 0.2V  
 Logic low: (RX to  $\overline{RX}$ ) < -0.2V

**B5 TX output**  
**B6 TX output**

Serial communications tri-state differential outputs.

Signal level: 0V to +5V  
 Maximum current:  $\pm 60mA$   
 Logic low:  $\overline{TX} = +5V$ , TX = 0V  
 Logic high:  $\overline{TX} = 0V$ , TX = +5V

When not transmitting, the Transmit outputs are disabled (tri-state).

Internal pull-up resistor on  $\overline{TX}$  output:

10k $\Omega$  connected to +5V

Internal pull-down resistor on TX output:

10k $\Omega$  connected to 0V

**B7 0V common****B8 Preset speed 1**  
**B9 Preset speed 2**  
**B10 Jog / Preset speed 3**

Default logic sense: Negative  
 Logic high (input open-circuit): >15V  
 Logic low (input connected to 0V): <5V  
 Input impedance: 2.9k $\Omega$   
 Sample period: 8 to 16ms

The input signal must be maintained for at least 16ms to ensure accurate sampling.

The functions of these inputs are controlled by **b20** Preset speed selector, as follows:

### b20 set at 0

Three preset speeds and one Jog speed are available. Terminals B8 and B9 may be configured to give the following four settings (terminal B10 is configured for Jog).

B10	B9	B8	Output	Display
0	0	0	Normal speed control	run
0	0	1	Preset speed 1	run
0	1	0	Preset speed 2	run
0	1	1	Preset speed 3	run
1	0	0	Jog	rdY

The Drive must be enabled, and the display must show **rdY** to allow Jog to be activated.

### b20 set at 1

Seven preset speeds are available. Terminals B8, B9 and B10 may be configured to give the following seven settings:

B10	B9	B8	Output
0	0	0	Normal speed control
0	0	1	Preset speed 1
0	1	0	Preset speed 2
0	1	1	Preset speed 3
1	0	0	Preset speed 4
1	0	1	Preset speed 5
1	1	0	Preset speed 6
1	1	1	Preset speed 7

### CON 5

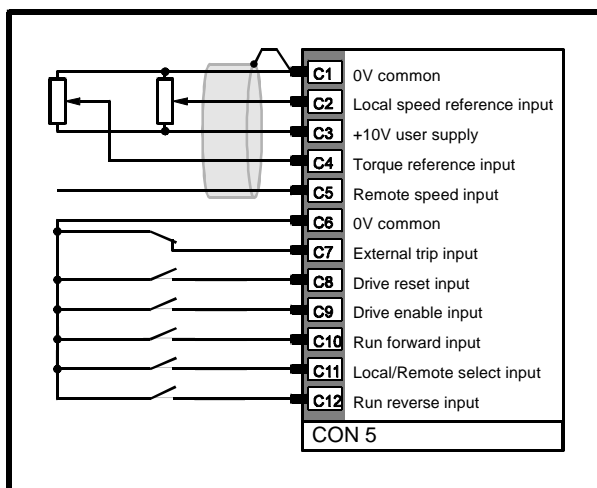


Figure 4–23 Signal connections to CON 5

### C1 0V common

### C2 LOCAL SPEED REFERENCE input

Voltage range: –10V to +10V

Input impedance: 94kΩ

Sample time: 8 to 16ms

The function of this input is controlled by the setting of **b4 Bipolar select**.

### b4 set at 1

Uni-polar speed reference is selected. The local speed reference can be obtained from a 10kΩ potentiometer connected between terminal C1 (0V common) and terminal C3 (+10V user supply).

When the speed reference signal is 0V, the motor speed is the value held in parameter **p0 Minimum frequency**.

When the speed reference signal is +10V, the motor speed is the value held in parameter **p1 Maximum frequency**.

### b4 set at 0

Bi-polar speed reference is selected. A positive input signal produces forward rotation of the motor; a negative signal produces reverse rotation.

When the speed reference signal is +10V or –10V, the motor speed is the value held in parameter **p1 Maximum frequency**.

### C3 +10V user supply

Voltage: 10.18V ±2%

Maximum output current: 5mA

Short-circuit protected

### C4 TORQUE REFERENCE input

Voltage range: 0V to +10V

Input impedance: 27.6kΩ

Sample time: 8 to 16ms

The torque reference can be obtained from a 10kΩ potentiometer connected between terminal C1 (0V common) and terminal C3 (+10V user supply).

When the torque reference signal is 0V, the torque is 10% of full load current (FLC).

When the torque reference signal is +10V, the torque is the value held in parameter **p4 Timed current limit**.

Terminal C4 is active irrespective of the setting of parameter **b0 Speed or torque reference selector**.



**C5 REMOTE SPEED REFERENCE input**

Current input  
 Input impedance = 100Ω  
 Sample time: 8 to 16ms  
 Current ranges:  
     4mA to 20mA  
     0 to 20mA  
     20mA to 4mA

Current range is selected using parameter **b11**  
*Remote speed reference input selector* as follows:

<b>b11 setting</b>	<b>Speed reference Input current mA</b>	<b>Speed defined in...</b>
4.20	4	p0
	20	p1
20.4	20	p0
	4	p1
0.20	0	p0
	20	p1

**C6 0V common****C7 EXTERNAL TRIP input**

The external trip input can be used to trip the Drive from an external source.  
 The default logic sense is negative. When terminal C7 is connected to 0V, the Drive runs (provided no other trips have occurred). When terminal C7 is open-circuit, the Drive trips. The trip code **Et** will be displayed.  
 When this function is not required, connect terminal C7 to terminal C6 (0V common).

**C8 DRIVE RESET input**

The default logic sense is negative. Momentarily connect terminal C8 to 0V common to reset the Drive after a trip.

**C9 DRIVE ENABLE input**

The default logic sense is negative. Connect terminal C9 to 0V common to enable the Drive.  
 When the Drive is running and C9 is disconnected from 0V to disable the Drive, the Drive decelerates using the braking mode selected using parameters **b2**, **b7** and **b27** *Stopping mode selectors*.

**C10 RUN FORWARD input**

The default logic sense is negative. Connect terminal C10 to 0V common to select forward direction.

When the Drive is running and C10 is disconnected from 0V while C9 remains connected to 0V, the Drive decelerates to a halt using the Standard ramp for deceleration (see parameters **b2**, **b7** and **b27**).

**C11 LOCAL/REMOTE SELECT input**

The default logic sense is negative. When terminal C11 is connected to 0V, a remote analog current signal may be applied to terminal C5 to control the speed of the Drive (See terminal C5 and parameter **b11** *Remote reference input selector*).

When terminal C11 is open-circuit, a local analog voltage signal may be applied to terminal C2 to control the speed of the Drive (See terminal C2 and parameter **b4** *Bipolar select*).  
 (See parameter **b28** *PI control selector* in Chapter 10 *List of parameters*.)

**C12 RUN REVERSE input**

The default logic sense is negative. Connect terminal C12 to 0V common to run the motor in the reverse direction.

When the Drive is running and C12 is disconnected from 0V while C9 remains connected to 0V, the Drive decelerates to a halt using the Standard ramp for deceleration (see parameters **b2**, **b7** and **b27**).

**Drive enable and direction control**

<b>Enable</b>	<b>Run forward</b>	<b>Run reverse</b>	<b>Action</b>
<b>Terminal C9</b>	<b>Terminal C10</b>	<b>Terminal C12</b>	
O/C	O/C	O/C	Drive stopped
0V	O/C	O/C	Drive stopped
0V	O/C	0V	Run reverse
0V	0V	O/C	Run forward
0V	0V	0V	Drive stopped

## 4.28 Connecting digital inputs in parallel

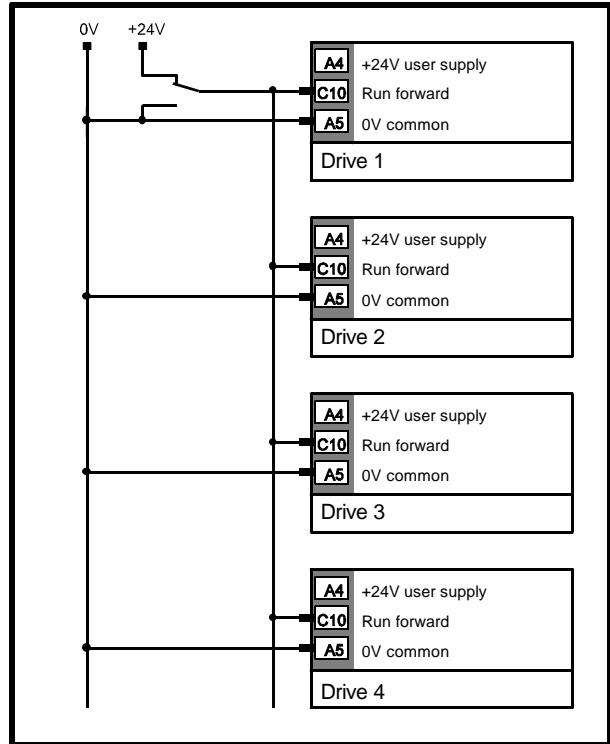
Make the following connections when the digital inputs of a number of Inverter 2B Drives are to be controlled from the same source:

Connect the relevant digital input (eg. terminal C10) on all the Drives in parallel.

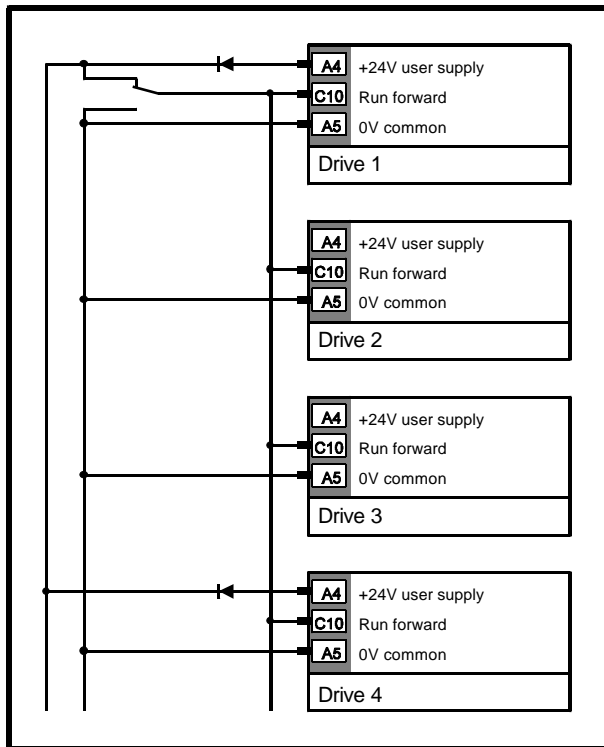
Use an external +24V supply, or use the +24V user supply on terminal A4. When using terminal A4 for more than three Drives, connect in parallel terminal A4 from a number of Drives. See Figure 4–25. Make each connection through a 300mA diode. For each additional three Drives, connect another terminal A4 through a diode.

Ensure that the controlling signal produces definite logic states; a logic state must not be assumed by leaving an input disconnected (eg. use a change-over relay, not a single contact).

Provided these conditions are met, any number of Drives can be controlled in parallel using positive or negative logic.



**Figure 4–25 Example parallel signal connections using an external 24V supply**



**Figure 4–24 Example parallel signal connections using the 24V user supply of the Drive**

## 5 Display and Keypad

The display and keypad are used for the following:

- Changing parameter values
- Stopping and starting the Drive
- Displaying the operating status of the Drive
- Displaying fault or trip codes

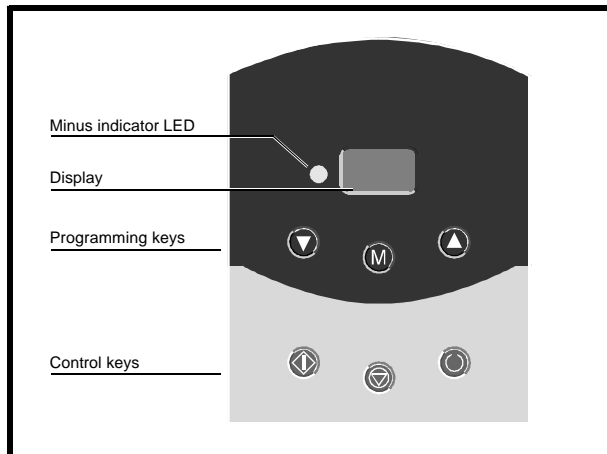


Figure 5-1 Display and keypad

### 5.1 Display

The display has three digits used for the following:

- Reading parameter values
- Reading status messages
- Reading trip codes

The display has three modes of operation which are selected using the keypad. The modes are as follows:

#### Status mode

This is the normal working mode of operation. The display is constant and shows the current status of the Drive (eg **rdY** or a trip code).

#### Parameter mode

Parameter mode allows a parameter to be displayed. The display alternates between the parameter number and the parameter value.

#### Edit mode

Edit mode allows the displayed parameter to be edited (change a numeric value, or a character string). The parameter value is shown as a constant display.

### Display behaviour

The behaviour of the display when it is in Parameter mode can be selected using parameter **b10** *Display time-out mode*, as follows:

#### b10 set at 0

The display alternately shows the parameter number and the parameter value. The display returns to Status mode 8 seconds after no key has been pressed.

#### b10 set at 1

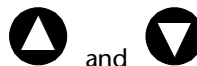
The display returns to Status mode after the Mode key is pressed for 1 second.

### Display indication

When the display is in Status mode and the Drive is running, depending on the setting of parameter **b8** *Display mode selector*, the display can indicate either of the following:

b8	Displayed function
0	Output frequency of the Drive
1	% full load current (FLC)

The display can be quickly switched to show the function that is not selected by parameter **b8**. To do this, press the following keys simultaneously for as long as you wish to display the function:



and

## 5.2 Keypad

### Programming keys

The programming keys are used for the following:

- Changing the mode of operation of the display
- Selecting a parameter to edit
- Editing a parameter value

The functions of the keys are as follows:



#### Display in Parameter mode

Change displayed parameter number.

#### Display in Edit mode

Change a parameter value.



(Mode)

#### Display in Status mode

Select Parameter mode.

#### Display in Parameter mode

Select Edit mode.

#### Display in Edit mode

Select Parameter mode.

### Control keys

Depending on the settings of the following parameters...

**b9** Terminal or keypad mode selector

**b55** Stop/Reset key selector

...the control keys are used to control the motor, as follows:



(Green key) Drive run



(Red key) Stop or reset the Drive



(Blue key) Reverse the direction of the motor to the same speed

## 5.3 Status indicators

When in Status mode, the display shows one of the following:

#### rdY

The Drive is waiting for a command.

#### Inh

At the moment this indication appears, the IGBT bridge is disabled and the selected deceleration ramp is started, even though it cannot control the motor. If the motor is spinning, it coasts to rest. The display will show **inh** until one second after the selected deceleration ramp is completed. At this point, the display shows **rdY** and the Drive can be re-started (see parameters **b2** and **b7** *Stopping mode selector* in Chapter 10 *List of parameters*). To re-start the Drive while the motor is still spinning, parameter **b52** *Synchronise to a spinning motor* should be set at 1.

#### dc

DC injection braking is being applied.

#### Scn

The Drive is synchronizing to a spinning motor (see parameter **b52** *Synchronise to a spinning motor* in chapter 10 *List of parameters*).

...

When the output current of the Drive exceeds for a time the level set in parameter **p5** *Maximum continuous current*, the decimal points flash. If the overload is subsequently removed, or the Drive stopped, the decimal points continue to flash for a period that depends on the extent of the [I x t] overload.

When a trip occurs, the display indicates the fault code (see *Trip codes* in Chapter 11 *Diagnostics*).

## 6 Getting Started



### Stored charge

#### Warning

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.



### Isolation

#### Warning

The control circuits and terminals are isolated from the power circuits only by basic insulation to IEC664-1. The installer must 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.



The Drive must be operated only by personnel having the necessary training or experience.



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.



The motor must be fixed down and the shaft guarded against inadvertent contact.



Do not change parameter values without careful consideration; wrong values may cause damage or a safety hazard.

The Drive can be configured for Terminal mode or Keypad mode of operation. The following diagrams show the basic connections that need to be made to allow the Drive to be operated in either mode.

## 6.1 Operation in terminal mode

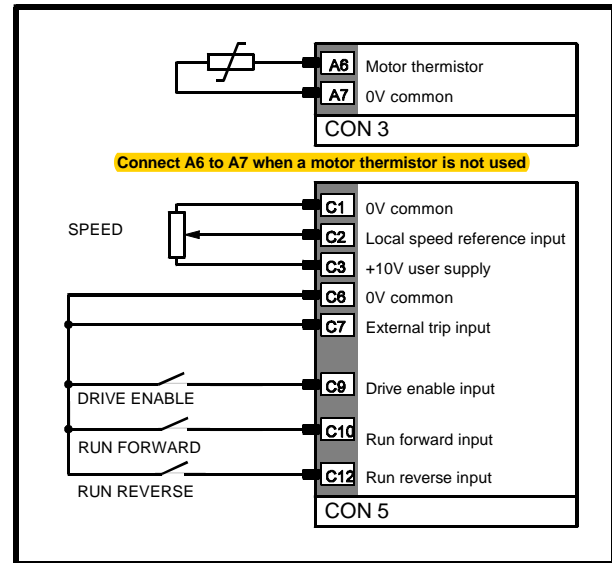


Figure 6-1 Basic connections for Terminal mode



#### Warning

Do not apply AC power until the checks in instruction 3 (below) have been performed successfully.

1. Connect the Drive to the AC supply circuit and motor as described in Chapter 4 *Installing the Drive*. **Do not apply AC power to the Drive.**
2. Make the signal connections shown in Figure 6-1.
3. Perform the following checks:
  - AC supply and motor connections are correct.
  - Motor installation is correct.
  - Motor shaft is not exposed.
  - Signal connector terminals C9, C10, C12 are not connected to 0V. (This ensures the motor will not start when AC power is applied.)
  - SPEED potentiometer set at minimum.
4. Apply AC power to the Drive.
5. Check that the value of parameter **p1** *Maximum frequency* does not exceed the permissible frequency of the motor.
6. Check that values of the following parameters:
  - pc** *Maximum voltage frequency* is the same as the rated frequency of the motor
  - b9** *Terminal or Keypad mode selector* is set at 1
7. Check the display indicates **rdY**.



8. Close the **DRIVE ENABLE** switch.
9. Close either the **RUN FORWARD** or **RUN REVERSE** switch.
10. Check the display indicates zero frequency.
11. Advance the **SPEED** potentiometer.
12. Check that the motor speed and displayed frequency change accordingly.
13. To display the percentage of full load current (FLC), press the following two keys at the same time:



14. If parameter **b55** is already set at 1 and the Drive trips, press...



(red key)

...to reset the Drive.

## 6.2 Operation in keypad mode

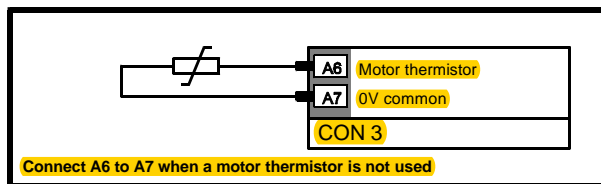


Figure 6–2 Basic connections for Keypad mode



**Warning**


**Do not apply AC power until the checks in instruction 3 (below) have been performed successfully.**


1. Connect the Drive to the AC supply circuit and motor as described in Chapter 4 *Electrical Installation*. **Do not apply AC power to the Drive.**
2. Make the signal connections shown in Figure 6–2.
3. Perform the following checks:
  - AC supply and motor connections are correct
  - Motor installation is correct
  - Motor shaft is not exposed
4. Apply AC power to the Drive.
5. Check that the value of parameter **p1** *Maximum frequency* does not exceed the maximum permissible frequency of the motor.

6. Check that values of the following parameters: **pc** *Maximum voltage frequency* is the same as the rated frequency of the motor


7. Set parameter **b9** *Terminal or Keypad mode selector* at 0 for Keypad mode.


When the display returns to Status mode, it displays trip **Et**.


8. Press  (red key) to reset the Drive.
9. Check that the Drive indicates **rdY** alternating with the minimum frequency.


10. Press  (green key) to run the Drive.

11. Check the display indicates zero frequency.

12. Press  to raise the frequency. Check that the motor speed increases.

13. Press  to reduce the frequency. Check that the motor speed decreases.

14. To stop the Drive, press  (red key).

15. If the Drive trips, press  (red key) to reset the Drive.

**Note**

**The FORWARD/REVERSE  (blue key) may be enabled by setting parameter b51 at 1.**

## 7 Programming Instructions

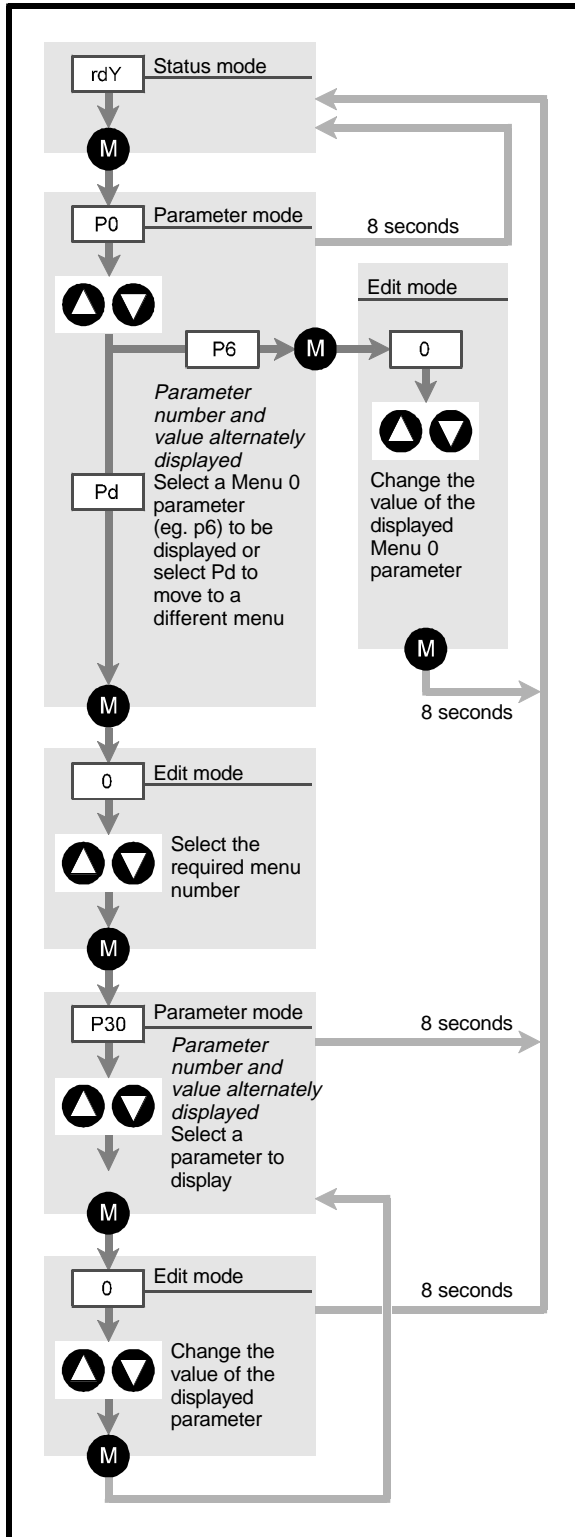










Figure 7-1 Sequence for displaying and editing parameters

### 7.1 Display and change a parameter value

#### Note

The motor must be stopped and the Drive must display rdY or a trip condition before the value of a bit parameter can be changed (See *Types of parameter* in Chapter 9 Working with Parameters)

1. When AC power is applied to the Drive, the display shows the current status (eg. **rdY**).
2. Press **M** once. The display is now in Parameter mode and shows a parameter number in the form of **p0** or **b0** alternating with the parameter value. (When **b10** is set at 0, after eight seconds the display returns to show the current status.)
3. To select a different parameter in Menu 0 press:  
 or 
4. Repeatedly press the key to scroll through the parameters of Menu 0.
5. To select another menu, scroll through Menu 0 until parameter **pd** is shown on the display.
6. Press **M** once to select Edit mode.
7. To select a different menu, press:  
 or   
to display the required menu number.
8. Press **M** once to select Parameter mode.
9. To select a different parameter number in the displayed menu, press:  
 or 
10. Press **M** once to select Edit mode.
11. To change the parameter value press:  
 or 
12. Press **M** once to select Parameter mode.
13. After 8 seconds the display reverts to Status.

## 7.2 Save parameter values

The last value of any parameter that has been changed is stored during power down.

## 7.3 Restore all parameters to the default values

To restore all parameters to the default values, set parameter **b13** at 1 and press:



**b13** will revert to 0. All parameters except those in Menu 60 will be reset to their default values (see *Menus* in Chapter 9 *Working with Parameters*).

### **Note**

**The logic sense (set in b5) is not affected when parameters are restored to the default values.**

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## 8 Security

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No security is set up when the Drive is supplied. A security code may be entered to prevent unauthorised changes to the parameter values.

### 8.1 Set up a security code




1. Connect the Drive to the AC supply.
2. Press  once.
3. Press  or  to display parameter **pb**.
4. Press  once.
5. Press  or  to set the required security code number.
6. Press  once to set the code.
7. Disconnect the Drive from the AC supply.





#### Note

**If a security code is set using the control keypad, the value must be in the range 100 to 255. If the security code is set using serial communications, the value can be in the range 1 to 255.**












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### 8.2 Security access

1. Connect the Drive to the AC supply.
2. Press  once.
3. Press  or  to display parameter **pb**.

4. Press  once.
5. Press  or  to display the required security code number.
6. Press  once.

### 8.3 Change a security code

1. Connect the Drive to the AC supply.
2. Press  once.
3. Press  or  to display parameter **pb**.
4. Press  once.
5. Press  or  to display the required security code to gain access.
6. Press  once.
7. While the display alternately shows **pb** and the value, press:  
 once again.
8. Press  or  to set the required security code number.
9. Press  once (to start the new code).
10. Disconnect the Drive from the AC supply.



## 9 Working with Parameters



### Warning

**This product uses software which is controlled by parameters. The product will perform to specification with the setting of correct and logical values. Incorrect setting of parameters is potentially hazardous.**

**Adjustment of the parameters must be carried out by skilled and trained personnel.**

The Drive is controlled by programmable software parameters. The parameters are positioned at strategic places in the control system.

You can improve the configuration of the Drive for the motor used and for simple applications by changing the values of appropriate parameters. Programming instructions are given in Chapter 7 *Programming Instructions*.

### 9.1 Types of parameter

There are two types of parameter, as follows:

- Operating parameters, denoted by **pxx**
- Bit parameters denoted by **bx**

Operating parameters allow the following to be entered:

- Values
- Character strings
- Selection options

Bit parameters allow digital settings to be made.

Both types of parameter can be as follows:

- Read–write (R–W)
- Read-only (RO)

Read–write parameters are programmable by the user. Read-only parameters are for information purposes. They cannot be programmed.

The settings of read–write and read-only parameters can be read on the display or remotely on a host PC using serial communications.

Each parameter has a number and a name which are represented in this Guide as in the following example:

**p2** Acceleration time

**b2** Stopping mode selector

Where:

**p** indicates a variable parameter

**b** indicates a bit parameter

You can read and change (edit, write to) parameter values using the following:

Using the display and keys on the Drive

Using serial communications and a host PC

### 9.2 Serial Communications mnemonics

Each parameter has a mnemonic that must be used when addressing the parameter using serial communications.

### 9.3 Default values

Each read–write parameter has a default value which is defined by the manufacturer. These default values allow a motor having the specified power rating to be adequately controlled by the Drive when used in simple applications.

Although the parameter values can be changed, the default values themselves cannot be erased or changed by the user.

### 9.4 Menus

The parameters are grouped in menus as follows:

Menu 0 Standard parameters

Menu 10 Skip frequencies

Menu 20 Preset speeds

Menu 30 Preset acceleration

Menu 40 Preset deceleration

Menu 50 Automatic reset

Menu 60 Read-only parameters and dynamic braking voltage

The parameters are listed in the same order as they appear on the display.



# 10 List of Parameters

## 10.1 Menu 0 — Standard parameters

<b>p0</b>	<b>Minimum frequency</b>	mnem	MN	R-W
Range	0.0 to p1	Hz	Def. val.	0.0
Related parameters	p1, p10 to p12, p20 to p26, b4, b14			

Use in unipolar mode to define the minimum frequency of the Drive in order to determine the minimum speed of the motor.

<b>p1</b>	<b>Maximum frequency</b>	mnem	MX	R-W
Range	p0 to ULF	Hz	Def. val.	50.0 (EUR) 60.0 (USA)
Related parameters	p0, p10 to p12, p20 to p26, b4, b14			

Set at a value to define the maximum frequency above which the motor will not operate.

(ULF = Upper Limit Frequency)

<b>p2</b>	<b>Acceleration time</b>	mnem	AL	R-W
Range	0.2 to 999	sec	Def. val.	5.0
Related parameters	p3, b14			

Set at the time required for the Drive to accelerate the motor from 0Hz to the upper limit frequency (ULF) set in **b14**. Acceleration is also referred to as **ramp**. Refer to Figure 10–1.

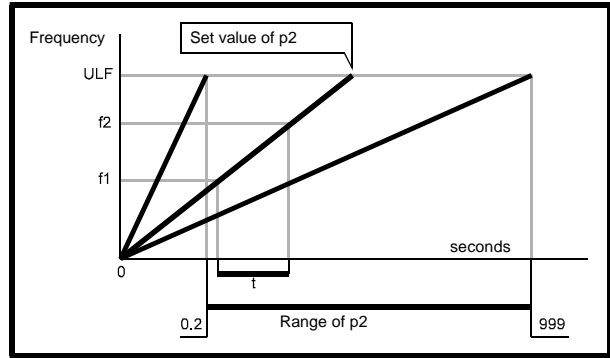
$$t_{acc} = p2 \frac{(f_2 - f_1)}{ULF}$$

<b>p3</b>	<b>Deceleration time</b>	mnem	DL	R-W
Range	0.2 to 999	sec	Def. val.	10.0
Related parameters	p2, b14			

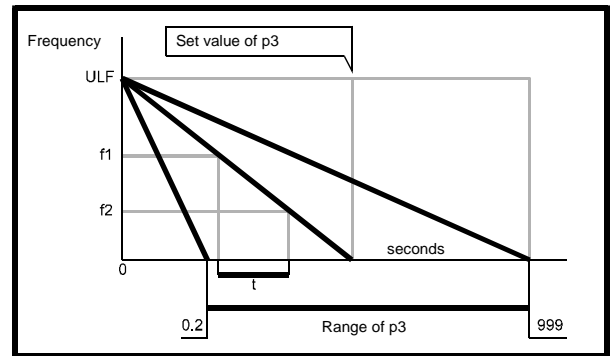
Set at the time required for the Drive to decelerate the motor from ULF to 0Hz. Deceleration is also referred to as **ramp**. Refer to Figure 10–2.

$$t_{dec} = p3 \frac{(f_1 - f_2)}{ULF}$$

(ULF = Upper limit frequency)



**Figure 10–1 Acceleration time p2.**  
The time *t* to acceleration from *f*<sub>1</sub> to *f*<sub>2</sub> depends on the value selected for ULF as well as for p2.



**Figure 10–2 Deceleration time p3.**  
The time *t* to deceleration from *f*<sub>1</sub> to *f*<sub>2</sub> depends on the value selected for ULF as well as for p3.

When any of the following conditions apply, it may be necessary to increase the value of **p3** to prevent excessive voltage occurring on the DC bus during braking and causing the Drive to trip (trip code **OV**).

- When **b27** is set at 1
- If the AC supply voltage is at or near the maximum permissible value for the Drive
- If the DC-bus voltage is raised by the action of an external source (eg. when DC buses are connected in parallel)
- When long motor cables are used

<b>p4</b>	<b>Timed current limit</b>	mnem	TR	R-W
Range	p5 to 150%	%FLC	Def. val.	150
Related parameters	p5			

Set the maximum level of controlled output current. This must be greater than the value of **p5**.

(FLC = Full-load current).

<b>p5</b>	<b>Maximum continuous current</b>	mnem	TH	R-W
Range	10% to 105%	%FLC	Def. val.	100
Related parameters	p4			

Set the level of continuous output current which may be supplied to the motor. The relationship between **p5** and the motor rated current is:

$$p5 = \frac{\text{Motor full load current}}{\text{Drive full load current}} \times 100$$

Since a Drive is usually selected to have a maximum continuous current rating to match that of the motor, to prevent overheating of the motor at full load, the motor Full Load Current (FLC) must not be exceeded.

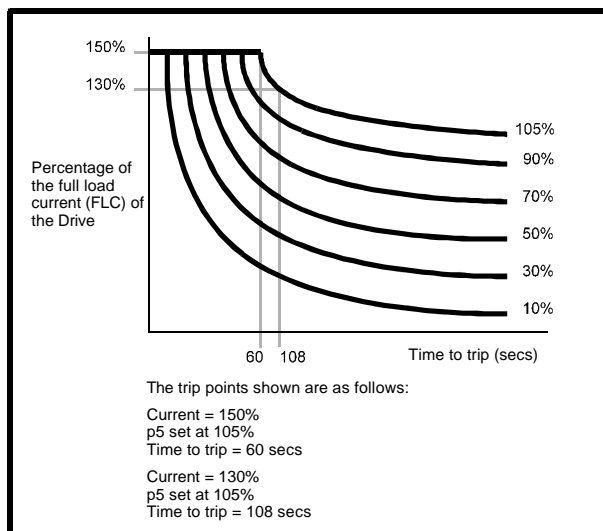
To set **p5** accurately, enter the value of the percentage FLC that is shown on the display (see step 13 in *Operation in terminal mode* in Chapter 6 *Getting Started*) when the actual motor current is at the FLC value. Use a suitable current probe or power analyser to measure the actual current.

Current in excess of the value of **p5** initiates **I x t** protection.

$$\text{The trip time of the Drive} = \frac{k \times p5}{\%I - p5} \text{ seconds.}$$

$$k = 25.7$$

**FLC** = Full-load current



**Figure 10-3** *I x t characteristics*

<b>p6</b>	<b>Torque (Voltage) boost</b>	mnem	BO	R-W
Range	0 to 25.5	%V	Def. val.	5.1 (EUR) 3.0 (USA)
Related parameters	b3			

Parameter **p6** is used to set the relationship between output voltage and frequency. The output voltage is dependent on the following:

- AC supply voltage
- Output frequency
- Maximum-voltage frequency set in **pc**
- Torque boost set in **b3**



**Caution**

**Avoid setting p6 at an excessive value for the motor. Doing so may cause the magnetic circuits in the motor to be saturated. Under these circumstances excessive currents will be drawn which could damage the motor over a period of time if it is not adequately protected (see the description for p5).**

**Setting p6 at an excessive value does not improve the starting torque; the motor may not start at all, even under no load. Furthermore, DC injection braking may not function properly (see the description for p8).**

**p6 set at 0**

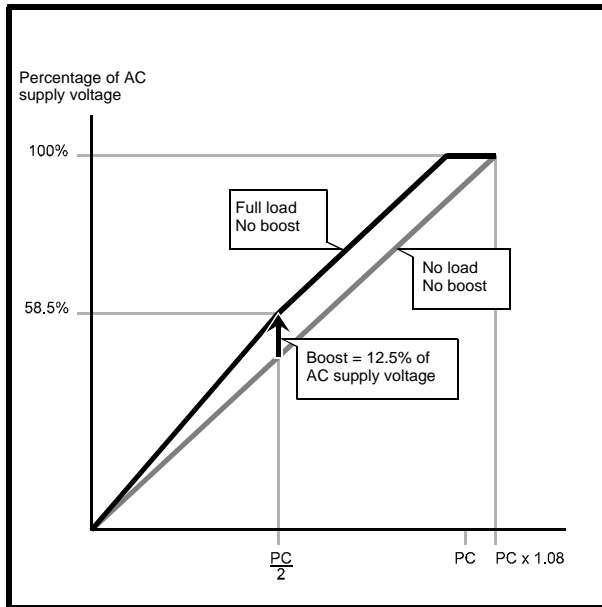
**Load regulation**

At frequencies below [**pc** ÷ 2], voltage boost increases with frequency. At frequencies above [**pc** ÷ 2], voltage boost depends on the value of load current.

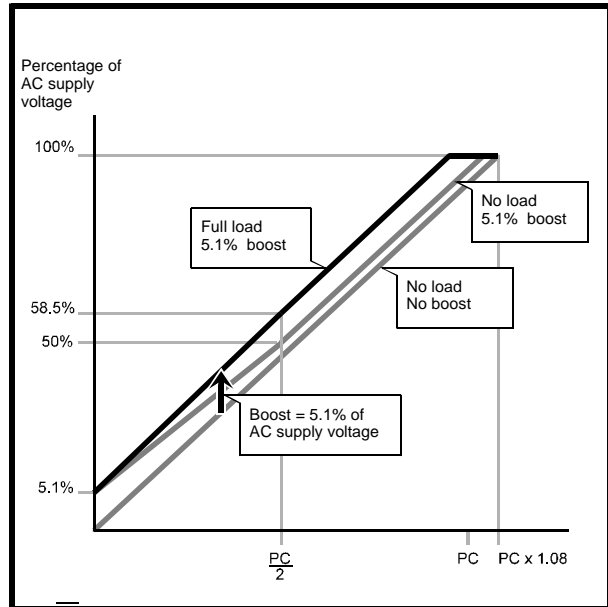
The maximum amount of boost is 12.5% of the AC supply voltage.

**Full load No boost**

The output voltage increases linearly with frequency to [**pc** ÷ 2]. At this frequency, the output voltage equals 58.5% of the AC supply voltage, giving 12.5% boost in relation to the output voltage under no load. Above this frequency, the output voltage rises linearly to 100%, maintaining the 12.5% boost.



**Figure 10-4** The relationship between no-load and full-load boost when no boost is applied (*p6* set at 0)



**Figure 10-5** The relationship between no-load and full-load boost when 5.1% boost is applied (*p6* set at 5.1)

### **p6 set at 5.1%**

#### **No load 5.1% boost**

The output voltage increases with frequency from 5.1% of the AC supply voltage to  $[pc \div 2]$ . At this frequency, the output voltage equals  $[46 + (p6 \div 2)]\%$  of the AC supply voltage, giving  $[p6 \div 2]\%$  boost in relation to the output voltage under no load. Above this frequency, the output rises linearly to 100%, maintaining the  $[p6 \div 2]\%$  boost.

#### **Full load 5.1% boost**

The output voltage increases linearly with frequency from 5.1% of the AC supply voltage to  $[pc \div 2]$ . At this frequency, the output voltage equals 58.8% of the AC supply voltage, giving 12.5% boost. Above this frequency, the output voltage rises linearly to 100%, maintaining 12.5% boost.

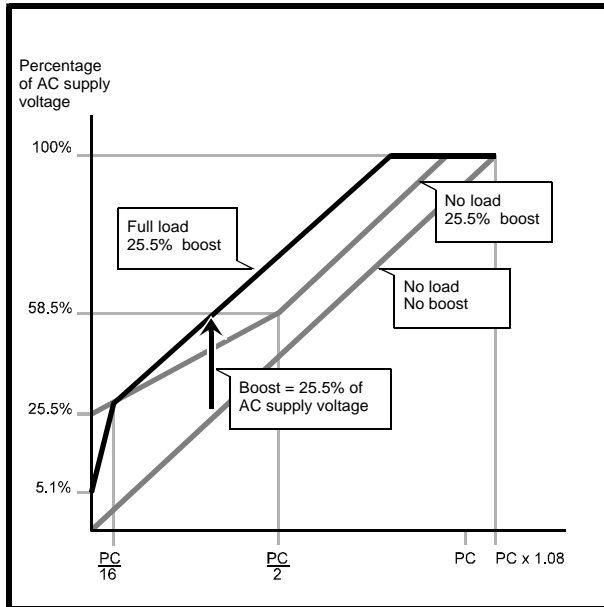
### **p6 set at 25.5%**

#### **No load 25.5% boost**

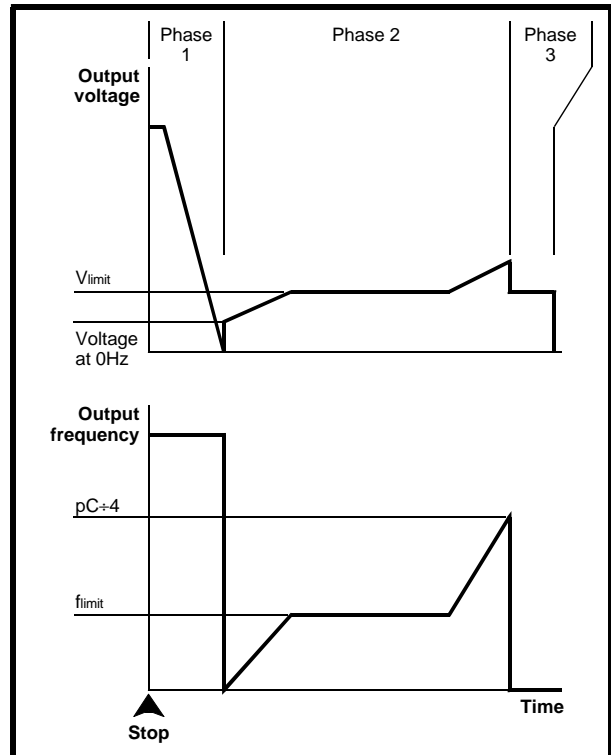
The output voltage increases linearly with frequency from 5.1% of the AC supply voltage to  $[pc \div 16]$ . At this frequency, the output voltage equals 29.5% of the AC supply voltage. Above this frequency, the output voltage rises linearly to  $[pc \div 2]$ . At this frequency, the output voltage equals  $[46 + (p6 \div 2)]\%$  of the AC supply voltage giving  $[p6 \div 2]\%$  boost. Above this frequency, the output voltage rises linearly to 100%, maintaining the  $[p6 \div 2]\%$  boost.

#### **Full load 25.5% boost**

The output voltage increases linearly with frequency from 5.1% of the AC supply voltage to  $[pc \div 16]$ . At this frequency, the output voltage equals 29.5% of the AC supply voltage, giving 25.5% boost. Above this frequency, the output voltage rises to 100%, maintaining the 25.5% boost.



**Figure 10-6** The relationship between no-load and full-load boost when 25.5% boost is applied (p6 set at 25.5)



**Figure 10-7** DC injection braking

<b>p7</b>	<b>Slip compensation</b>	mnem	SL	R-W
Range	0 to 5 when b14 = 120 0 to 10 when b14 = 240 0 to 20 when b14 = 480 0 to 25 when b14 = 960	Hz	Def. val.	0.0
Related parameters	b14, b5			

Use to increase output frequency in relation to load in order to compensate for motor slip.

$$\text{Compensation} = \frac{I_{\text{Load}} \%}{p5} \times p7 (\text{Hz})$$

Where  $I_{\text{load}}$  is the percentage load current as on the DInverter display (see Section 6-1).

<b>p8</b>	<b>DC injection brake current</b>	mnem	BR	R-W
Range	40% to 150%	%FLC	Def. val.	150 (EUR) 120 (USA)
Related parameters	b2, b7			

Use to set the maximum level of injection braking current.

### Phase 1

The motor is de-fluxed by the applied motor voltage being reduced rapidly to zero while the frequency is maintained constant. The frequency is then reduced to 0Hz.

### Phase 2

The frequency is increased from 0Hz (at a rate that is independent of **p2 Acceleration time**). During the course of this frequency increase, the voltage increases to a level  $V_{\text{limit}}$  at which point the load current (as a percentage of FLC) equals the value set in parameter **p8**.

The Drive is then held in current limit for the time required for the motor speed to reduce to just above  $f_{\text{limit}}$ . At this point, the load-current starts to reduce. The frequency then continues to increase to the value of **pC**/4Hz (this is observed as a brief period of acceleration of the motor) before phase 3 commences.



### Phase 3

A DC voltage proportional to  $V_{limit}$  is applied for 1 second to bring the motor to a halt.

#### Note

The voltages in phase 2 follow the standard V/f curves as described in Figures 10–4 to 10–6 (they are independent of the setting of **b54 Voltage-to-frequency ratio selector**). The setting of **p6 Torque (voltage) boost** and **b3 Low-speed torque-boost selector** will affect the voltage at 0Hz, which must not be higher than  $V_{limit}$  otherwise DC injection braking will fail.

If **p6** is set at an excessive value for the motor, the current drawn might exceed the value set in **p8 DC injection brake current** (even when the motor has slowed down to  $f_{limit}$ ) so that the Drive cannot complete phase 2. If this problem occurs, decrease the value of **p6** or increase the value of **p8**.



#### Caution

When DC injection braking is being used, certain configurations of the Drive may cause the Drive not to stop the motor. If this occurs, make the following adjustments:

- Increase the value of parameter **p8**
- Decrease the value of parameter **p6**
- Set parameter **b14** at 11.7(kHz)

<b>p9</b>	Serial address	mnem	SE	R–W
Range	0 to 99		Def. val.	11
Related parameters	b6, b12			

Use to identify the Drive for serial communications.

<b>pA</b>	Fault log	mnem	T0 (pA0) to T9 (pA9)	RO
Range	0 to 9		Def. val.	0 to 9
Related parameters	None			

This parameter contains the trip codes for the last ten trips, from the most recent (PA0) to the ninth previous (PA9).

See Chapter 11 *Diagnostics* for details of how to read the fault log and interrupt the codes.

<b>pb</b>	Security code	mnem	SC	R–W
Range	Keypad: 100 to 255 Serial Comms: 0 to 255		Def. val.	0
Related parameters	None			

This parameter is used to contain the security code number.

See Chapter 8 *Security* for details of setting up and using parameter **pb**.

<b>b0</b>	Speed or Torque reference selector	mnem	DS–14	R–W
Range	0 or 1		Def. val.	1
Related parameters	p0, p1, p4			

Set **b0** at 0 to select Torque reference. The speed is set using **p1**. The direction is determined by the Forward/Reverse key.

Set **b0** at 1 to select Speed reference. Speed and Torque references are both active. The Torque reference is subject to the limit set in **p4**

<b>b1</b>	Keypad Auto or Manual Start selector	mnem	DS–13	R–W
Range	0 or 1		Def. val.	1
Related parameters	None			

### Keypad mode

The setting of **b1** defines the behaviour of the Drive when AC power is applied.

#### **b1 set at 0 (Keypad Auto Start)**

The Drive starts the motor as soon as AC power is applied to the Drive.

#### **b1 set at 1 (Keypad Manual Start)**

When AC power is applied to the Drive, the display shows **rdY** alternating with the set speed.



To start the Drive, press

## Drive tripped

If the Drive is in a trip condition when AC power is applied, press the following keys in the order given to start the Drive:



## Terminal mode

The setting of **b1** defines the behaviour of the Drive under the following conditions:

After a momentary loss of AC power when the motor is running (ie. the display does not go blank)

**UU** trip shown on the display

### b1 set at 0

When AC power is restored, the Drive automatically re-starts the motor. The display returns to showing the set speed.

### b1 set at 1

When AC power is restored, the Drive remains tripped. The display continues to show **UU**.

<b>b2</b>	<b>Stopping mode selector</b>	mnem	DS-12	R-W
Range	0 or 1	Def. val.	0	
Related parameters	b7, b27			

Make settings for the required stopping mode, as follows:

Parameter	Settings			
b27	0	0	0	0
b2	0	0	1	1
b7	0	1	0	1
When <b>Enable</b> signal is removed (terminal C9)	Standard ramp	Coast	DC injection	High-level ramp
When <b>RUN</b> signal is removed (terminal C10 or C12)	Standard ramp	Standard ramp	Standard ramp	High-level ramp
When <b>SPEED</b> reference is reduced (terminal C2 or C5)	Standard ramp	Standard ramp	Standard ramp	High-level ramp
Display	<b>Speed</b> or <b>% FLC</b>	<b>Inh</b>	<b>dC</b>	<b>Speed</b> or <b>% FLC</b>

When **b27** is set at 1, see parameter **b27** for the stopping conditions.

## Standard ramp

If regenerated energy causes the DC-bus voltage to reach its upper threshold level, deceleration ceases. When the DC-bus voltage then falls to below its lower threshold level, deceleration continues. This can result in speed being reduced in steps and the overall deceleration time extended.

If the regenerated energy is excessive, the Drive will trip (trip code: **OV**).

## High-level ramp

Deceleration is continuous. If the DC-bus voltage reaches its maximum limit, the Drive will trip (trip code **OV**).

Use this mode when a braking resistor is connected to the Drive (see *External braking resistor* in Chapter 4 *Installing the Drive*).

## Coast

Following a **STOP** command, the output stage of the Drive is immediately disabled, allowing the motor to coast.

1 second after the **STOP** command, the display shows **rdY** and the Drive can be re-started.

## DC injection

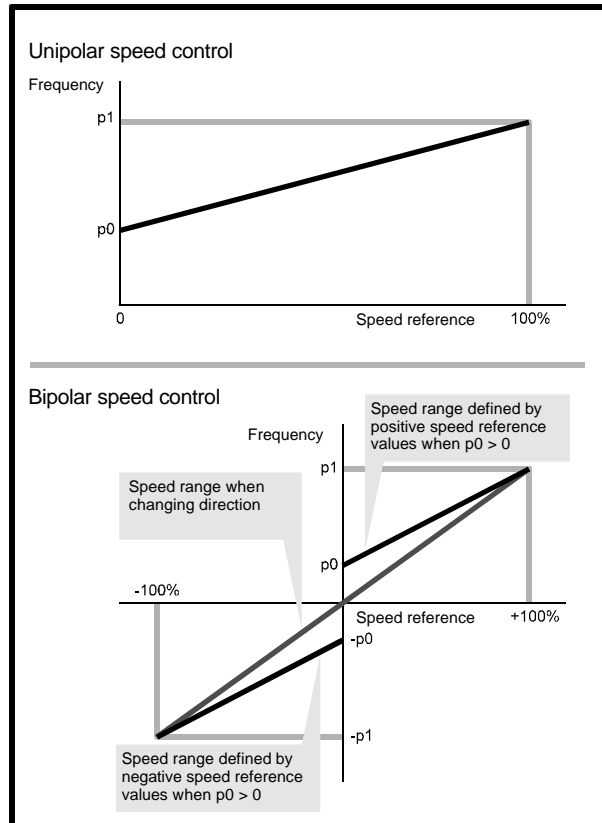
See parameter **p8**.

<b>b3</b>	<b>Low-speed torque boost selector</b>	mnem	DS-11	R-W
Range	0 or 1	Def. val.	0	
Related parameters	p6			

Set **b3** at 0 to select auto boost. This is dependent on the load. The maximum voltage boost is set in **p6**.

Set **b3** at 1 to select fixed boost. This is independent of the load. The value is set in **p6**.

<b>b4</b>	<b>Bipolar select</b>	mnem	DS-10	R-W
Range	0 or 1		Def. val.	1
Related parameters	p0, p1			



**Figure 10-8** Speed ranges in unipolar and bipolar modes

### b4 set at 0

Bipolar mode selected. An analog signal applied to terminal C2 is scaled so that +10V corresponds to the positive value set in p1. -10V corresponds to the negative value.

### b4 set at 1

Unipolar mode selected. An analog signal applied to terminal C2 is scaled so that +10V corresponds to the value set in p1. 0V corresponds to the value set in p0.

Negative input signals are treated the same as 0V.

<b>b5</b>	<b>Logic selector</b>	mnem	DS-9	R-W
Range	0 or 1		*	
Related parameters	None			

\* **b5** does not have a default setting, and is not affected when **b13** *Parameter reset* is set at 1.

Set **b5** at 0 to select positive logic (0 = 0V, 1 = 24V). Set **b5** at 1 to select negative logic (0 = 24V, 1 = 0V).

Since the setting of **b5** takes effect only when AC power is applied to the Drive, after changing the setting of **b5**, remove and re-connect AC power.



**Warning**

**Connecting a Drive configured in negative logic to a positive-logic PLC could cause the Drive to start the motor automatically when power is connected to the Drive.**

<b>b6</b>	<b>Speed reference selector</b>	mnem	DS-8	R-W
Range	0 or 1		Def. val.	0
Related parameters	b9, b11			

Set **b6** and apply a signal to terminal C11 to select the source of the speed reference, as follows:

### b6 set at 0 Terminal C11 not connected

Speed is controlled by an analog voltage applied to terminal C2.

Parameters may be read using serial communications.

### b6 set at 0 Terminal C11 connected to 0V

Speed is controlled by an analog current applied to terminal C5.

Parameters may be read using serial communications.

### b6 set at 1 C11 not connected

Speed is controlled by an analog voltage applied to terminal C2.

Parameters may be read using serial communications.

### b6 set at 1 C11 connected to 0V

Speed is controlled using serial communications. Read-write parameters may be changed using serial communications.

<b>b7</b>	<b>Stopping mode selector</b>	mnem	DS-7	R-W
Range	0 or 1	Def. val.	0	
Related parameters	b2, b27			

See parameter **b2**.

<b>b8</b>	<b>Display mode selector</b>	mnem	DS-6	R-W
Range	0 or 1	Def. val.	0	
Related parameters	None			

Set **b8** at 0 for the frequency to be displayed.

Set **b8** at 1 for the % FLC to be displayed.

When **b9** is set to 0 for operation in Keypad mode, **b8** has no effect; only the frequency can then be displayed.

<b>b9</b>	<b>Terminal or Keypad mode selector</b>	mnem	DS-5	R-W
Range	0 or 1	Def. val.	1	
Related parameters	b51			

Set **b9** at 0 to select Keypad mode.

Set **b9** at 1 to select Terminal mode.

<b>b10</b>	<b>Display time-out mode</b>	mnem	DS-4	R-W
Range	0 or 1	Def. val.	0	
Related parameters	None			

Set **b10** at 0 for the display to return from Edit mode to Status mode after eight seconds of no key presses.

Set **b10** at 1 for the display to return from Edit mode to Status mode by pressing the Mode key for 1 second.

<b>b11</b>	<b>Remote reference input selector</b>	mnem	DS-2,3	R-W
Range	4.20, 20.4 or 0.20	Def. val.	4.20	
Related parameters	b26, b28			

Select the range of the current signal applied to terminal C5, as follows:

**b11** set at **4.20**

4mA Minimum frequency  
20mA Maximum frequency

**b11** set at **20.4**

20mA Minimum frequency  
4mA Maximum frequency

**b11** set at **0.20**

0mA Minimum frequency  
20mA Maximum frequency

The direction of rotation is controlled by signals applied to terminals C10 and C12.

<b>b12</b>	<b>Baud rate selector</b>	mnem	DS-0	R-W
Range	4.8 or 9.6	Def. val.	4.8	
Related parameters	p9, b6			

Select the required baud rate as follows:

4.8 = 4800 baud  
9.6 = 9600 baud

<b>b13</b>	<b>Parameter reset</b>	mnem		R-W
Range	0 or 1	Def. val.	0	
Related parameters	All R-W parameters			



**Warning**

**Before resetting all R-W parameters to their default values, check that the safety of the system will not be impaired.**

Set **b13** at 1 to reset all parameters to the corresponding default setting, except for **b5** Logic selector and those in Menu 60. When the Drive parameters are reset, **b13** returns to 0.

<b>b14</b>	<b>Switching frequency and frequency range selector</b>	mnem	FQ	R-W
Range	2.9, 5.9, 8.8, 11.7 120, 240, 480, 960	kHz Hz	Def. val.	2.9, 120
Related parameters	p0, p1, p7, pc, p10 to p12, p20 to p26			

Two entries are required for this parameter. The first entry defines the PWM switching frequency. When the Mode key is pressed, the second entry is displayed. This defines the Upper Limit Frequency (ULF).

Note that higher ULFs can be selected only when a higher PWM switching frequency is used.

PWM frequency (kHz)	Permissible settings for ULF (Hz)			
2.9	120	240		
5.9	120	240		
8.8	120	240	480	
11.7	120	240	480	960

### PWM switching frequency

Setting a higher PWM frequency has the following effects:

- More heat produced in the Drive
- Less torque produced at very low speed
- Higher ULF can be set
- Less acoustic noise produced by the motor

#### Note

**The electrical noise emissions increase with higher PWM switching frequencies. See *Electromagnetic compatibility in Chapter 2 Data*.**

### Upper Limit Frequency (ULF)

When using a standard 50Hz or 60Hz motor, the ULF should be set at 120Hz. If a special high-speed motor is used, the ULF may be set at a higher value.

The behaviour of other control functions is dependent on the ULF value, as follows:

- Minimum frequency set in **p0**
- Maximum frequency set in **p1**
- Acceleration time set in **p2**
- Deceleration time set in **p3**
- Maximum voltage frequency set in **pC**



**Warning**

**After changing the value of b14, ensure p0, p1, p2, p3 and pC are set correctly before starting the Drive.**

<b>pc</b>	<b>Maximum voltage frequency</b>	mnem	BS	R-W
Range	[ULF ÷ 16] to ULF	Hz	Def. val.	50 (EUR) 60 (USA)
Related parameters	b14, b54			

Set the lowest frequency at which the Drive is able to deliver the rated output voltage.

(ULF = Upper Limit Frequency)

<b>pd</b>	<b>Menu selector</b>	mnem		R-W
Range	0, 10, 20, 30, 40, 50, 60	Def. val.		<b>0</b>
Related parameters	None			

Enter the required menu number to display parameters in another menu,. The menus are as follows:

Value	Menu
<b>0</b>	<b>Standard parameters</b>
10	Skip frequencies and bands
20	Preset speeds
30	Preset accelerations and jog
40	Preset decelerations and jog
50	Auto reset
60	Drive information

Parameter **pd** appears at the end of each menu.



## 10.2 Menu 10 — Skip frequencies

<b>p10</b> <b>p11</b> <b>p12</b>	<b>Skip frequency 1</b> <b>Skip frequency 2</b> <b>Skip frequency 3</b>	mnem	S1 S2 S3	R–W
Range	Between the values of p0 and p1	Hz	Def. val.	0
Related parameters	p0, p1, p13 to p15			

If the mechanical system resonates at one or more frequencies, setting Skip frequencies prevents the Drive operating at these frequencies. During acceleration and deceleration, the Drive ignores the Skip frequencies.

### Note

**If the values of p0 and p1 are changed, it may be necessary to change the Skip frequencies in order to keep them within the permissible frequency range.**

When **p10**, **p11** and **p12** are set at **p0** or **p1**, the Skip frequency is disabled.

<b>p13</b> <b>p14</b> <b>p15</b>	<b>Skip band 1</b> <b>Skip band 2</b> <b>Skip band 3</b>	mnem	B1 B2 B3	R–W
Range	$\pm 0.5$ to $\pm 5.0$	Hz	Def. val.	$\pm 0.5$
Related parameters	p0, p1, p10 to p12			

Select the width of a band either side of the related Skip frequency through which the output frequency is required to pass but not stabilize.

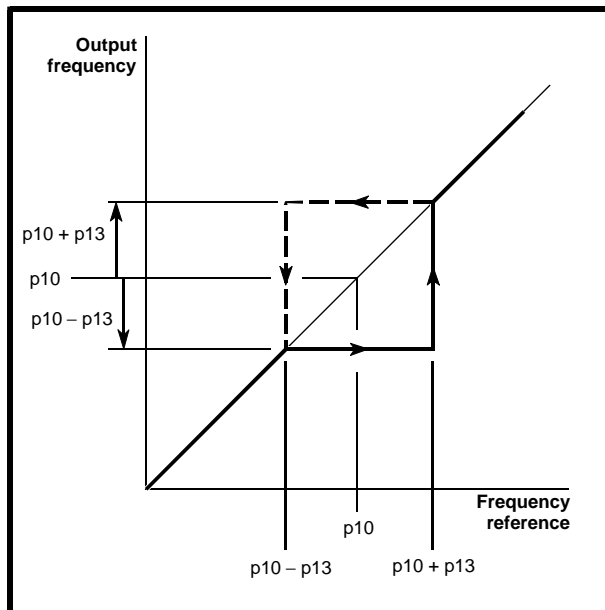


Figure 10–9 Action of Skip frequencies

## 10.3 Menu 20 — Preset speeds

<b>p20 ~ p26</b>	<b>Preset speeds</b>	R–W
Range	p0 to $\pm p1$	Hz Def. val. 0

Enter the required preset speeds.

Parameter	Preset speed	mnemonic	Related parameters
p20	1	P1	p30, p40 b20, b21, b22, b23
p21	2	P2	p31, p41 b20, b21, b22, b23
p22	3	P3	p32, p42 b20, b21, b22, b23
p23	4	P4	p33, p43 b20, b21, b22, b23
p24	5	P5	p34, p44 b20, b21, b22, b23
p25	6	P6	p35, p45 b20, b21, b22, b23, b28
p26	7	P7	p36, p46 b20, b21, b22, b23, b28

### Note

**If the values of p0 or p1 are changed, it may be necessary to change the values of p20 to p26 to maintain them within the permissible range.**

When **b28** is set at 1 to select PI control, the functions of parameters **p25** and **p26** are changed as follows:

- p25** Proportional gain
- p26** Integral gain

<b>p27</b>	<b>Jog Speed</b>	mnem	PJ	R–W
Range	$\pm 15$	Hz	Def. val.	+1.5 (EUR) +5.0 (USA)
Related parameters	p37, p47, b20, b21, b22, b23			

When adjusting the jog speed, press the Forward/Reverse key to set the direction of rotation of the motor during jog.

<b>b20</b>	<b>Preset speed selector</b>	mnem	C1–8	R–W
Range	0 or 1	Def. val.	0	
Related parameters	p20 to p27			

Set **b20** at 0 to select three preset speeds and jog. Terminals B8 and B9 are used to select the three preset speeds. Terminal B10 is used for jog control.

## 10-10 List of Parameters

The jog function operates only when the display shows **rdY**.

**Note**

**The jog acceleration and deceleration times are always controlled by parameters p37 and p47.**

Set **b20** at 1 to select seven preset speeds. Terminals B8, B9 and B10 are used to control these preset speeds. Jog is not available in this mode.

<b>b21</b> <b>b23</b>	<b>Preset ramp selectors</b>	mnem	C1-9 C1-6	R-W
Range	0 or 1	Def. val.	b21 = 0 b23 = 0	
Related parameters	p2, p3, p20 to p27, p30 to p37, p40 to p47			

A combination of settings for parameters **b21** and **b23** selects acceleration and deceleration times. The settings can also be used to configure terminals B8, B9 and B10 as ramp select inputs.

**b21 set at 0**  
**b23 set at 0**

The preset speeds use the acceleration and deceleration times set in **p2** and **p3**.

**b21 set at 1**  
**b23 set at 0 or 1**

The preset speeds use their own acceleration and deceleration times, as follows:

- Preset speed 1 (**p20**) uses Preset acceleration 1 (**p30**) and Preset deceleration 1 (**p40**)
- Preset speed 2 (**p21**) uses Preset acceleration 2 (**p31**) and Preset deceleration 2 (**p41**)

**b21 set at 0**  
**b23 set at 1**

Terminals B8, B9 and B10 can be configured as digital inputs for selecting pre-programmed acceleration and deceleration times. The output frequency is determined by the reference frequency since the preset speeds set in **p20** to **p26** are ignored. Refer to the following tables:

**b20** set at 0 (3 preset speeds and jog)

Terminals		Acceleration set in...	Deceleration set in...
B9	B8		
O/C	O/C	p2	p3
O/C	0V	p30	p40
0V	O/C	p31	p41
0V	0V	p32	p42

**Note**

**The jog control input on terminal B10 operates normally.**

**b20** set at 1 (7 preset speeds)

Terminals			Acceleration set in...	Deceleration set in...
B10	B9	B8		
O/C	O/C	O/C	p2	p3
O/C	O/C	0V	p30	p40
O/C	0V	O/C	p31	p41
O/C	0V	0V	p32	p42
0V	O/C	O/C	p33	p43
0V	O/C	0V	p34	p44
0V	0V	O/C	p35	p45
0V	0V	0V	p36	p46

**b21 set at 1**  
**b23 set at 1**

The preset speeds use their own acceleration and deceleration times, as follows:

- Preset speed 2 (**p21**) uses Preset acceleration 2 (**p31**) and Preset deceleration 2 (**p41**)
- Preset speed 3 (**p22**) uses Preset acceleration 3 (**p32**) and Preset deceleration 3 (**p42**)
- Preset speed 4 (**p23**) uses Preset acceleration 4 (**p33**) and Preset deceleration 4 (**p43**)
- Preset speed 5 (**p24**) uses Preset acceleration 5 (**p34**) and Preset deceleration 5 (**p44**)
- Preset speed 6 (**p25**) uses Preset acceleration 6 (**p35**) and Preset deceleration 6 (**p45**)
- Preset speed 7 (**p26**) uses Preset acceleration 7 (**p36**) and Preset deceleration 7 (**p46**)

<b>b22</b>	<b>Preset speed reversal selector</b>	mnem	C1-7	R-W
Range	0 or 1	Def. val.	0	
Related parameters	p20 to p26			

Set **b22** at 0 to enable the direction of rotation to be controlled by terminals C10 and C12 when the motor is running.

Set **b22** at 1 to enable the direction of rotation to be controlled by the polarity of preset speeds **p20** to **p26**. To reverse the rotation when adjusting a preset speed, press:



<b>b24</b>	<b>Analog output selector</b>	mnem	C1-5	R-W
<b>b25</b>			C1-4	
Range	0 or 1	Def. val.	b24 = 0 b25 = 0	
Related parameters	p1, p5			

### **b24 set at 0** **b25 set at 0**

An analog voltage signal proportional to the Drive frequency is produced on terminal B1.

Voltage range: 0 to  $\pm 10V$   
 Maximum current: 5mA  
 Accuracy:  $\pm 5\%$  of full-scale  
 0V at 0Hz  
 +10V at **+p1**, -10V at **-p1**

An analog current signal proportional to the load on the motor is produced on terminal B2.

Current range: 4 to 20mA  
 Accuracy:  $\pm 10\%$  above 15Hz with matched motor  
 4mA at 0% FLC  
 20mA at 150% FLC (motoring and regenerating)

### **b24 set at 0** **b25 set at 1**

An analog voltage signal proportional to the load on the motor is produced on terminal B1.

Voltage range: 0V to  $\pm 10V$   
 Maximum current: 5mA  
 Accuracy:  $\pm 10\%$  above 15Hz with matched motor  
 0V at 0% FLC  
 +10V at 150% FLC motoring  
 -10V at 150% FLC regenerating

An analog current signal proportional to the Drive frequency is produced on terminal B2.

Current range: 4 to 20mA  
 Accuracy:  $\pm 5\%$  of full-scale  
 4mA at 0Hz  
 20mA at  **$\pm p1$**

### **b24 set at 1** **b25 set at 0**

A digital signal of +10V is produced on terminal B1 when the output current of the Drive equals the percentage of full load current (FLC) entered in **p5**. An analog current output signal proportional to the load on the motor is produced on terminal B2.

Current range: 4 to 20mA  
 Accuracy:  $\pm 10\%$  above 15Hz with matched motor  
 4mA at 0% FLC  
 20mA at 150% FLC (motoring or regenerating)

### **b24 set at 1** **b25 set at 1**

A digital signal of +10V is produced on terminal B1 when the output current of the Drive equals the percentage of full load current (FLC) entered in **p5**.

An analog current output signal proportional to the Drive frequency is produced on terminal B2.

Current range: 4 to 20mA  
 Accuracy:  $\pm 5\%$  of full-scale  
 4mA at 0Hz  
 20mA at  **$\pm p1$**

<b>b26</b>	<b>Current-loop loss selector</b>	mnem	C1-3	R-W
Range			Def. val.	
Range	0 or 1	Def. val.	0	
Related parameters	None			

Set **b26** at 0 for the Drive to trip on loss of current loop. The Drive trips when the current applied to terminal C5 falls below 3mA.

Set **b26** at 1 for the Drive not to trip on loss of current loop.



<b>b27</b>	<b>Normal-running ramp selector</b>	mnem	C1-2	R-W
Range	0 or 1		Def. val.	0
Related parameters	b2, b7			

Set **b27** at 1 for high-level ramp deceleration instead of standard-ramp deceleration when **b2** and **b7** are set as follows:

Parameter	Settings			
	1	1	1	1
b27	1	1	1	1
b2	0	0	1	1
b7	0	1	0	1
When <b>Enable</b> signal is removed (terminal C9)	High-level ramp	Coast	DC injection	High-level ramp
When <b>RUN</b> signal is removed (terminal C10 or C12)	High-level ramp	High-level ramp	High-level ramp	High-level ramp
When <b>SPEED</b> reference is reduced (terminal C2 or C5)	High-level ramp	High-level ramp	High-level ramp	High-level ramp
Display	<b>Speed</b> or <b>% FLC</b>	<b>Inh</b>	<b>dC</b>	<b>Speed</b> or <b>% FLC</b>

### High AC supply voltages, Parallel DC buses, Spurious increases in DC-bus voltage

It is advisable to set **b27** at 1 when either or both the following conditions apply:

- The AC supply voltage is at or near the maximum permissible value for the Drive
- The DC-bus voltage is raised by the action of an external source (eg. when DC buses are connected in parallel, or when long motor cables cause spurious increases in DC-bus voltage)

Setting **b27** at 1 prevents the standard-ramp function from becoming confused and indefinitely prolonging the deceleration ramp. In this case, the Drive would not stop the motor.

### Adjusting the deceleration time

When **b27** is set at 1, it may be necessary to increase the value of **p3** *Deceleration time* in order to prevent the Drive tripping due to excessive DC-bus voltage (trip code **OV**).

<b>b28</b>	<b>PI control selector</b>	mnem	PI	R-W
Range	0 or 1		Def. val.	0
Related parameters	p25, p26, b11			

The PI loop in the Drive can be used to control the speed of a motor in applications where a constant level (pressure, air-flow, temperature, etc) needs to be maintained. A transducer is used to feed back a signal representing the quantity that is to be controlled. If the feedback signal is lower than the required level, the Drive responds by increasing the motor speed until the required level is attained. If the feedback signal is higher than the required level, the Drive responds by reducing the motor speed towards zero (but never into reverse) until the required level is attained.

To select PI control, set **b28** at 1 and connect terminal C11 to 0V.

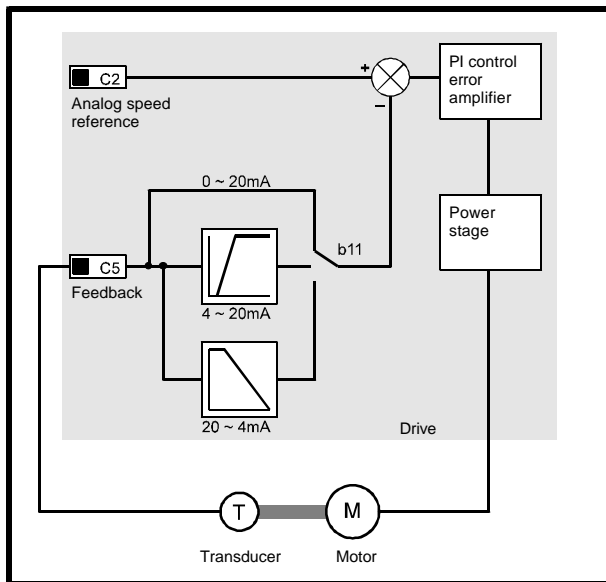
A combination of settings for **b28** and connections to terminal C11 (Local/Remote) selects the source of the frequency reference, as follows:

<b>b28</b>	<b>Terminal C11</b>	<b>Frequency source</b>
0	O/C	Local
0	0V	Remote
1	O/C	Local
1	0V	PI loop

If the transducer fails, this arrangement allows local control of the Drive to be selected without changing the setting of **b28**. This ensures the system can remain in operation.

When **b28** is set at 1 to select PI control, **p25** and **p26** are no longer used as preset speeds. Their functions become as follows:

- p25** Proportional gain
- p26** Integral gain



**Figure 10-10** PI control loop

The required level of the quantity that is being controlled is set by a reference signal applied to terminal C2 (local speed reference input). The feedback from the transducer is applied to terminal C5 (remote speed reference input).

The transducer output must be in one of the following ranges:

- 4 to 20mA
- 20 to 4mA
- 0 to 20mA

Refer to parameter **b11** *Remote reference input selector*.

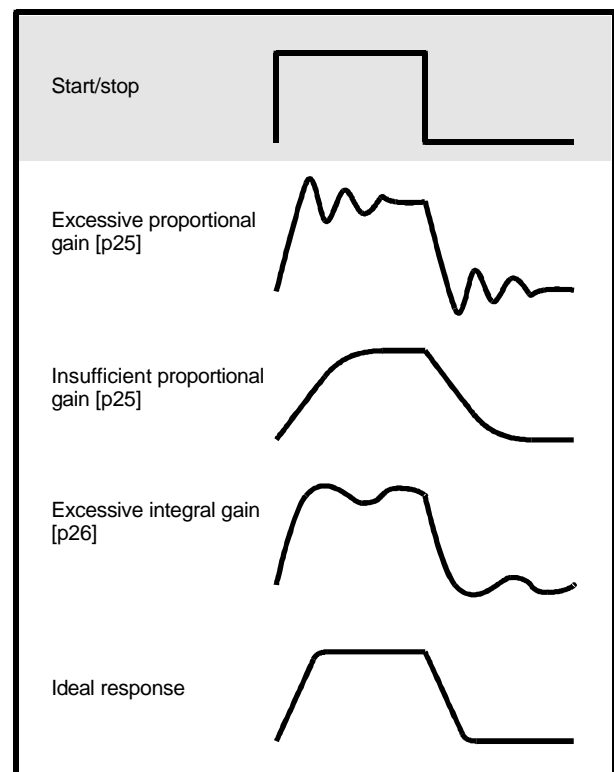
If the transducer output is a voltage signal, the signal must be converted and scaled into an appropriate current signal.

### Setting up PI control

To achieve optimum performance using PI control, use the following procedure:

1. Set **p2** and **p3** as low as is practical without upsetting the load or tripping the Drive. Verify this by starting and stopping the Drive in local control. Setting **p2** or **p3** too high may affect the dynamic performance of the Drive.
2. Connect an oscilloscope probe to terminal C5.

3. Set the local speed reference (terminal C2) to represent a level of the controlled quantity that is significantly higher than that obtained before the AC supply is connected to the Drive.
4. Start the Drive and observe the oscilloscope trace as the Drive tries to increase the controlled quantity to the set level. Increase the value of parameter **p25** *Proportional gain* as necessary.
5. Stop the Drive and repeat steps 3 to 5 using progressively higher values for **p25**. If instability is observed (refer to Figure 10-10), decrease the value of **p25** slightly.
6. Stop the Drive and repeat steps 3 to 6 using the last value of **p25** and but progressively higher values of **p26** *Integral gain*. If instability is observed, decrease the value of **p26** slightly.
7. Set the local speed reference (terminal C2) at the required value.



**Figure 10-11** Effects of adjusting the proportional and integral gains

## 10.4 Menu 30 — Preset acceleration times

### Calculating acceleration and deceleration times

Use the following equations to calculate the time required to accelerate from speed  $f_1$  to Preset speed 1, or to decelerate from speed  $f_1$  to Preset speed 1.

$$t_{acc} = p30 \frac{(p20 - f_1)}{ULF}$$

$$t_{dec} = p40 \frac{(f_1 - p20)}{ULF}$$

Where:

The value of **p20** defines the speed prior to the change.

**t** = Time required for the Drive output frequency to change

**ULF** = Upper Limit Frequency in Hz (value of parameter **b14**)

To calculate acceleration and deceleration for other preset speeds, substitute the appropriate parameter numbers in the equations (eg. for acceleration to Preset speed 2, use parameters **p31** and **p21**. For deceleration, use parameters **p41** and **p21**). See **p30 ~ p36** and **p40 ~ p46** below.

When the speed is returned from a preset speed to the speed reference (by opening the appropriate contact at terminals B8, B9 or B10), the acceleration ramp set in **p2** and the deceleration ramp set in **p3** are applied.

<b>p30 ~ p36</b>	<b>Preset accelerations</b>			R-W
Range	0.2 to 600	sec	Def. val.	5.0

Enter the required preset acceleration times.

Parameter	Preset accel	mnemonic	Related parameters
p30	1	A1	p20, p40 b21, b22, b23
p31	2	A2	p21, p41 b21, b22, b23
p32	3	A3	p22, p42 b21, b22, b23
p33	4	A4	p23, p43 b21, b22, b23
p34	5	A5	p24, p44 b21, b22, b23
p35	6	A6	p25, p45 b21, b22, b23
p36	7	A7	p26, p46 b21, b22, b23

<b>p37</b>	<b>Jog acceleration</b>	mnem	AJ	R-W
Range	0.2 to 600	sec	Def. val.	0.2
Related parameters	p27, p47, b21, b22, b23			

Enter the required jog acceleration time.

## 10.5 Menu 40 — Preset deceleration times

<b>p40 ~ p46</b>	<b>Preset decelerations</b>	R-W
Range	0.2 to 600 sec	Def. val. 10.0
Related parameters		

Enter the required preset deceleration times.

Parameter	Preset decel	mnemonic	Related parameters
p40	1	D1	p20, p30 b21, b22, b23
p41	2	D2	p21, p31 b21, b22, b23
p42	3	D3	p22, p32 b21, b22, b23
p43	4	D4	p23, p33 b21, b22, b23
p44	5	D5	p24, p34 b21, b22, b23
p45	6	D6	p25, p35 b21, b22, b23
p46	7	D7	p26, p36 b21, b22, b23

<b>p47</b>	<b>Jog deceleration</b>	mnem	DJ	R-W
Range	0.2 to 600 sec	Def. val.	0.2	
Related parameters	p27, p37, b21, b22, b23			

Enter the required jog deceleration time.

## 10.6 Menu 50 — Automatic reset

<b>p50</b>	<b>Number of reset attempts</b>	mnem	RN	R-W
Range	0, 1, 2, 3, 4, 5	Def. val.	0	
Related parameters	None			

Set **p50** at the number of automatic resets (attempted or successful) that may be performed before a manual reset is needed.

Set **p50** at 0 to disable automatic reset.

While an automatic reset is being attempted, the number of remaining attempts is shown flashing on the display (this figure decrements by 1 for each attempt).

The attempts counter is restored to the value of **p50** when any of the following occur:

- AC supply is applied to the Drive
- p50** is changed
- A trip is manually reset

### Note

**The automatic reset function does not operate when an external trip (trip code: Et) or phase loss trip (trip code: ph) has occurred.**

<b>p51</b>	<b>Reset delay</b>	mnem	RD	R-W
Range	1.0 to 5.0 secs	Def. val.	1.0	
Related parameters	None			

Set **p51** at a value to delay the start of the automatic reset after the occurrence of a trip.

<b>b50</b>	<b>Status relay selector</b>	mnem	C1-10	R-W
Range	0 or 1	Def. val.	0	
Related parameters	None			

Set **b50** at 0 for the status relay contacts to be closed for **Drive normal**.

Set **b50** at 1 for the status relay contacts to be closed for **At speed**.

The relay contacts open when AC power is removed or when the Drive trips.

<b>b51</b>	<b>FORWARD/REVERSE key selector</b>	mnem	C1-11	R-W
Range	0 or 1		Def. val.	0
Related parameters	None			

When **b9** is set at 0, set **b51** at 0 to disable the FORWARD/REVERSE key.

Set **b51** at 1 to enable the FORWARD/REVERSE key.

<b>b52</b>	<b>Synchronize to a spinning motor selector</b>	mnem	C1-12	R-W
Range	0 or 1		Def. val.	0
Related parameters	None			

Set **b52** at 1 to enable the Drive to be synchronized with a motor whose shaft is spinning, without causing the Drive to trip.

When the Drive receives a RUN command, the Drive scans the motor frequency from the value of **p1** to 0Hz in the last direction of motor rotation, and from the value of **p1** to 0Hz in the opposite direction. The Drive frequency will then be synchronized with the motor speed.

When the Drive speed is synchronized with the motor speed, the Drive accelerates or decelerates the motor to the speed set by the frequency reference input.

During the scanning period, the display shows **Scn**.

<b>b53</b>	<b>Status output selector</b>	mnem	C1-13	R-W
Range	0 or 1		Def. val.	0
Related parameters	None			

**b53** is used to select the mode of operation of the DRIVE STATUS output (terminal A3), as follows:

### Negative logic (b5 set at 1)

#### b53 set at 0

When the Drive is running, the DRIVE STATUS output transistor is on. When the Drive is not running, the transistor is off.

#### b53 set at 1

When the Drive is above **Minimum speed**, the DRIVE STATUS output transistor is on. When the Drive is at or below **Minimum speed**, the transistor is off.

### Positive logic (b5 set at 0)

#### b53 set at 0

When the Drive is running, the DRIVE STATUS output transistor is off. When the Drive is not running, the transistor is on.

#### b53 set at 1

When the Drive is above **Minimum speed**, the DRIVE STATUS output transistor is off. When the Drive is at or below **Minimum speed**, the transistor is on.

<b>b54</b>	<b>Voltage-to-frequency ratio selector</b>	mnem	C1-14	R-W
Range	0 or 1		Def. val.	0
Related parameters	pc, p6, b3			

Set **b54** at 1 to select dynamic voltage-to-frequency ratio. The output voltage is then dependent on load current.

At zero load, the applied voltage is 50% of the normal full voltage. As the load increases, the applied voltage increases in proportion to the load. Maximum voltage is applied at, and above, 70% of full load.

<b>b55</b>	<b>Stop/reset key selector</b>	mnem	C1-1	R-W
Range	0 or 1		Def. val.	0
Related parameters	b9			

### Operation in Terminal mode

#### b55 set at 0



Stop/reset has no function.

#### b55 set at 1



Stop/reset can be used to manually reset the Drive when it has tripped.



### Warning

**Pressing the red Stop/Reset key may cause the Drive to start if signals are still applied to any of the following terminals:**

**C9 ENABLE**

**C10 RUN FORWARD**

**C12 RUN REVERSE**

**The Drive may start also if Serial Communications control is in use requesting the Drive to run.**

**If the Drive is to be left running unattended, it is advisable to ensure b55 is set at 0.**

0Hz, the output stage is disabled and the trip code flashes.

If the Drive is reset during deceleration it will decelerate to 0Hz, then accelerate to the set frequency.

### Keypad mode

When the Drive is in Keypad mode, the display indicates the trip condition during deceleration by alternating between the set frequency value and the trip code.

If the Drive is reset during deceleration, it will not accelerate the motor to the set speed. The Drive will continue to decelerate to 0Hz and display **rdY** alternating with the value of the set frequency.

## Keypad mode

### b55 set at 0 or 1



*Stop/reset* can be used to reset trips. The Drive displays **rdY** and will not start until either of the following occurs:



*Run* is pressed.

Parameter **b1** *Keypad Auto or Manual start selector* is set at 0 for Auto-start and the AC supply is next connected to the Drive.

<b>b56</b>	<b>Deceleration selector for non-important trips</b>	mnem	C1-0	R-W
Range	0 or 1		Def. val.	0
Related parameters	None			

When **b56** is set at 1, a non-important trip will cause the Drive to decelerate to a halt using the Standard ramp for deceleration (see parameter **b27**).

The non-important trips are as follows:

- Oh** Heatsink temperature
- th** Motor temperature
- Et** External trip
- cL** Loss of reference signal current loop

### Terminal mode

When the Drive is in Terminal mode, the display shows a constant (not flashing) trip code during deceleration. When the Drive frequency reaches

## 10.7 Menu 60 — Read-only parameters

<b>p60</b>	<b>Power rating of the Drive</b>	mnem	DR	RO
Range		kW	Def. val.	
Related parameters	None			

**p60** shows the power rating of the Drive as follows:

Model	Number of phases	AC supply voltage	Motor rating		Value displayed
		V	kW	HP	
DIN1220075B	1	200 ~ 240	0.75	1.0	751
DIN1220150B	1	200 ~ 240	1.5	2.0	151
DIN1220220B	1	200 ~ 240	2.2	3.0	221
DIN3220075B	3	200 ~ 240	0.75	1.0	752
DIN3220150B	3	200 ~ 240	1.5	2.0	152
DIN3220220B	3	200 ~ 240	2.2	3.0	222
DIN3380075B	3	380 ~ 480	0.75	1.0	753
DIN3380110B	3	380 ~ 480	1.1	1.5	113
DIN3380150B	3	380 ~ 480	1.5	2.0	153
DIN3380220B	3	380 ~ 480	2.2	3.0	223
DIN3380300B	3	380 ~ 480	3.0	4.0	303
DIN3380400B	3	380 ~ 480	4.0	5.3	403

<b>p61</b>	<b>Drive software version number</b>	mnem	SV	RO
Range			Def. val.	
Related parameters	None			

**p61** shows the software version of the Drive.

<b>p62</b>	<b>Duration of Drive running time</b>	mnem	RL	RO
<b>p63</b>			RH	
Range	Hrs	Def. val.		
Related parameters	None			

**p62** shows the time the Drive has been running in hours. (eg. if the display shows 56.7 the Drive has been running for 567 hours — ignore the decimal point.)

**p63** shows the time the Drive has been running in units of 1,000 hours. (eg. if the display shows 1.2, the Drive has been powered-up for 12,000 hours — ignore the decimal point.)

In this example, the total time the Drive has been powered-on is 12,567 hours.

### Reading p62 and p63 on a host computer

The complete running-time figure is stored in the Drive as a 20-bit word. To read the running-time on a host computer, read the values of **RH** and **RL** and store them as separate hexadecimal numbers. Then combine the two hexadecimal numbers as in the following example:

RH = 0800

RL = 12AB

The combined hexadecimal number = 812AB.  
(The zeroes in the value of **RH** are ignored.)

Convert the hexadecimal number into a decimal number (the decimal value of 812AB is 529067).

Perform the following on the decimal number in order to obtain the running time in various units:

#### Hours

Divide by 16 (529067 ÷ 16 = 33066.7)

#### Days

Divide by 24 (33066.7 ÷ 24 = 1377.8)

#### Weeks

Divide by 7 (1377.8 ÷ 7 = 196.8)

#### Years

Divide by 52 (196.8 ÷ 52 = 3.78)

<b>p64</b>	<b>DC bus braking level</b>	mnem	BL	R-W
Range				
Related parameters	b2, b7, b27			

The value of **p64** defines the DC bus voltage at which the braking resistor is switched into circuit.

### Single-phase models Three-phase 200V to 240V models

This parameter can be adjusted, but has no effect.

Fixed value: 377V

### Three-phase 380V to 480V models

Enter the required value of DC bus voltage for DC braking to be applied.

Calculate the required voltage from:

$$p64 = (1.1 \times Vac_{(nom)} \times \sqrt{2}) + 50$$

where:

**Vac<sub>(nom)</sub>** is the nominal AC supply voltage (subject to a ±10% tolerance)

Values in excess of the calculated value will cause the following to occur when braking:

- Increased braking torque
- Motor to be excessively fluxed
- Drive can trip on overcurrent (OI)



#### Warning

**Values below the calculated value can cause the braking circuit to be in continuous operation. This can destroy the braking resistor and present a fire hazard if the thermal protection described in *External braking resistor in Chapter 4 Installing the Drive* is not effective.**

<b>p65</b>	<b>(Unused)</b>			

<b>b60 ~ b65</b>	<b>Factory settings</b>			

These parameters cannot be used.



# 11 Diagnostics



## Warning

If an Err 6 trip code occurs, all parameters except for those in Menu 60 will be reset to their default values.

If an EE trip occurs, check that parameter p60 indicates the correct value for the Drive model (see parameter p60 in Chapter 10 *List of Parameters*). Note that all parameters including those in Menu 60 will be reset to their default values.

If an Err trip occurs more than once or an EE trip occurs, contact the supplier of the Drive.



## Warning

A faulty Drive must be returned to the supplier for repair. Internal repairs by the user are not authorized and may be hazardous.

## 11.1 Trip codes

If the Drive trips, the cause of the trip is indicated by a trip code which appears on the display.

The trip codes are as follows:

### UU

Under-voltage

The DC-bus voltage is below the following value:

Models	VDC
Single-phase	160
Three-phase, low voltage	160
Three-phase, high voltage	360

### Note

### AC supply voltages

Even though the values stated in the table indicate that the Drive will continue to operate when the AC supply has fallen below the specified minimum voltage (see Chapter 3 *Data*), do not use a supply that is continuously or intentionally below the specified minimum voltage.

### DC supply voltages

The same applies when the Drive is powered by a DC supply connected to the DC bus (see *Connecting an external supply to the DC bus* in Chapter 4 *Installing the Drive*).

### OU

Over-voltage

The DC bus voltage is above the maximum acceptable value. This could be caused by motor regeneration during braking or the AC supply voltage being too high.

### Ph

Phase loss from AC supply

The ripple voltage on the DC bus has exceeded 70V pk-pk for more than 16 seconds. The amplitude of the ripple voltage is dependent on the model size of Drive and the motor current.

### It

I × t protection

I × t protection occurs when the load current exceeds the value of parameter p5. Under this condition, the decimal points on the display start flashing, and continue to do so for a short period after the load current is reduced below the value of p5. If I × t protection is allowed to continue, the Drive will cease operating, and the display will show It. This indicates that the maximum permissible value of I × t has been reached.

### Oh

Over-heating

The maximum permitted heatsink temperature has been exceeded.

### th

Thermal resistor value

The temperature of the motor is too high or a connection to the motor thermal resistor is broken.

If a motor thermal resistor is not being used, this trip code indicates that pin A6 is not connected to OV.

### Et

External trip

An external trip signal has been received on pin C7.

If the external trip input is not being used, this trip code indicates that pin C7 is open circuit.

### cL

Current loop loss

If the frequency reference signal is a current signal, this trip code indicates the current signal is below 3mA (4 to 20 mA, or 20 to 4mA only).

The trip is disabled when parameter **b26** is set at 1.

### PS

Power supply fault

A fault has been detected in the internal switch-mode power supply.

### OI

Instantaneous over-current trip

Excess current has been detected in the output stage of the Drive. This can also indicate a phase-to-phase or phase-to-ground fault.



### Err

Error

The self-test which is executed when AC power is applied to the Drive has detected that a hardware fault exists.

The **Err** trip code alternates with a number from 1 to 10.

It may be possible to clear the error code by re-initializing the Drive, as follows:

1. Remove AC power from the Drive and wait for the display to go blank.
2. While holding down  and , apply AC power to the Drive. The display flashes between **Err** and **6**.
3. Remove AC power and wait for the display to go blank.
4. Apply AC power to the Drive.  
The Drive is now re-initialized. All parameters are now set at their default settings (except for **b5** *Logic selector* and those in Menu 60).

### EE

NOVRAM error





A saved parameter setting is corrupt.

## 11.2 Fault history

It is possible that more than one type of trip can occur in quick succession. Trips may also have occurred and been reset automatically while the Drive was unattended (see *Menu 5* in Chapter 10 *List of Parameters*).

So that the nature of these trips may be identified, the Drive stores the trip codes of the ten most recent trips in parameter **pA**. This fault history is saved when the AC supply is subsequently disconnected from the Drive and cleared only when defaults are restored (see parameter **b13**).

Use the following procedure to view the fault history:

1. Select parameter **pA**
2. Press 
3. Press  to see the trip code for the last trip.
4. Repeatedly press  to view the preceding trip codes.  
Each trip code is preceded by a number (eg. 0 for the most recent trip, -1 for the previous trip, -2 the trip before that, etc.)
5. Press  again to exit. Note that the **pA** is read-only and cannot be modified by the user.

## 12 Serial Communications

### 12.1 Introduction

Serial communications can be used by a host computer to perform the following:

- Read and edit the values of parameters
- Control the Drive

One host computer may control up to 99 Drives when line buffers are used, or 32 Drives without using line buffers.

The protocol is the following industry standard:

**ANSI x 3.28 – 2.5 – A4**

### Connections



#### Warning

**The RS485 serial communications connections in the Drive are not isolated from the other control circuits and are separated from the live parts by basic insulation; if the serial communications circuit is to be accessible to personnel, an isolation unit must be used. When multiple RS485 networks are to be used, each network will require its own isolation unit.**

#### Note

**It is not recommended that 2-wire serial communications are used. This would require the transmit and receive terminals in the Drive to be connected in parallel. Although the protocol would operate correctly, the maximum loading on the network may be exceeded; communications would then become unreliable.**

If more than one Drive is to be connected to a serial link, make connections as shown in Figure 12–1. If only one Drive is to be connected, make the connections shown for the last Drive.

1. A termination resistor **must** be fitted between terminals B3 and B4 of the last (or only) Drive on the serial link. The value of this resistor should be  $120\Omega$  0.25W.
2. The serial communications cable must be shielded. The shield(s) must be connected as shown in Figure 12–2.
3. Ensure the total cable length does not exceed 1200 metres (4,000 feet).
4. A unique address code must be given to each Drive that is connected to a port of the host computer.

### RS485 Multidrop link

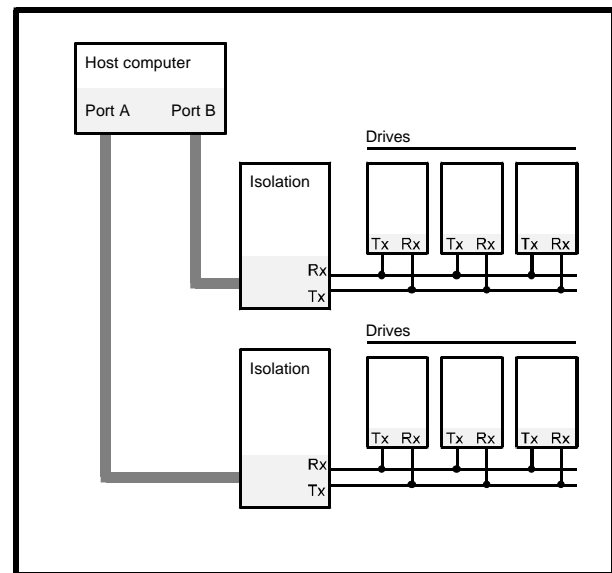
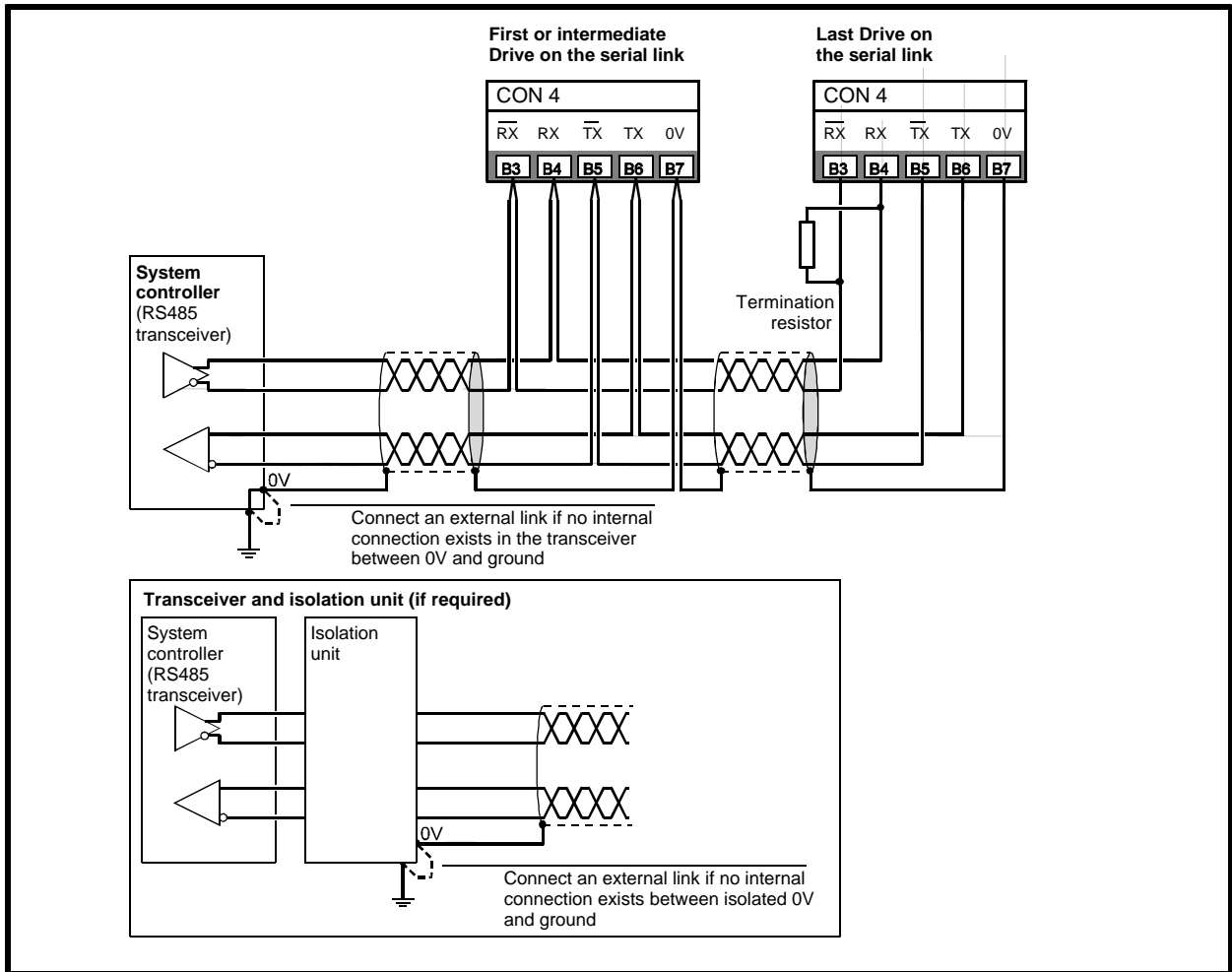


Figure 12–1 Basic RS485 Serial Communications



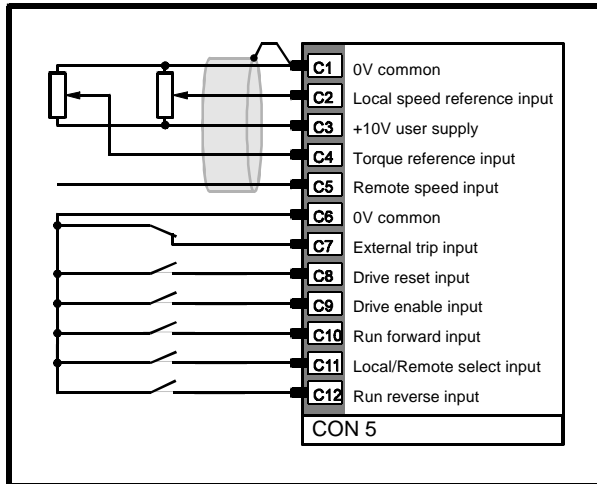
**Figure 12–2 RS485 or RS422 Serial Communications connections with isolation**

## 12.2 List of mnemonics

The following list shows the sequence in which the mnemonics (and their corresponding parameter values) appear in response to repeated <ACK> messages from the host to the Drive.

Mnemonic	Parameter number and name	Type	Notes
SV	p61	Drive software version number	RO
ER		Error code	RO
SP		Set speed	R-W Enter the required value in Hz.
TP		Set torque	R-W Enter % FLC
AC		Actual speed	RO
LD		Actual torque	RO
MN	p0	Minimum frequency	R-W Enter value in Hz
MX	p1	Maximum frequency	R-W Enter value in Hz
AL	p2	Acceleration time	R-W Enter number of seconds from 0Hz to ULF
DL	p3	Deceleration time	R-W Enter number of seconds from ULF to 0Hz
TR	p4	Timed current limit	R-W Enter % FLC > value of p5
TH	p5	Maximum continuous current	R-W Enter % FLC
BO	p6	Torque (Voltage) boost	R-W Select require voltage boost
SL	p7	Slip compensation	R-W Enter number of Hz
BR	p8	DC injection brake current	R-W Enter value for maximum DC injection current as % FLC
SE	p9	Serial address	R-W Enter the required Drive address.
SC	pb	Security code	R-W Enter value: 0 to 255 (100 to 255 using keypad)
SW		Status word	RO
DS-	b0 ~ b12	Drive configuration	R-W b6, b9, b10, b12 cannot be changed
FQ	b14	Switching frequency and frequency range selector	R-W Select from a range of values
BS	pc	Maximum voltage frequency	R-W Enter the minimum required frequency for the motor voltage to be at maximum
CW		Command word	R-W Enter the required code.
S1 ~ S3	p10	Skip frequencies 1, 2, 3	R-W Enter Hz to avoid mechanical resonances
B1 ~ B3	p13 ~ p15	Skip bands 1, 2, 3	R-W Enter required width in Hz
P1 ~ P7	p20 ~ p26	Preset speeds	R-W Enter required speeds in Hz Select preset speeds using terminals or by programming
PJ	p27	Jog Speed	R-W Set b20 at 0 to select three preset speeds and jog
A1 ~ A7	p30 ~ p36	Preset accelerations	R-W Enter number of seconds from 0Hz to ULF Use b21 and b23 to select standard or preset acceleration
AJ	p37	Jog acceleration	R-W Set b20 at 0 to select three preset speeds and jog
D1 ~ D7	p40 ~ p46	Preset decelerations	R-W Use b21 and b23 to select standard or preset acceleration
DJ	p47	Jog deceleration	R-W Set b20 at 0 to select three preset speeds and jog
C1-	b20 ~ b27 b50 ~ b56	Drive configuration	R-W Enter the required code.
PI	b28	PI control selector	R-W When b28 = 1, p25 and p26 control the PI loop
PS		Select preset speed	R-W Select three preset speeds and jog, or seven preset speeds
RN	p50	Number of reset attempts	R-W Enter the number of attempts required.
RD	p51	Reset delay	R-W Enter the value of the required delay.
RC		Reset counter	RO
HR		High resolution speed control	R-W Enter the required number in Hz.
DR	p60	Power rating of the Drive	RO
RL	p63	Duration of Drive running time	RO
RH	p63	Duration of Drive running time	RO Combine the values for total running time
T0 ~ T9	pA ~ p9	Trip logs	RO T0 is most recent trip
BL	p64	DC bus braking level	R-W Enter required DC bus threshold voltage for braking

## 12.3 Additional connections



**Figure 12-3 Basic connections for serial communications control (parameter b6 must be set at 1)**

Make the connections as shown in Figure 12-3.

The Drive runs when Command Word bits 0, 1, 2 and 4 are all set at 1 (ie. the hexadecimal number sent to mnemonic CW must be >17 (see the *List of Mnemonics*).

The Drive stops when Command Word bits 0 and 1 are both set at 0 (ie. the hexadecimal number sent to mnemonic CW must be >14).

Note that the Drive can be tripped by an open-circuit at terminal C9. Restoring the connection does not re-start the Drive. The Drive can be re-started only by using the mnemonic CW.

## 12.4 Switching between local and remote control

If the Drive is running in local control, it is possible to switch to remote control by closing the contact at terminal C11. The motor continues running at the speed immediately before the change-over, and in the same direction.

When the contact at terminal C11 is opened in order to return to local control, full control is resumed at the terminals.



**Warning**

**The Drive will start immediately on return to local mode if the contacts at terminal C9 and at either C10 or C12 are closed**

## 12.5 ANSI communications protocol

### Host-to-Drive message types

#### Sending data

The message always contains 16 bytes.

```
<EOT> a1 a2 a3 a4 <STX> m1 m2 ...
```

```
... d1 d2 d3 d4 d5 d6 <ETX> bcc
```

Example: <EOT> 1144 <STX> SP -047.6 <ETX> &

#### Sending a *high-resolution speed setting*

The message always contains 16 bytes.

```
<EOT> a1 a2 a3 a4 <STX> H R ...
```

```
... d1 d2 d3 d4 d5 d6 d7 d8 <ETX> bcc
```

Example: <EOT> 1144 <STX> HR -047.001 <ETX> 8

#### Requesting data

The message always contains 8 bytes.

```
<EOT> a1 a2 a3 a4 m1 m2 <ENQ>
```

Example: <EOT> 1122 <SP> <ENQ>

#### Repeat request for the same mnemonic

The message always contains 1 byte.

```
<NAK>
```

#### Repeat request for the next mnemonic in the sequence

The message always contains 1 byte.

```
<ACK>
```

## Drive-to-host message types

### Response when the received message is accepted

The message always contains 1 byte.

**<ACK>**

### Response when the received message, the format of the data bytes or the block checksum is invalid

The message always contains 1 byte.

**<NAK>**

### Response to valid requests for data

The message always contains 11 bytes.

**<STX> m1 m2 d1 d2 d3 d4 d5 d6 ...**

**... <ETX> bcc**

Example: <STX> SP +011.2 <ETX>

### Response to valid requests for a high-resolution speed setting

The message always contains 11 bytes.

**<STX> H R d1 d2 d3 d4 ...**

**... d5 d6 d7 d8 <ETX> bcc**

Example: <STX> HR -047.001 <ETX> 8

### Response to messages with unrecognised mnemonics

The message always contains 4 bytes.

**<STX> m1 m2 <EOT>**

The data bytes are as follows:

<b>a1</b>	First digit (group) of address of Drive as an ASCII digit 1 to 9
<b>a2</b>	Same as <b>a1</b>
<b>a3</b>	Second digit (unit) of address of Drive as an ASCII digit 1 to 9
<b>a4</b>	Same as <b>a3</b>
<b>m1</b>	First character of mnemonic (ASCII letter)
<b>m2</b>	Second character of mnemonic (ASCII letter or digit)
<b>d1 ~ d2</b>	Value of data in ASCII decimal or hexadecimal (see below)
<b>bcc</b>	Block checksum as a single ASCII character calculated below

## Calculating the block checksum

Use the following procedure to calculate the bcc.

1. Start with the first byte after the <STX> code.
2. Convert the bytes into binary  
eg. digit 0 = 30 (hex) = 00110000 (binary).
3. Arrange the binary codes vertically, as follows:

S	0	1	0	1	0	0	1	1
P	0	1	0	1	0	0	0	0
-	0	0	1	0	1	1	0	1
0	0	0	1	1	0	0	0	0
4	0	0	1	1	0	1	0	0
7	0	0	1	1	0	1	1	1
.	0	0	1	0	1	1	1	0
6	0	0	1	1	0	1	1	0
<ETX>	0	0	0	0	0	0	1	1

4. Count the occurrences of the number **1** in each column (eg. the second column has two occurrences of the number **1**, the third column has six occurrences).

When the number is even, the bcc is 0 for that column. When the number is odd, the bcc is 1 for that column. (This is not binary addition so do not *carry* to the next column).

For the example shown above, the bcc is 00000110.

5. If the total is less than 20 (hex), add 20 (hex).  
For the example shown above, 06 (hex) is less than 20 (hex), so add 20 (hex) to give 26 (hex). This is sent to the host as the ASCII **&** character.

## 12.6 Data formats

### Decimal

The values of most parameters that represent a quantity are represented in decimal notation having six characters, as follows:

Character	Information
1	Sign (+ or -)
2	Integer
3	
4	
5	Decimal point
6	Decimal value (often zero)

### Example

d1	d2	d3	d4	d5	d6
+	0	9	5	.	0

The *high-resolution speed* setting uses eight characters, as in the following example:

d1	d2	d3	d4	d5	d6	d7	d8
-	0	4	7	.	0	0	1

## 12.7 Accessing the mnemonics

Some mnemonics require to be accessed by a two-digit hexadecimal number; other mnemonics require a four-digit hexadecimal number.

### Two-digit hexadecimal mnemonics

The mnemonics listed in this section must be accessed in the two-digit hexadecimal format shown below:

d1	d2	d3	d4	d5	d6
space	space	space	>	h1	h2

where **h1** and **h2** are hexadecimal digits

When individual bits are stored, they are allocated as follows:

- h1** contains bits 4 to 7
- h2** contains bits 0 to 3

### SE

Serial address accessed as hex  
(eg. address 22 would be read as >16)

### SC

Security code accessed as hex  
(eg. **pb** set at 100 would be read as >64)

### FQ

There are 12 valid codes which may be stored in **FQ** to determine the PWM switching frequency and the ULF, as follows:

FQ	Nominal PWM frequency	ULF
	kHz	Hz
>00	2.9	120
>01	2.9	240
>10	5.9	120
>11	5.9	240
>12	5.9	480
>20	8.8	120
>21	8.8	240
>22	8.8	480
>30	11.7	120
>31	11.7	240
>32	11.7	480
>33	11.7	960

### CW

Except for bits 2 and 3 which are read-only (labelled **RO** in the following table), the six least-significant bits of **h2** can be used to read the state of terminals C7 to C12 and to over-ride these terminals for controlling the Drive in remote control (in this case, parameter **b6** must be set at 1).

Note that these bits have a latching action which is different from the wire-proof action of the terminals they over-ride.

Bit	When set at 0...	When set at 1...
0	No effect	Drive starts (subject to the state of bits 1, 2, 4, 5)
1	Forces the Drive to stop	Allows the Drive to start
2 (RO)	Indicates the Drive is in local control (C11 contact is open)	Indicates the Drive is in remote control (C11 contact is closed)
3 (RO)	Indicates forward direction	Indicates reverse direction
4	Causes an external trip	No effect
5	No effect	Resets the Drive

Bits 6 and 7 are unused and should both be set at 0.



Note that with software version 1.02.07 onward, the contacts at terminals C7 EXTERNAL TRIP and C9 ENABLE must be closed so that the Drive can be run under serial communications control.

Opening the contact at terminal C7 EXTERNAL TRIP will trip the Drive.

Opening the contact at C9 will stop the Drive. Re-closing the contact at C9 will not re-start the Drive until bits 0 and 1 are subsequently set at 1.

## PI

>20 indicates that PI control is disabled

>A0 indicates that PI control is enabled

## PS

The three least-significant bits of **h2** can be used to read the state of terminals B8, B9, B10 and to over-ride these terminals for control of the Drive. In this case parameter **b6** must be set at 1).

Bits 3 to 7 are unused and should be all set at 0.

Bit	When set at 0...	When set at 1...
0	B8 contact open	B8 contact closed
1	B9 contact open	B9 contact closed
2	B10 contact open	B10 contact closed

## RN

This is a decimal number that corresponds with parameter **p50** which is indicated as a hexadecimal number (eg. five attempts would be indicated as >05).

## RC

This is a decimal number that corresponds with the number of remaining attempts that will be displayed at the next attempt. This is indicated as a hexadecimal number (eg. 4 remaining attempts would be indicated as >04).

## Four-digit hexadecimal mnemonics

The mnemonics listed in this section must be accessed in the four-digit hexadecimal format shown below:

d1	d2	d3	d4	d5	d6
space	>	h1	h2	h3	h4

where **h1** to **h4** are hexadecimal digits

When individual bits are stored, they are allocated as follows:

**h1** contains bits 12 to 14

**h2** contains bits 8 to 11

**h3** contains bits 4 to 7

**h4** contains bits 0 to 3

## SW

This is the Status Word which contains 14 read-only bits. They are used to indicate the following:

- Trip status
- Local or remote control selected by terminal C11
- Run and ready states

Bit	When set at 0...	When set at 1...
1		<b>Oh</b> trip
2		<b>th</b> trip
3		<b>It</b> trip
4	<b>OI</b> trip	
5	<b>PS</b> trip	
6	<b>UV</b> trip	
7	<b>OV</b> trip	
8		<b>Ph</b> trip
9		<b>cL</b> trip
10		<b>Err</b> condition
11		Drive tripped
12	<b>RUN</b> flag is reset (0)	<b>RUN</b> flag is set (1)
13	<b>READY</b> flag is reset (0)	<b>READY</b> flag is set (1)
14	Local operation	Remote operation

Bits 0 and 15 are unused and indicate zero.

The following table shows the states of the flags for the basic conditions of the Drive.

Condition	READY flag	RUN flag
Display shows <b>rdY</b>	1	0
Drive running	0	1
Drive is stopping	0	0
Drive tripped	1	1

## T0 ~ T9

These correspond to parameters **pA0** to **pA9** and have the same data format as mnemonic **SW**.



## 13 Parameter Settings Table

Parameter number and name		Default value	Min	Max	Setting 1	Setting 2
p0	Minimum frequency	0.0	0	p1		
p1	Maximum frequency	50 (EUR) 60 (USA)	[p0]	ULF		
p2	Acceleration time	5.0	0.2	999		
p3	Deceleration time	10.0	0.2	999		
p4	Timed current limit	150	[p5]	150		
p5	Maximum continuous current	100	10	105		
p6	Torque (Voltage) boost	5.1 (EUR) 3.0 (USA)	0	25.5		
p7	Slip compensation	0.0	0	25		
p8	DC injection brake current	150 (EUR) 120 (USA)	40	150		
p9	Serial address	11	0	99		
pa	Fault log	0 to 9				
pb	Security code <i>Set by keypad</i> <i>Set by serial comms.</i>	0	100 1	255 255		
b0	Speed or Torque reference selector	1				
b1	Auto or Manual start selector	1				
b2	Stopping mode selector	0				
b3	Low-speed torque boost selector	0				
b4	Bipolar select	1				
b5	Logic selector	1				
b6	Speed reference selector	0				
b7	Stopping mode selector	0				
b8	Display mode selector	0				
b9	Terminal or Keypad mode selector	1				
b10	Display time-out mode	0				
b11	Remote reference input selector	4.20				
b12	Baud rate selector	4.8	4800	9600		
b13	Parameter reset	0				
b14	Switching frequency and frequency range selector	2.9, 120	2.9 120	11.7 960		
pc	Maximum-voltage frequency	50 (EUR) 60 (USA)	ULF ÷ 16	ULF		
pd	Menu selector	0	0	60		
p10	Skip frequency 1	0	[p0]	[p1]		
p11	Skip frequency 2	0	[p0]	[p1]		
p12	Skip frequency 3	0	[p0]	[p1]		
p13	Skip band 1	±0.5	±0.5	±5.0		
p14	Skip band 2	±0.5	±0.5	±5.0		
p15	Skip band 3	±0.5	±0.5	±5.0		

Parameter number and name		Default value	Min	Max	Setting 1	Setting 2
p20	Preset speeds	0	[p0]	±[p1]		
p21	Preset speeds	0	[p0]	±[p1]		
p22	Preset speeds	0	[p0]	±[p1]		
p23	Preset speeds	0	[p0]	±[p1]		
p24	Preset speeds	0	[p0]	±[p1]		
p25	Preset speeds	0	[p0]	±[p1]		
p26	Preset speeds	0	[p0]	±[p1]		
p27	Jog Speed	+1.5 (EUR) +5.0 (USA)	0	±15		
b20	Preset speed selector	0				
b21	Preset ramp selectors	b21 = 0				
b23	Preset ramp selectors	b23 = 0				
b22	Preset speed reversal selector	0				
b24	Analog output selector	b24 = 0				
b25	Analog output selector	b25 = 0				
b26	Current-loop loss selector	0				
b27	Normal-running ramp selector	0				
b28	PI control selector	0				
p30	Preset accelerations	5.0	0.2	600		
p31	Preset accelerations	5.0	0.2	600		
p32	Preset accelerations	5.0	0.2	600		
p33	Preset accelerations	5.0	0.2	600		
p34	Preset accelerations	5.0	0.2	600		
p35	Preset accelerations	5.0	0.2	600		
p36	Preset accelerations	5.0	0.2	600		
p37	Jog acceleration	0.2	0.2	600		
p40	Preset decelerations	10.0	0.2	600		
p41	Preset decelerations	10.0	0.2	600		
p42	Preset decelerations	10.0	0.2	600		
p43	Preset decelerations	10.0	0.2	600		
p44	Preset decelerations	10.0	0.2	600		
p45	Preset decelerations	10.0	0.2	600		
p46	Preset decelerations	10.0	0.2	600		
p47	Jog deceleration	0.2	0.2	600		
p50	Number of reset attempts	0	1	5		
p51	Reset delay	1.0	1.0	5.0		
b50	Status relay selector	0				
b51	FWD/REV key selector	0				
b52	Catch a spinning motor selector	0				
b53	Status output selector	0				
b54	Voltage-to-frequency ratio selector	0				
b55	Stop/Reset key selector	0				
b56	Deceleration selector for non-important trips	0				

Parameter number and name		Default value	Min	Max	Setting 1	Setting 2
p60	Power rating of the Drive					
p61	Drive software version number					
p62	Duration of Drive running time					
p63	Duration of Drive running time					
p64	DC bus braking level	750 (EUR) 770 (USA)	540	840		
b60	Factory settings					
b61	Factory settings					
b62	Factory settings					
b63	Factory settings					
b64	Factory settings					
b65	Factory settings					

