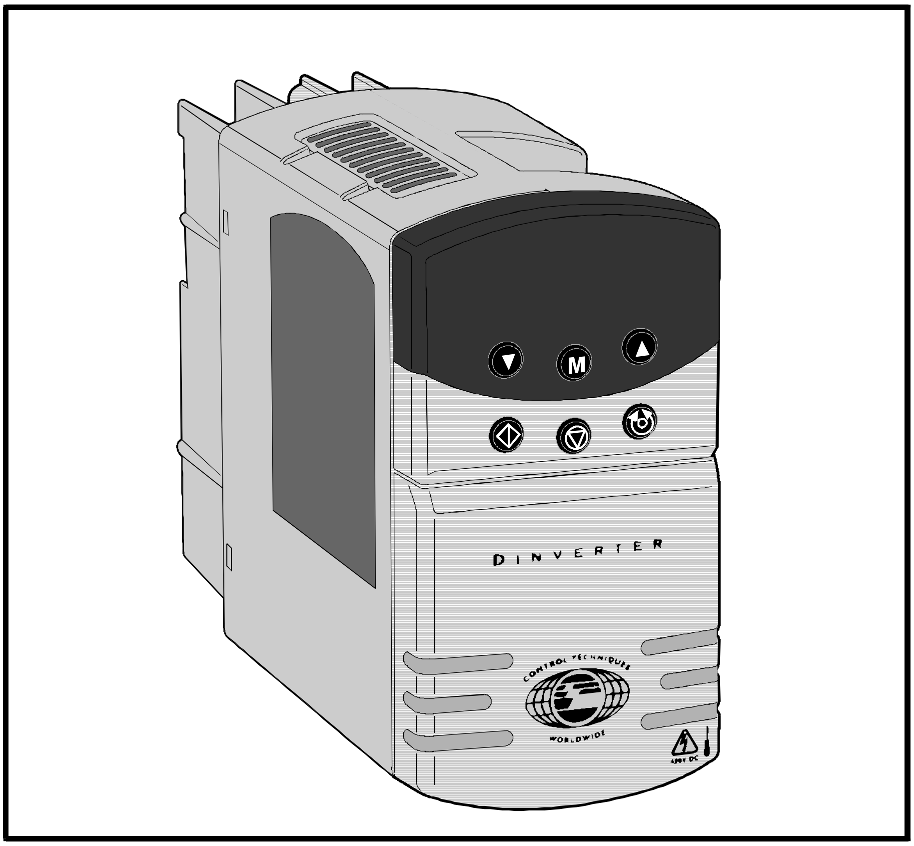
# Technical Reference

# Dinverter A




**A compact variable speed drive**

**for 3-phase induction motors**

**0.25kW to 0.75kW**

**0.33HP to 1.0HP**

**Part No:- 0446-0008**

**Issue No:- 3**

**Issue Code:-** **DINA**

**Issue Date:-** **February 1997**

**Software Version:-** **V01.03.00**

**Editor:-** **MKF**

**Safety Information - General Overview**

Variable speed drives (also referred to as drive converters or drives) and associated option units can be hazardous if they are not correctly installed, maintained and operated.

Persons supervising and performing the installation or maintenance of a drive and/or any external option unit must be suitably qualified and competent in these duties. They should be given the opportunity to study, and if necessary, to discuss the User Guide before work is started.

Important safety related information is given in the Sections on Mechanical Installation, Electrical Installation and Getting Started.

**General Information**

The manufacturer accepts no liability for any consequences resulting from negligence or incorrect installation or adjustment of the operating parameters of the equipment or from mismatching the drive with the motor.

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

## Warnings, Cautions and Notes

Warning, Caution and Note paragraphs appear throughout the text of this User Guide. These reminders are for the installers and operators of this equipment.

This guide contains important information affecting safety in the following sections:-

| | |
|---|---|
| Electrical Shock Risk | Section 5.1 |
| Stored Electric Charge | Section 5.1 |
| Fire Enclosures | Section 4.1 |
| Effect on Driven Plant | Section 6.1 |

### Warning

A Warning indicates that there may be danger of loss of life or personal injury unless the instructions are strictly observed.

### Caution

A Caution indicates that there may be danger or damage to equipment if the instructions are not strictly observed.

### Note

A Note draws to the attention of the personnel using the equipment to information that will assist in their understanding of the equipment or its operation.

## Safe Use of Drives

## General

The instructions in this 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.

The installer is responsible for complying with all relevant regulations, such as national wiring regulations and accident prevention 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.

## Intended Use

Drives are intended as components for incorporation into electrical control systems or machines. It is the responsibility of the installer to ensure that the drive is installed safely and in accordance with any regulations which apply to the end product at the place of use, for example regarding safety or electro-magnetic compatibility.

To ensure mechanical safety, additional safety devices such as electro-mechanical interlocks may be required.

This guide contains instructions for achieving compliance with specific EMC (Electromagnetic Compatibility) standards.

**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 the European Council Directives 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 must comply with the EMC Directive 89/336/EEC. Section 5.4 describes how the drive must be installed to ensure that it meets relevant EMC standards.

If the drive is incorporated into a machine, the manufacturer is responsible for ensuring that the machine complies with the Machinery Directive 89/392/EEC. In particular, the electrical equipment should generally comply with European Harmonised standard EN60204-1.

**Contents**

# 1.0 Using this Guide

Reading through the sections in numerical order will take you through the correct stages that are needed to install and operate the drive. In particular:-

- Section 2.0 gives an overview of the drive and its features.
- Section 3.0 gives a complete set of data/specification details for the drive and options.
- Section 4.0 details how to mechanically install the drive and options.
- Section 5.0 gives electrical installation details.
- Section 6.0 gives details concerning the operation of the LED/keypad of the drive to adjust drive parameters.
- Section 7.0 gives details about the Menu 0 parameters that enable the drive to be set-up for the majority of applications.
- Section 8.0 gives brief details as to how to operate the drive with a minimum amount of set-up.
- Section 9.0 gives advanced operating details available through the standard extended menus and parameters
- Section 10.0 gives diagnostic and fault indication details.
- Section 11.0 gives details about using serial communications.
- Section 12.0 provides examples of typical application examples using the drive.
- Section 13.0 provides you a comment/response sheet for your feedback and opinions about the drive and this manual for future drive improvements .

It is important that the basic installation and operating procedures have been carried out correctly before attempting to use any of the extended menu operating features detailed in Section 9.0 onwards.

All safety information relates to the drive itself and the drive with the RFI (Radio Frequency Interference) filter option.

## 2.0 Drive Description

### 2.1 Basic Information

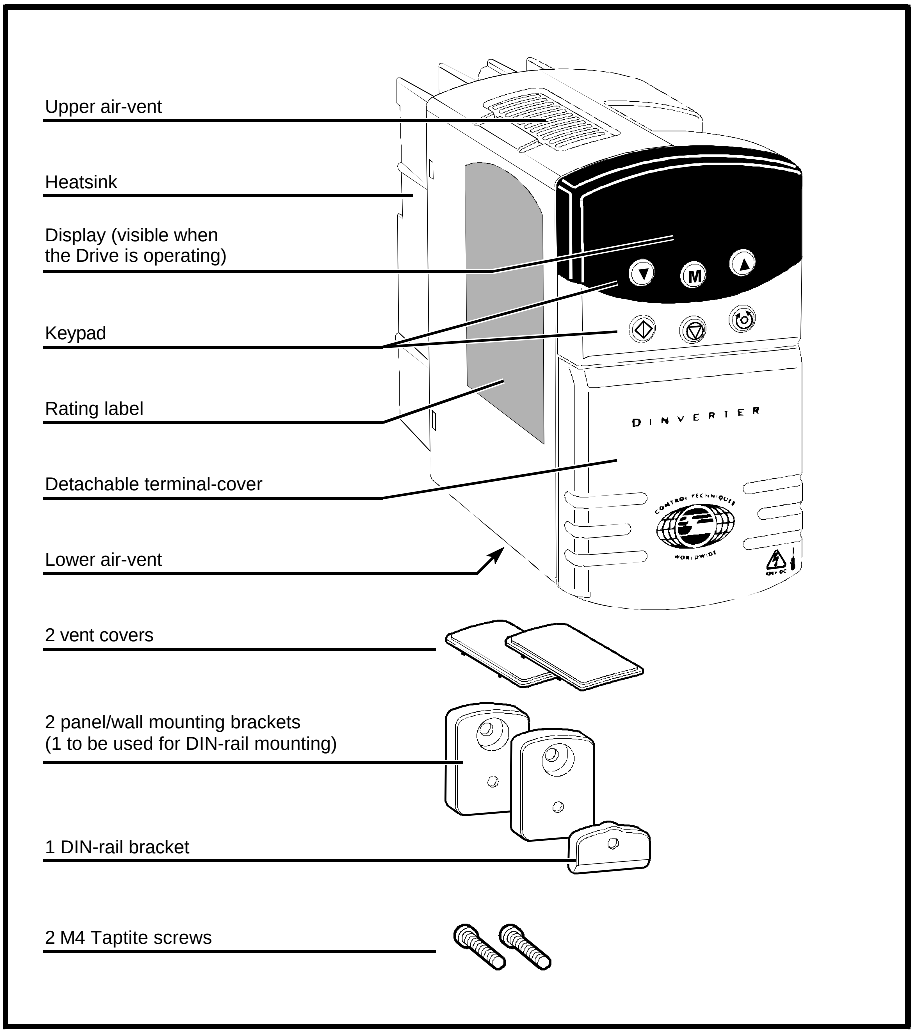



Fig. 2.1 Dinverter A showing all parts supplied.

The Dinverter A is one drive size in a family of Dinverter drives designed to operate as variable speed electronic drives for squirrel cage induction motors (or synchronous motors).

The Dinverter requires a 200 to 240V (line to line or line to neutral) 50 to 60Hz supply to drive three phase motors with a total output power of up to 0.75kW (1.0HP).

The speed of the motor is controlled by the drive which has a user interface consisting of a display and keypad, digital/analogue inputs and outputs, and a serial communications interface. The drive user can control the motor speed by using any of the user interfaces.

The Dinverter is fully digital (microprocessor controlled) and uses the latest power electronic devices to digitally control the flow of electrical power between the incoming AC supply and the driven motor.

The Dinverter is designed to be either panel mounted or DIN rail mounted using the brackets supplied.

## 2.2 Features

The main features are:

- Single phase (line to neutral) or two phase (line to line) 200 - 240VAC supply requirement
- Motor powers up to 0.75kW (1.0HP)
- UL listed
- IP20 with vent covers removed.

| | |
|---|---|
| Ingress protection | Gland plate not fitted: IP00 |
| | Gland plate fitted; cable glands not fitted: IP10 |
| | Cable-glands fitted; vent covers not fitted: IP20 |
| | Cable-glands fitted; vent covers fitted: IP20, NEMA 1 |

- NEMA 1 with upper vent cover fitted
- DIN rail or panel/wall mounting
- In-built braking (requires an external braking resistor)
- Full digital control
- 150% overload for 60 seconds
- Motor speed capability up to 960Hz
- Drive inverter switching frequency up to 12kHz for quiet motor operation
- High impedance isolation between power circuit and control connections so that the control interface is not directly linked to the power circuit

Control features include:

- Programmable motor voltages and frequencies
- Standard 2-wire RS485 serial communications
- Standard display and 6 button keypad for drive set-up/diagnostics
- Set up includes ramp rates, preset speeds, skip frequencies, auto reset etc.
- Flexible and programmable digital/analogue inputs and outputs
    - 1 Volt-free 2A 250VAC contact
    - 1 Differential analogue current input (configurable as 0 to 20mA, 4 to 20mA, 20 to 0mA, 20 to 4mA or motor thermistor input).
    - 1 Analogue voltage input (configurable as -10V to +10V, or motor thermistor input)
    - 1 Analogue output (0-20mA or 0-10V)
    - 5 Digital inputs (2 configurable as digital outputs) with positive and negative logic capability

## 2.3 Block Diagram

The key elements of the drive are shown below:

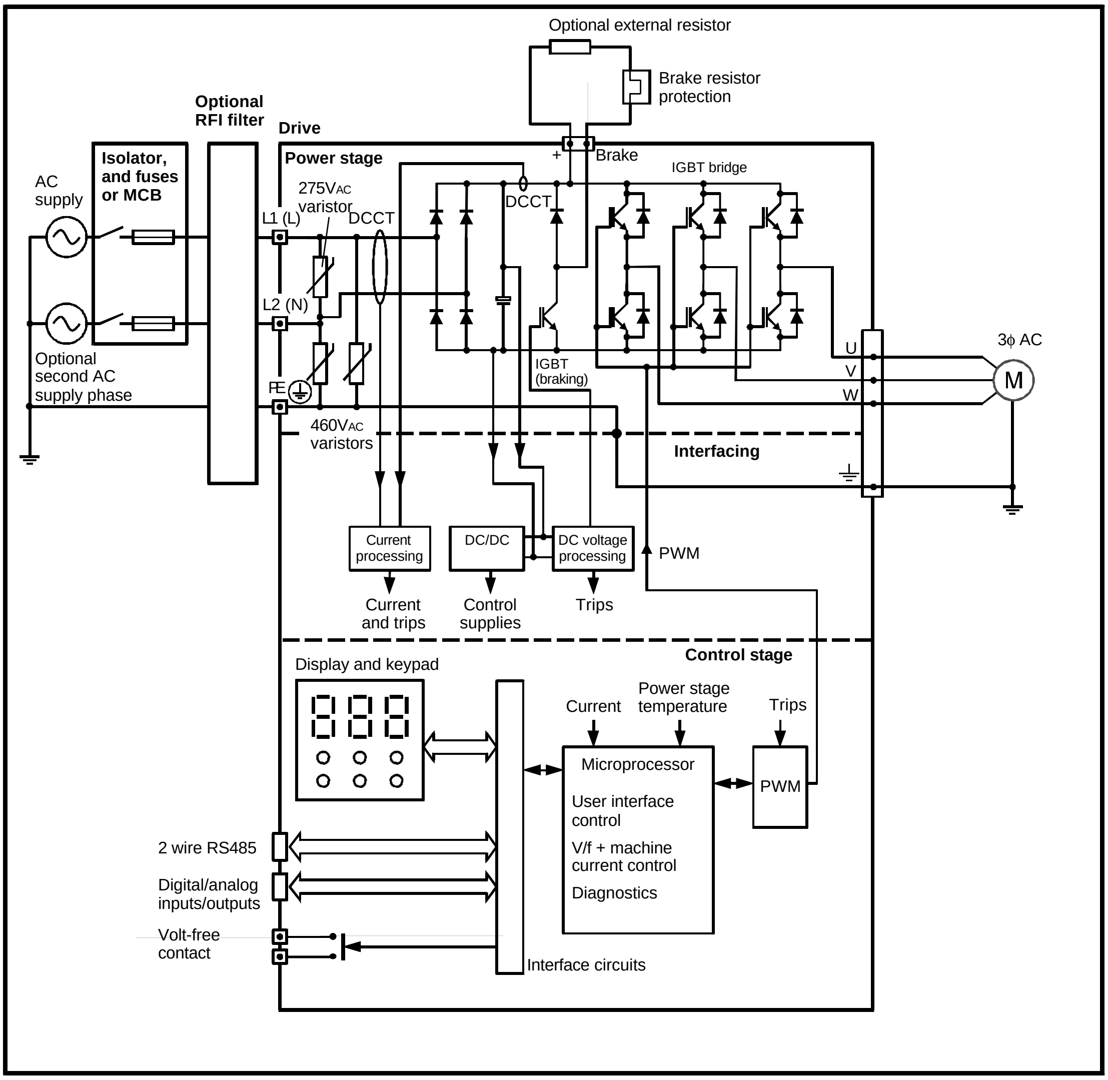



Fig. 2.2 Electrical block diagram of Dinverter A

3.0 Drive and Options - Data and Specification

3.1 Drive Rating Label

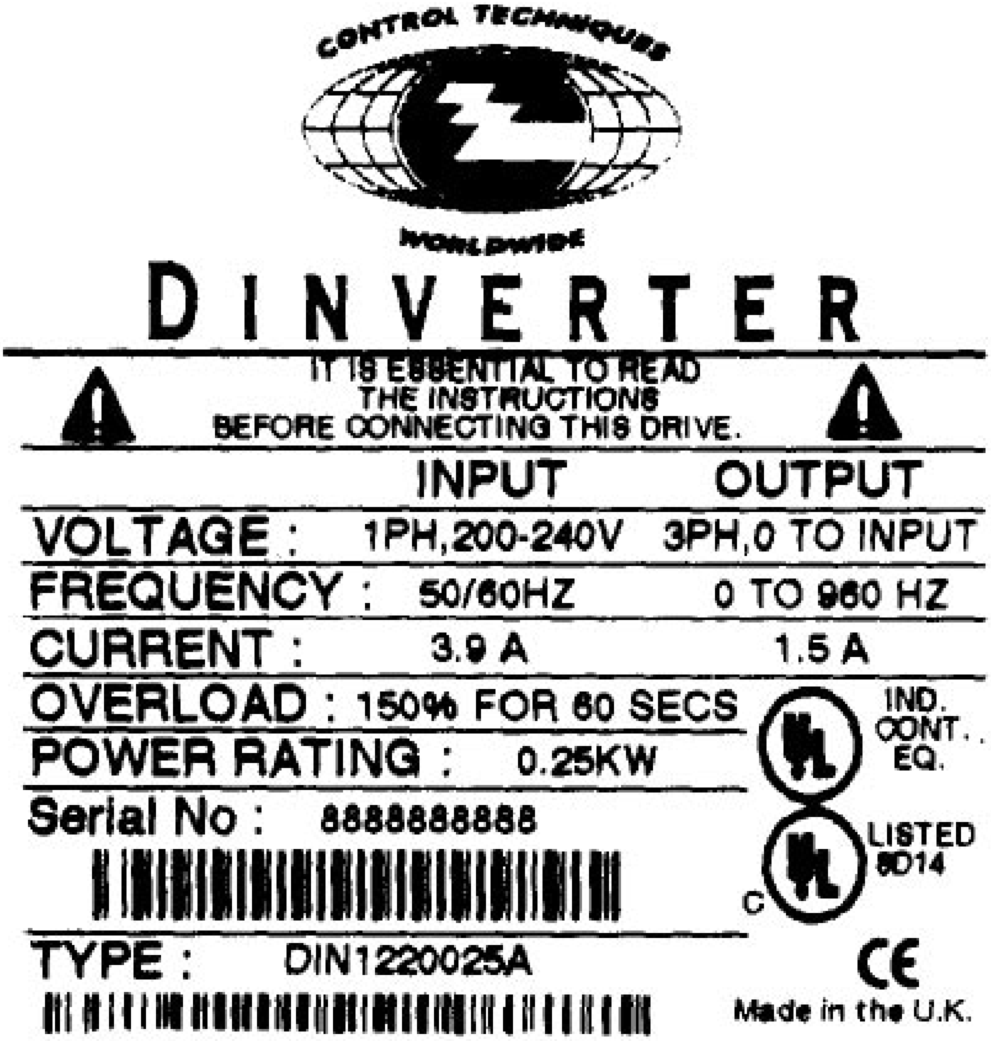



Fig. 3.1 Dinverter A rating label example

Key to Type/Model No.:

DIN 1 220 025 A

DIN - The drive family, i.e. Dinverter

1 - Number of input supply phases, i.e. 1 phase

220 - Nominal supply voltage, i.e. 220V

025 - Maximum continuous shaft power of connected motor (multiply figure by 10 for power in Watts, i.e. 25 x 10 = 250W)

A - Frame size, i.e. A

3.2 Drive Power Stage Data

| | | | | |
|---|---|---|---|---|
| Drive Rating (kW)<br><br>(Maximum continuous motor shaft power) | 0.25 | 0.37 | 0.55 | 0.75 |
| Drive Rating (HP)<br><br>(Maximum continuous motor shaft power) | 0.33 | 0.50 | 0.75 | 1.00 |
| Model Number | DIN1220025 A | DIN1220037 A | DIN1220055 A | DIN1220075 A |
| Supply Voltage | Single Phase 200 to 240VAC +/- 10% | | | |
| Supply Frequency | 50 to 60Hz +/- 2Hz | | | |
| Continuous RMS Input Current (A)<br><br>(worst case at zero supply impedance at 100% full load) | 3.9 | 5.7 | 8.4 | 11.5 |
| Recommended supply fuse current ratings (A) | 6 | 6 | 10 | 16 |

| | | | | |
|---|---|---|---|---|
| UL tested fuse (fast acting type)<br><br>Bussmann Limitron KTK-15A<br><br>(600VAC 100kA breaking capacity<br><br>10.3 x 38 mm Midget Fuse) | 15 | 15 | 15 | 15 |
| Continuous RMS Output Current (A)<br><br>(at 100% full load)<br><br>Note: * - Refer to de-rating curves given in Figs 3.2 and 3.3 below. | 1.5 | 2.3 | 3.0* | 4.3* |
| Overload (150%) RMS Output Current for 60 seconds (A) | 2.3 | 3.5 | 4.5 | 6.5 |
| Output Voltage (Line to Line) | 0 to Supply Voltage | | | |
| Output Frequency | 0 to 960Hz | | | |
| Output Switching Frequencies*<br><br>Note: * - Refer to de-rating curves given in Figs 3.2 and 3.3 below. | 3, 6, 9 and 12kHz | | | |
| Maximum power losses (as heat) (W)<br><br>at 3kHz switching frequency | 17.3 | 22.1 | 26.1 | 39.9 |
| Maximum power losses (as heat) (W)<br><br>at 6kHz switching frequency | 19.1 | 24.4 | 29.3 | 45.7 |

| | | | | |
|---|---|---|---|---|
| Maximum power losses (as heat) (W)<br><br>at 9kHz switching frequency | 19.9 | 27.1 | 34.5 | 50.9 |
| Maximum power losses (as heat) (W)<br><br>at 12kHz switching frequency | 21.3 | 29.9 | 38.3 | 55.9 |
| Power up surge (worst case peak value)<br><br>Repetition rate - unlimited<br><br>(a half sinewave current pulse of a quarter supply cycle duration) (A)<br><br>- 50Hz Supply | 55 | 55 | 110 | 110 |
| Power up surge (worst case peak value)<br><br>Repetition rate - unlimited<br><br>(a half sinewave current pulse of a quarter supply cycle duration) (A)<br><br>- 60Hz Supply | 66 | 66 | 130 | 130 |
| Motor starts per hour | Limited by motor only | | | |
| In-built DC bus Discharge Resistor | Will discharge DC bus voltage to less than 50VDC within a maximum 8 minute period after removing the AC supply, independently of whether the drive is functioning. (Under certain unusual circumstances the drive can be energised from the motor connections.) | | | |

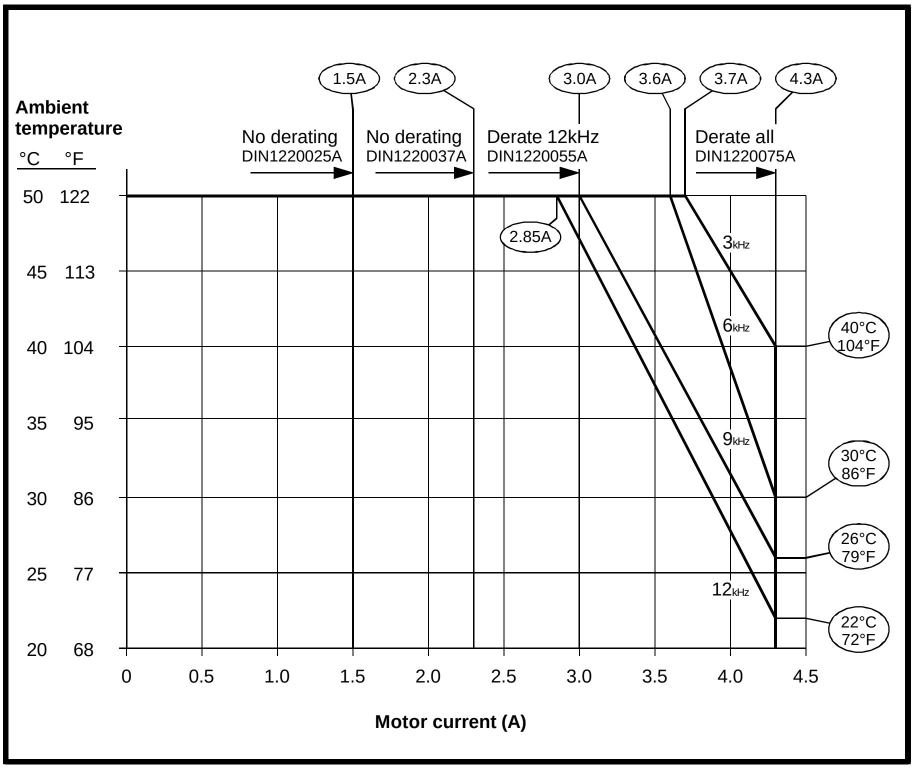



Fig. 3.2 De-rating curves that apply when no Vent Covers are fitted

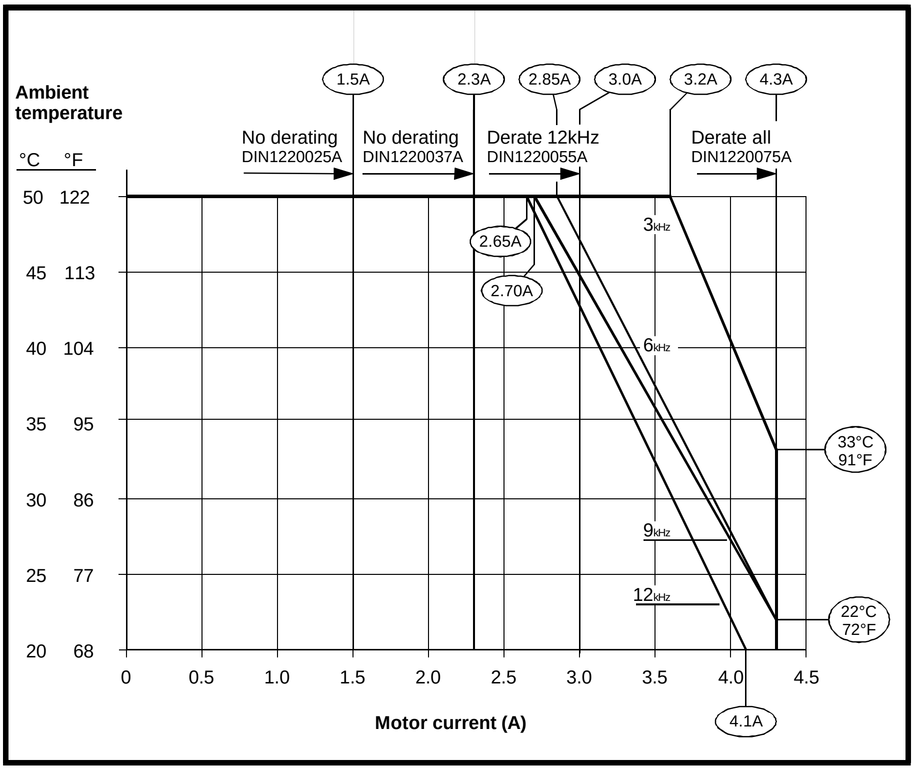



Fig. 3.3 De-rating curves that apply when one or both Vent Covers are fitted

As an example to aid using the above diagrams, consider the requirement of a drive needing to run a motor with a current requirement of 3.5A in a 40°C ambient.

Firstly this current requirement is only available with the 0.75kW (1.0HP) unit.

If the Vent Covers are not fitted, Fig. 3.2 indicates that the drive will operate within specification at 9kHz, 6kHz or 3kHz but not 12kHz. (At 12kHz the maximum allowable ambient is about 38°C at 3.5A, or at 40°C ambient the allowable current is 3.4A).

If the Vent Covers are fitted, Fig. 3.3 indicates that the drive will operate within specification at 6kHz or 3kHz but not at 9 or 12kHz. (At 12kHz the maximum allowable ambient is about 32°C at 3.5A, or at 40°C ambient the allowable current is 3.1A. Similarly, at 9kHz the maximum allowable ambient is about 36 °C at 3.5A, or at 40°C ambient the allowable current is 3.3A.)

## 3.3 Drive Environmental Data

| | |
|---|---|
| Ambient Operating Temperature Range:<br>(Note: - Refer to de-rating curves Figs 3.2 and 3.3 above.) | -10°C to +50°C<br>+15°F to +120°F |
| Storage Temperature Range:<br>(12 months maximum) | -40°C to +50°C<br>-40°F to +120°F |
| Cooling: | Natural convection |
| Ingress Protection classification: | Vent Covers fitted - IP20<br>Top vent cover fitted - NEMA 1<br>Vent Covers removed - IP10 |
| Operating Humidity Range: | Up to 85% - non-condensing. |
| Altitude De-rating:<br>(of Output RMS Current) | None up to 1,000m (3,300 ft) above sea level.<br>1% per 100m (330ft) above 1,000m (3,300ft) up to a maximum of 30% de-rate at 4,000m (13,200ft). |
| Vibration: | The drive meets IEC 68-2-34 Part 2.1 test Fd (BS2011). The test covered the frequency bandwidth of 5 to 150Hz, an acceleration spectral density of 0.01$g^2$/Hz, in all 3 mutually perpendicular axes with 1 hour test in each axis. |

## 3.4 Drive Weights and Dimensions

| | | |
|---|---|---|
| Weight: | DIN1220025A ) | 1.14 kg |
| | DIN1220037A ) | 2.51 lbs |
| | DIN1220055A ) | 1.21 kg |
| | DIN1220075A ) | 2.67 lbs |

| | | | |
|---|---|---|---|
| Dimensions: | Height: | 140mm | (5.5”) |
| | Width: | 75mm | (3.0”) |
| | Depth: | 192mm | (7.5”) |

## 3.5 Drive Control Data

| | |
|---|---|
| Internal output frequency accuracy: | ± 0.01% |
| Internal output frequency resolution: | 0.001Hz up to 480Hz<br>0.002Hz up to 960Hz |
| Internal output voltage accuracy: | Depends on supply stability |
| Internal output voltage resolution: | 0.4% |
| Internal current/load accuracy: | ±10% above 20Hz with a matched motor. |
| Internal current/load resolution: | 0.1% |
| Internal current limit/torque control: | Sampled every 2ms |

0V Common(Terminals A1, B1 and C1)

- Quantity per drive - 3
- Isolated by 3.3MΩ to power circuit and basic insulation.
- Capable of withstanding 2.0kVAC between power connections and control connections continuously.
- Drive will operate with no adverse effects with the 0V Common at a potential difference of up to 90VAC (at the AC supply frequency) from either input of the AC supply

Analogue Voltage Input (Terminal A2)

- Quantity per drive - 1
- Configurable as -10V to +10V, 0V to 10V, or motor thermistor input.
- Permissible voltage range - +50V to -50V (with respect to 0V Common)
- Input impedance - 94kΩ
- Schematic:

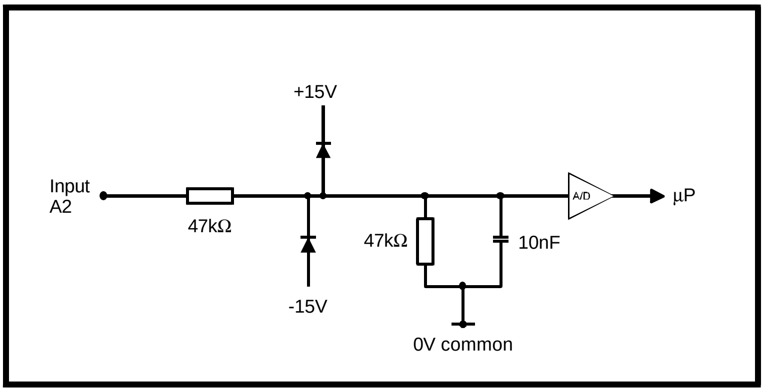



Fig. 3.4 Schematic of internal circuitry within drive for Terminal A2

- Analogue to Digital sampling - every 16ms (60Hz)
- Analogue to Digital resolution - 10 bits from 0 to +10V, and from 0 to -10V (11 bits total over -10V to +10V)
- Absolute accuracy - ±2% of 10V

Differential Analogue Current Input or RS485 Input (Terminals C4 and C5)

- Quantity per drive - 1
- Configurable as 0 to 20mA, 4 to 20mA, 20 to 0mA, 20 to 4mA or motor thermistor input.
- Permissible voltage range - -7V to +12V (on each input with respect to 0V Common)
- Input impedance - 100Ω (C4/C5 terminating resistor accessible in terminal chamber)
- Operating Common Mode Voltage Range: - -5V to +10V (with respect to 0V Common)
- RS485 Protocol - ANSI x3.28 - 2.5 A4 at 4800 baud only

- Schematic:

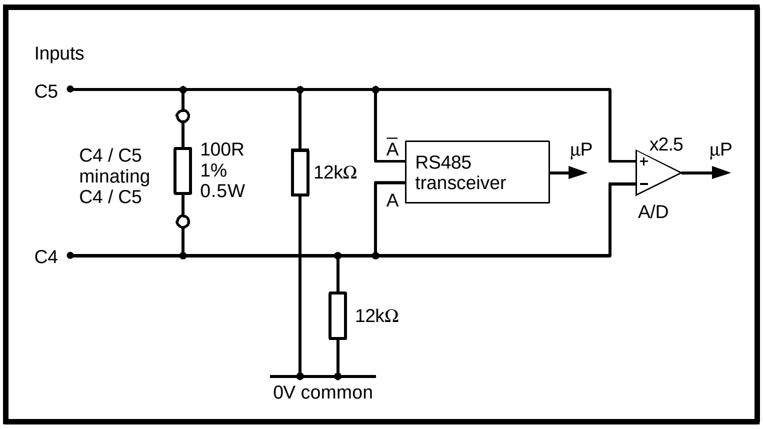



Fig. 3.5 Schematic of internal circuitry within drive for Terminals C4 and C5

- Analogue to Digital sampling - every 16ms (60Hz)
- Analogue to Digital resolution - 10 bits (over 0 to 20mA input)
- Absolute accuracy - ±3% of 20mA

Analogue Output (Terminal C2)

- Quantity per drive - 1
- Configurable as 0 to 20mA, 4 to 20mA, or 0 to 10V
- Permissible voltage (applied to output) - 0V to +15V (with respect to 0V Common)
- Output can tolerate a short-circuit to 0V Common continuously
- Schematic:

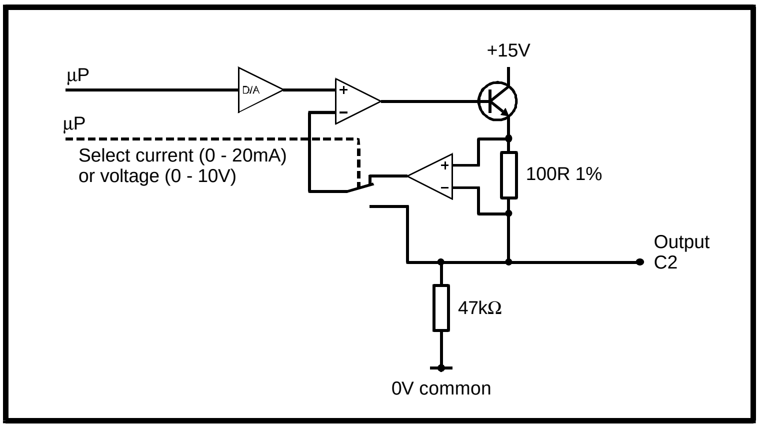



Fig. 3.6 Schematic of internal circuitry within drive for Terminal C2

- Digital to Analogue update - every 32ms (30Hz)
- Digital to Analogue resolution - 10 bits (over 0 to 20mA or 0 to +10V)
- Absolute accuracy - ±5% of 10V or 20mA
- 0 to +10V output source capability - 5mA minimum.
- 0 to 20mA output voltage capability - 0 to +10V minimum range.

+10V Reference Output (Terminal A3)

- Quantity per drive - 1
- Output can tolerate a short-circuit to 0V Common continuously.
- Absolute accuracy - ±3%
- Source capability - 5mA minimum.

Volt-Free Normally open (N/O) Contact (Terminals A4 and A5)

- Quantity per drive - 1
- Contact switching capability - 2A (resistive) at 250VAC or 24VDC
- Contact resistance - maximum of 100mΩ
- Contact controlled by microprocessor update rate - every 8ms (120Hz)
- Contact (open) withstand capability - 750VAC
- Contact isolation to all other circuitry - 2.5kVAC (meets IEC664-1 with overvoltage category III)

Digital Inputs (0 to +24V) (Terminals B2, B3 and B4)

- Quantity per drive - 3
- Permissible voltage - -3V to +30V (with respect to 0V Common)
- Schematic:

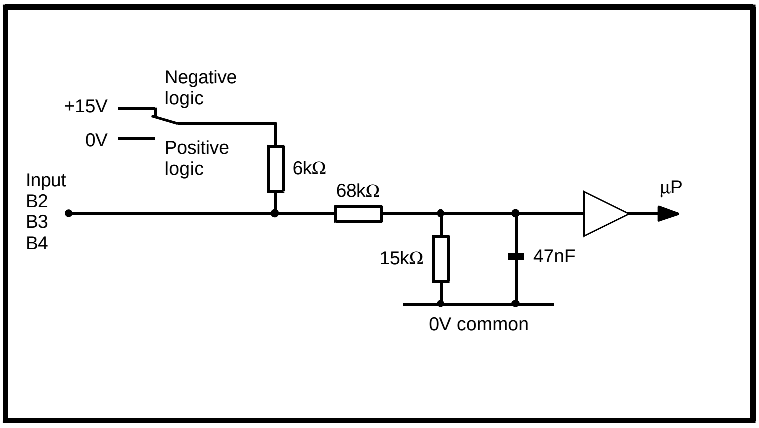



Fig. 3.7 Schematic of internal circuitry for within drive Terminals B2, B3 and B4

- Digital sampling - every 8ms
- Negative logic (Volt-free input) - inactive high ≥ 11.1V or ≥ 21.2 kΩ

  - active low ≤ 4.4V or ≤ 2.6 kΩ

  (all referenced to 0V Common)
- Positive logic (Active input) - active high ≥ 11.1V

  - inactive low ≤ 4.4V

  - input impedance 5.6kΩ to 0V

  (all referenced to 0V Common).

Digital Input/Outputs (0 to +24V) with Relay Drive Capability (Terminals B5 and C3)

- Quantity per drive - 2
- Permissible voltage - -3V to + 30V (with respect to 0V Common)
- Relay Driver output has a current foldback protection circuit that ensures the output will shut-down and protect if overloaded, or connected to any voltage over the permissible range
- Schematic:

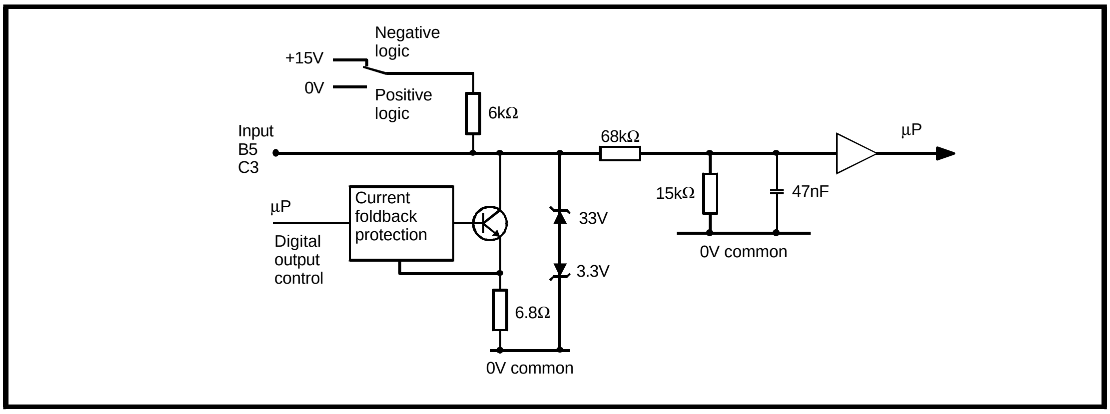



Fig. 3.8 Schematic of internal circuitry within drive for Terminals B5 and C3

- Digital sampling of input - every 8ms
- Digital update of output - every 8ms
- Negative logic (Volt-free input) - inactive high ≥ 11.1V or ≥ 21.2 kΩ

  - active low ≤ 4.4V or ≤ 2.6 kΩ

  (all referenced to 0V Common)
- Positive logic (Active input) - active high ≥ 11.1V

  - inactive low ≤ 4.4V

  - input impedance 5.6kΩ to 0V

  (all referenced to 0V Common).
- Digital output sinking capability - 50mA minimum with an output voltage less than 1V
- Digital output goes high impedance when current foldback protection operates. (Reset by removing overload and resetting the drive)
- Digital output sourcing capability (when input configured as negative logic)

  - an internal 5.6kΩ in series with 14.0V to 0V Common (i.e. 2.5mA when shorted to 0V Common)

## 3.6 Drive Electrical Protection Data

The Dinverter is internally protected against external influences outside the specified working ranges. This protection is designed to prevent internal damage. However, if certain limits are exceeded the drive will fail (see Section 3.6.1 below). The drive is also protected against internal malfunctions.

The drive has the following shutdown faults: (See Section 10.3 for details concerning how these faults are indicated and simple measures to avoid their occurrence).

- Overvoltage in the DC link circuit caused by excessive deceleration or machine braking
- Undervoltage in the DC link circuit caused by loss of or low AC supply
- Short circuit or earth/ground fault at the inverter output.
- Short circuit at the brake output.
- Overheating of the power stage.
- Overheating at the motor (using the motor thermistor input capability or the Ixt facility)
- External trip/fault input.
- Low current input (open circuit or < 3.0mA) on 4-20mA analogue input.
- Internal power supplies outside specification.
- Overspeed during high levels of regeneration.
- Errors in stored parameter data during software verification.
- Keypad pushbutton depressed at power-up.
- Software not functioning correctly during operation caused by external electrical noise corrupting the microprocessor program
- Microprocessor oscillator faulty during operation.
- Current measuring offset too high at power-up.

| | |
|---|---|
| The above faults are: | readable on the drive display, |
| | or accessible via serial communications, |
| | or can appear as a logic state change at the digital outputs |
| or | the volt-free relay contact. |

### 3.6.1 Power Stage Protection Limits

- DC Bus Overvoltage Trip level - 405VDC (+/-3%)

  (Above which the DC bus capacitors are liable to fail, followed by the main power devices.)

- DC Bus Undervoltage Trip level - 159VDC (+/-3%)

  (Below which the switch mode supply cannot produce an orderly shut-down of the microprocessor software and save the relevant drive parameters.)

- AC Supply overvoltage capability - 275VAC.

  (Above this level the protection varistor (MOV) will destructively fail and the braking IGBT will be “on” continuously.)

- Transient overvoltage protection - 4kV (IEEE/ANSI 1.2/50 µs surge i.e. 1.2µs rise time, 50µs duration).

  (between any input line to earth/ground and between input lines.)

  (The varistors (MOVs) have an energy absorption capability of 63J (between line to line) and 135J (between line to earth/ground to tolerate these impulses.)

- Instantaneous Output Current Trip level

  - 14A (+/-5%) (DIN1220055A and DIN1220075A)
  - 7A (+/-5%) (DIN1220025A and DIN1220037A)

  (The drive will trip under the following faults

  - Output Phase to Output Phase Short Circuit,
  - Output Phase to Earth/Ground Short Circuit,
  - Output Brake to +DC Short Circuit)

- Overheating Trip Temperature of the power stage -100$^{o}$C (+/-2$^{o}$C) (212$^{o}$F(+/-4$^{o}$F)

### 3.6.2 Motor Protection

The drive includes a thermal model to give protection for the motor (see Section 9.5). In addition there is the capability of using motor thermistors to detect excessive motor temperature (see Section 5.5).

## 3.7 Option Data

The Dinverter drive has two options available:

- The DIN1012F RFI (Radio Frequency Interference) Filter
- Braking Resistor with the necessary thermal overload

All other features are built into the drive as standard.

The DIN1012F RFI filter is required if the drive installation needs to meet the CENELEC (European) or other EMC (Electromagnetic Compatibility) conducted emission standards.

A braking resistor is required for applications where regeneration occurs (i.e. power flows from the motor shaft into the motor and then into the drive) and is at such a level that inherent losses in the drive system cannot dissipate the power (excess regeneration will cause an overvoltage trip in the drive). Regeneration is caused by mechanical loads overhauling the motor shaft, and is also typically caused when the drive decelerates. The rate of deceleration and motor inertia determines whether a braking resistor is needed.

### 3.7.1 RFI Filter Data

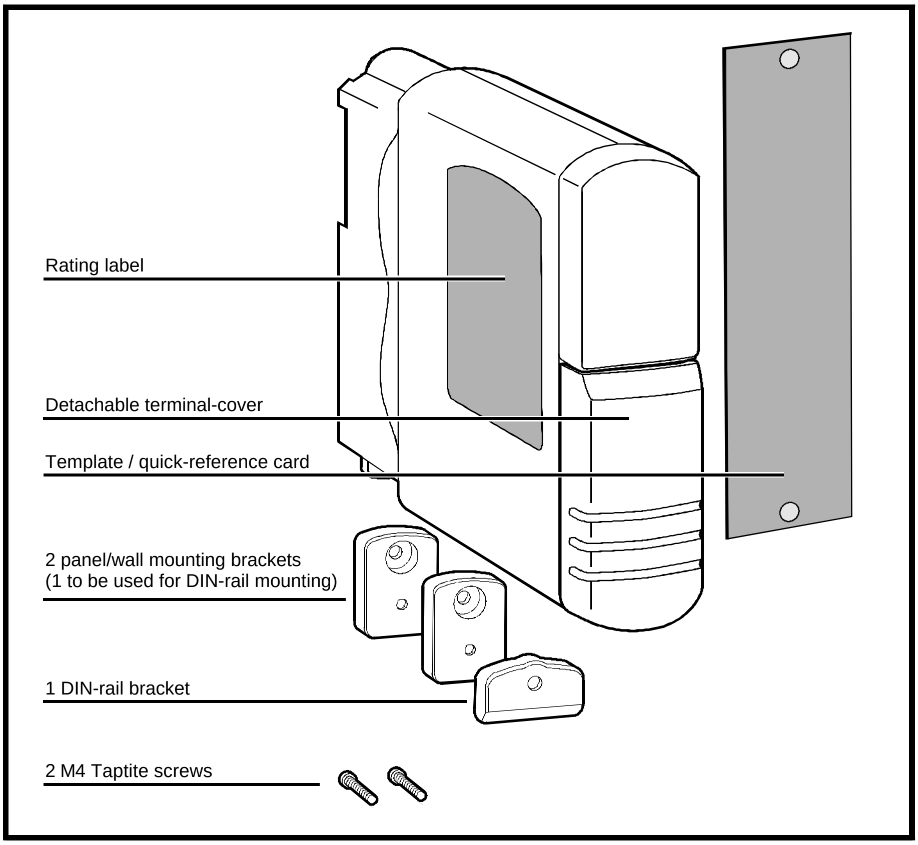


Fig. 3.9 Dinverter A RFI Filter showing all parts supplied

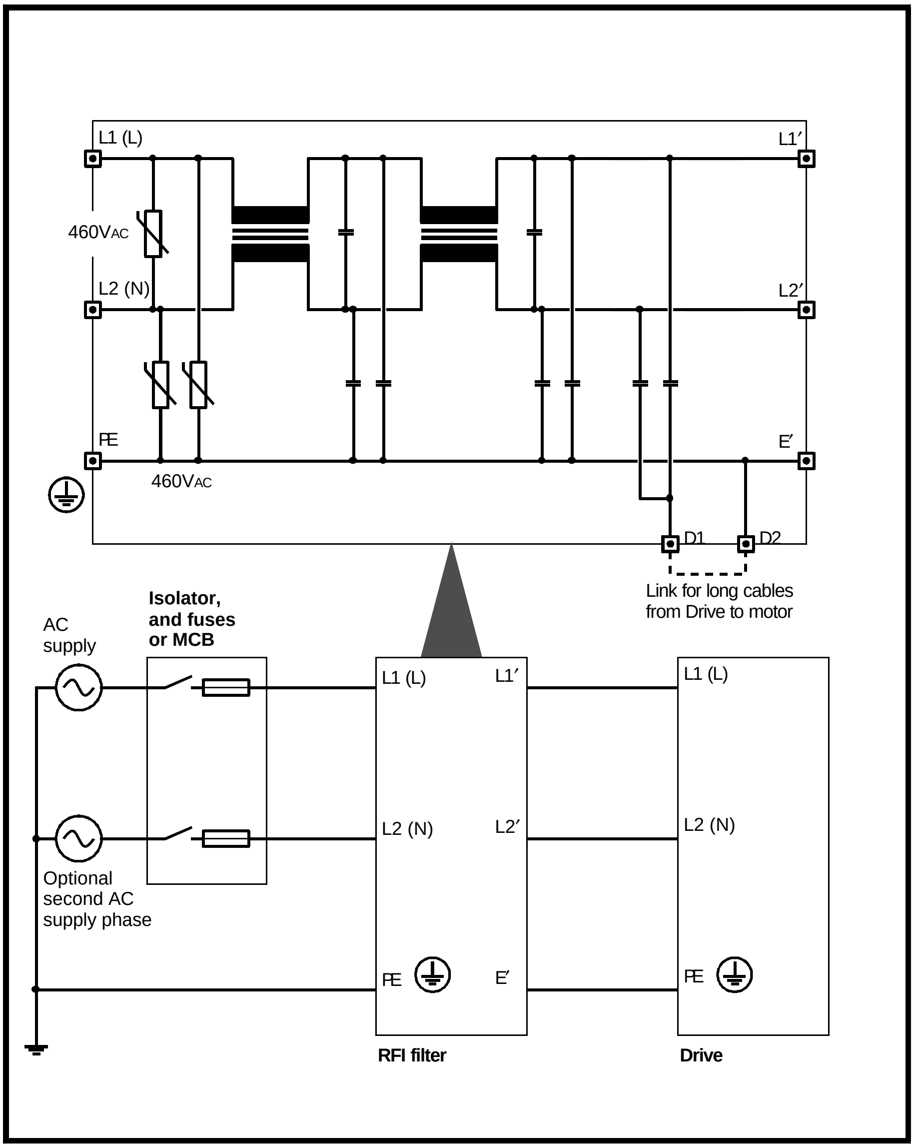



Fig. 3.10 Electrical block diagram of Dinverter A RFI Filter and Drive

The RFI (Radio Frequency Interference) filter Model No. DIN1012F is suitable for all Dinverter Size A models. The filter can be configured in two ways depending on the motor cable length (see Section 3.7.1.5). The specification of the RFI filter matches the Dinverter drive but has the following major differences as detailed below in the sub-sections.

3.7.1.1 Rating Label

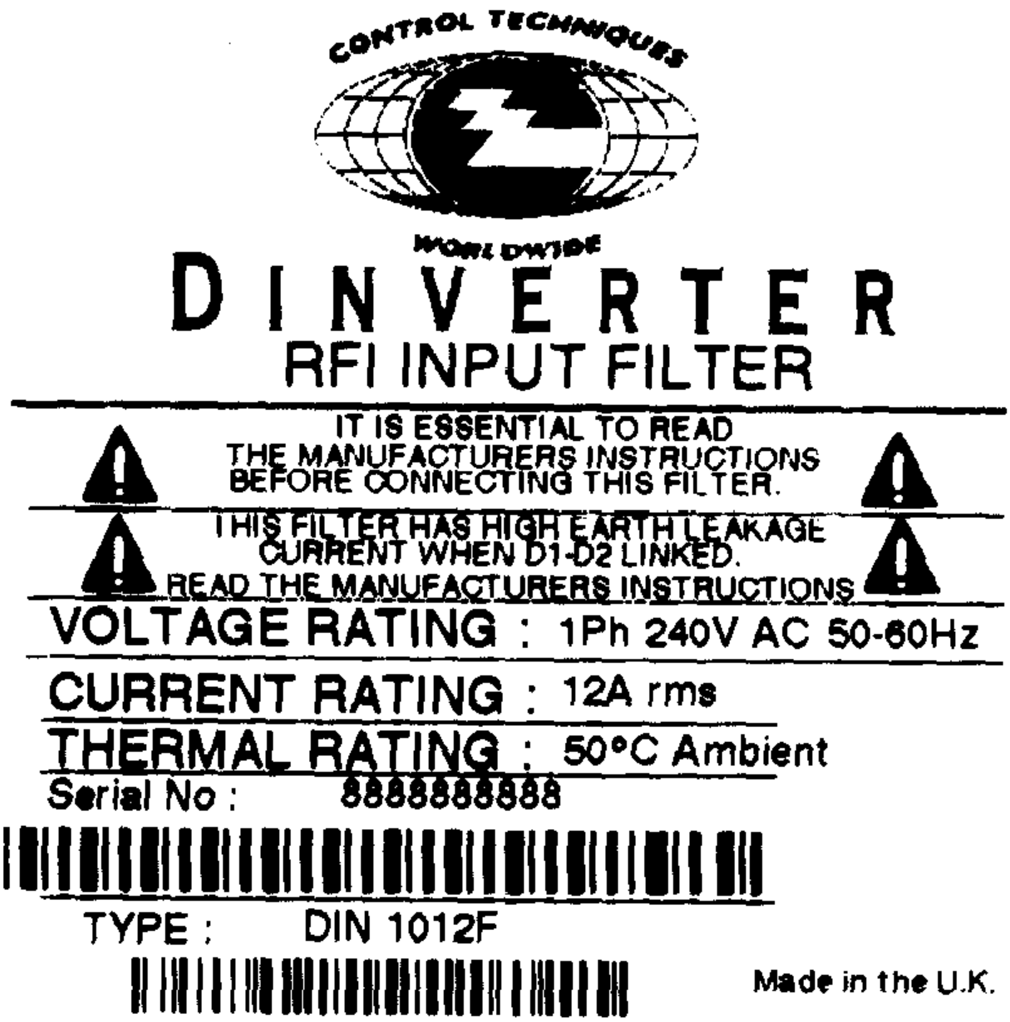



Fig. 3.11 Dinverter A RFI Filter rating label example

### 3.7.1.2 Power Data

As for the drive except the following:

- Power terminal block is pluggable for ease of cabling.

- Rated 100% Continuous Current - 12ARMS

- Maximum Power losses: (W) - 8W

  (for all drive switching frequencies)

- Maximum Earth/Ground Leakage Current (configured in Standard Mode - D1 and D2 not linked)

  - 2.7mA (at 240V 50Hz)
  - 3.0mA (at 220V 60Hz)

  (Above figures can be directly scaled for other voltages and frequencies.)

  Example : leakage current at 230V, 60Hz = $2.7 \times (230/240) \times (60/50)$ = 3.11mA

- Maximum Earth/Ground Leakage Current (configured in Long Cable Mode - D1 and D2 linked)

  - 52.5mA (at 240V 50Hz)
  - 57.7mA (at 220V 60Hz)

(Above figures can be directly scaled for other voltages and frequencies as illustrated above.)

- Voltage drop at rated current < 1V

- No de-ratings needed for any ambient temperature up to 40°C (104°F). De-rate by 0.2A/°C (0.11A/°F ) to 50°C (122°F). Note that due to the impedance of the filter the drive input current is reduced. Therefore in practice, this de-rating is not needed with Dinverter A.

3.7.1.3 Environmental Data

As for the drive except the following:

| | |
|---|---|
| Ambient Operating Temperature Range:<br><br>(Note: - Refer to de-rating information in Section 3.7.1.2 above.) | -10°C to +50°C<br><br>+15°F to +120°F |

.

3.7.1.4 Weights and Dimensions

- Weight: 0.65 kg (1.4lbs)
- Dimensions: Height 140mm (5.5”)

  Width 40mm (1.6”)

  Depth 192mm (7.5”)

3.7.1.5 EMC Specifications

The Dinverter RFI Filter has been designed for optimum performance with the 0.25-0.75kW range of Dinverter Size A drives. The filter will permit the drive to comply with the conducted emission requirements of the CENELEC generic emission standards:

EN50081-1 Residential environment

EN50081-2 Industrial environment

The filter has two modes of operation

a.) Standard mode

The filter can operate in its standard mode for most applications in which the motor cable length does not exceed 20m (66ft). In such applications the earth leakage current is less than 3.5mA complying with most safety standards. This mode is achieved by not connecting D1 and D2.

b.) Long cable mode

The filter has an optional link to increase the filter performance for long motor cable and high switching frequency applications. This is achieved by connecting D1 to D2. This will increase the earth leakage current. In this mode it is essential that a permanent secure earth connection is made.

The following table specifies the filter performance with respect to motor cable length and drive switching frequency. The table also specifies the required modes of operation.

| Motor cable length | Drive switching frequency | | | |
|---|---|---|---|---|
| | 3kHz | 6kHz | 9kHz | 12kHz |
| 1m (3ft) | R | R | R | R |
| 5m (16ft) | R | R | R | R |
| 10m (33ft) | R | R | R | R |
| 15m (49ft) | R | R* | R* | I* |
| 20m (66ft) | R | R* | I* | I* |
| 30m (99ft) | R* | I* | I* | I* |
| 50m (165ft) | R* | I* | I* | I* |
| 100m (330ft) | I* | I* | I* | I* |

R Residential environment - Standard mode (D1 and D2 not connected)

R* Residential environment - Long cable mode (D1 connected to D2)

I* Industrial environment - Long cable mode (D1 connected to D2)

### 3.7.1.6 Filter Protection Limits

The RFI Filter has no internal protection capability except the input varistors. Therefore the only limits are:

- AC Supply overvoltage capability - 275VAC.

  (Above this level the internal AC line capacitors are outside specification and are liable to fail, but in such a manner that there is no internal damage, the filter will no longer operate within the EMC specifications.)

- Transient overvoltage protection - 4kV (IEEE/ANSI 1.2/50 µs surge i.e. 1.2µs rise time, 50µs duration).

  (between any input line to earth/ground and between input lines.)

  (The varistors (MOVs) have an energy absorption capability of 135J to tolerate these impulses.)

## 3.7.2 Braking Resistor Data

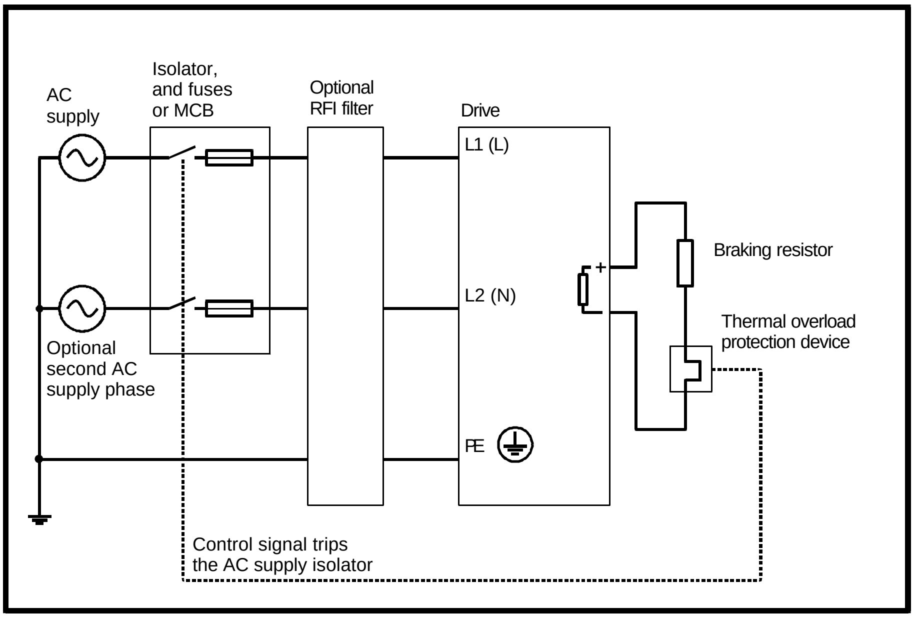



Fig. 3.12 Recommended braking resistor electrical connection to drive

The braking resistor can be any suitably mounted and rated device for the duty. The main specification requirements are as follows:

- Resistance: $\geq 100\Omega$ (depends on power to be dissipated).
- Instantaneous Joule capability: Must tolerate 400VDC switched across it on a pulsed basis depending on the power to be dissipated.
- Resistance self-inductance: Not critical.

Refer to Sections 5.3.4.1 and 5.3.4.2 giving details about electrically sizing the resistor.

## 4.0 Mechanical Installation

### 4.1 Warnings

#### Electrical Safety

Before installing the drive ensure that the drive has been electrically disconnected from the AC supply for at least 5 minutes before any cover is removed to ensure that there are no electrical shock hazards caused by stored electrical charge within the drive itself.

#### Access to the Drive

The drive should be installed in a location which prevents access to all personnel except for authorised, trained service personnel.

#### Fire Enclosure

The drive case is not classified as a Fire Enclosure.  For applications where this is a requirement, the drive must be installed in a fire enclosure.  However, the drive plastic enclosure is made from plastic with a UL94V0 rating which is self-extinguishing.

## Environmental Protection

The drive is not protected against the ingress of water.

The drive case can be configured with or without vent covers fitted. If the vent covers are not fitted access to live parts is possible with objects less than 3mm (0.125”) in diameter.

## 4.2 Parts Supplied with Drive

Contents of Drive Package:

- 1 Dinverter Size A (with a Terminal cover and gland plate fitted)
- 2 Vent Covers (loose)
- 1 User Guide (not shown in Fig. 4.1 below)
- 2 Mounting Brackets
- 1 DIN Rail Bracket
- 2 M4 Taptite Screws for fixing 2 of the 3 supplied Brackets to Drive heatsink. (Suitable for cross-head or flat-head screwdrivers.)

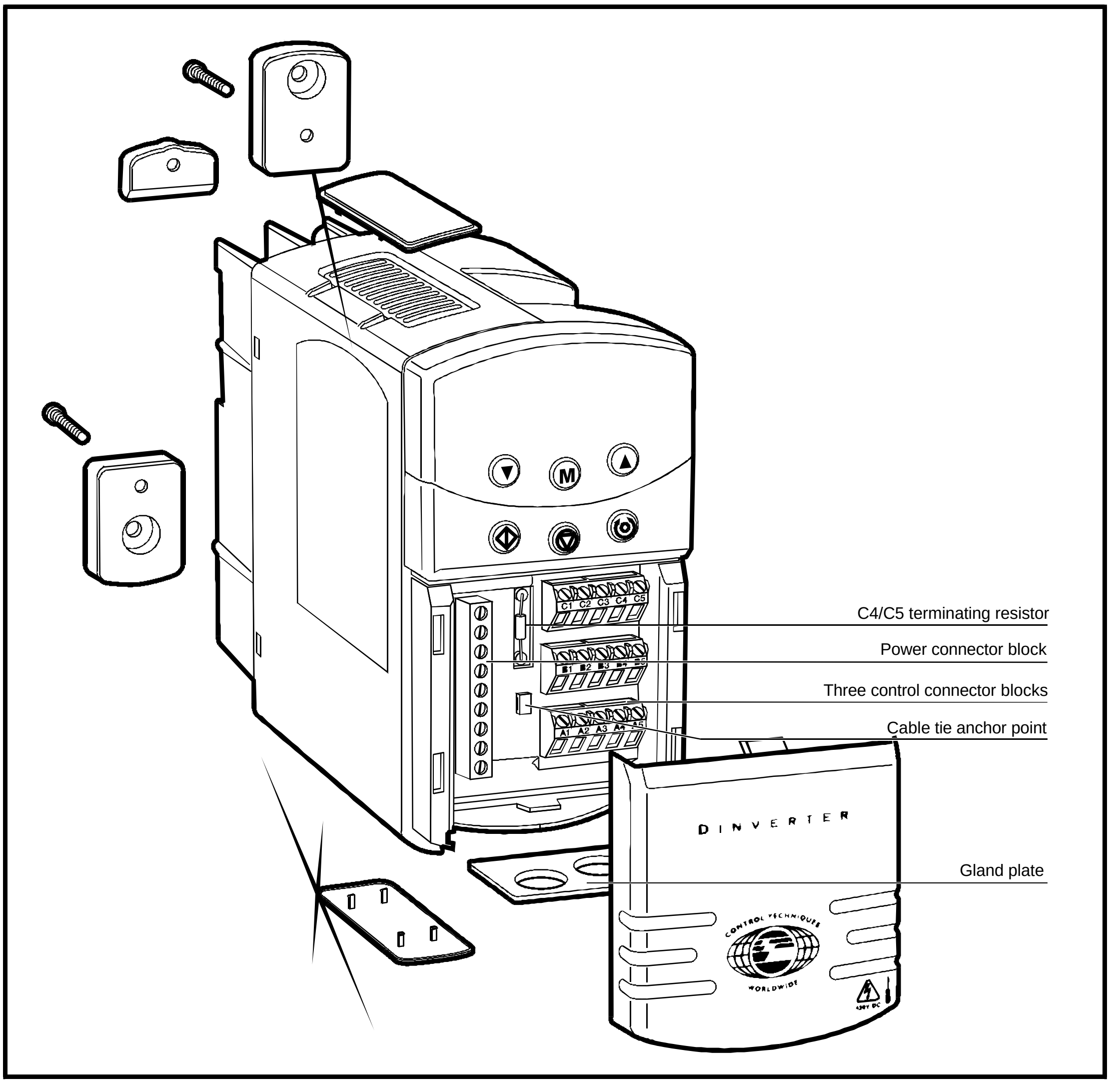



Fig. 4.1 Dinverter A parts supplied showing terminal chamber

(For removing the terminal cover as shown in Fig. 4.1 please refer to Section 4.6.1 below.)

### 4.2.1 Parts Supplied with the Optional RFI Filter

Contents of RFI Filter Package:

- 1 RFI Filter (with a Terminal cover, connector block and gland plate fitted)
- 1 Quick Reference Card (not shown in Fig. 4.2 below)
- 2 Mounting Brackets
- 1 DIN Rail Bracket

- 2 M4 Taptite Screws for fixing 2 of the 3 supplied Brackets to Drive heatsink. (Suitable for cross-head or flat-head screwdrivers.)

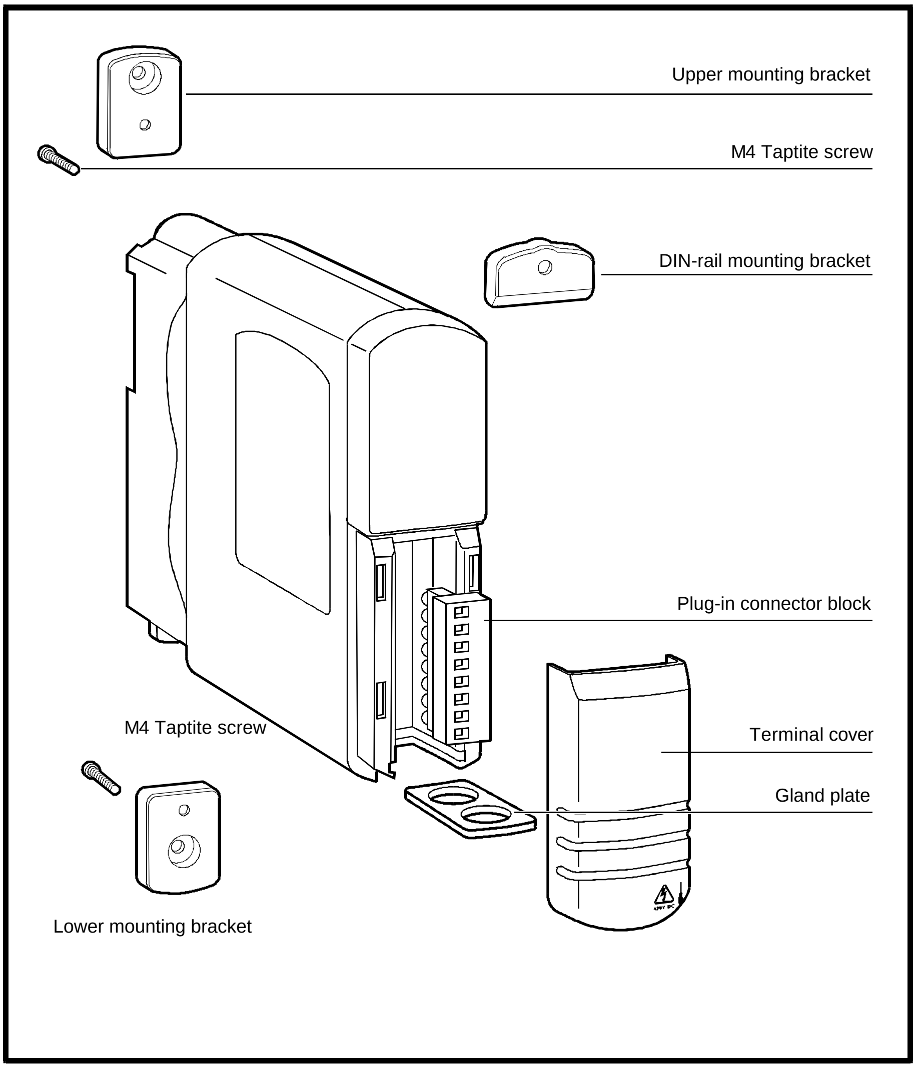



Fig. 4.2 RFI Filter parts supplied showing terminal chamber

(For removing the terminal cover as shown in Fig. 4.2 please refer to Section 4.6.4 below.)

4.3 Storage and Transportation

4.3.1 Storage

The drive can be safely stored in its “as delivered” state for up to 2 years provided the drive environment is in the limits specified in Section 3.3 (Drive Environmental Data).

Following a 2 year storage period the DC bus electrolytic capacitors will need reforming. This is a simple operation requiring a variable AC source (such as a Variac or variable autotransformer). Provided the DC electrolytic capacitors are reformed at the end of each and every 2 year storage period, the drive can be stored indefinitely.

The reforming process is carried out as follows.

- Connect the drive as shown:

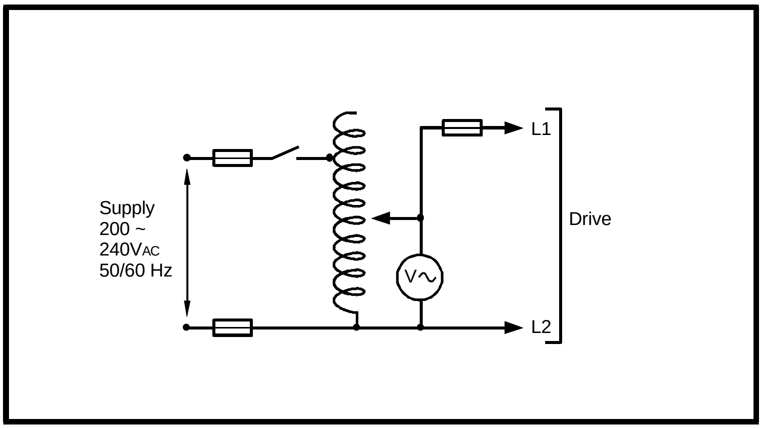



Fig. 4.3 Electrical arrangement for reforming DC bus electrolytic capacitors

- No other control/power connections are necessary.

- Suitably fuse the input to the Variac using slow-blow type fuses (e.g. 0.5A or similar), and a similar rated fuse to the input of the drive.

- With the Variac set to 0VAC output, turn on the supply and gradually increase the voltage to the drive (e.g. 4.5 VAC per minute with a maximum of 5VAC steps). Over a period of 1 hour increase the voltage from 0VAC to 275VAC. At the end of the 1 hour period, with 275 VAC applied remove the drive from the supply.

- The reforming process is now complete and the drive can be stored for another 2 years.

### 4.3.2 Transportation

The drive can be either transported in its own supplied packaging or already mounted in its assembled enclosure.

Section 3.3 (Drive Environmental Data) gives details concerning vibration and other relevant data. However, please ensure severe shocks are avoided during transportation especially when already mounted in an enclosure as the shock capability of the drive, although good, will not tolerate dropping. Therefore it is always good practice to inspect the drive following transportation to ensure that the drive has not been damaged.

## 4.4 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 drive environment is acceptable (the acceptable limits are defined in Section 3.3 (Drive Environmental Data).
- The maximum permissible ambient temperature of the drive is not exceeded (see Section 3.3).
- The EMC (Electromagnetic Compatibility) requirement is met.
- The electrical installation meets the safety requirements.

A typical procedure to plan the installation in an enclosure is as follows:

1. Decide how many drives are to be installed in the enclosure.
2. Decide whether the drives require the optional RFI filter.
   (Either all or none will require them.)
3. Decide which (if any) drives require an optional braking resistor, and whether this is to be mounted external or internal to the enclosure.
4. Decide how the drives are to be vertically mounted in the enclosure, either:
   - DIN-rail mounted, or
   - Surface, wall or panel mounted.
5. Estimate the drive ambient operating temperature, switching frequency and output current required. From the data given in Figs 3.2 and 3.3 (in Section 3.2 ) and the operating environment of the drive decide whether the drive needs the Vent Covers fitting, and determine from the Drive Data in Section 3.2 the heat loss of the drive and filter.
6. Plan the installation layout using Fig. 4.4 below as a guide. Further details are given in this Section, but also refer to Section 5 on Electrical Installation.

7. Decide whether the enclosure is to be sealed or ventilated. Ensure that the heat generated within the enclosure does not cause the enclosure ambient to exceed the drives rating and that there is enough enclosure surface area or air flow to meet these requirements. See Section 4.7 for calculation details.

8. Re-arrange the enclosure layout, if necessary, by repeating the above steps 1 through to 7 until all criteria are met.

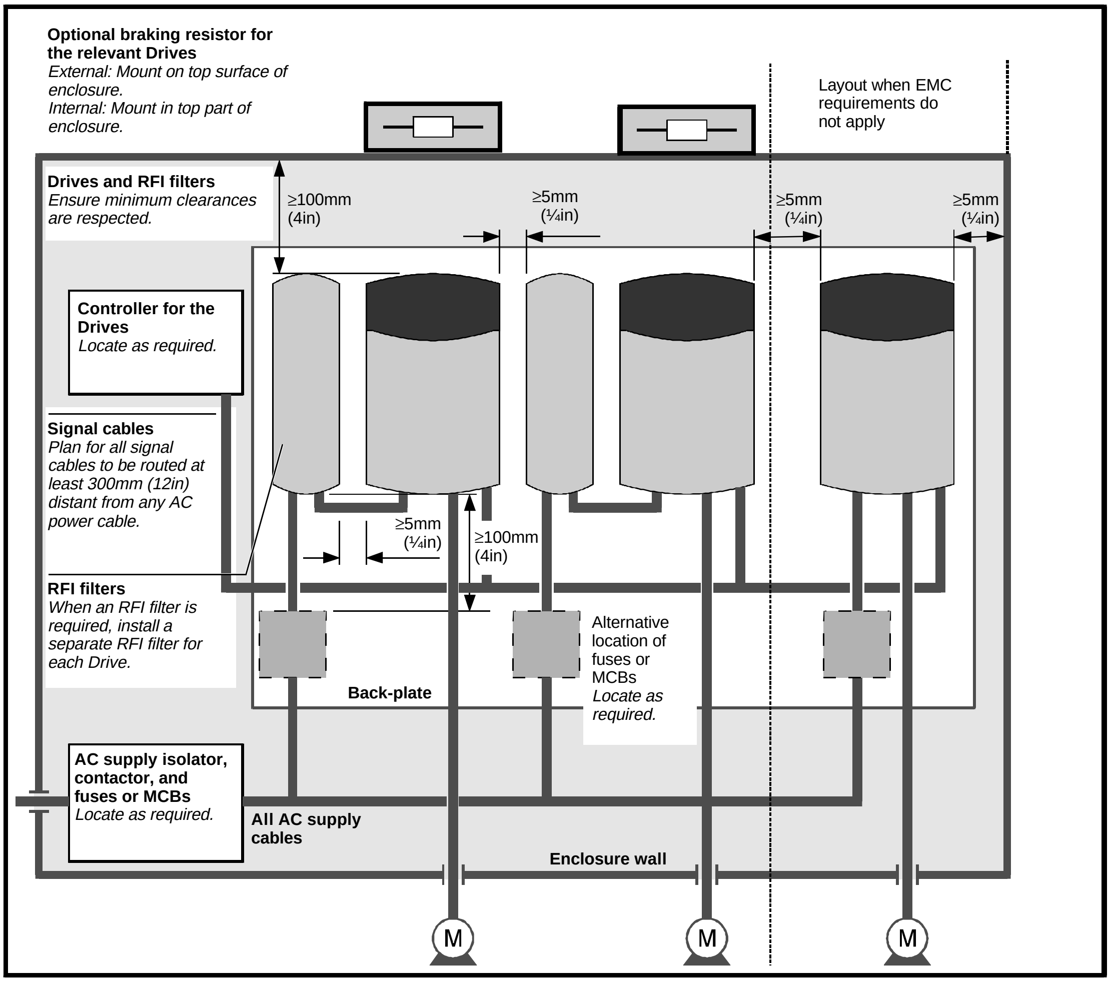



Fig. 4.4 Planning the layout of the enclosure

Further details concerning installation are given in the following sections. However the following general details are helpful:

1. The drive must be located in an environment that is free from dust (unless vent covers fitted), corrosive vapours, gases and all liquids, including condensation of atmospheric moisture.
2. If condensation is likely to occur when the drive is not in use, install an anti-condensation heater. This heater must be switched off when the drive is in use; automatic switching is recommended.
3. Do not locate the drive in a classified hazardous area, unless the drive is installed in an approved enclosure and the enclosure and the installation is approved.
4. Install the drive vertically.
5. Observe the requirements for ambient temperature if the drive is to be mounted directly above any heat generating equipment, such as another drive.
6. If the drive is to be installed directly beneath other equipment, such as another drive, ensure that the drive does not cause the ambient temperature requirements of the equipment to be exceeded.
7. Allow at least 100mm (4”) clearance above and below the drive.
8. Allow at least 5mm (0.25”) clearance each side of the drive.
9. Mount the RFI Filter to the left of the drive to minimise the cable length between the drive and the RFI filter.

## 4.5 Mounting the Drive

Before the drive is mounted, a decision has to be made regarding the ingress protection requirement as to whether the Vent Covers need to be fitted. (See Section 4.4). From the data given in Section 3.2, the operating ambient temperature, switching frequency and motor full load current, a decision can be made.

If the vent covers need to be fitted for environmental ingress protection, please ensure correct orientation and firm fit.

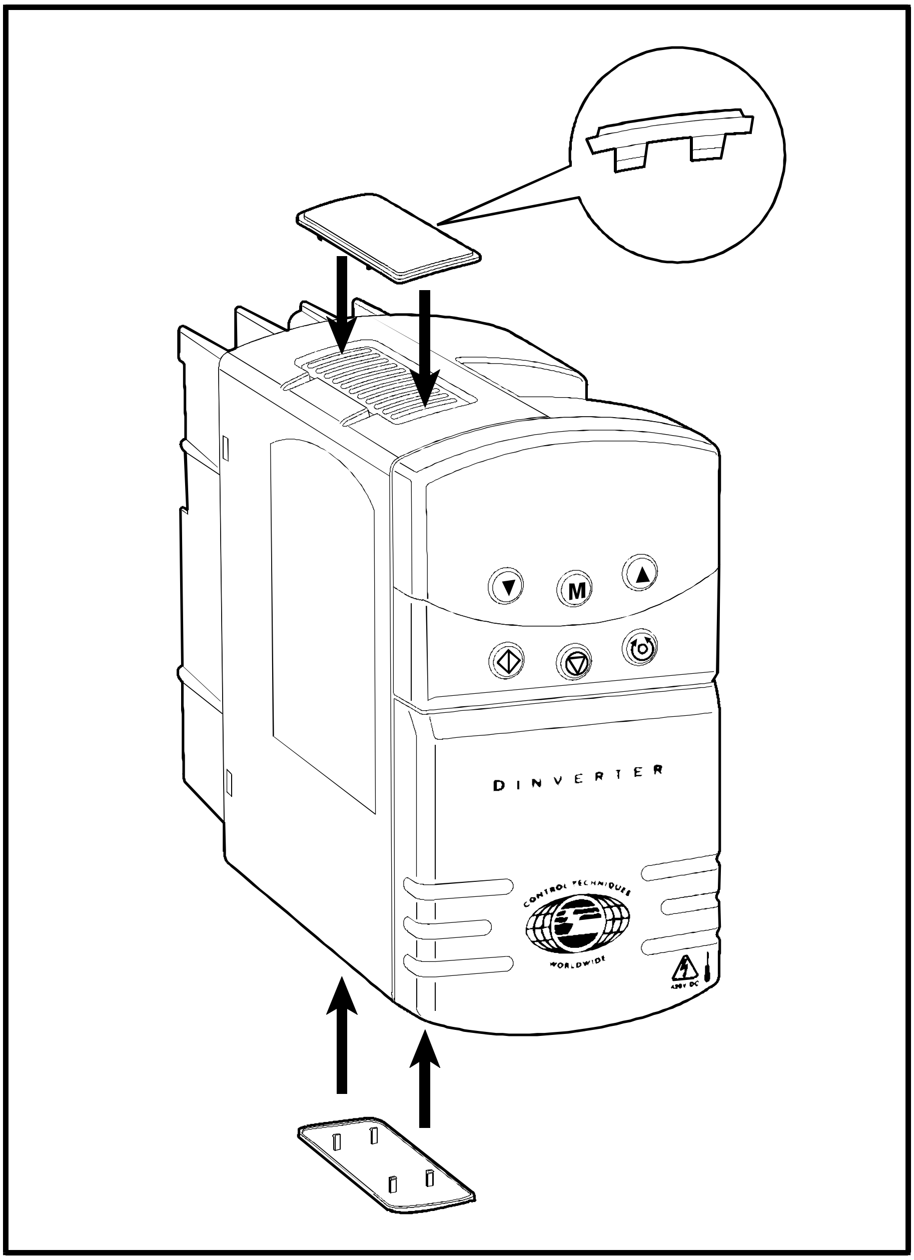



Fig. 4.5 Fitting the Vent Covers

Depending on whether the drive is to be DIN rail mounted or panel mounted the mounting methods are as follows:

4.5.1 DIN Rail Mounting

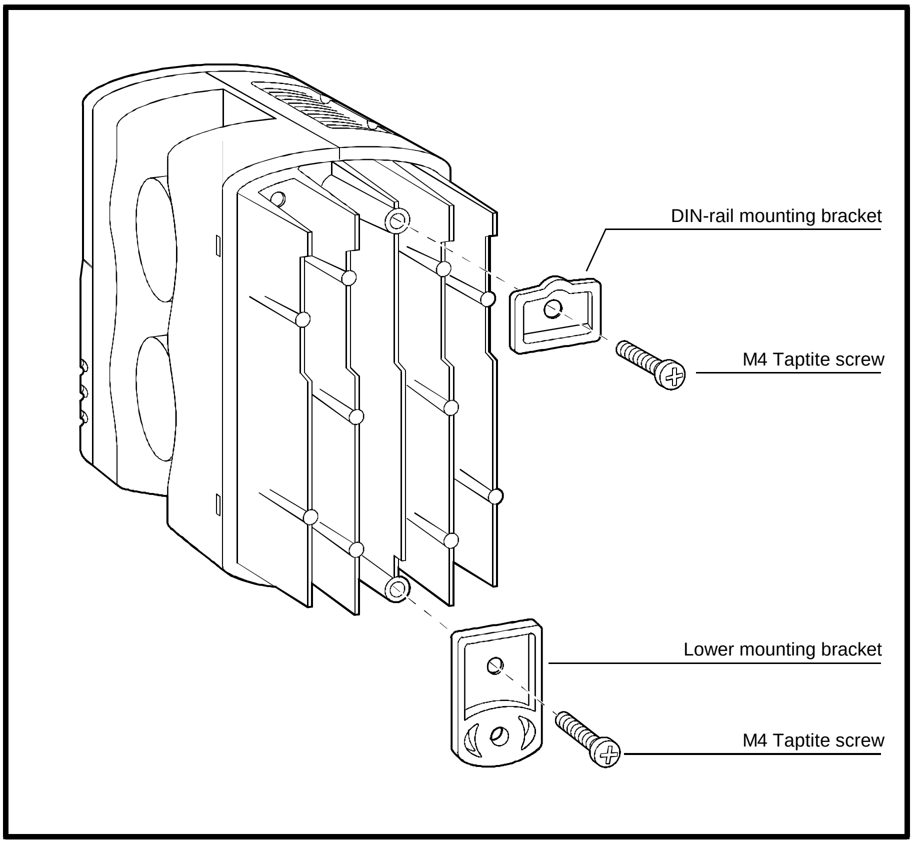



Fig. 4.6 Fitting the brackets to the heatsink in preparation for DIN rail mounting

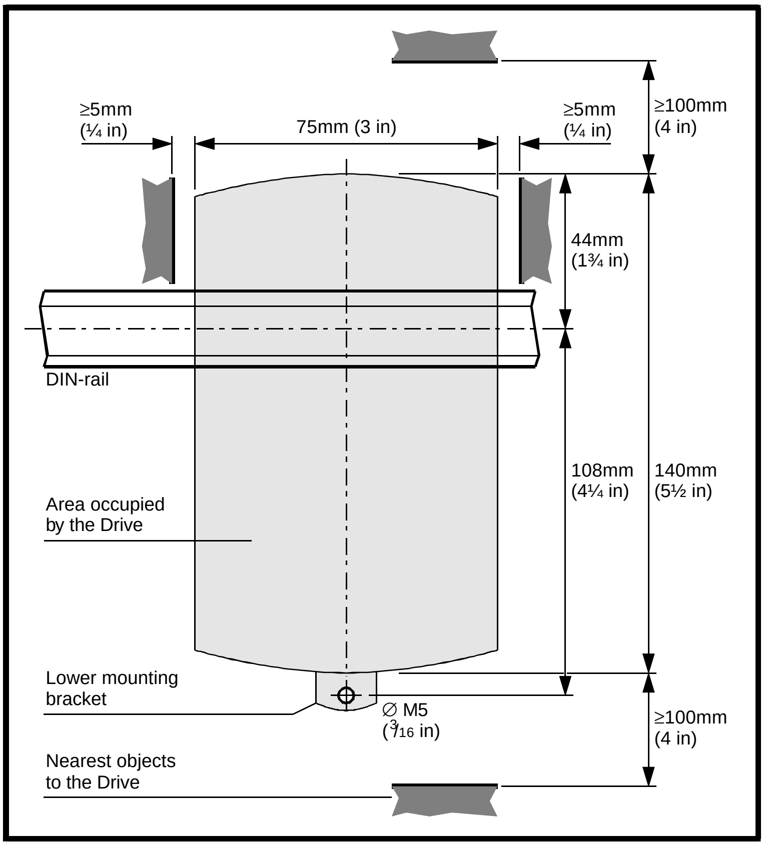



Fig. 4.7 Preparing the panel/wall or surface for DIN rail mounting

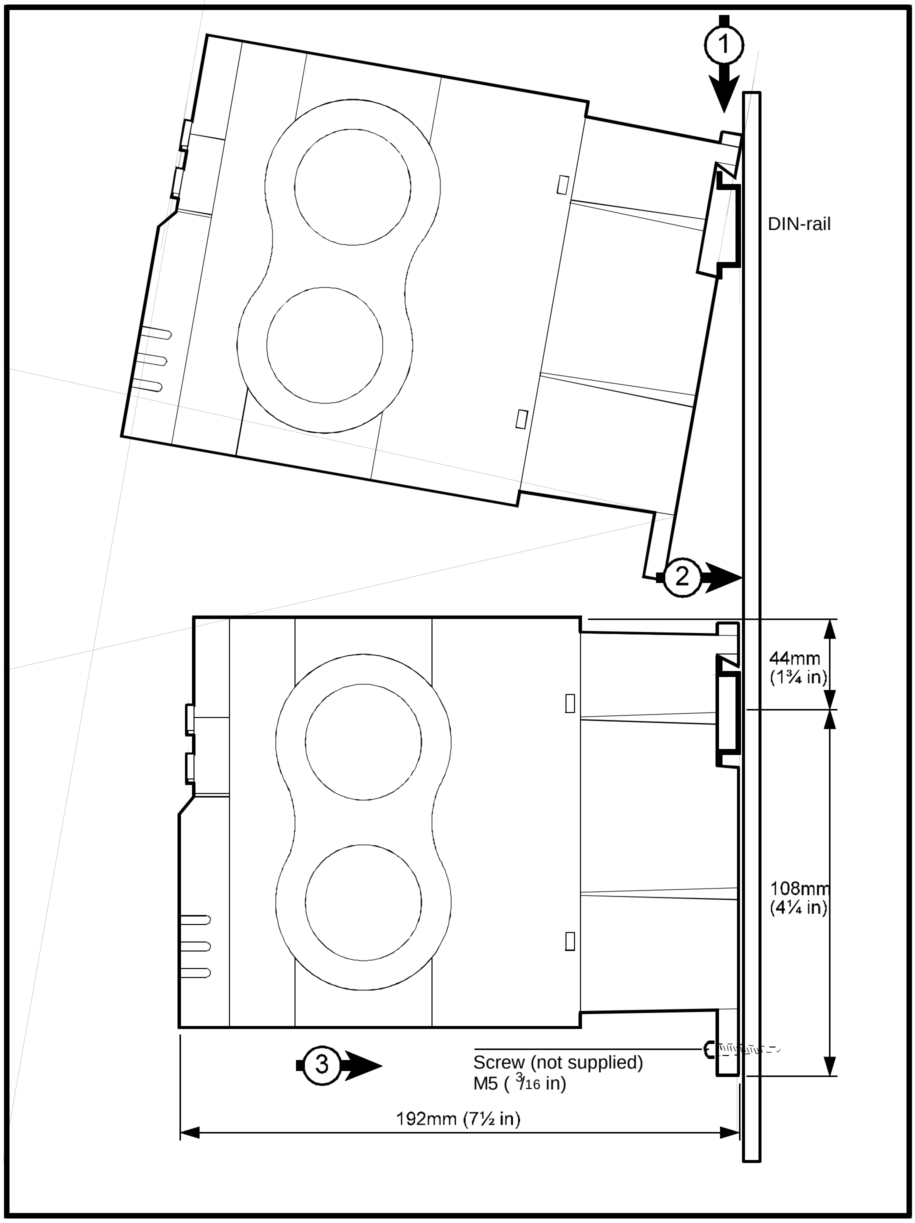



Fig. 4.8 DIN rail mounting the drive

1. Slide the DIN Rail Bracket into the recess between the fins at the top of the heatsink with the orientations shown in Fig. 4.6 above.

2. Insert one of the M4 Taptite screws supplied through the DIN Rail Bracket into the Heatsink hole. Tighten to hold Bracket to heatsink.

3. Slide one of the Mounting Brackets into the recess between the fins at the bottom of the heatsink with the orientation as shown in Fig. 4.6 above.

4. Insert and tighten the remaining M4 Taptite screw supplied through the Mounting Bracket and into the Heatsink.

5. Drill and tap a 5mm (3/16”) mounting hole 108mm (4 1/4”) vertically below the centre of the 35mm (1 3/8”) DIN rail on the back panel of the enclosure where the drive is to be installed. (See Fig. 4.7 above.)

6. Locate the drive on the DIN rail as indicated in Fig. 4.8 above.

7. Secure the lower Mounting Bracket to the back panel of the enclosure using the hole made in Step 5 above with a 5mm (3/16”) screw (not supplied).

### 4.5.2 Panel Mounting

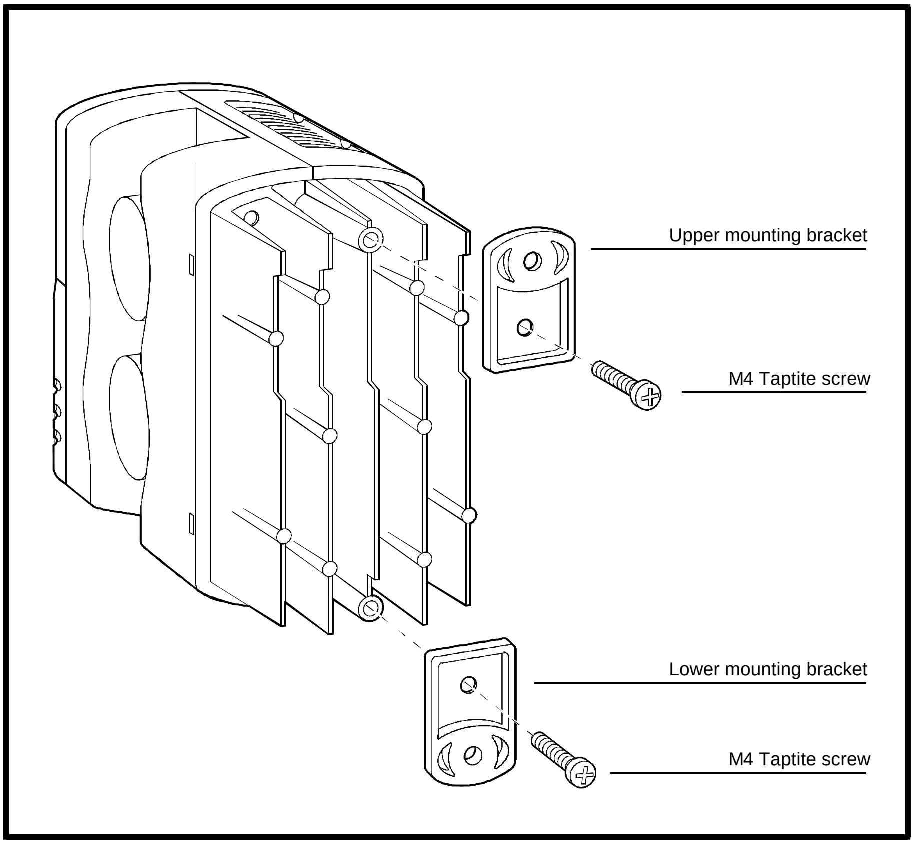



Fig. 4.9 Fitting the brackets to the heatsink in preparation for panel mounting

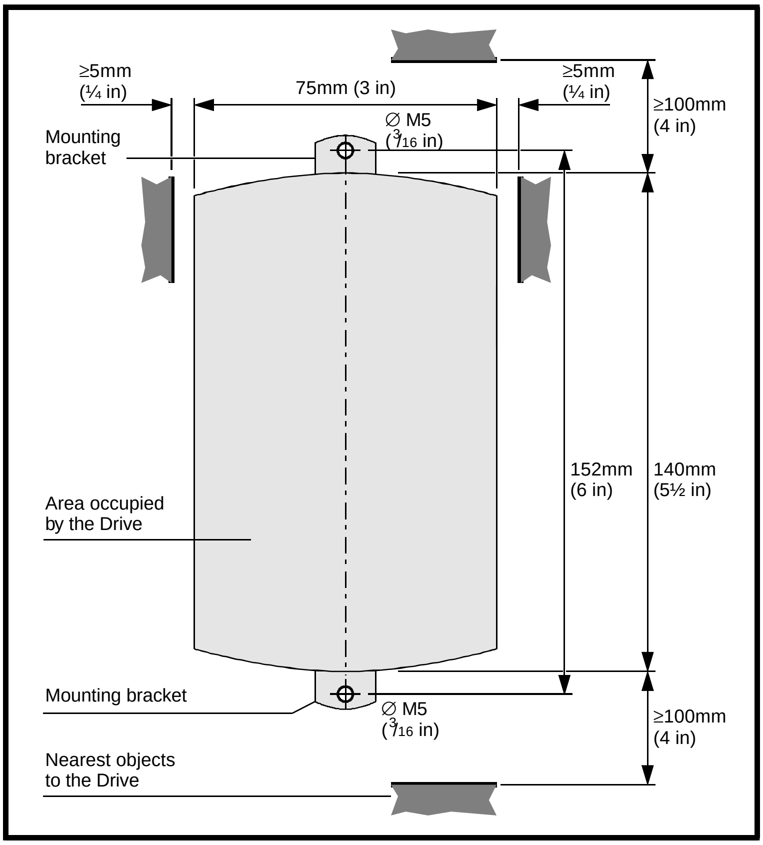



Fig. 4.10 Preparing the panel/wall or surface for panel mounting

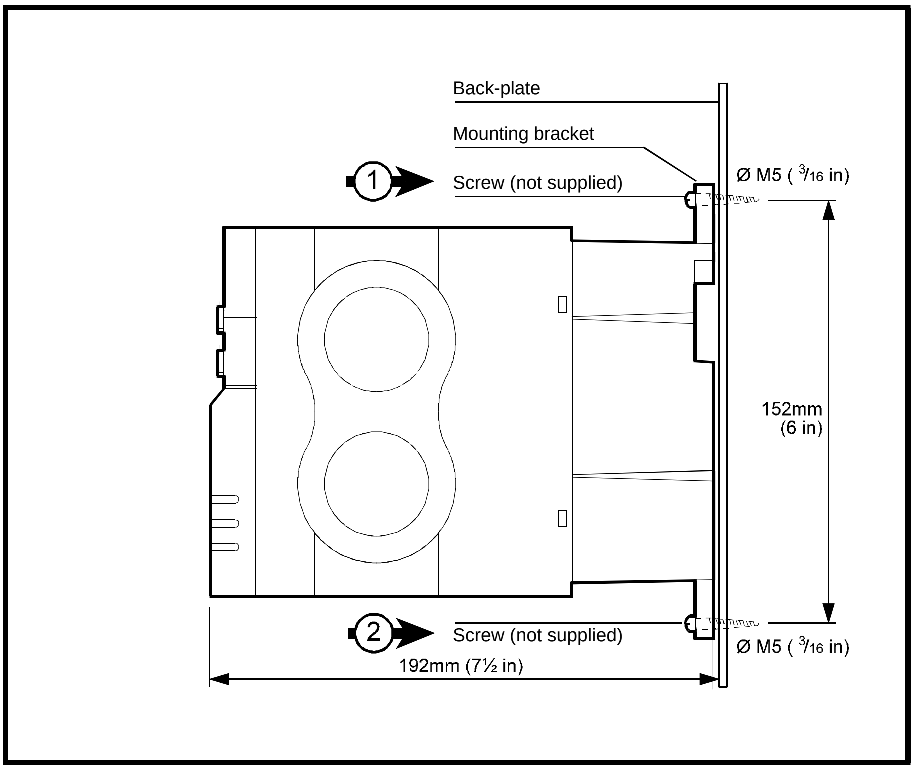



Fig. 4.11 Panel mounting the drive

1. Slide the 2 Mounting Brackets into the recesses between the fins at the top and bottom of the heatsink with the orientation as shown in the Fig. 4.9 above.

2. Insert and tighten the 2 supplied M4 Taptite screws through the Mounting Brackets and into the Heatsink.

3. Drill and tap two mounting holes 152mm (6”) vertically apart on the centre line of the back panel of the enclosure where the drive is to be installed (see Fig. 4.10 above).

4. Secure the drive via the Mounting Brackets to the back panel of the enclosure using the holes made in Step 3 above with two 5mm (3/16”) screws (not supplied). (See Fig. 4.11 above.)

### 4.5.3 Mounting the Optional RFI Filter

The RFI filter mounting arrangement is the same as for the drive, except that the filter width is only 40mm (1.6in) compared to the drive width of 75mm (3in). Therefore the above sections 4.5.1 and 4.5.2 are appropriate for the RFI filter.

The Filter Quick Reference Card provides a mounting hole template for panel mounting to ease installation.

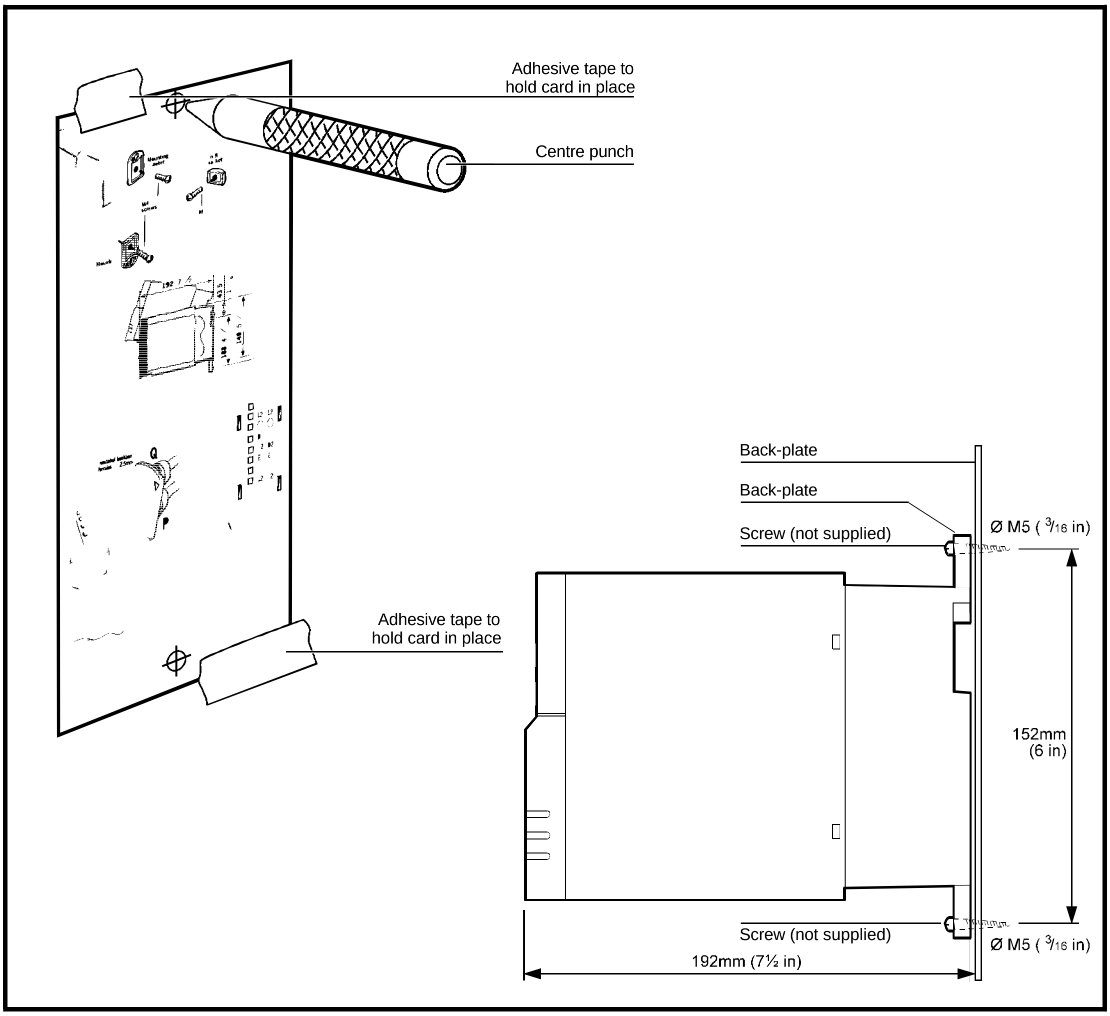



Fig. 4.12 Using the RFI Filter Quick Reference Card for panel mounting the filter

### 4.5.4 Mounting the Optional Braking Resistor

**Warning**

The Braking Resistor must be mounted so that the heat generated will not damage other local components within the panel.

If the Braking Resistor is to be mounted externally to the enclosure, it must be fitted with a strong grille to allow the heat to escape but still give protection from human contact.

Please refer to Section 5.3.4 for electrical protection and sizing of the braking resistor.

## 4.6 Cabling the Drive

The following details provide an overview to how the drive should be connected to the supply, motor, drive controller and optional RFI filter and braking resistor if used. Further details are given in Section 5, Electrical Installation, with regard to cable termination points, cable sizes etc.

### 4.6.1 Access to the Drive Terminal Chamber

All of the electrical connections to the drive are made via the Gland Plate and terminated in the chamber underneath the Terminal Cover.

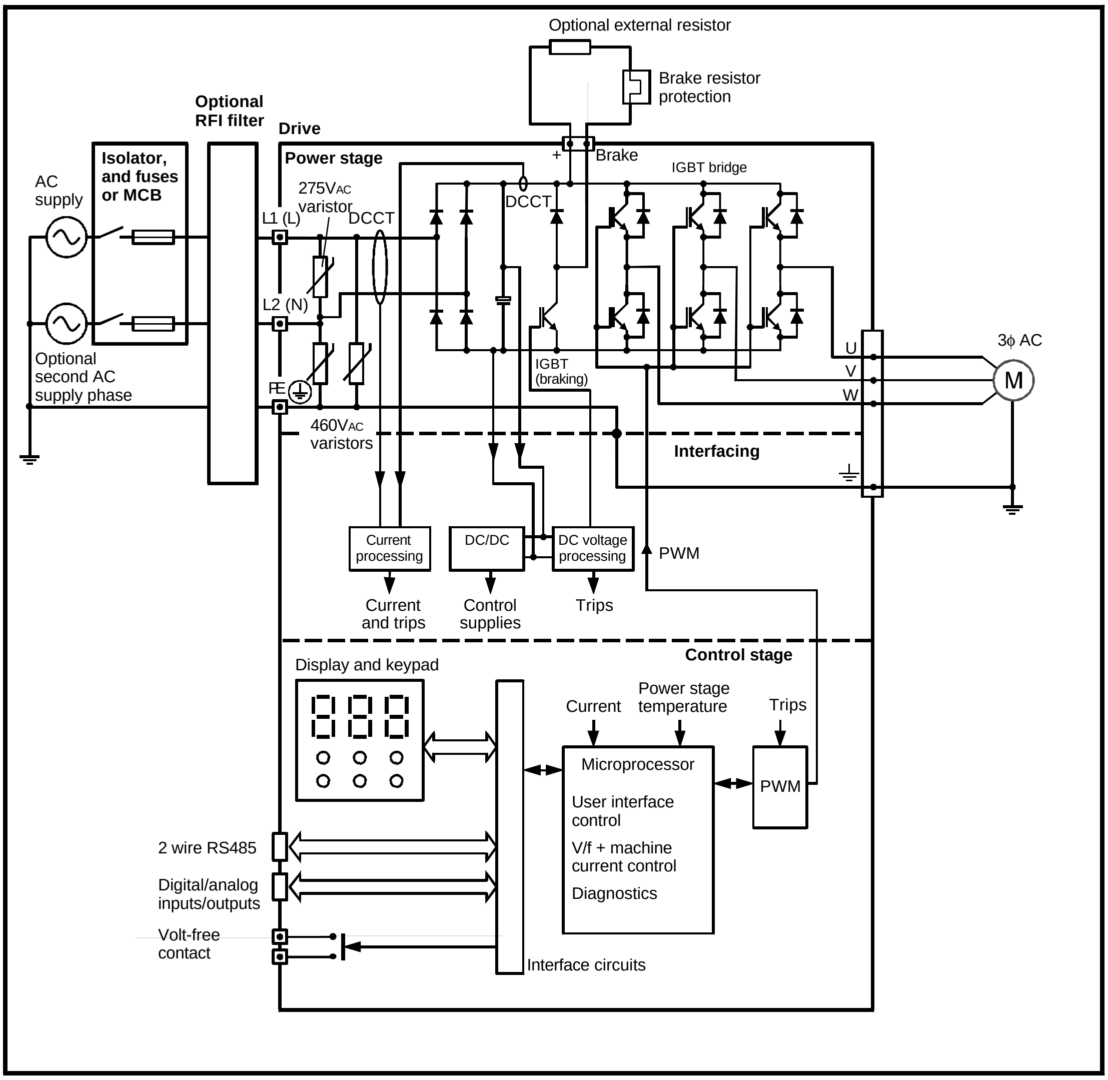



Fig. 4.13 Tool removal of the Terminal Cover for access

To gain access into the Terminal Chamber the Terminal Cover must be removed/unclipped. To do this use a ϕ3mm (1/8") flat-head screwdriver and insert into the aperture at the bottom right hand side of the drive. Push the blade up vertically until the Terminal Cover is unclipped and can then be pulled off by hand.

The Gland Plate can now be unclipped and pulled out for ease of cabling.

## 4.6.2 Gland Plate

The Gland Plate has two ϕ13mm (1/2") diameter holes and a similar sized "knockout". Depending on the installation requirement, and environmental protection that the drive needs, the Gland Plate can either be used with or without cable glands (not supplied) on either 2 or 3 positions depending on whether the "knockout" is pushed/drilled out.

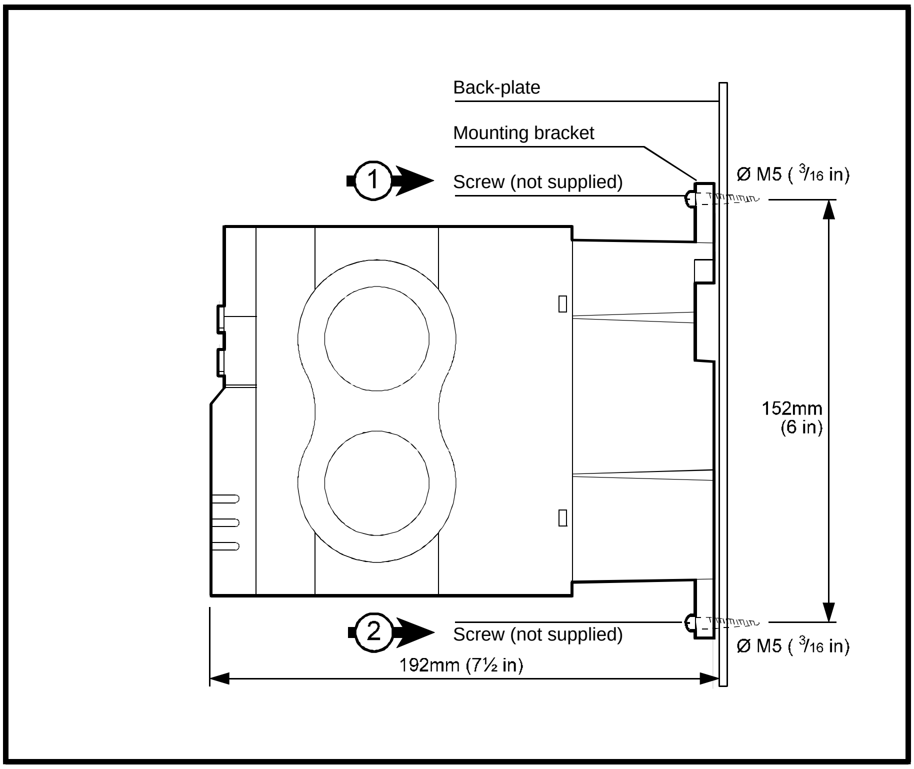



Fig. 4.14 Terminal chamber with gland plate installed prior to cabling

If suitable cable glands are used, the drive environmental classification (IP20/NEMA 1 etc.) is maintained. Without cable glands fitted, or other means of restricting access, the drive is only IP10 with no NEMA classification provided the gland plate is still fitted (otherwise IP00 if it is not).

The Gland Plate holes are allocated as follows to aid cabling; (Please note that the glands will not accept the cabling as described with shielding/screening.)

X - AC Supply Cables (Gland will accept 3 x 2.5mm$^2$/14AWG)

Y - Motor and Braking Resistor Cables (Gland will accept 6 x 1.0mm$^2$/18AWG).

Z - Control Cables (Gland will accept 10 x 0.5mm$^2$/20AWG).

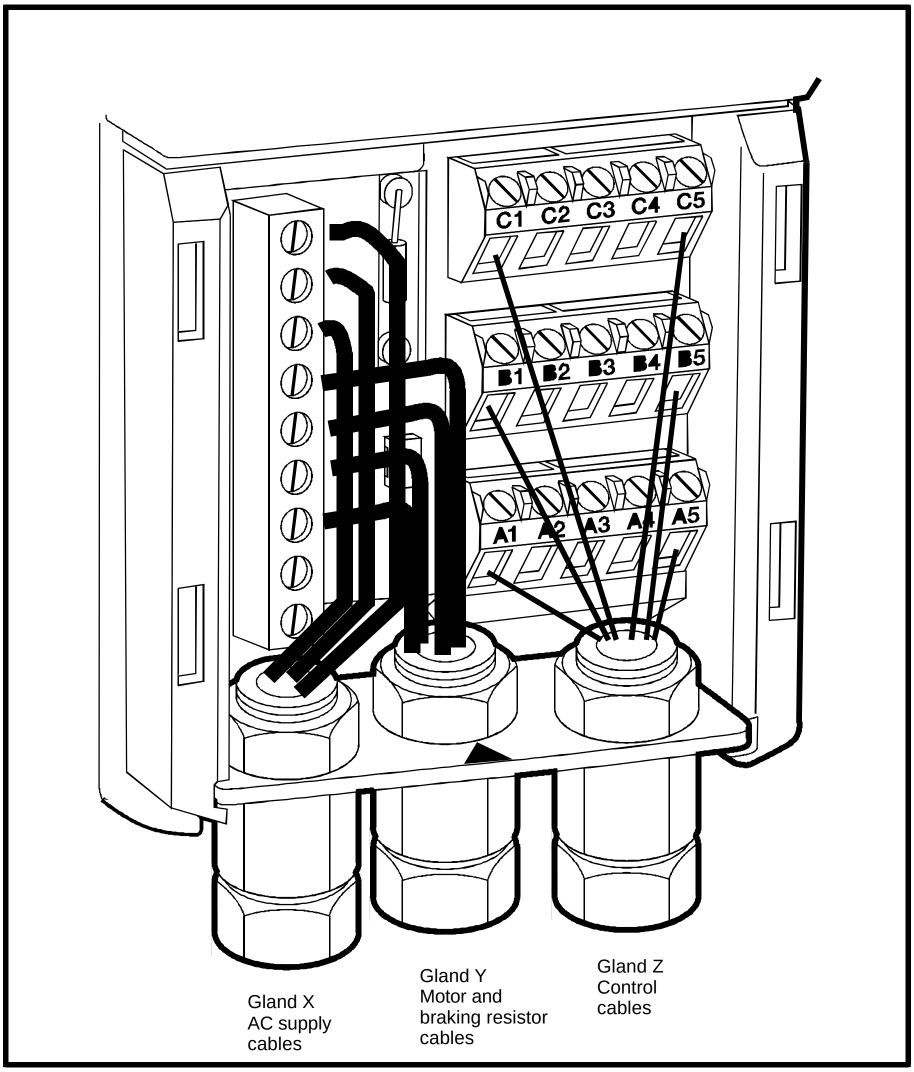



Fig. 4.15 Completed cabling using gland plate and glands

Once the cabling has been completed the Gland Plate can be snapped back into position (as indicated by the arrow on the Gland Plate), with the necessary cable glands fitted.

At this stage, the tie point in the Terminal Chamber can be used to tie any wires into position to help segregate Control from Power.

Finally, clip the Terminal Cover back into position, ensuring that the tongue aligns in the hole in the drive. See the figure below.

### 4.6.3 Cabling Notes

- Each of the Power Connector terminals can accept cables up to a total maximum 2.5mm$^2$ (12AWG) in cross sectional area. Only use a $\phi$3mm (0.125”) flat head screwdriver and only tighten up to 0.5Nm (4.4 lb.in) torque.
- Each of the Control Connector terminals can accept cables up to a total maximum of 2.5mm$^2$ (12AWG) in cross sectional area. Only use a $\phi$3mm (0.125”)screwdriver and only tighten up to 0.4Nm (3.5 lb.in) torque
- Always segregate Control and Power cabling by at least 300mm (12”) where possible.
- Segregate supply and motor cabling by at least 300mm (12”) where possible for good EMC practice.
- Use armoured, shielded cable or conduit to connect the motor to the drive where EMC emission standards must be met and the motor cable passes outside the drive enclosure. In this case connect the armour, shield or conduit to the drive and the motor frame.

4.6.4 Cabling the Optional RFI Filter

The cabling of the Filter is similar to cabling the drive. The main differences are detailed below for the Filter.

Access to the Filter Terminal Chamber and cabling are illustrated in the figures below.

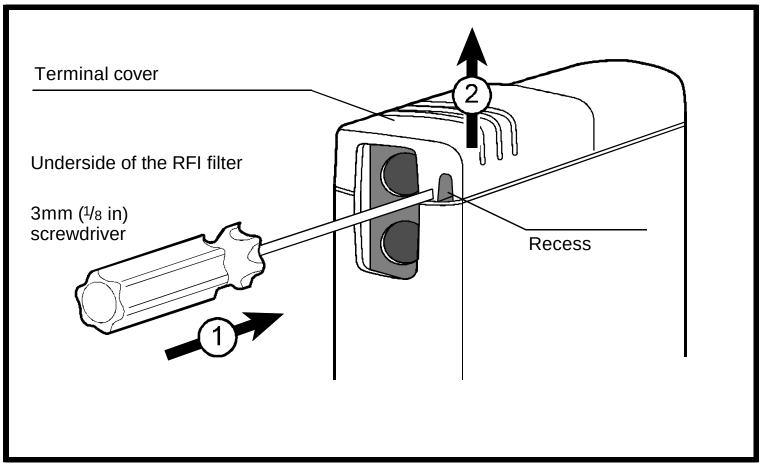



Fig. 4.16 Tool removal of the Filter Terminal Cover for access

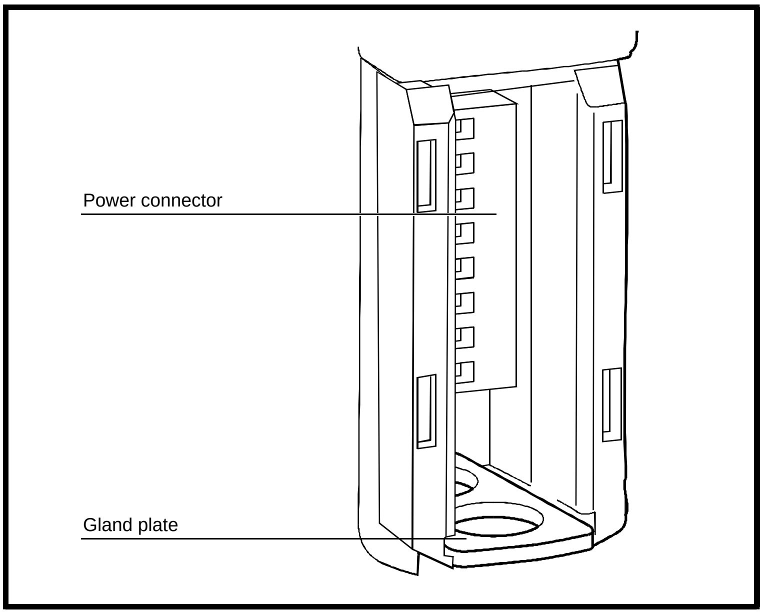



Fig. 4.17 Filter terminal chamber with gland plate installed prior to cabling

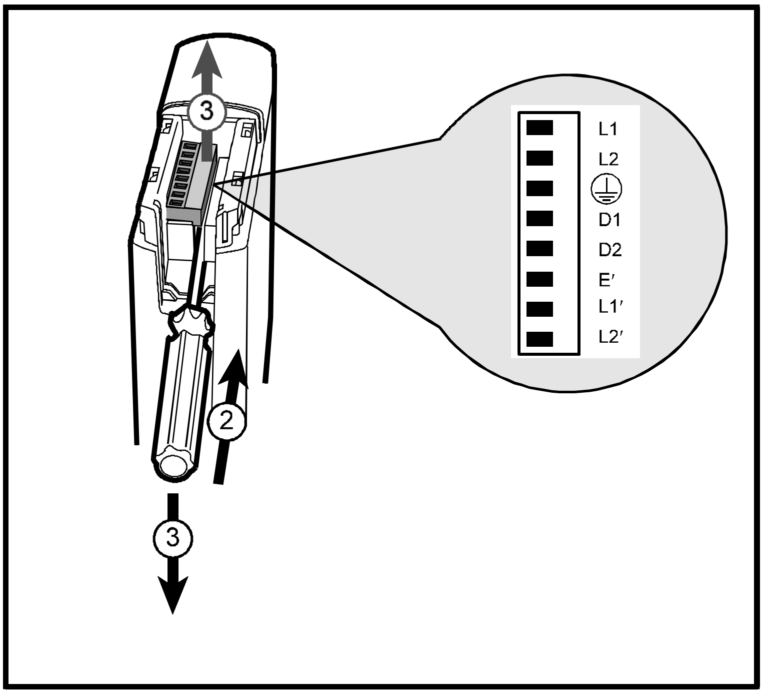



Fig. 4.18 Removing the pluggable filter terminal block to enable cabling

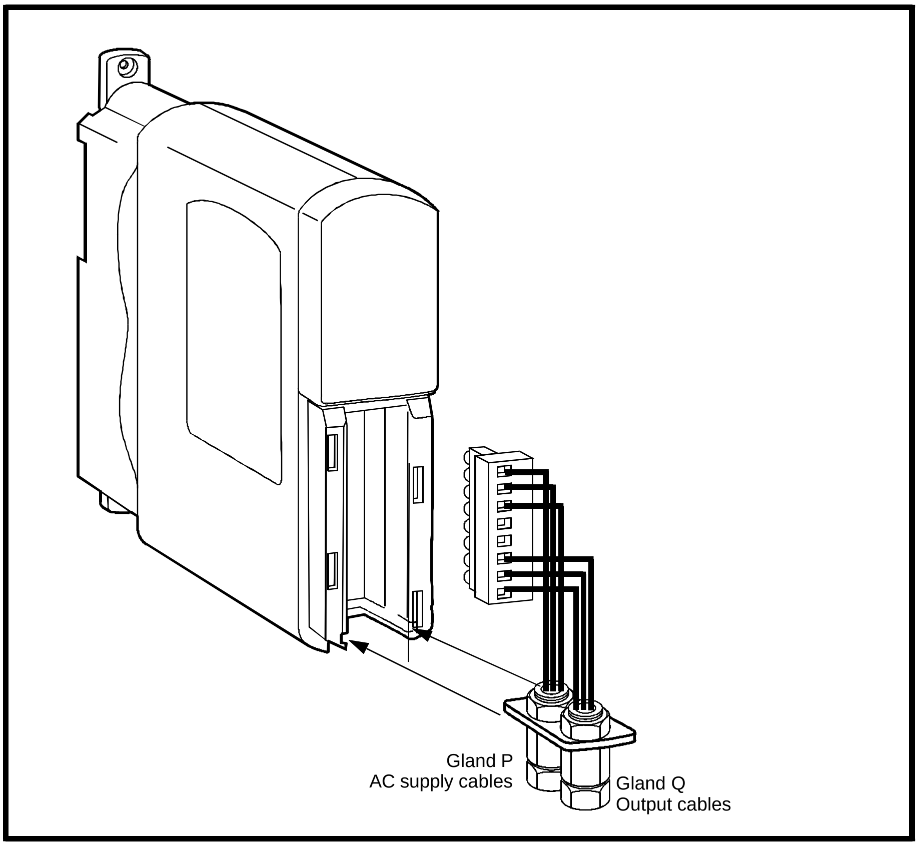



Fig. 4.19 Completed cabling using gland plate and glands prior to insertion of gland plate and plug-in terminal block

The Gland Plate holes for the RFI filter are allocated as follows to aid cabling; (Please note that the glands will not accept the cabling as described with shielding/screening.)

P - Input Supply Cables (Gland will accept 3 x 2.5mm$^2$/14AWG)

Q - Output Cables to Drive (Gland will accept 3 x 2.5mm$^2$/14AWG).

Once the cabling has been completed the Gland Plate can be snapped back into position (as indicated by the arrows on the Gland Plate), with the necessary cable glands fitted.

Finally, clip the Terminal Cover back into position, ensuring that the tongue aligns in the hole in the filter.

### 4.6.5 Cabling the Optional Braking Resistor

Cabling the braking resistor is very dependent on the resistor used. The only additional points apart from the details given in Sections 4.6.1 to 4.6.4 above, are that the cabling used must have suitable insulation with regard to the operating temperature, and have suitable screening/shielding for EMC emission standards. The braking resistor will heat the cable via conducted heat along the electrical connections. Therefore a high temperature insulation is recommended especially at the brake resistor end of the cable. (At the drive end, normal insulation is adequate.) The cable should be screened or armoured if passing outside the drive enclosure and EMC emission standards apply.

## 4.7 Enclosure Heat Dissipation Calculations

### 4.7.1 Sealed Enclosures

To maintain the correct level of cooling for the drive when it is installed in a sealed enclosure, the heat generated by <u>all</u> of the equipment within the enclosure must be included in the calculations to determine the cooling area needed (and therefore wall area for the correct enclosure size). The equation to establish the cooling area/wall area is as follows:

Ae = P/[k(Ti - Tamb)]

where: Ae is the total unobstructed heat conducting area in $m^2$, equal to the sum of all the enclosure surfaces/walls which are not in contact with any other surface.

(Note: Multiply Ae value above by 10.8 to obtain area in $ft^2$ instead of $m^2$.)

P is the total power in W dissipated by all the heat sources within the enclosure

k is the heat transmission coefficient of the enclosure material in $W/m^2/^oC$ (e.g. a value of 5.5 $W/m^2/^oC$ for typical 2mm (3/16") painted sheet steel)

Tamb is the maximum expected ambient temperature external to the enclosure in $^oC$

Ti is the maximum permissible operating temperature of the enclosure internal equipment (e.g. the drive) in $^oC$

If possible, locate heat generating equipment (apart from Braking Resistors) in the lower part of the enclosure to encourage internal convection. The best place for the Braking Resistors is external to the sealed enclosure, but if this is not feasible, site them at the top of the enclosure to avoid heating all other equipment by convection.

### 4.7.2 Ventilated Enclosures

If the ingress protection of a sealed enclosure is not required, then a ventilation fan may be used to reduce the enclosure size compared to that required for a sealed enclosure. To calculate the volume of air for the ventilation fan use the following equation:

V = 3.1kP/(Ti - Tamb)

where: V is the ventilation fan air volume in $m^3$/hour

(Note: Multiply V value above by 0.59 to obtain area in $ft^3$/minute instead of $m^3$/hour.)

P is the power in W dissipated by all the heat sources in the enclosure

Tamb is the maximum expected ambient temperature external to the enclosure in $^oC$

Ti is the maximum permissible operating temperature of the enclosure internal equipment (e.g. the drive) in $^oC$

k is the ratio of sea-level atmospheric pressure to the actual pressure at the installation (typically a safety factor of 1.20 to 1.30 should be used to allow for pressure drops due to dirty air filters).

5.0 Electrical Installation

5.1 Warnings

**Voltages/Electric Shock Risk**

The voltages present in the drive are capable of inflicting a severe electric shock and may be lethal.

The stop function of the drive does not remove dangerous voltages from the drive or the driven motor.

Mains supplies to the unit must be disconnected using an approved isolation device before any cover is removed or servicing work is performed. Wherever possible the disconnection device should be located close to and within sight of the drive.

**Stored charge - to service personnel, and to plug/socket**

The drive contains capacitors which may remain charged to a potentially lethal voltage after the supply is removed. An interval of 5 minutes must be allowed between disconnecting the supply and gaining access to the connections to the drive.

Special attention must be given if the drive is installed in equipment which is connected to the supply through a plug and socket. This is because the capacitors are connected to the drive input circuit through diodes, so that if they were to fail the plug would become “live”. If the equipment side of the plug can be touched when removed from the socket, then means must be provided for automatically isolating the plug from the drive input when it is disconnected - for example, a latching contactor.

**Protection of motor**

The drive has facilities for protecting the motor from overload either via current monitoring or a motor thermistor. The current monitoring protective function must be correctly set up in order to avoid the risk of motor over-heating in the event of electrical or mechanical failure. It will not protect the motor from over-heating at low speed, due to the reduction in the effectiveness of the cooling fan. The use of a temperature sensing thermistor in the motor winding connected to the drive thermistor trip input is recommended if operation at high torque and low speed is required.

**EMC**

The drive is designed to high standards of electromagnetic compatibility (EMC). EMC data is provided in the manual and in the EMC data sheet, including advice for achieving compliance with specific emission standards. Under extreme conditions the drive may cause or suffer from disturbance due to electromagnetic interaction with other equipment. The installer is responsible for ensuring compliance with regulations in force at the place of use.

## 5.2 Overview and Notes

### 5.2.1 Access to Electrical Connections

Refer to Section 4.6.1 and 4.6.2 giving details concerning access to the Terminal Chamber of the drive and use of the Gland Plate.

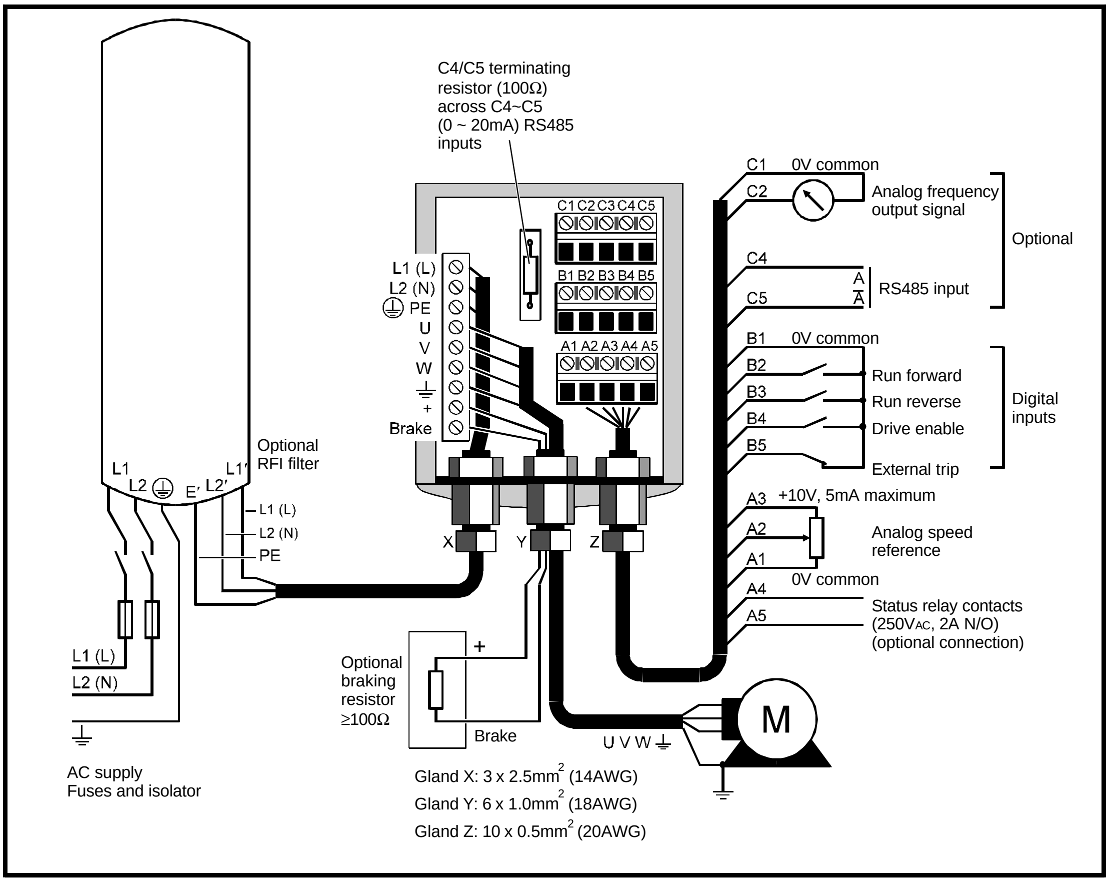



Fig. 5.1 Typical electrical connections for operation of the drive

### 5.2.2 Earthing/Ground Connections

**Earthing (grounding, equipotential bonding)**

The drive must be earthed/grounded through a conductor adequate to carry the prospective fault current.

The relevant drive connection (⏚) can be connected either via the RFI filter or directly if no filter is used.

The wiring must conform with local regulations and codes of practice.

Ground loop impedance must conform to the requirements of local industrial safely regulations. The ground connections should be inspected and tested at appropriate and regular intervals.

### 5.2.3 AC Supplies

The drive is designed to work from either one phase (220VAC nominal) and neutral (star-point) from a three phase system (380VAC nominal), or from two phases (line to line) (220VAC nominal) from a three phase system (220VAC).

The input protection within the drive ensures that the potentials between L1 to Ground, L2 to Ground, and, L1 to L2, can be within the 240V + 10% supply capability. Therefore the drive will work successfully from grounded delta supplies.

### 5.2.4 EMC Wiring Layout Recommendations

Electromagnetic Compatibility (EMC) considerations can have an important effect on the wiring arrangement.

Section 5.4 below gives guidance on wiring to prevent interference, and also where compliance with specific EMC emission standards is required. Section 4.5.3 includes instructions on mechanical installation of RFI Filters where required.

### 5.2.5 Fuses and Cable Sizes

The wiring and fusing must conform with the local regulations and codes of practice.

**Cabling, wiring regulations, fusing**

The power supply to the drive must be fitted with suitable protection against overload and short circuits. The table below shows recommended fuse ratings and cable sizes for all power connections. Failure to observe this recommendation will cause a risk of fire. In the event of a conflict with local wiring regulations, the local regulations prevail. The table is based on PVC insulated copper conductors with or without shielding as required, laid in accordance with the manufacturer's instructions.

All cable sizes are based on the 100% full load RMS currents, with a 50°C ambient temperature with multi-core cables housed in trunking/conduit.

The UL listing of this drive is conditional on the use of UL listed fuses of the following type:

Bussmann Limitron KTK-15A (fast acting type)
(600VAC 100kA breaking capacity 10.3 x 38mm Midget Fuse)

Since a current surge occurs when AC power is applied to the drive, the use of slow-blow fuses is recommended. As an alternative to fuses, an MCB (Miniature Circuit Breaker) or MCCB (Moulded Case Circuit Breaker) may be used if equipped with adjustable thermal and magnetic trip devices with suitable ratings.

| | DIN1220025A | DIN1220037A | DIN1220055A | DIN1220075A |
|---|---|---|---|---|
| Supply Fuse Rating (A)<br>(slow-blow type or<br>similar MCB, MCCB) | 6 | 6 | 10 | 16 |
| | Recommended Minimum Cross Sectional Areas Per Conductor | | | |
| AC Supply and RFI Filter Cables<br>(240VAC minimum rating) | 1.0mm$^2$<br>(18AWG) | 1.0mm$^2$<br>(18AWG) | 1.5mm$^2$<br>(16AWG) | 2.5mm$^2$<br>(14AWG) |
| Braking Resistor Cables<br>(400VDC minimum rating<br>unshielded or shielded twin) | 1.0mm$^2$<br>(18AWG) | 1.0mm$^2$<br>(18AWG) | 1.0mm$^2$<br>(18AWG) | 1.0mm$^2$<br>(18AWG) |

| | | | | |
|---|---|---|---|---|
| Motor Cables<br>(240VAC minimum rating<br>4-core unshielded/shielded or 3-core shielded) | $1.0mm^2$<br>(18AWG) | $1.0mm^2$<br>(18AWG) | $1.0mm^2$<br>(18AWG) | $1.0mm^2$<br>(18AWG) |
| Control Cables | $0.5mm^2$<br>(20AWG) | $0.5mm^2$<br>(20AWG) | $0.5mm^2$<br>(20AWG) | $0.5mm^2$<br>(20AWG) |

### 5.2.6 Cable Lengths

The cable sizes given in Section 5.2.5 do not take into account voltage drops. As a rough guide, the cables used should have a voltage drop of less than 5% of the nominal voltage. If this voltage drop is exceeded, larger cross-sectional area cables should be used to avoid loss of motor torque at high speed.

Please refer to Section 3.7.1.5 with regard to cable lengths (from the drive to the motor) and the installation meeting the relevant EMC requirements.

For cable lengths greater than 100m (330ft) between the drive and the motor please consult your supplier with regard to meeting any EMC requirements and possible drive operating problems.

### 5.2.7 Matching Motor(s) to the Drive

It is important that the motor(s) connected to the drive is(are) properly rated. In particular, ensure that the total connected motor(s) power rating is less than or equal to the drive power rating. In addition to this ensure that the total connected motor(s) current rating is less than or equal to the drive current rating. Finally ensure that the motor(s) voltage rating is similar or less than the drive AC supply voltage. For multi-motor arrangements, it is essential that each motor connected to the same drive has the same voltage rating.

5.2.8 Multi-Motor Arrangements

Where more than one motor is supplied from a single drive, individual overload protection must be provided for each motor.

Where the motor cables are long (e.g. greater than 50m (165ft)) it is recommended that a single cable is used to serially connect all motors, rather than a separate cable to each motor from the drive.

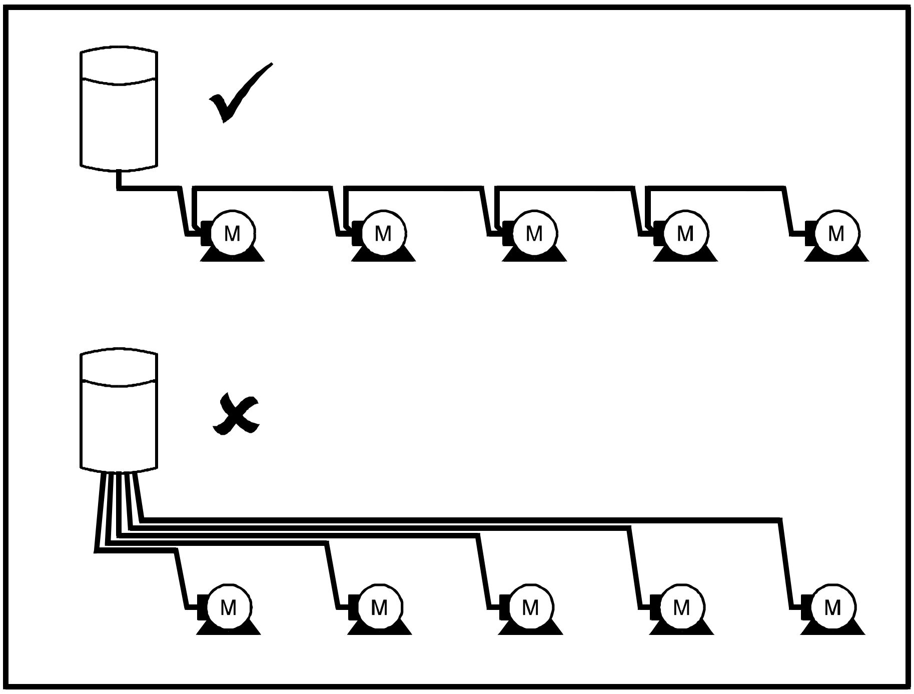



Fig. 5.2 Correct multi-motor arrangement

5.2.9 Switching the Motor to the Drive

The normal practice is not to have any disconnection means between the drive and motor, however a safety isolator/disconnect switch can be installed if required. In this situation the isolator/disconnect switch must only be operated when the drive has no supply and has internally shut-down.

Switching a stationary or rotating motor to the drive output when the drive is operating may cause the drive to trip due to the starting current surge or electrical noise from contact bounce.

Switching off a rotating motor from the drive output whilst the drive is operating is only permitted if the drive output has been first electronically disabled using one of the control inputs.

## 5.3 Power Connections

### 5.3.1 AC Supply Connections

Using the Cable Gland position X (see Fig. 5.1 in Section 5.2.1) the supply connections are routed through to the Power Connection positions (L1, L2 and Ground (include terminal symbol)).

A recommended electrical arrangement is shown as follows:- (Please refer to local wiring regulations for guidance.)

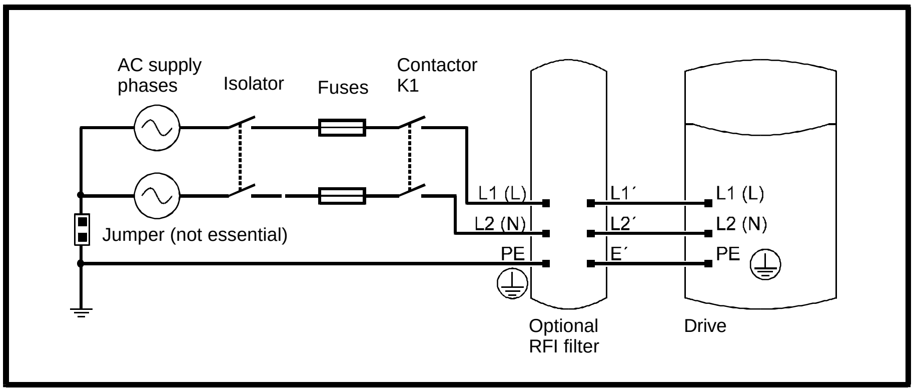



Fig. 5.3 Connecting the drive to the AC supply

A simple external on/off control arrangement for the AC supply to the drive is:

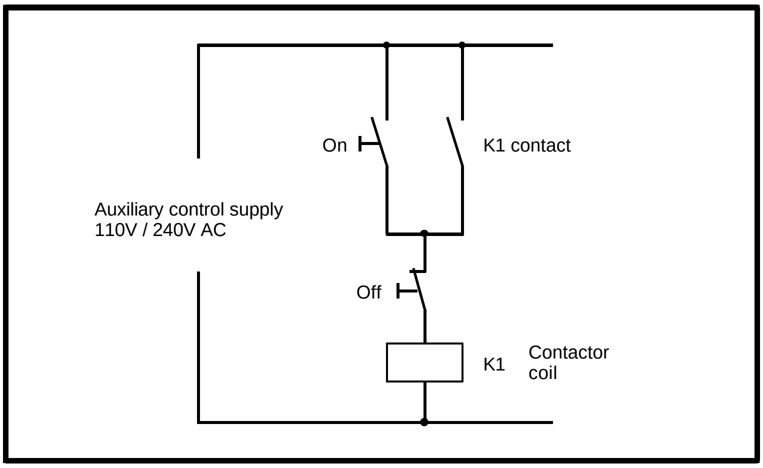



Fig. 5.4 Simple control arrangement for AC supply contactor

### 5.3.2 Motor Connections

Using the Cable Gland position Y (see Fig. 5.1 in Section 5.2.1), the motor connections are routed through to the Motor Connection positions (U, V, W and Ground (include symbol)).

The electrical arrangement is shown as follows:-

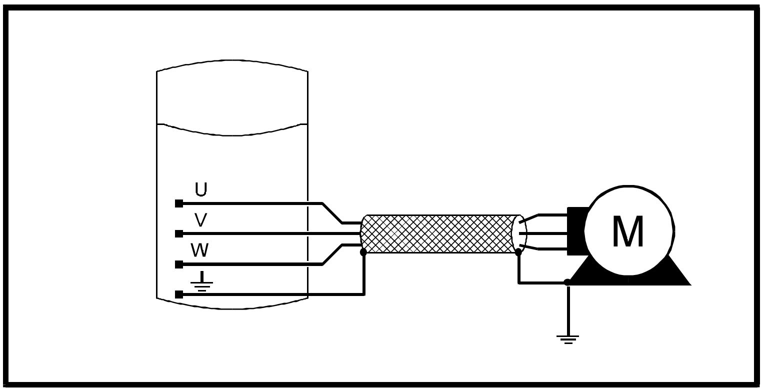



Fig. 5.5 Connecting the motor to the drive

### 5.3.3 Optional RFI Filter Connections

The filter has two modes of operation as detailed in Section 3.7.1.5 (standard mode and long cable mode). Refer to the table in Section 3.7.1.5 to decide which mode is to be used depending on the motor cable length, desired drive switching frequency and EMC specification requirements.

If the long cable mode is to be used, terminals D1 and D2 will need to be connected together using similar sized cable to that for the other filter/drive connections.

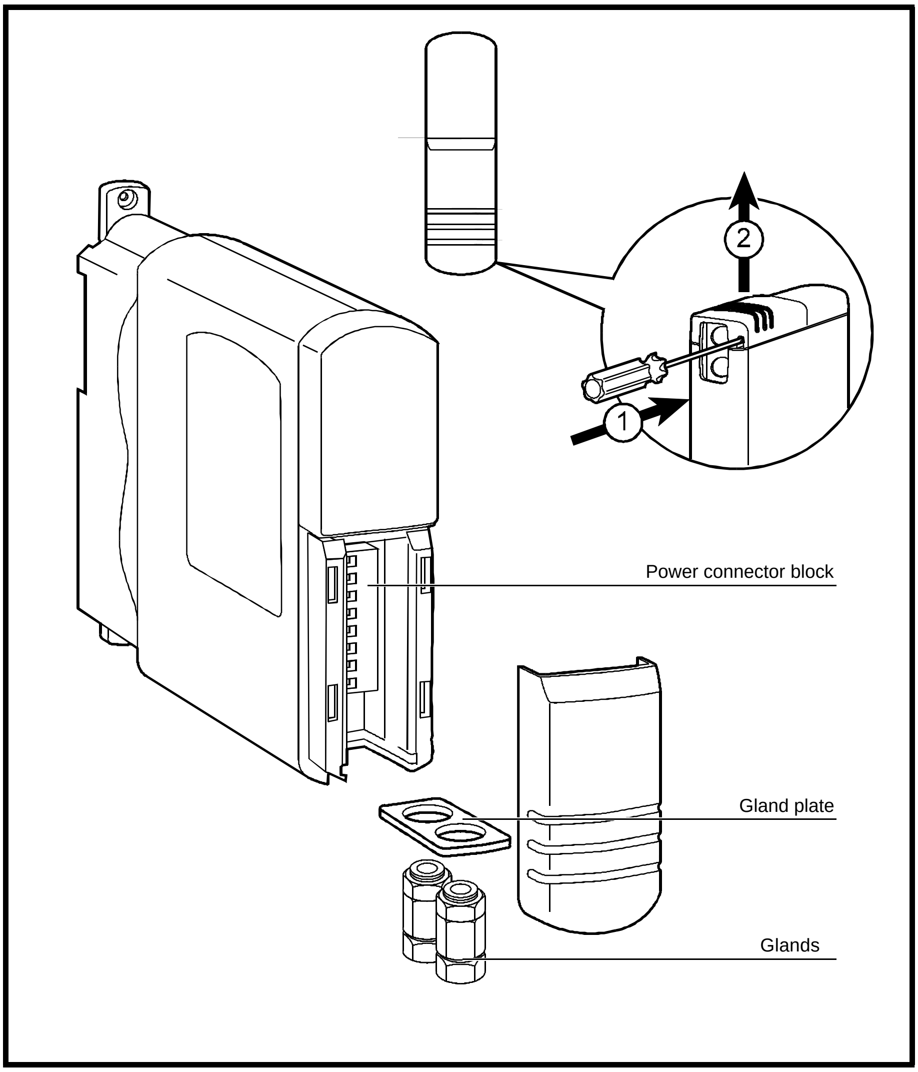



Fig. 5.6 Access to RFI Filter Terminal Chamber

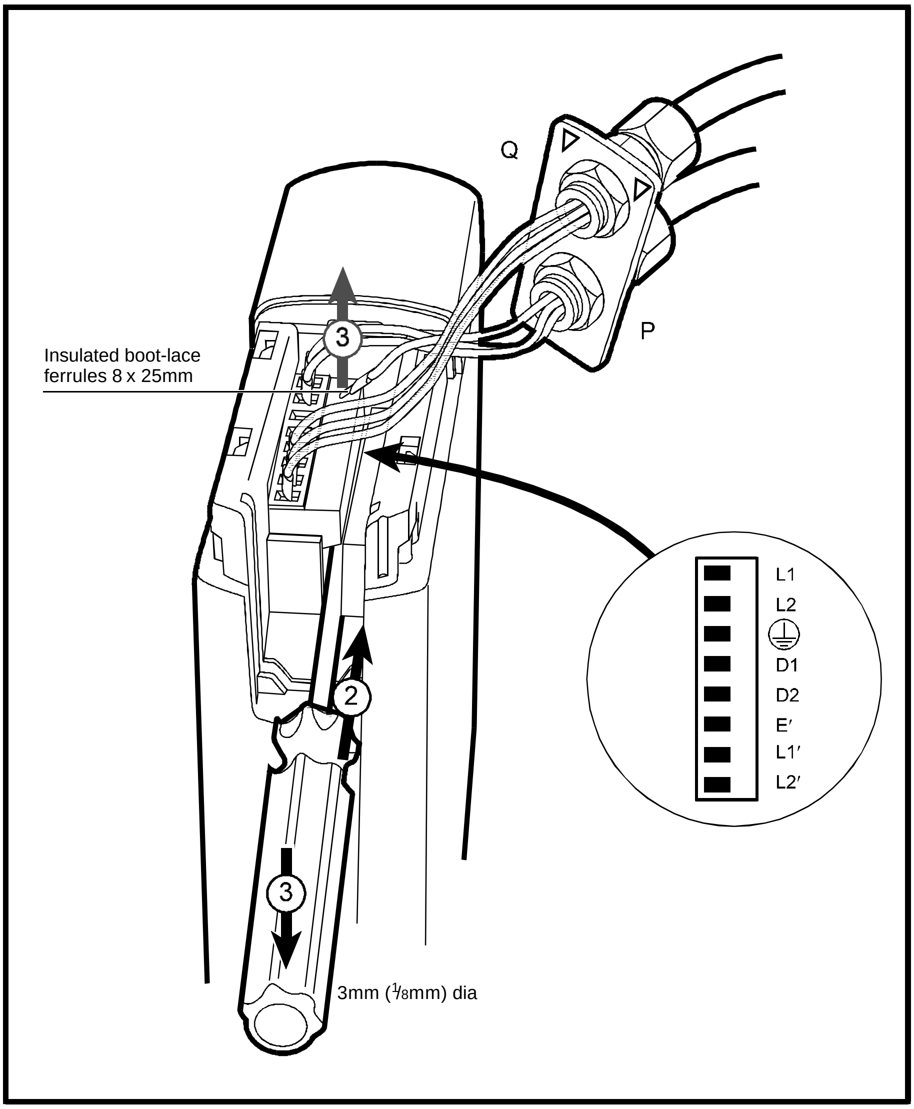



Fig. 5.7 Cabling the RFI Filter

Using the Cable Gland position P (see Fig 5.7 above) the supply to filter connections are routed through to the Power Connection positions (L1, L2 and Ground (include terminal symbol)).

Using the Cable Gland position Q (see Fig 5.7 above) the filter to drive connections are routed through to the Power Connection positions (L1', L2' and E').

Ensure the above conditions are met in order to meet the EMC specifications defined in Section 3.7.1.5.

5.3.4 Optional Braking Resistor Connections

**Braking resistors**

In the event of unexpectedly high braking energy or loss of control of the braking circuit, excessive dissipation may occur in the braking resistor. Depending on the rating, position and detailed design of the resistor this may cause a fire hazard. It is recommended that some form of protection circuit be fitted. One suitable method is a thermal overload relay, arranged to disconnect the AC supply to the drive in the event of excessive energy being supplied to the resistor.

Using the Cable Gland position Y (see Fig. 5.1 in Section 5.2.1), the brake resistor connections are routed through to the Brake Connection positions ('+' and 'Brake' (include symbol)).

The electrical arrangement is shown as follows:-

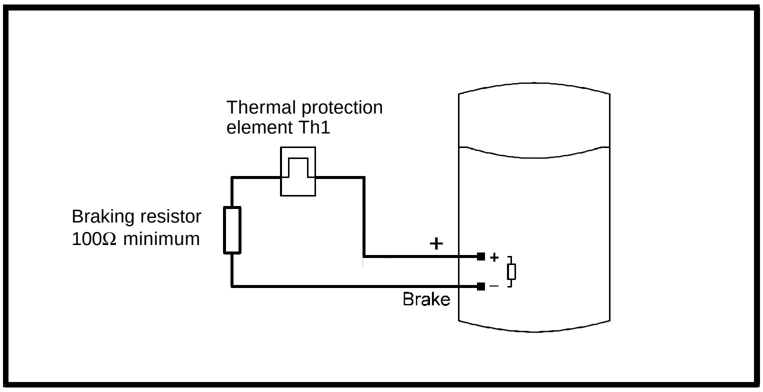



Fig. 5.8 Connecting the braking resistor to the drive

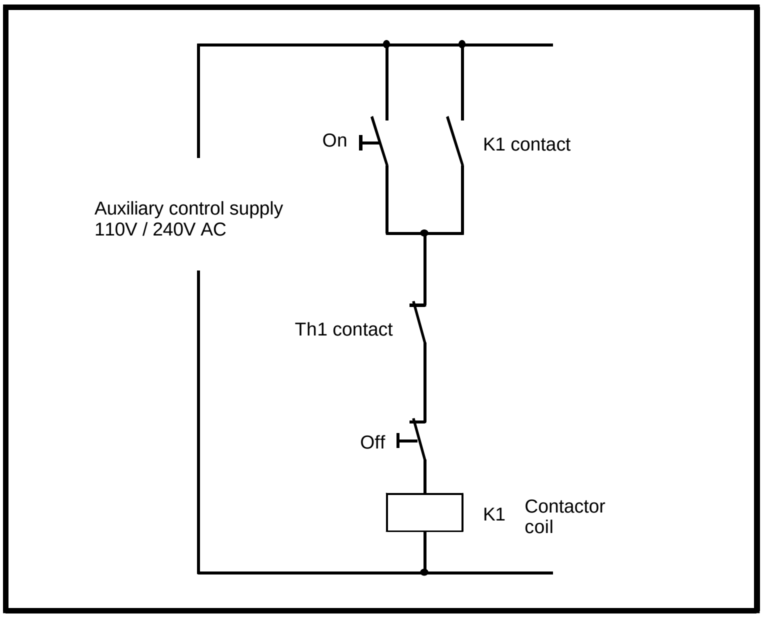



Fig. 5.9 Control protection for the braking resistor

### 5.3.4.1 Braking Resistor Sizing - Essential Requirements

Any braking resistor used must be able to tolerate the pulsed DC power that the drive applies. During drive operation, if the motor regenerates due to an overhauling load or deceleration, energy is fed back into the drive. This causes the DC bus voltage within the drive to rise, and at a nominal value of 391VDC, the brake resistor is electronically switched in circuit. The electronic switch remains closed until the DC bus voltage falls below 389VDC.

Under worst case operating conditions the braking resistor will see a transient/pulse voltage of up to 420V and must be sized to meet this surge. Therefore, with a 100Ω braking resistor the instantaneous power capability must be at least 1.8kW. Higher resistance values for the brake resistor will lower this instantaneous power requirement.

**100Ω is the minimum value of braking resistor that should be fitted.**

Recommended braking resistance values for the drives are as follows: (providing a 1.5 times continuous power braking capability, e.g.. providing (1.5 x 0.55 kW) braking capability for a 0.55kW drive).

| | DIN1220025A | DIN1220037A | DIN1220055A | DIN1220075A |
|---|---|---|---|---|
| Typical Braking Resistor Resistance | 330Ω | 220Ω | 150Ω | 120Ω |
| **Instantaneous** Peak Power Requirement<br>(based on short term<br>application of 420VDC) | 0.5kW | 0.8kW | 1.2kW | 1.5kW |

#### 5.3.4.2 Braking Resistor Sizing - Optimisation

To further optimise the braking resistor used, it is important to understand the braking requirements and the nature of the mechanical load. To this end, the peak and average regenerative power requirements need to be calculated as follows. The peak regenerative power is the peak power that is produced by the mechanical load and will eventually be dissipated by the braking resistor. The average regenerative power is the average regenerative power produced by the mechanical load. Neither of these 2 figures affect the instantaneous peak power requirement of the braking resistor (given in Section 5.3.4.1 above) as this instantaneous power is defined by the drive operation and is not influenced by the mechanical load.

The figure below shows the braking power for a motor/drive during a typical speed cycle.

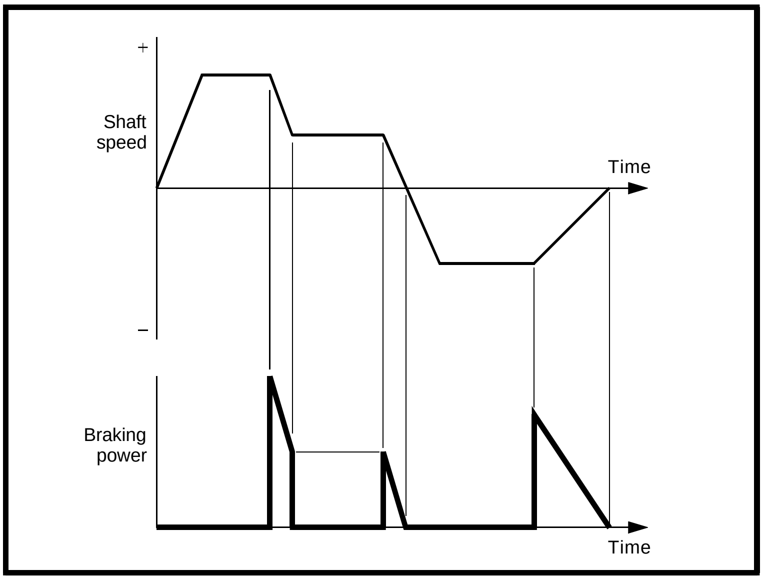



Fig. 5.10 Braking power for various shaft speed changes

The maximum power (Pmax) that the resistor must dissipate is dependent on the required motor deceleration, initial deceleration speed and the load inertia (ignoring losses and loading), as follows:

Pmax = J x (angular deceleration in rad/sec2) x (initial angular speed in rad/sec)

= 100.(fmax). J.(4π/p)2/(tmin)

where:
fmax maximum operating frequency of the drive in Hz

J Total inertia referred to motor in kg.m2.

p Number of motor poles (e.g. 2,4, 6 or 8 as set in #0.42 etc.)

tmin Minimum required deceleration time parameter (#0.04) set in the drive as seconds/100Hz.

If inertia is given in lb.ft2 then the above constant of 100 becomes 2375.

If Pmax is greater than 1.5 times the drive power a larger drive is necessary to achieve the desired deceleration.

If Pmax is less than 0.2 times the drive power rating a braking resistor is usually not necessary, as the power should easily be dissipated in the motor and drive losses.

Once the value of Pmax is calculated, the applicable braking resistor value can be determined as follows:

$$R \le (390)^2/P_{max}$$

where: R Resistance in ohms of Braking Resistor (select the next lower preferred value)

390 is the nominal DC voltage applied to the Braking Resistor

provided $R \ge 100\Omega$

The braking resistor will also require a continuous or average power rating for correct sizing. To calculate the average power required, the energy loss (Eloss) per braking cycle must first be known.

$$E_{loss} = (0.5).\ J.\ (4\pi/p)^2.\ (f_1^2 - f_2^2)$$

where: Eloss Energy to be removed in Joules

J Total inertia referred to motor in $kg.m^2$.

p Number of motor poles (e.g. 2,4, 6 or 8 as set in parameter #0.42.)

f1 Highest operating frequency of motor in Hz

f2 Minimum frequency of motor after deceleration (typically 0) in Hz

Therefore, from consideration of the duty cycle, the average power dissipation (Pav) is as follows:

$$P_{av} = E_{loss}/ (t_1 + t_2)$$

where: Eloss Energy to be removed in Joules

t1 Duration of braking period in seconds

t2 Time between braking periods in seconds

Fig. 5.11 below illustrates how the braking resistor characteristic must meet the various limits calculated above. (The resulting braking resistor characteristic also provides a characteristic that the thermal protection device must have. The thermal protection device must have a characteristic that matches (but still protects) the braking resistor whilst still allowing the brake resistor to provide the drive braking control required.) The (Pmax/2) and (tdecel/2) terms are the average power and times for a linear deceleration from fmax where the initial deceleration power is Pmax.

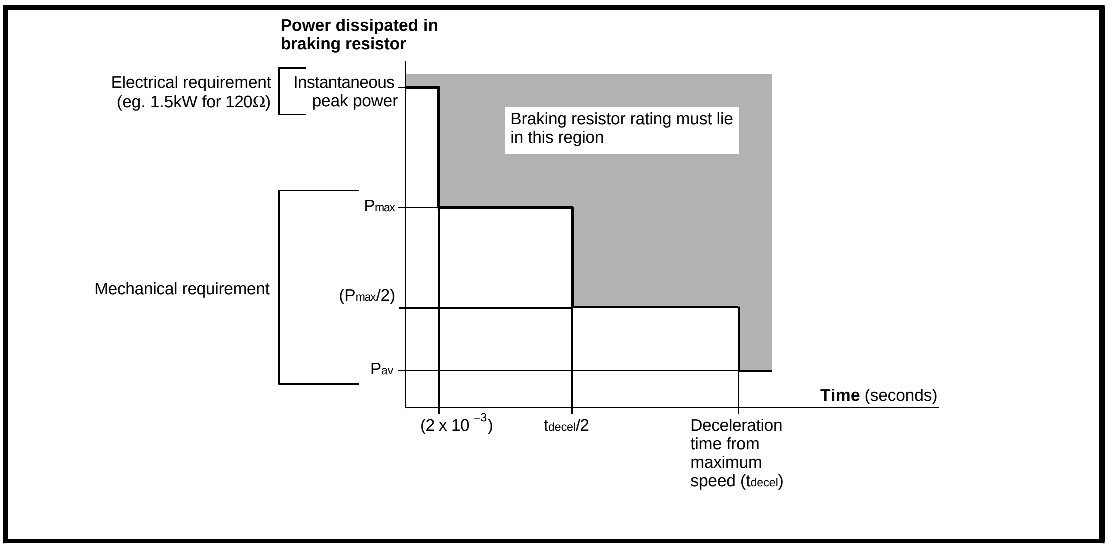



Fig. 5.11 Braking resistor rating requirements

## 5.4 EMC Considerations

### 5.4.1 General Principles

These Drives 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 the Drives correctly, including using the specified RFI Filters. The Drives 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. The Dinverter A EMC Data Sheet is also available giving detailed EMC information.

These Drives will comply with the standard for emission, EN50081-2, only if the instructions given in Section 5.4.3 are followed closely.

### 5.4.2 Routine EMC Precautions

These precautions are recommended where strict compliance with emission standards is not required. The risk of disturbing adjacent electronic equipment is minimised by following these precautions. Where the drive is installed in a residential area, or adjacent to sensitive electronic equipment using radio receivers or similar, it is recommended that the full precautions given in Section 5.4.3 are taken.

**Enclosure**

Install the Drive(s) in a metal enclosure. This does not need to be a special EMC enclosure.

**Motor Cable**

Ensure that the motor cable is shielded and its length does not exceed 100m (330ft).

**Wiring Guidelines**

Observe the wiring guidelines given in the following figure and attached key. The details of individual installations may vary, but details which are indicated in the figure to be important for EMC must be strictly adhered to.

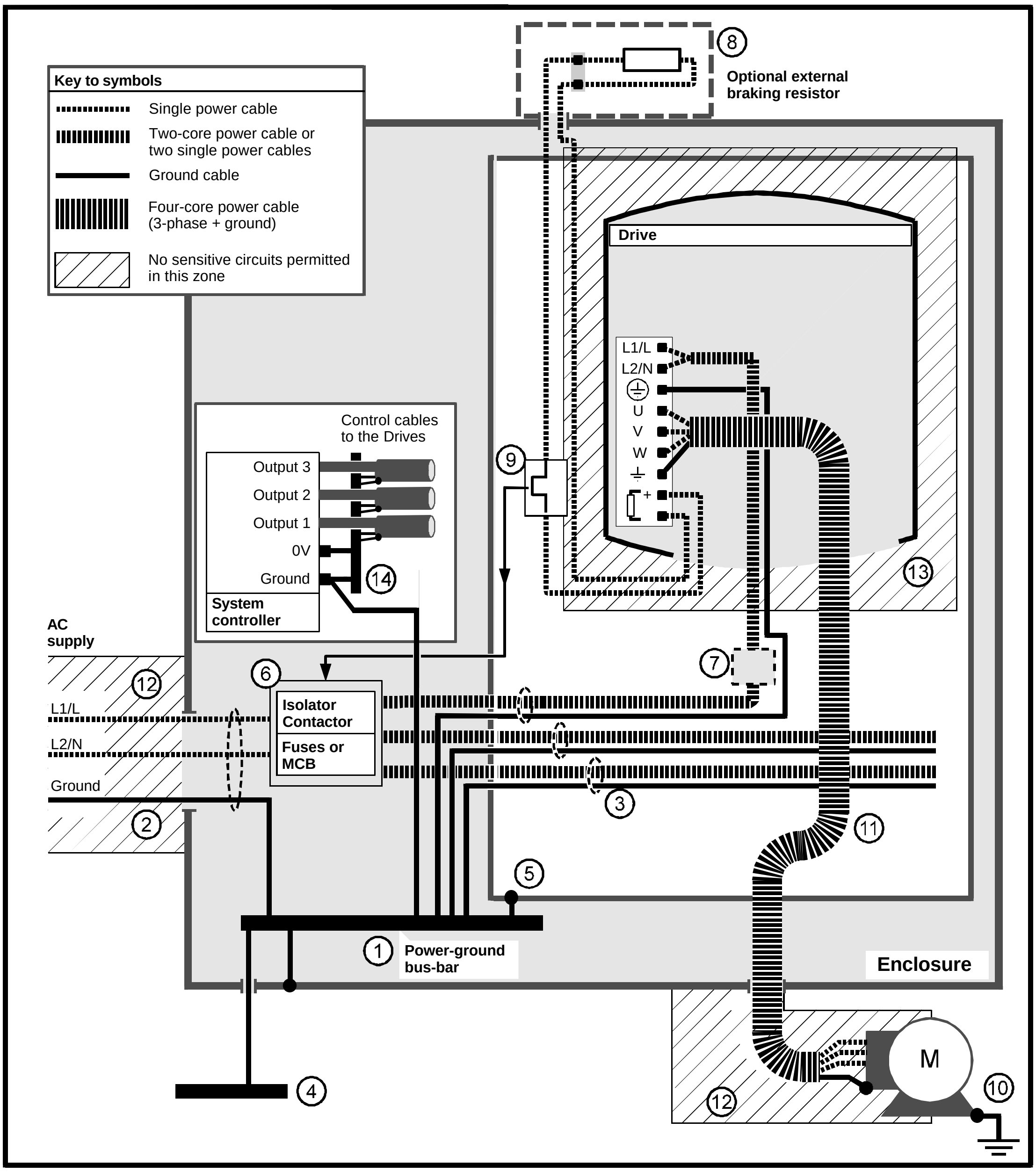



Fig. 5.12 Wiring guidelines for Dinverter A drive - routine EMC precautions

The numbers in the above figure relate to the following recommendations:

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. Optional braking resistor mounted externally, protected and shielded by a metal grille.

9. Thermal overload device to protect the braking resistor.

10 Motor-frame ground connection, if required.

Routine EMC precautions:

11. 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 busbar.

12. 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 ft), ensure that the separation is at least 0.3m (12in).

- 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 x 40 / 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 and grounded at the drive only (as shown in Fig. 5.19 later).

13. Do not place sensitive signal circuits in a zone extending 0.3m (12in) all around the drive.

14 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.

### 5.4.3 Compliance with EMC Emission Standards

**Enclosure**

Install the Drive(s) in a metal enclosure. This does not need to be a special EMC enclosure.

**Motor Cable**

Ensure that the motor cable is shielded and its length does not exceed 100m (330ft).

**Wiring Guidelines**

Observe the wiring guidelines given in the following figure and attached key. The details of individual installations may vary, but details which are indicated in the figure to be important for EMC must be strictly adhered to.

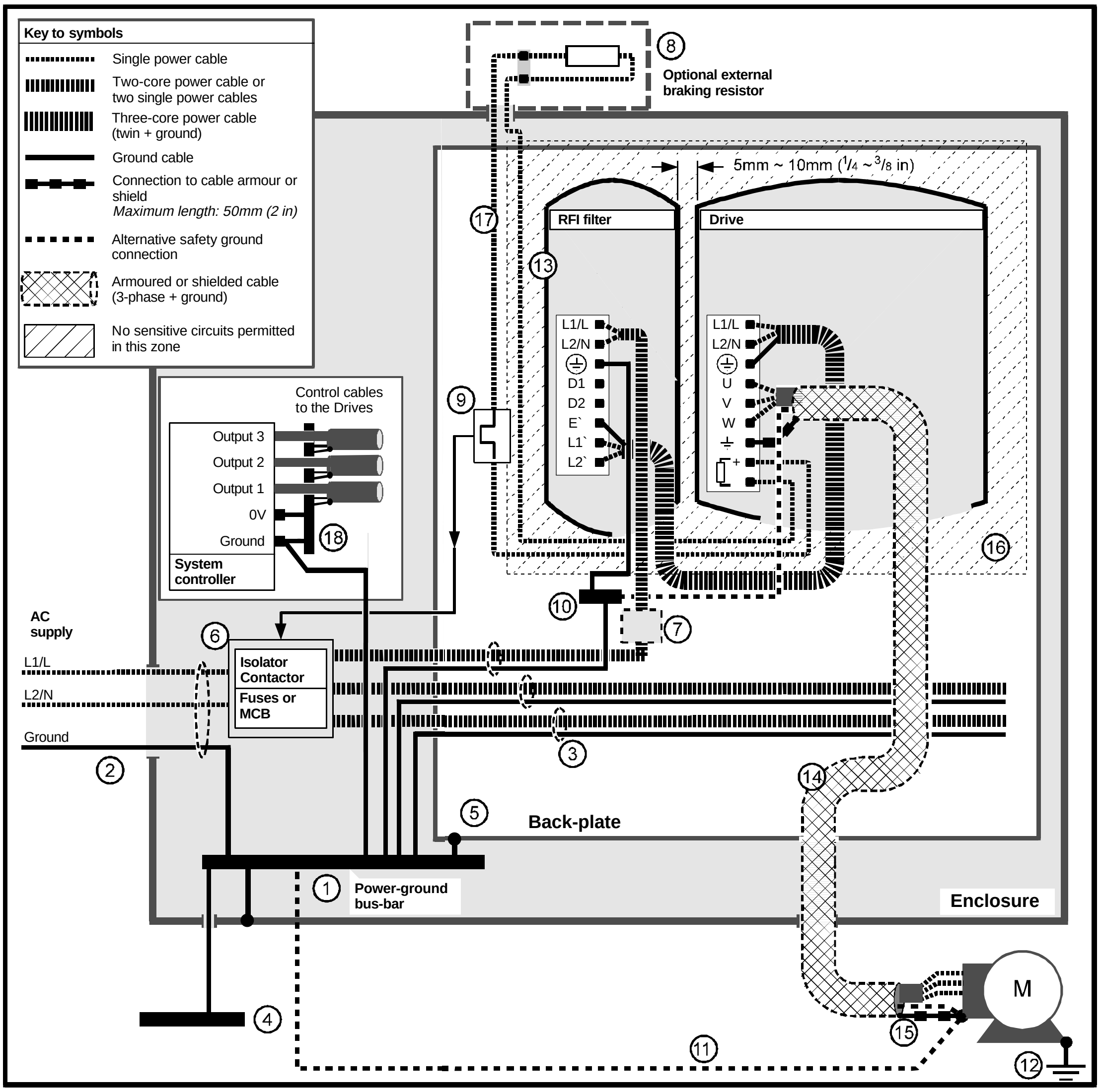



Fig. 5.13 Wiring guidelines for Dinverter A drive to meet EMC emission standards

The numbers in the above figure relate to the following guidelines:

General features:

1. Single power ground busbar, or low impedance ground terminal.
2. Incoming AC supply ground connected to the power ground busbar.
3. Connect grounds of any other circuits to the power ground busbar.
4. Site ground if required.
5. Metal back-plate, safety bonded to the power ground busbar.
6. System isolator, circuit contactors and fuses/MCB.
7. Alternative position for the 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. When the motor ground connection is made at the drive, fit a local ground busbar close to the drive.
11. Alternative safety ground for the motor.

12. Motor-frame ground connection, if required.

    Routine EMC precautions:

13. Mount the RFI filter at the left side of the drive.  Ensure a separation of 5 to 10mm (0.25 to 0.375in) from the drive.  Minimise the length of cables between the drive and the RFI filter.

14. A shielded (screened) or steel wire-armoured cable must be used to connect the drive to the motor.  The shield of the cable must be connected to the motor ground terminal in the drive by a connection no longer than 50mm (2in).

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 (2in) in length.

16. Do not place sensitive signal circuits in a zone extending 0.3m (12in) all around the 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 (12in) from signal wiring and the AC supply wiring to the RFI filters.

18. If the control circuit 0V Common is to be grounded, this should be done at the host controller (e.g. PLC) and not at the drive.  This is to avoid injecting noise currents into the 0V Common circuit.

#### 5.4.3.1 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/armour 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.

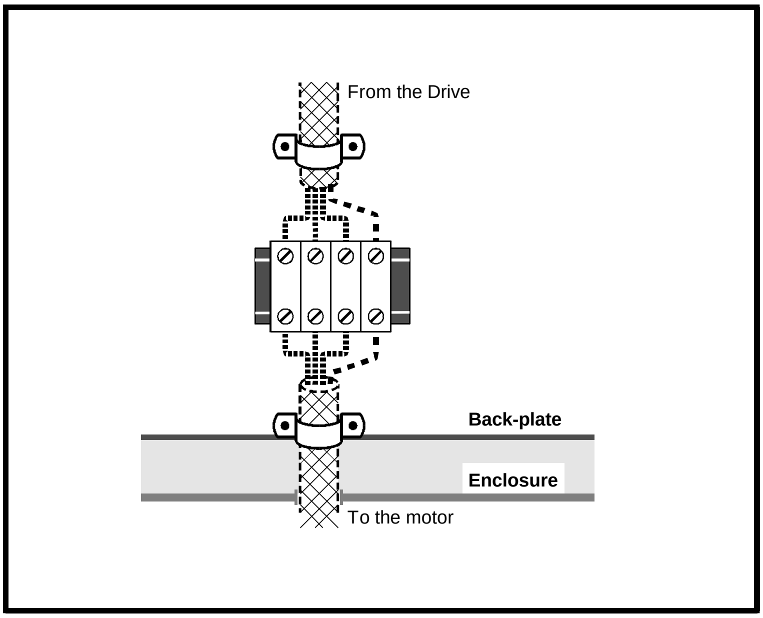



Fig. 5.14 Connecting the motor cable to a terminal block in the enclosure (Refer to Key to Symbols in Figs. 5.13)

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/earthed to a known low-impedance ground/earth nearby, for example a large metallic structure which is connected closely to the drive ground.

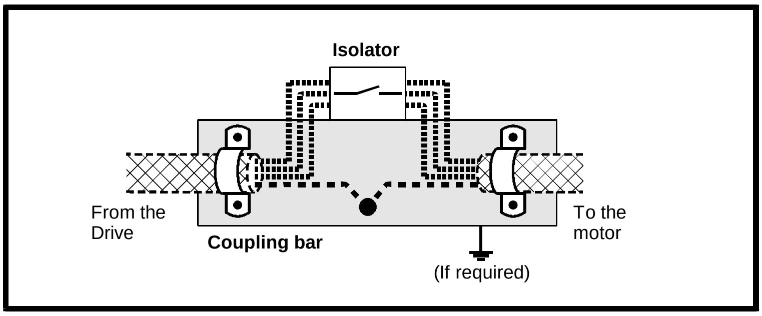



Fig. 5.15 Connecting the motor cable to an isolating switch (Refer to Key to Symbols in Figs. 5.13)

### 5.4.3.2 Braking Resistor Wiring External to the Drive Enclosure

Shielded cable must be used when the wiring to an optional braking resistor runs external to the enclosure. The cable shields should be bonded to the enclosure back-plate using uninsulated metal cable-clamps which should be positioned as close as possible to the thermal protection device as shown in Fig. 5.16 below. In addition, both the brake resistor cable and the motor cable should be bonded to the back-plate as close as possible to the drive using similar cable-clamps. Keep the length of exposed power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away.

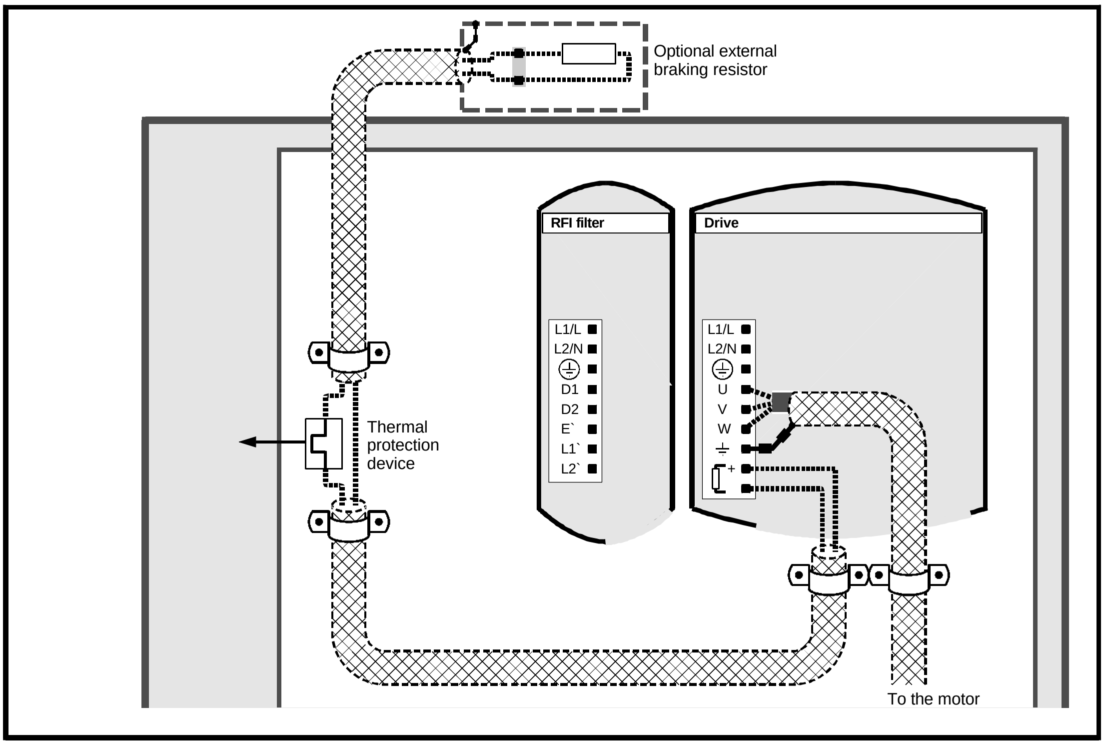



Fig. 5.16 Braking resistor wiring external to the drive enclosure (Refer to Key to Symbols in Figs. 5.13)

## 5.5 Control Connections

**Isolation of control circuits, wiring requirements**

The control circuits and terminals are isolated from power circuits, but they are separated by basic insulation only. The installer must ensure that all control circuits are separated from human contact by at least one layer of insulation rated for use at the mains potential.

If the control circuits are to be connected to other circuits classified as Safety Extra Low Voltage (SELV) - for example, to a Personal Computer - a further isolating barrier must be included if the SELV classification is to be maintained.

There is a high resistance connection within the drive between the power and control circuits. A typical resistance is 3.3MΩ. Where testing of power circuit insulation is carried out as a safety check, this resistance value will be observed. If it is too low for a satisfactory test, the drive input must be temporarily disconnected for the test.

**Note**

If the 0V Common connection is to be grounded, this should be done at the controller (e.g. PLC) not at the drive, to avoid injecting noise currents into the 0V circuit.

Using the Cable Gland Position Z (see Fig. 5.1in Section 5.2.1), the control connections are routed through to the Control Connector positions (A1, A2, ..... A5, B1, ...... B5 and C1, .......C5).

### 5.5.1 Positive/Negative Digital Input Logic

The drive is supplied operational with negative logic (i.e. control inputs are active when 0V signals referenced to 0V Common are applied). The connection examples shown in the remainder of this Section 5.5 (and all other parts of this Guide) apply to negative logic.

To select positive logic (i.e. control inputs activated by +24VDC signals, e.g. from a higher level control such as a PLC) adjust the parameter #8.27 (Select digital input (B2/B3/B4/B5/C3) positive logic -see Section 9.9).

[#8.27] = 0 negative digital input logic (default as supplied)

[#8.27] = 1 positive digital input logic.

When a drive with negative logic is controlled by a positive logic PLC, the drive may start automatically when power is applied.

The electrical connection arrangement for all the Control Terminals is given in the following Sections 5.5.2 to 5.5.4.  (See Section 3.5 for the full drive Control Terminal specifications.)

## 5.5.2 Control Terminal Block 'A1' to 'A5'

Default arrangement :

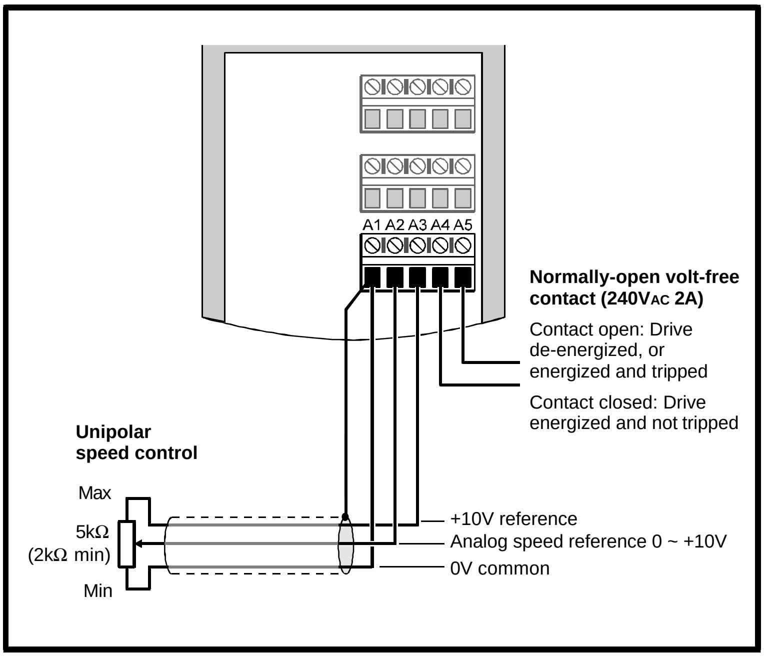



Fig. 5.17 Default electrical control connections for Terminals A1 to A5

| Control Terminal | Default Configuration | Optional Configurations | Relevant Parameters |
|---|---|---|---|
| A1 | 0V Common | - | - |
| A2 | 0 to +10V Analogue Input 1<br><br>(Frequency (/‘speed’) reference) | -10V to +10V Analogue Input see Fig. 5.18<br><br>Motor Thermistor Input<br><br>see Fig. 5.19 | #7.06 Analogue input 1 (A2) mode selector<br><br>#7.08 Analogue input 1 (A2) scale factor #7.09 Invert analogue input 1 (A2)<br><br>#7.10 Analogue input 1 (A2) destination selector<br><br>#1.10 Select bipolar frequency reference |
| A3 | +10V Reference | - | - |
| A4 and A5 | N/O Contact indicating Drive Healthy when contact closed | - | #8.25 Relay output (A4/A5) source selector<br><br>#8.26 Invert relay output (A4/A5) |

Optional arrangements:

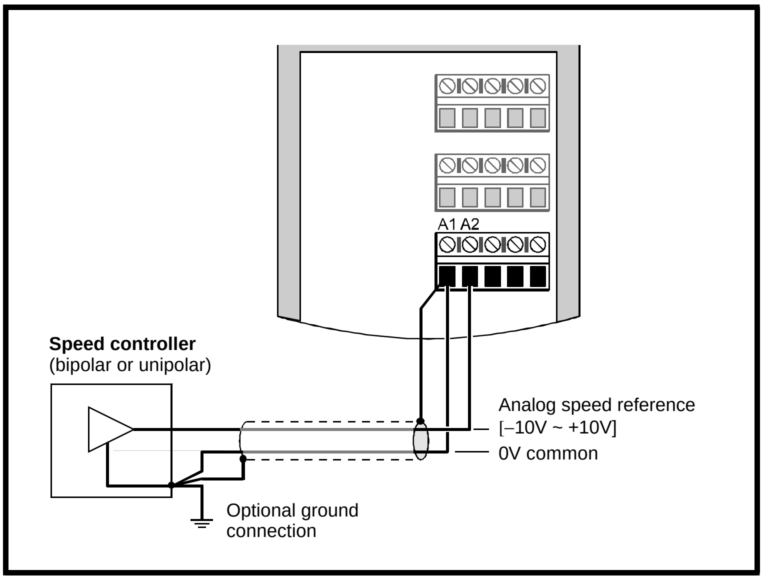



Fig. 5.18 Optional bipolar analogue voltage input for Terminal A2

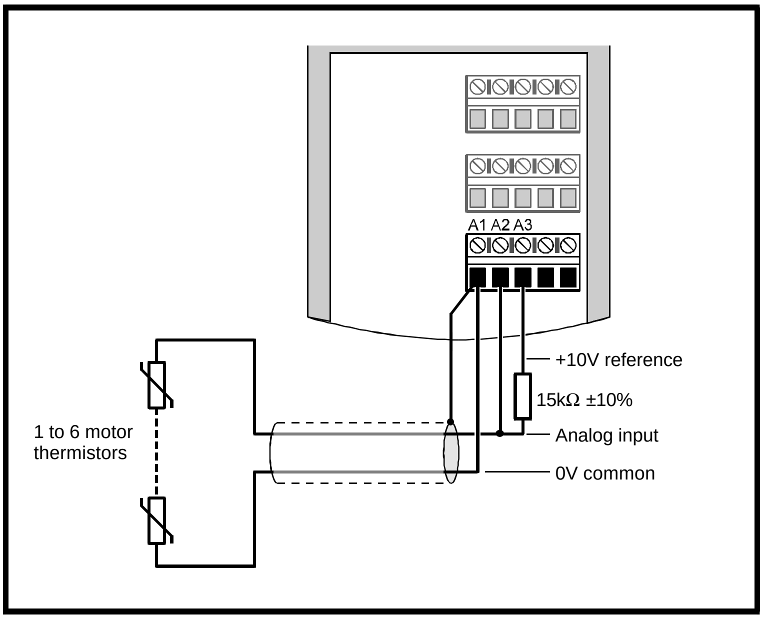



Fig. 5.19 Optional motor thermistor input arrangement for Terminal A2

5.5.3 Control Terminal Block ‘B1’ to ‘B5’

Default Arrangement:

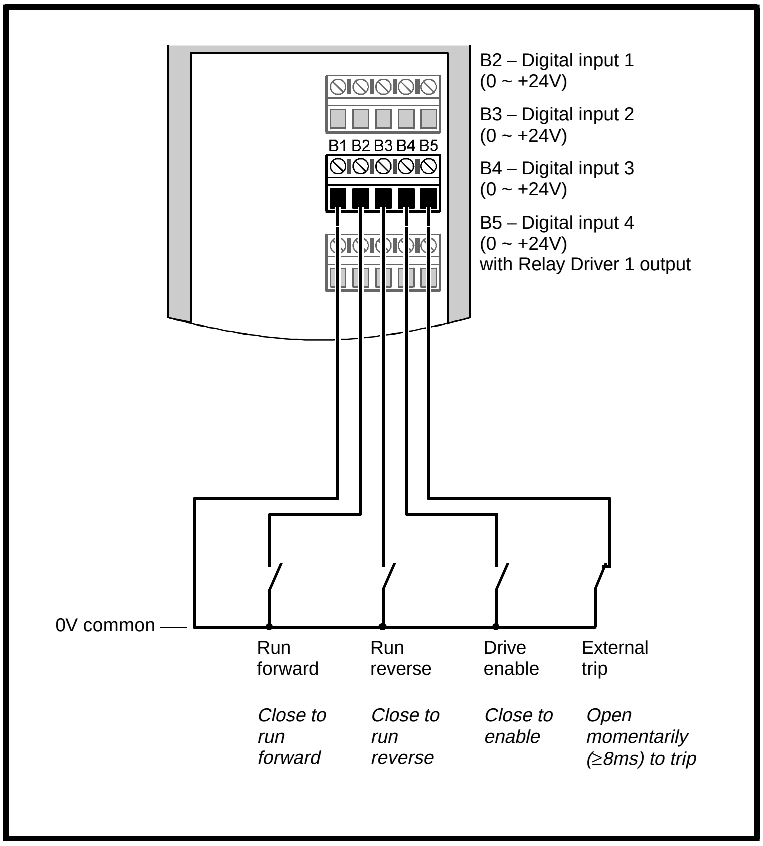



Fig. 5.20 Default electrical control connections for Terminals B1 to B5

| Control Terminal | Default Configuration | Optional Configurations | Relevant Parameters |
|---|---|---|---|
| B1 | 0V Common | - | - |
| B2 | 0 to +24V Digital Input 1<br><br>(Run forward) | - | #8.16 F3 input (B2) destination selector<br><br>#8.17 Invert F3 input (B2)<br><br>#8.27 Select digital input positive logic |
| B3 | 0 to +24V Digital Input 2<br><br>(Run reverse) | - | #8.19 F4 input (B3) destination selector<br><br>#8.20 Invert F4 input (B3)<br><br>#8.27 Select digital input positive logic |
| B4 | 0 to +24V Digital Input 3<br><br>(Enable) | - | #8.21 F5 input (B4) destination selector<br><br>#8.22 Invert F5 input (B4)<br><br>#8.27 Select digital input positive logic |
| B5 | 0 to +24V Digital Input 4<br><br>(External trip) | Relay Driver 1 Digital Output (see Fig. 5.21 below) | #8.10 F1 input (B5) destination/output source selector<br><br>#8.11 Invert F1 input/output (B5)<br><br>#8.12 Activate output 1 (B5)<br><br>#8.27 Select digital input positive logic |

Optional arrangements:

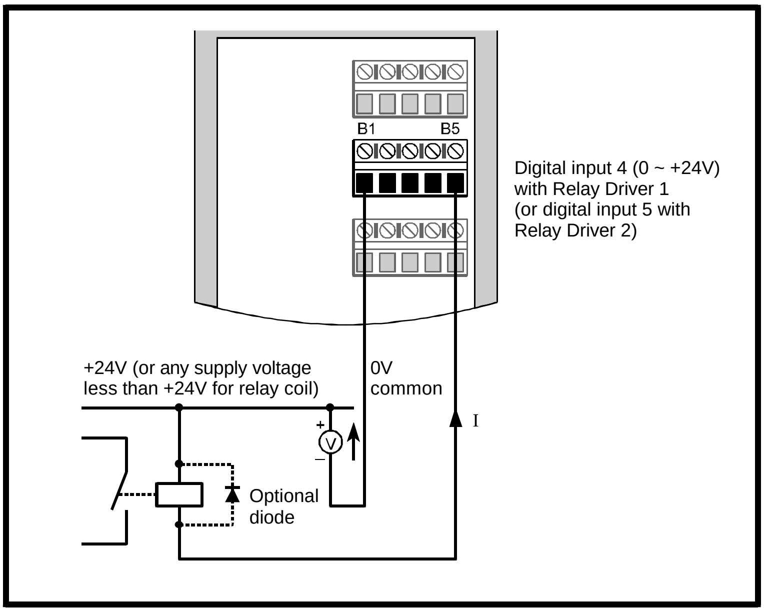
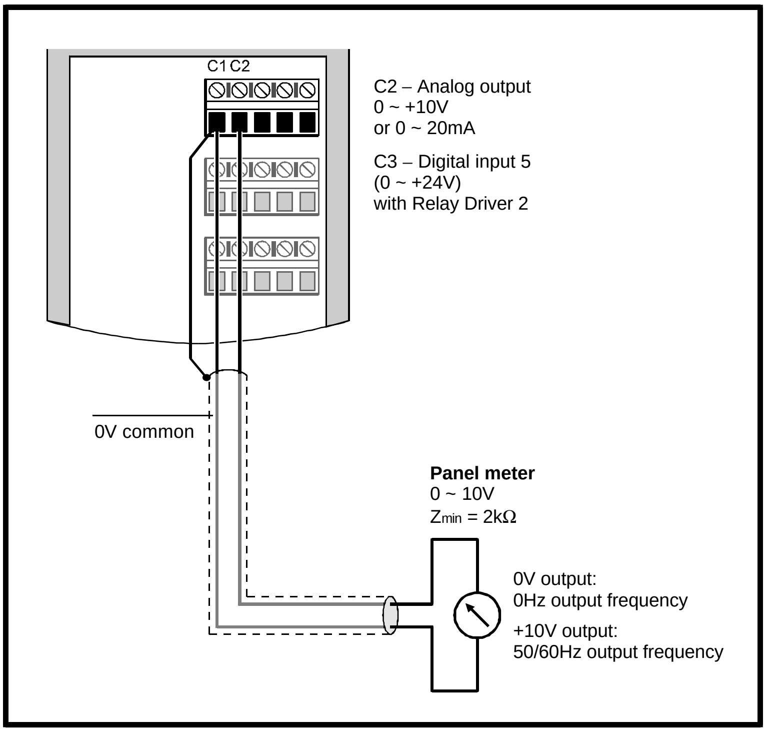



Fig. 5.21 Optional relay driver output arrangement for Terminal B5 and C3

## 5.5.4 Control Terminal Block 'C1' to 'C5'

Default Arrangement:



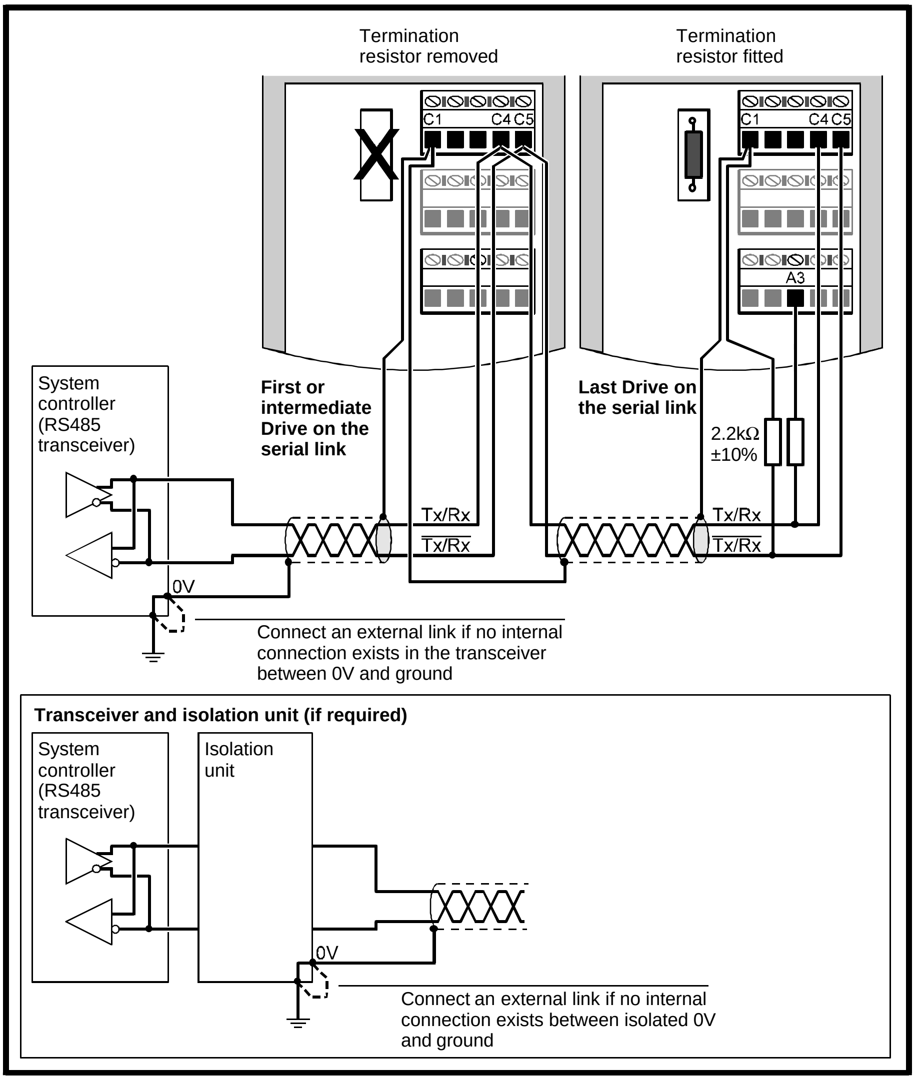



Fig. 5.22 Default electrical control connections for Terminals C1 to C5

| Control Terminal | Default Configuration | Optional Configurations | Relevant Parameters |
|---|---|---|---|
| C1 | 0V Common | - | - |
| C2 | 0 to +10V Analogue Output 1<br><br>(Output frequency) | 0 to 20mA Analogue Output<br><br>4 to 20mA Analogue Output<br><br>(circuit identical to voltage output except use 0 to 20mA full scale meter (500Ω maximum) instead of 10V) | #7.19 Analogue output 1 (C2) source selector<br><br>#7.20 Analogue output 1 (C2) scale factor<br><br>#7.21 Analogue output 1 (C2) mode selector |

| | | | |
|---|---|---|---|
| C3 | 0 to +24V Digital Input 5<br><br>(Not used) | Relay Driver 2 Digital Output (see Fig. 5.21 above) | #8.13 F2 input (C3) destination/output source selector<br><br>#8.14 Invert F2 input/output (C3)<br><br>#8.15 Activate output 2 (C3)<br><br>#8.27 Select digital input positive logic |
| C4 and C5 | ANSI RS485 Serial Comms Input/Output with 4800 baud | Differential Current Input 2<br><br>(0 to 20mA, 20 to 0mA,<br><br>4 to 20mA or 20 to 4mA) (see Fig. 5.23 below)<br><br>Motor Thermistor Input (see Fig. 5.24 below) | #b.23 Serial interface address<br><br>#b.26 Serial transmit delay time (after message receipt)<br><br>#7.11 Analogue input 2 (C4/C5) mode selector<br><br>#7.12 Analogue input 2 (C4/C5) scale factor<br><br>#7.13 Invert analogue input 2 (C4/C5)<br><br>#7.14 Analogue input 2 (C4/C5) destination selector |

Note for RS485 use: The 100Ω accessible resistor can be used as the termination resistor at the far end of the RS485 link. (The resistor value can be altered if desired.) For intermediate drives along the RS485 link, cut the 100Ω resistor out of circuit.

For good noise immune operation the RS485 lines will need suitable pull-up and pull-down resistors as shown in the above figure, at the far end of the RS485 link to force a “high” logic state when all of the transmitters are inactive.

In summary, use only one termination resistor per RS485 link, and use only one set of 2.2kΩ pull-up and pull-down resistors per 100Ω termination resistor.

Optional arrangements:

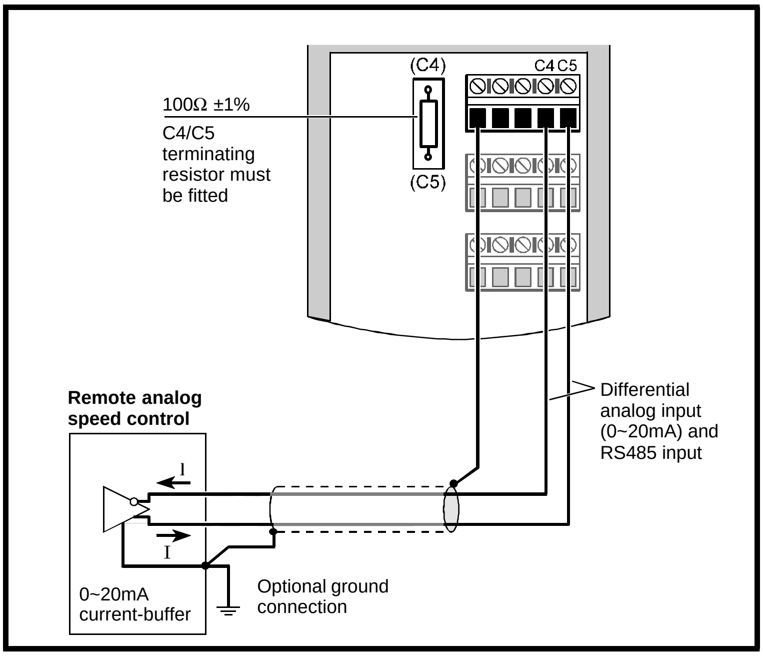



Fig. 5.23	Optional differential 0 to 20mA analogue input arrangement for Terminals C4 and C5

Note for Differential Current Input use:   With a full scale input of 20mA, the voltage across C5/C4 is 2.0V with the accessible 100Ω resistor.  By changing the resistor resistance, a full scale of 2.0V can be achieved with other current levels if desired.

If the resistor is cut open-circuit, the C4/C5 input can be used as a 2.0V full scale differential unipolar voltage input.

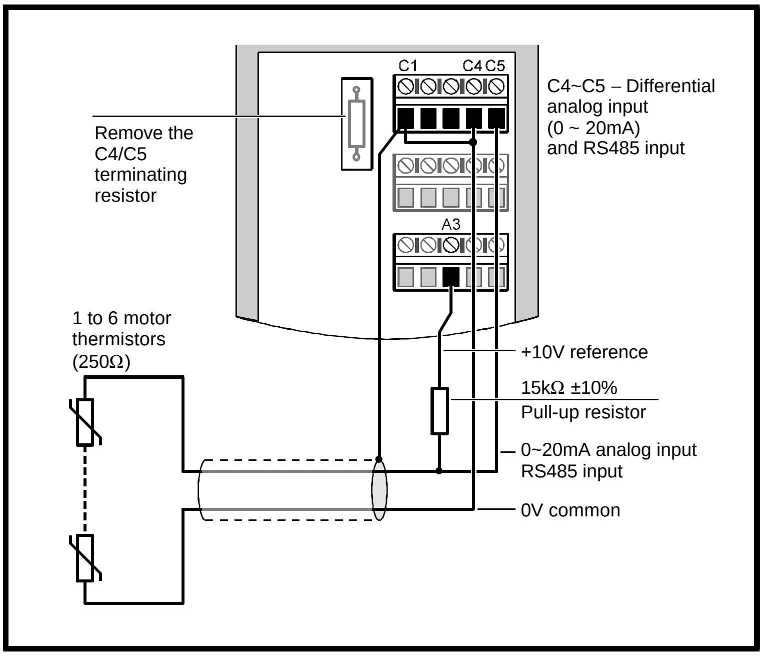


Fig. 5.24 Optional motor thermistor input arrangement for Terminals C4 and C5

### 5.5.4.1 Terminal Chamber Resistor - C4/C5 Terminating Resistor

A user accessible 100Ω, 0.5W resistor connects directly between Terminals C4 and C5. Section 5.5.4 gives possible options/uses for this resistor.

The resistor provides 0 to 20mA input and RS485 termination.

The resistor is accessible in order for it to be either cut-out if required, or, changed to a different resistance value.

---

# 6.0 Operation of Display, Keypad and Parameters

## 6.1 Warnings

**Safety of application:**

Careful consideration must be given to safety aspects of the system in which the drive is incorporated.

The drive is a complex system containing many electronic components and software. Control Techniques has made every effort to minimise the failure rate and to eliminate programming errors. However in common with all such drives the integrity of the unit is not high enough to carry out safety-related functions without independent high-integrity protection.

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

Some common examples of functions which might be safety-related are:

– Stop/start, and emergency stop
– Auto-start
– Forward/reverse
– Maximum speed

However there may be others, depending on the exact application. These will be revealed by the risk assessment.

**Warning**

Some of the parameters have a profound effect on drive operation. They must not be altered without careful consideration to the impact on the controlled plant, and measures must be taken to prevent unwanted changes through error or tampering.

**Motor Speed/Safety**

Standard squirrel-cage AC induction motors are designed as single speed motors. If it is intended to use the capability of the drive to run the motor at speeds above its designed maximum, it is strongly recommended that the motor manufacturer is consulted first. The principal risks due to overspeeding are the destruction of the rotor by centrifugal force, or of the bearings by vibration and overheat.

Do not rely on the maximum speed setting parameter of the drive for overspeed protection. If the possibility of overspeeding is a serious problem, other means of protection must be provided.

Low speed operation may result in overheating of the motor because the effectiveness of the internal cooling fan reduces with shaft speed. Motors should be equipped with thermistor protection, and if full benefit of the use at low speeds is to be gained it may be necessary to arrange additional forced cooling for the motor.

## 6.2 Initial Electrical and Mechanical Set-Up

Prior to powering the drive up for the first time, ensure that Sections 4 & 5 of this manual have been studied and the necessary recommended actions have been taken. For initial operation and set-up of the drive, it is assumed that the connections are as shown in Fig. 6.1.

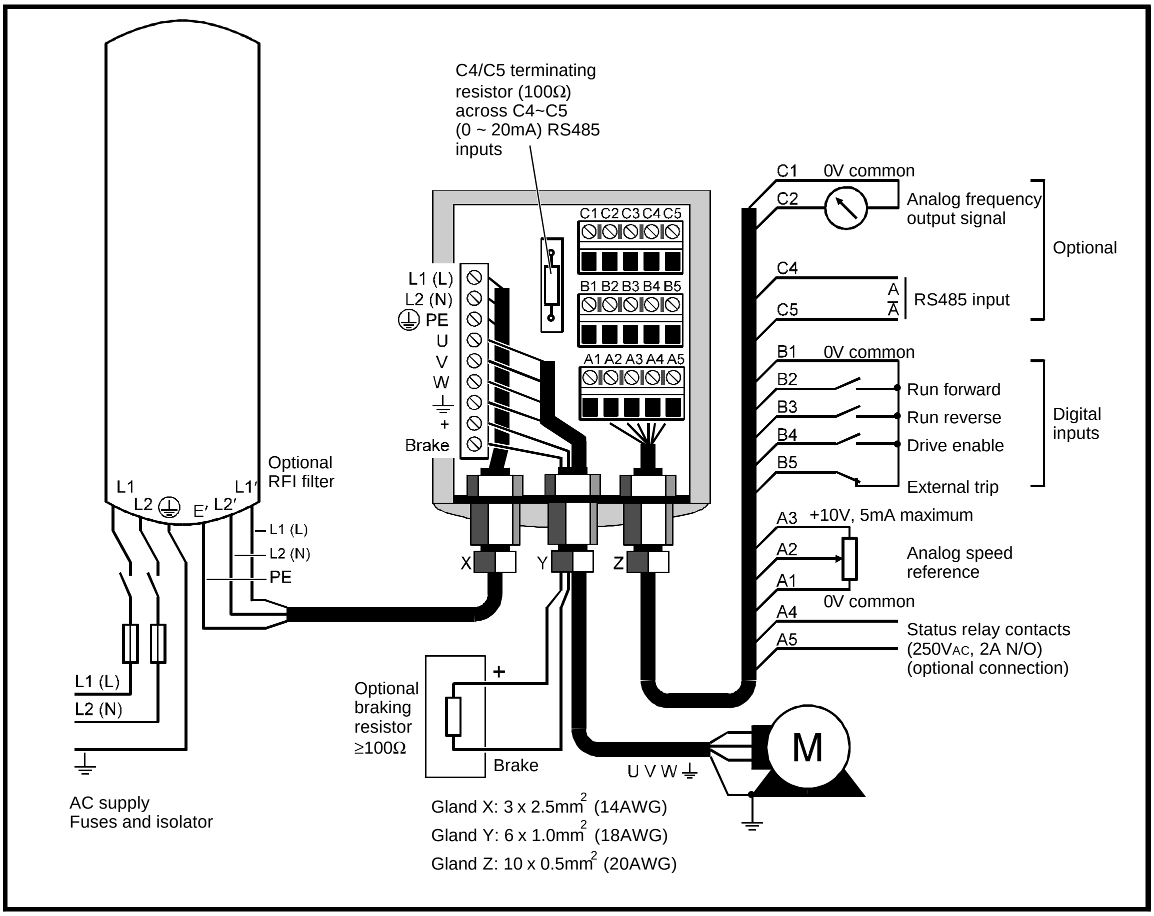



Fig. 6.1 Electrical connections for initial set-up and operation

In particular:

- Check that the wiring and motor installation is correct and safe and that the motor shaft is not exposed,.
- Check that the signal connections B2, and B3 are not connected to 0V Common (i.e. the switches/contacts are open), and B4 and B5 are connected to 0V Common (i.e. the switches/contacts are closed). This ensures that the motor shaft will not turn when AC power is applied to the drive.

## 6.3 User Interface (Display and Keypad)

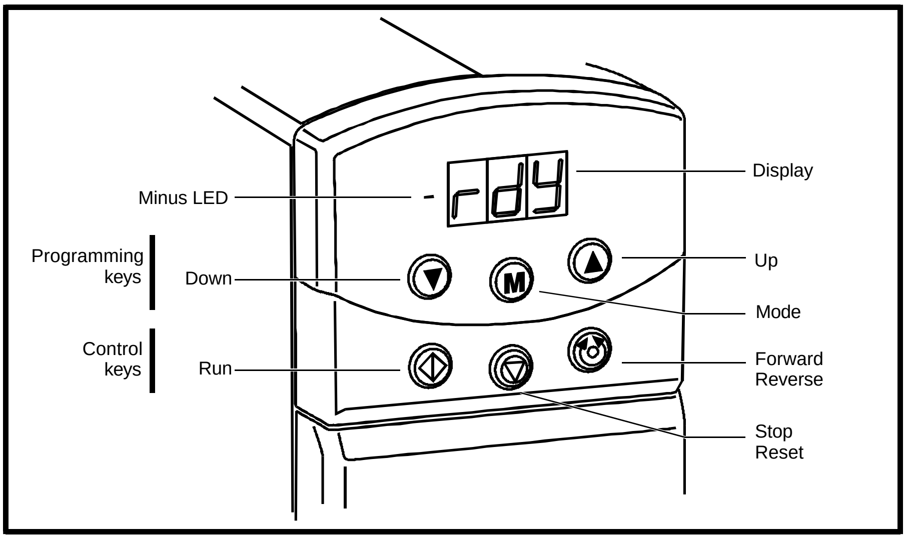



Fig. 6.2 Display and keypad

At 'power-up' the display should indicate 'rdy' as illustrated in the above figure, provided the drive is configured as per the initial set-up in Section 6.2.

The digital keypad and display is a standard part of the Dinverter. It contains:

- A three digit plus minus sign LED display.
- Programming keys ('MODE' (), 'UP' () and 'DOWN' ())
- Control keys for drive operation ('RUN' () , 'STOP/RESET' () and 'FWD/REV' ())

### 6.3.1 LED Display

The LED display is used to:

- Display the operational modes (Status Mode)
- Display the selected parameters (or parameter numbers) (Parameter Mode)
- Display the selected parameter contents (or parameter value) (Value/Edit Mode)
- Display the various drive faults (Trip Mode)
- Display the various warnings (Any of above Modes)

1) Status Mode

This is the normal (default) working mode of the display and indicates either the status of the drive (e.g. ‘rdy’), warnings indicating impending trips are imminent (e.g. ‘hot’), or the value of the last selected parameter. (At power up the selected parameter is #0.10, (the motor frequency (/‘speed’) in Hz).)

2) Parameter Mode

This mode is entered from the Status Mode for adjustment of the drive parameters. This mode displays the selected parameter (and menu) number and allows the user to sequence through to other parameters (and menus). The Parameter Mode is indicated by a display flashing between two numerical values (e.g. “0._ _” alternating with “_.10” for parameter #0.10 (and Menu 0)).

3) Value/Edit Mode

This mode is entered once the selected parameter number has been chosen in the Parameter Mode. This mode displays the selected parameter value and allows the user to look at and/or modify the parameter value. The Value/Edit Mode is indicated by either a steady numerical value or the right-hand digit flashing. If the value is not flashing, the value cannot be adjusted/altered, whereas if it is flashing it can be adjusted/altered.

4) Trip Mode

This mode is automatically entered from any other display mode if the drive “trips” or shuts down (i.e. disables the output) for whatever reason during operation. A “trip” is indicated by an alphanumeric code flashing on the display (e.g. “Et” - External trip).

## 6.3.2 Keypad

Programming keys:

The setting of drive parameters is carried out with the 2 cursor keys (the 'UP' key (), and the 'DOWN' key ()) and the 'MODE' key (). They select the required drive parameter and control or adjust its value (see Section 6.5 for details).

In addition to the above, a simultaneous press of the 'MODE' and 'UP' will produce an effective 'right' action. Similarly simultaneously pressing 'MODE' and 'DOWN' will produce an effective 'left' action.

The cursor keys and can also change the motor speed when the drive is operated in keypad mode (for more information see Section 8.5).

These 3 keys are always active and enable a user to move from the Status Mode into the other operating Modes at any stage during drive operation.

Control keys:

The control keys are located below the programming keys

| | | |
|---|---|---|
| | (Green key) | Start the drive ('RUN') |
| | (Red key) | Stop or reset the drive ('STOP/RESET') |
| | (Blue key) | Change motor direction from forward to reverse, or, reverse to forward at the same speed ('FWD/ REV'). |

**Each control key can be activated via various software parameters, however, the default state is that the 'RUN', 'STOP', and 'FWD/REV' keys are inactive, but the 'RESET' function of the 'STOP/RESET' key is always active.**

## 6.4 Parameter Structure

The drive parameters define the drive's behaviour. In particular, the various parameters enable the drive to be matched to the motor and the application requirements. All settings in relation to the behaviour of the drive are defined by these parameters. Each parameter is set to a so-called default value by the manufacturer. These default values are chosen to keep to a minimum the setting and programming required for common applications.

### 6.4.1 Types of Parameter

Dinverter distinguishes between two basic types of parameter; 'numeric' parameters and 'bit' parameters.

Numeric Parameters are similar to a potentiometer function in that the parameter can have any one of many values. By utilising these parameters, parameter values can be read, set or changed.

Bit Parameters make "yes/no" decisions, or select/display one of two possibilities.

Some parameters (Numeric or Bit) display the various parameter values as text (e.g. 'Std') instead of the usual numerical value. These parameters are called Text Parameters. On the display, Text Parameters are shown as a series of characters, but when read via the serial interface only the parameter value is given. The series of characters, as well as the parameter values, are listed in the parameter listing in this User Guide (see Sections 7.0 and 9.0).

All parameters belong to one of the following sub groups:

- Read-write parameters (RW): Values of these parameters can be changed as well as read.
- Read-only parameters (RO): Values of these parameters can only be read, but cannot be changed via the display and keypad or serial comms. However, these parameters can be written to when used as destination parameters of other internal parameters, provided they are not protected (P type parameters).

Most parameters cause the drive operation to change immediately, so that it makes drive adjustment very easy.

Some parameters need a 'RESET' command before they affect drive operations. The 'RESET' command can be done via:

parameter #A.33 (drive reset) using the input terminals,

or: serial comms,

or: the 'STOP/RESET' key on the keypad.

This type of parameter is signified with 'R' (for 'RESET') in the parameter listings Sections 7.0 and 9.0.

Some parameters are automatically stored when the drive is disconnected from the mains. These parameters are signified with 'S' (for 'SAVE') in the parameters listings.

Finally there is the so-called "Parameter 0" (Zero) which has special functions with regard to parameter security and saving of parameter settings (see Section 6.4.3).

### 6.4.2 Organisation of Parameters

The number of parameters in Dinverter is quite large and as a result the flexibility of the drive system is quite high.

Parameters are available to configure control inputs from the terminal block, and direct these to control operating parameters of the drive. Similarly parameters are available to take various internal operating parameters, and, via configurable control outputs (using other parameters), feed these out to control outputs at the terminal block.

To reduce the risk of confusion due to the large number of parameters, they are organised into 14 menus or parameter groups according to their function. These 14 menus are referred to in the following text as "extended menus".

**Another "user menu", menu 0, is introduced, to make drive use even simpler. Menu 0 contains 50 parameters which are copies of parameters from the 'extended menus'. The parameters in Menu 0 are chosen to be the parameters most often needed for users, and therefore should be the only menu used for the majority of drive applications. To further simplify drive operation, 20 of the 50 parameters in Menu 0 are user defined in that these 20 parameters can be any parameters chosen (and therefore copied) from the 14 extended menus. (Menu 11 defines which parameters co-exist in Menu 0 and any of the other menus.)**

In summary, when the drive is in its default state, the parameters found in Menu 0 should be sufficient for the drive application. Use of parameters in extended menus is only necessary for special applications.

Throughout the Guide all parameters are referred to as '#x.yz' where '#x' is the menu number from 0 up to 9, A, b, c, d and E giving a total of 14 menus, and 'yz' is a 2 digit parameter number in the particular menu. The value of a parameter is designated as [#x.yz].

### 6.4.3 "Parameter 0"

The so-called 'Parameter 0' has a special meaning. It is always the first parameter in each menu and has the parameter number '#x.00' (where '#x' = any menu number). It is a multi-functional parameter and does not contain any drive operating parameters.

Note that the 14 different 'Parameter 0' values (i.e. #x.00) are one and the same, in that there is only one 'Parameter 0' and it can be accessed in any menu as #x.00.

Parameter 0 is used for several functions:

- Memorising or saving parameter values
- Enabling access to extended menus
- Disabling access to extended menus
- Loading of default-values to all parameters

The range of the "Parameter 0" is from 0 to 999. The functions mentioned above are accessed when "Parameter 0" has the following values:

| Parameter 0 Value | Description |
|---|---|
| 149 | Access to extended menus |
| 900 | Memorise, save or store new parameter values (Only following a drive 'RESET') |
| 544 | Reset parameters to the default 60Hz settings (Only following a drive 'RESET') |
| 533 | Reset parameters to the default 50Hz settings (Only following a drive 'RESET') |
| 800 | Disable access to extended menus and lock user security if set via parameter #b.30) |
| xyz | Allow write access to all parameters ('xyz' is a previously stored 3-digit user security code set in parameter #b.30) |

Each function in the above table is explained in more detail in Sections 6.6 and 6.7.

### 6.4.4 Parameter Location - Menus

As defined above their are 14 menus, each menu groups together common parameter types. The menus of parameter groups are as follows:

| Menu | Description |
|---|---|
| 0 | Default set of basic operating parameters - always visible (some are user selectable) |
| 1 | Frequency reference selection, limits and filters |
| 2 | Ramps |
| 3 | Frequency/speed sensing thresholds |
| 4 | Current control |
| 5 | Machine control |
| 6 | Drive sequencer and run-time clock |
| 7 | Analogue inputs and outputs |
| 8 | Digital inputs and outputs |
| 9 | Programmable logic and motorised potentiometer |
| A | Status logic and diagnostics |
| b | Miscellaneous and Menu 0 parameter selectors |
| c | Programmable threshold |
| d | Not used |
| E | PID controller |

## 6.5 Selecting, Viewing and Changing Parameters

### 6.5.1 LED Display Modes

To move between the 4 Display Modes described in Section 6.3.1, i.e. Trip Mode, Status Mode, Parameter Mode and Value/Edit Mode, the programming keys are used as diagrammatically explained in Fig. 6.3 below: (Further details are given in the following sub-sections.)

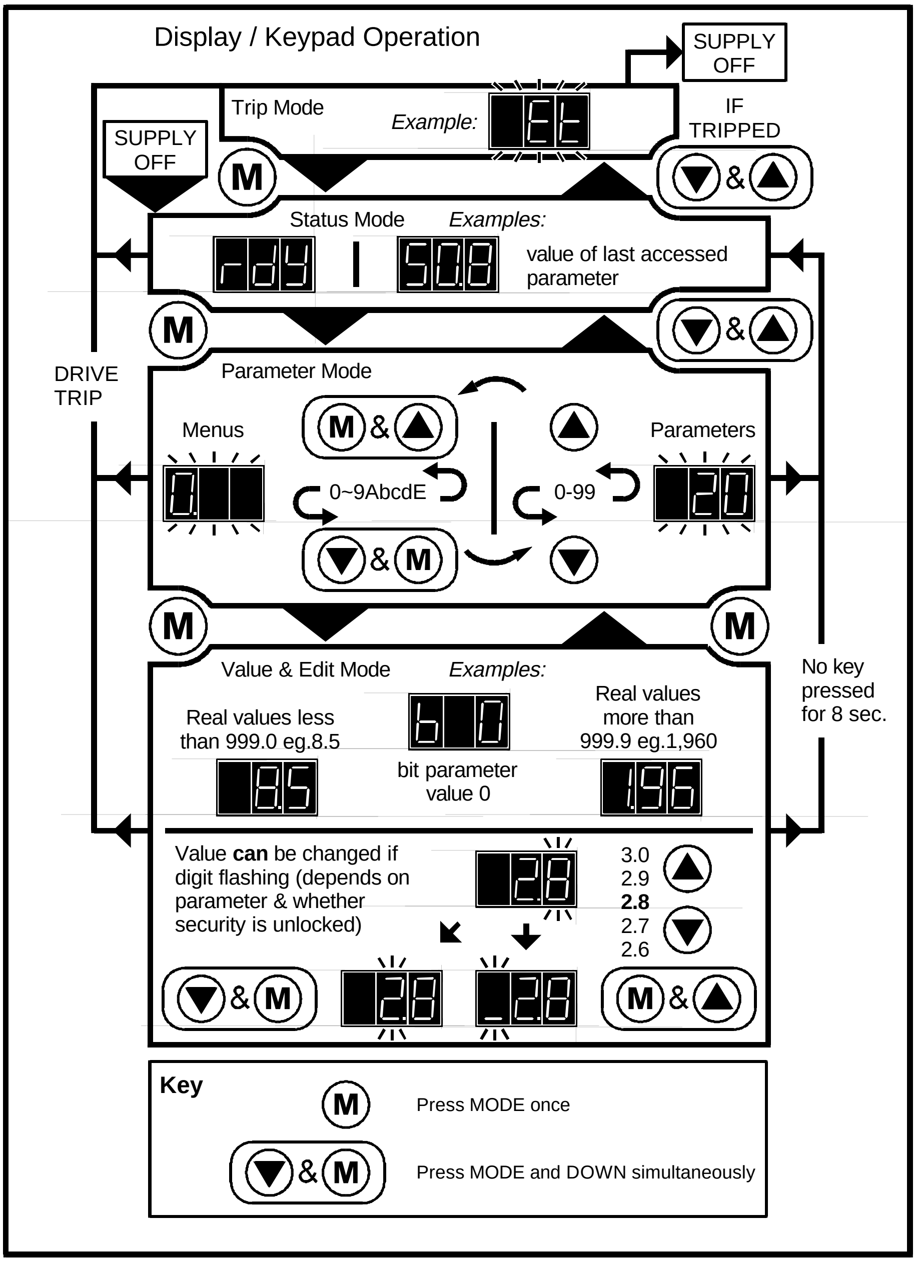



Fig. 6.3 Display operation and moving between modes

### 6.5.2 Selecting a Parameter Within a Menu

When power is first applied to the drive, the Display Mode will either be the Trip Mode (e.g. flashing text on the display), or the Status Mode (e.g. non-flashing text or a numeric value).

To get to the Parameter Mode, press 'MODE' (M) once if in the Status Mode, or press 'MODE' (M) twice if in the Trip Mode. (Pressing 'MODE' (M) once in Trip Mode takes you to the Status Mode.)

Once in the Parameter Mode, from the Power-Up condition, the display will be alternating between "0._ _" and "_.10". This indicates Menu 0 and Parameter #0.10 (i.e. Parameter 10 in Menu 0.)

Using the 'UP' (▲) or 'DOWN' (▼) keys will alter the Parameter number in that Menu. In this case:

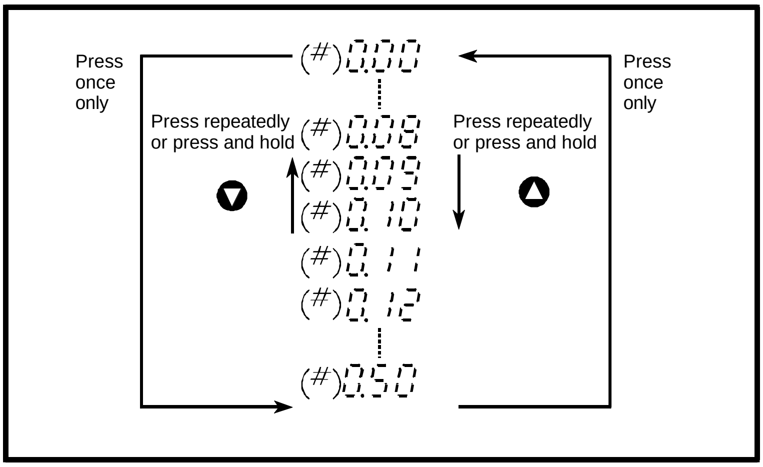



Fig. 6.4 Sequencing around the parameter numbers in a menu - Parameter Mode (Menu 0 in this example)

Please note that some parameters e.g. #0.18 and #0.19 have not been defined/programmed and are therefore skipped in the above sequencing.

Note that if no buttons are pressed for 8 seconds the Display Mode will automatically revert back to Status Mode from the Parameter Mode. (Press 'MODE' (M) once to get back to the Parameter Mode.)

To "exit" from the Parameter Mode (apart from waiting 8 seconds) press 'UP' (▲) and 'DOWN' (▼) simultaneously to go back to the Status Mode.

6.5.3 Viewing and Changing the Selected Parameter

To view the parameter selected using the procedure in Section 6.5.2 above (e.g. #0.20), press 'MODE' once when in the Parameter Mode with #0.20 selected in the display. The display will now show the value of parameter #0.20 (e.g. 0.0 (Hz)).

Depending on the type of parameter, the display could indicate the following:

- Flashing the least significant digit of a numerical value (e.g. '0.0' means parameter is read/write and can be altered if required (any user security will be unlocked at this stage).
- Non-flashing numerical value (e.g. '0.0' means either the parameter is read only, or, if it is read/write, security has not been unlocked).
- Flashing text (e.g. 'ULt' means the text parameter is read/write and can be altered if required.)
- Non-flashing text (e.g. 'ULt' means the text parameter is read only or is read/write with security set.)
- Flashing the bit value (e.g. 'b_0' means the bit parameter is read/write and can be altered to 1 if required.
- Non-flashing bit value (e.g. 'b_0' means that either the bit parameter is read only, or, if it is read/write, security has not been unlocked.)

Provided the parameter value being viewed is flashing, the value can now be altered using the 'UP' or 'DOWN' keys. If the display is not flashing, check whether the parameter is read only or whether security has been unlocked. (See Section 7.3 to verify the type of parameters in Menu 0 and Section 6.7 to unlock security).

As for setting the desired/correct parameter value, the 'UP' or 'DOWN' keys can either be pressed repeatedly or pressed and held down (only for numeric values) to alter the value. To speed up larger value numeric changes, the more significant digits can be selected by pressing 'left' ('DOWN' and 'MODE' simultaneously), or, 'right' ('MODE' and 'UP' simultaneously). For example, using #0.20 which has a value of '0.0' the most significant digit can be selected by the following process:

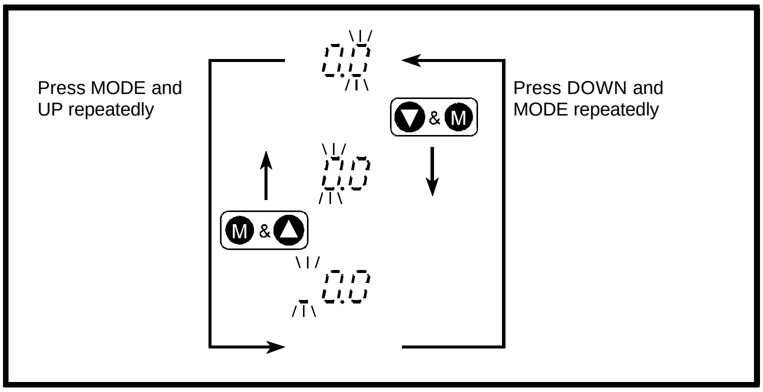



Fig. 6.5 Selecting the various digits of a parameter value - Value/Edit Mode (The value of Parameter #0.20 in this example)

Once the relevant digit is selected the ‘UP’ and ‘DOWN’ keys can then be used to sequence through the values. For example:

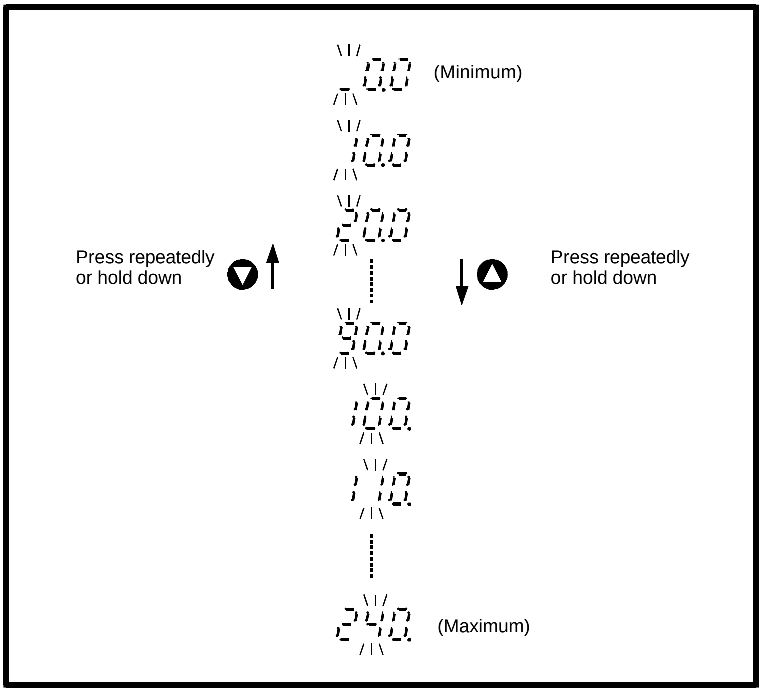



Fig. 6.6 Sequencing around the value of a parameter - Value/Edit Mode (The value of Parameter #0.20 in this example)

Note that for ease of use, pressing ‘UP’ and ‘DOWN’ simultaneously during the Value/Edit Mode, whilst varying a numeric value, will reset the value to “0.0”, or “0” depending on the parameter type.

Note that if the maximum allowable value is exceeded (not if it is equalled), whilst holding the ‘UP’ key down during the editing of a value where the least significant digit is not selected, the complete display will flash. The maximum allowable value will be set if the key is held for a further 3 seconds, whereas if the key is released before the 3 second period the value will revert to the next lower selected digit increment before the maximum value was exceeded. (For example, if the maximum value of a certain parameter was 250, and the hundreds digit is being incremented. The display will increment from 0 to 100 to 200 and then flash at 250 instead of displaying 300. If the ‘UP’ key is held at this time for 3 seconds the value will be set at 250. If the ‘UP’ key is released before the 3 second period, the value will be set at 200.)

The parameter value being altered takes immediate effect during adjustment. If the parameter is to be saved use Parameter 0, as explained in Section 6.4.3. If the new adjusted value is not saved, it will be lost at power down, and the original value will be restored at power up.

To exit from the Value/Edit Mode, press ‘MODE’ once to move back to the Parameter Mode, and then ‘UP’ and ‘DOWN’ simultaneously to enter the Status Mode.

6.5.4 Changing Menus

From power up, to select another Menu apart from 0, the following procedure needs to be followed:

1) Select Parameter #0.00 (see Section 6.5.2)

2) Set value to 149 (see Section 6.5.3)

3) Enter the Parameter Mode again.

(The above 3 steps only need to be performed once after power-up).

4) Press 'right' ('MODE' Ⓜ and 'UP' ▲ simultaneously), or 'left' ('DOWN' ▼ and 'MODE' Ⓜ simultaneously) to move through the 14 menus.

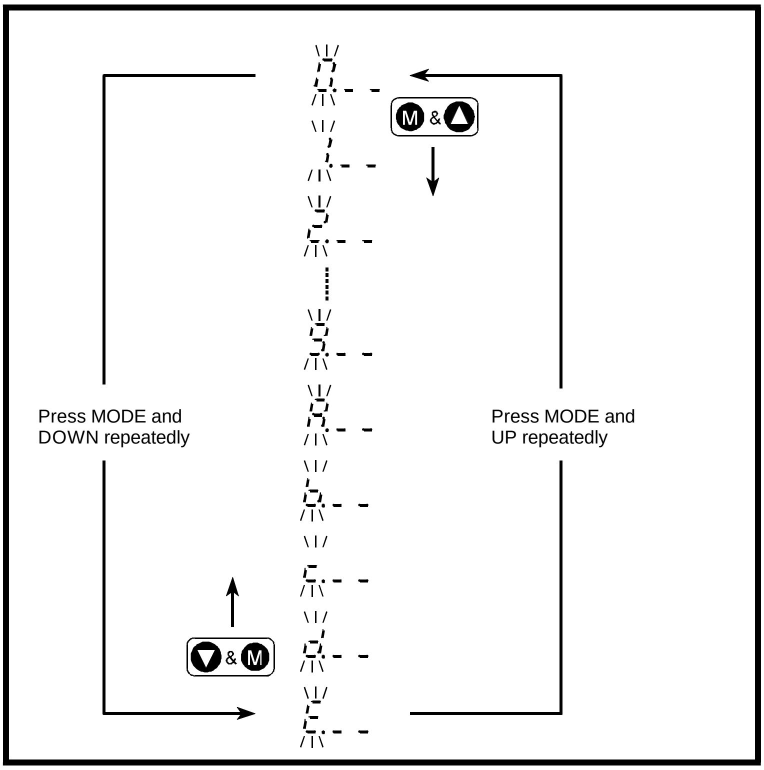



Fig. 6.7 Sequencing around the Menus - Parameter Mode

Once the new menu has been selected, the parameter can then be selected, and then its value changed as before.

Please note that the last parameter accessed in a certain Menu is the first parameter in that Menu to be accessed upon re-entry into that Menu. This enables easy movement between Menus as necessary.

## 6.6 Storing/Restoring Parameters

### 6.6.1 Storing/Saving and Restoring Parameters

Most parameters will not be saved at power-down (i.e. when the drive is switched off). This is done to provide the facility during commissioning that if many parameters have been adjusted (but not saved), it is a simple matter of powering off the drive and powering back up again to restore all parameters to their original values.

**To save/store parameters before the drive is powered down the following procedure must be followed:**

**1) (Set all parameters to the required values.)**

**2) Set Parameter 0 (#x.00) to ‘900’.**

**3) Apply a ‘RESET’ signal, by any of the following means:**

### 6.6.2 Resetting the Drive

The drive can be reset via any one of the following methods:

- Press the ‘STOP/RESET’ key on the drive keypad. (If the drive is in Keypad Mode where the ‘STOP/RESET’ key is active for drive stopping, etc., and the drive is running at the time, hold the ‘RUN’ key down whilst pressing the ‘STOP/RESET’ key to perform a ‘RESET’ instead of a ‘STOP’ action.)
- Set Parameter #A.33 (drive reset) to a 1 from 0 (via any of the Control Terminal Digital Inputs)
- Set Parameter #A.38 (user trip) to ‘100’ via serial comms.

Please note that the ‘RESET’ action is required to activate some parameter value changes (e.g. ‘Parameter 0’ is such an example as detailed in Section 6.4.3).

### 6.6.3 Setting Parameters to Default Values

The parameters can only be set to default values if the drive is not ‘running’.

There are 2 sets of default parameters held by the drive:

- 50Hz settings for 50Hz motors, and
- 60Hz settings for 60Hz motors.

However, the only parameters affected by the 2 different default sets are:

#0.02 (or #1.06)

#0.47 (or #5.06)

All the other default settings are the same regardless of whether they are 50Hz or 60Hz settings.

The default values are listed in Section 7.3 for Menu 0, and Section 9 for the extended menus.

To set all of the parameters back to the default settings, the following procedure must be followed: (please note that this adjusts all parameters not just ones relating to 50/60Hz operation)

1) Set Parameter 0 (#x.00) to ‘533’ for 50Hz settings, or ‘544’ for 60Hz settings.

2) Apply a ‘RESET’ signal (as given in Section 6.6.2).

(The default values have now been entered into all parameters. These values can now be used for drive operation but most of them will be lost at power down. Therefore it is sensible to save them by performing steps 3) and 4) below.)

3) Set Parameter 0 (#x.00) to 900.

4) Apply a ‘RESET’ signal to store the default values.

## 6.7 Parameter Security

The drive has 2 levels of security. This security only affects keypad access and the parameters of the drive, it does not affect parameter adjustment using serial comms. The first level of security restricts access to Menu 0 (as default) only until Parameter 0 (#x.00) is set to '149'. Once Parameter 0 is set to '149' access to all parameters in all menus is available. This first level of security is called 'standard security' and can be re-set either by powering off the drive and re-powering up, or, setting Parameter 0 (#x.00) to '800'.

The second level of security is not set with default settings. However, once a user security code is set in Parameter #b.30 (any value from '1' to '255' but not equal to '149'), and the drive is powered off and then on again, no parameters can be adjusted. This second level of security is called 'user security'. Once user security is set, all parameters can be read , but the values cannot be altered using the keypad. (Only Menu 0 can be viewed if Parameter 0 has not been set to 149).,, Once Parameter 0 (#x.00) has been set to 149 and then the User Security Code value following power-up, all parameters in all menus can be viewed and changed. If Parameter 0 is not set to 149, only Menu 0 parameters can be viewed and changed. Setting Parameter 0 (#x.00) to '800' will also re-set user security if it has been previously unlocked without the need to power off the drive.

Please note that Parameter #b.30 is automatically saved at power-down and does not need storing manually (i.e. setting Parameter #x.00 to '900', etc.).

To aid in determining the security status of a drive, Parameter #0.49 has the following states:

| | | | | |
|---|---|---|---|---|
| | #0.49 | = | 'a b c' | |
| where | a | = | 0 | No user security code in #b.30 saved |
| | | = | 1 | #b.30 has been assigned with a value other than '149'. |
| | b | = | 0 | User security code has been unlocked by setting #x.00 to 'code number'. |
| | | = | 1 | User security code locked (e.g. setting #x.00 to '800') |
| | c | = | 0 | Standard security has been unlocked by setting #x.00 to '149'. |
| | | = | 1 | Standard security locked (e.g. setting #x.00 to '800') |

The resulting value of #0.49 provides the following keypad access capability:

| **Value of #0.49** | **Access provided:** |
|---|---|
| 100 or 0 | View and modify Menus  0 to E parameters |
| 101 or 1 | View and modify Menu 0 parameters only |
| 110 only | View Menus  0 to E parameters only |
| 111 only | View Menu 0 parameters only |

The User Security Code enables all parameters to be “locked” so that they cannot be adjusted by unauthorised personnel.

Note:  To disable the User Security Code set Parameter #b.30 to ‘149’ (once ‘149’ and the User Security Code have been individually entered into Parameter #x.00 to allow adjustment of Parameter #b.30).

# 7.0 Menu 0 Parameter Descriptions

## 7.1 General

The 30 plus parameters contained in Menu 0 are not independent parameters, but are 'copies' of various parameters from the extended menus. They are selected in such a way, that most of the applications can be implemented using only the parameters in Menu 0, without needing to use the extended menus.

Some parameters in Menu 0 can be selected/chosen by the user (using Menu b), whilst the remainder cannot be re-assigned to other extended menu parameters. Menu 0 parameters are defined as follows:

#0.01 to #0.10, and #0.31 to #0.50: Pre-defined parameters which cannot be re-assigned.

#0.11 to #0.30 : User defined parameters, determined by parameters #b.01 to #b.20.

There are different parameter types that are used in the parameter descriptions that follow in Section 7.3.

List of parameter types:

| | | |
|---|---|---|
| RW | Read/Write | Read/ write parameter. (Parameters that can be set (written) by the user, as well as read.) |
| RO | Read Only | Read only parameter for displaying operating modes and parameter values. (Parameters that can be read by the user but not set by the user, although the internal drive software has read/write access to them, for example RO parameters can be destinations of digital inputs.) |
| Bit | Bit | Bit parameter, can exist in only 2 states, 0 or 1. |
| B | Bipolar | Bipolar parameter, can have positive or negative values. |
| U | Unipolar | Unipolar parameter, can have only positive values. |
| T | Text | Parameter has different options. Options are specified via text (or character string). |
| R | Reset | Parameter needs a RESET signal to implement value changes. (See Section 6.6.2) |
| S | Saved | Parameter is saved automatically by mains switch off. |
| P | Protected | Parameter cannot be used as a destination of programmable inputs and functions. |
| F | Fixed | Parameter in Menu 0 that cannot be re-assigned. |
| C | Custom | Parameter in Menu 0 than can be customer/user assigned. |

The following sections give a quick reference list of the Menu 0 parameters, and an in-depth description of each parameter.

## 7.2 Menu 0 logic block diagram - Default settings

The figure below illustrates the structure and function of the drive with default parameters set and how the various Menu 0 parameters are interlinked. It will be noted that all relevant parameters in the Menu 0 block diagram are indicated as '0.xy' (whereas in the text they are indicated as #0.xy) and related parameters indicated as 'x. yz'.

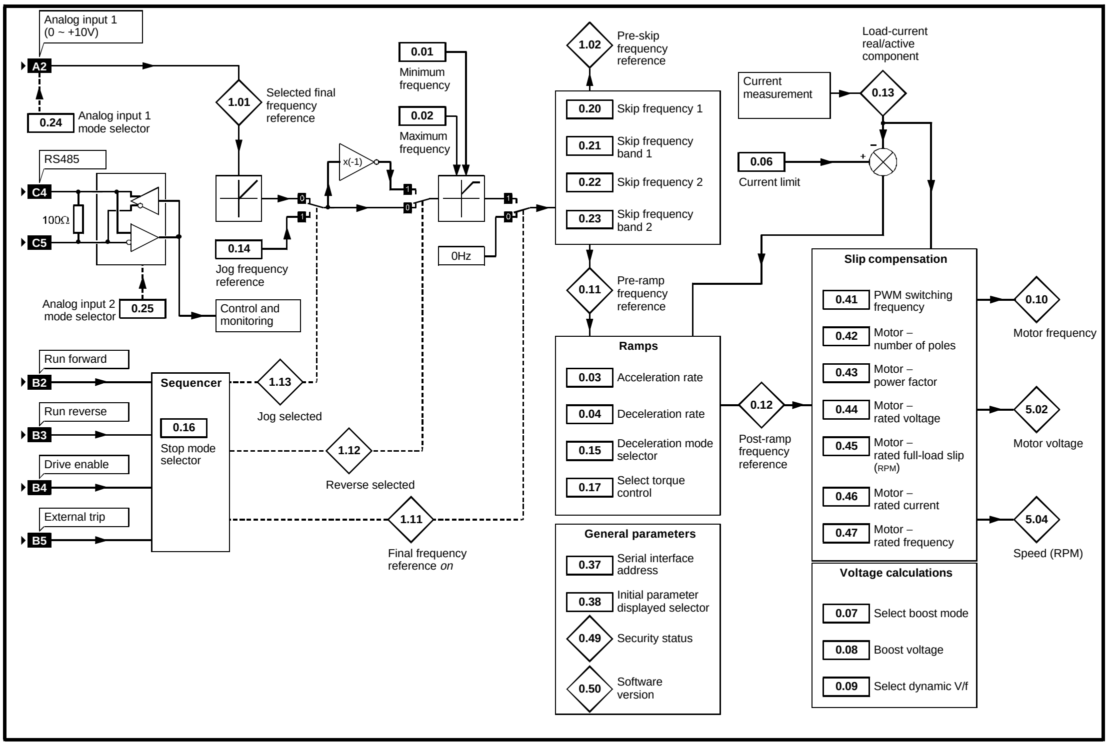



Fig. 7.1 Menu 0 parameter block diagram

7.3 Menu 0 Parameter List

| Parameter No.: | Equivalent to: | Type | Description | Range/Mode<br>Note: '**Std ( 0)** ...' where 'Std' is actual display value and '0' is value used by RS485 serial communications. | Default | Customer Setting: |
|---|---|---|---|---|---|---|
| #0.00 | #x.00 | RW, U, R, P, F | Security and parameter storage | 0 to 999 (See Section 6.4.3) | 0 | |
| #0.01 | #1.07 | RW, B, F | Minimum frequency | 0.0 to [#0.02] or -0.0 to -[ULF] | 0.0Hz | |
| #0.02 | #1.06 | RW, U, F | Maximum frequency | 0.0 to ULF, where:<br>ULF = 240Hz when #0.41 = 3 (kHz),<br>ULF = 480Hz when #0.41 = 6 (kHz),<br>ULF = 720Hz when #0.41 = 9 (kHz),<br>ULF = 960Hz when #0.41 = 12 (kHz) | 50.0 or 60.0<br>Hz | |
| #0.03 | #2.11 | RW, U, F | Acceleration rate | 0.0 to 999.0s per 100Hz | 5.0s/100 Hz | |
| #0.04 | #2.21 | RW, U, F | Deceleration rate | 0.0 to 999.0s per 100Hz | 10.0s/10 0Hz | |
| #0.05 | #1.14 | RW, U, P, F | Frequency reference selector | 0 = Selection via digital inputs<br>1 = Analogue reference 1<br>2 = Analogue reference 2<br>3 = Preset reference<br>4 = Keypad reference<br>5 = Precision reference | 0 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| #0.06 | #4.07 | RW, U, F | Current limit | 0.0 to {150% x FLC/[#0.46]}, where:<br><br>FLC = 4.3A for DIN1220075A,<br><br>FLC = 3.0A for DIN1220055A,<br><br>FLC = 2.3A for DIN1220037A,<br><br>FLC = 1.5A for DIN1220025A. | 150% | |
| #0.07 | #5.14 | RW, Bit, P, F | Select boost mode | 0 = Fixed boost<br><br>1 = Auto boost | 1 | |
| #0.08 | #5.15 | RW, U, F | Boost voltage | 0.0 to 25.5% rated motor voltage | 10.0% | |
| #0.09 | #5.13 | RW, Bit, F | Select dynamic V/f | 0 = Fixed V/f (Constant torque loads)<br><br>1 = Dynamic V/f (Fan/pump loads) | 0 | |
| #0.10 | #5.01 | RO, B, P, F | Motor frequency | 0.0 to ≈ ±[#0.02] Hz | | |
| #0.11 | #1.03 | RO, B, P, C | Pre-ramp frequency reference | ±[#0.02] Hz | | |
| #0.12 | #2.01 | RO, B, P, C | Post-ramp frequency reference | ≈ ±[#0.02] Hz | | |
| #0.13 | #4.02 | RO, B, P, C | Load current (real/active component) | 0.0 to {±[#0.43] x FLC x 1.5} A, where:<br><br>FLC = 4.3A for DIN1220075A,<br><br>FLC = 3.0A for DIN1220055A,<br><br>FLC = 2.3A for DIN1220037A,<br><br>FLC = 1.5A for DIN1220025A. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| #0.14 | #1.05 | RW, U, C | Jog frequency reference | 0.0 to 400Hz | 1.5Hz | |
| #0.15 | #2.04 | RW, U , T, P, C | Deceleration mode selector | Std (0) = decel with ramp hold<br>FSt (1) = no ramp hold | Std (0) | |
| #0.16 | #6.01 | RW, U, T, P, C | Stop mode selector | CSt (0) = Coast<br>rP (1) = Ramp<br>rP.I (2) = Ramp + 1s DC<br>dcI (3) = Timed DC | rP (1) | |
| #0.17 | #4.11 | RW, Bit, C | Select torque control | 0 = Frequency control<br>1 = Torque control | 0 | |
| #0.18 | - | C | Not programmed | Defined via #b.08 | | |
| #0.19 | - | C | Not programmed | Defined via #b.09 | | |
| #0.20 | #1.29 | RW, U, C | Skip frequency 1 | 0.0 to ULF Hz (see #0.02 above) | 0.0Hz | |
| #0.21 | #1.30 | RW, U, C | Skip frequency band 1 | 0.0 to 5.0Hz | 0.5Hz | |
| #0.22 | #1.31 | RW, U, C | Skip frequency 2 | 0.0 to ULF Hz (see #0.02 above) | 0.0Hz | |
| #0.23 | #1.32 | RW, U, C | Skip frequency band 2 | 0.0 to 5.0Hz | 0.5Hz | |
| #0.24 | #7.06 | RW, U, T, P, C | Analogue input 1 (A2) mode selector | ULt (0) = -10V to +10V input<br>th (1) = Thermistor input | ULt (0) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| #0.25 | #7.11 | RW, U, T, P, C | Analogue input 2 (C4/C5) mode selector | ANS (0) = ANSI comms port active<br>0.20 (1) = 0 to 20mA input<br>20.0 (2) = 20 to 0mA input<br>4.20 (3) = 4 to 20mA input<br>20.4 (4) = 20 to 4mA input<br>th (5) = Thermistor input | ANS (0) | |
| #0.26 | - | C | Not programmed | Defined via #b.16 | | |
| #0.27 | - | C | Not programmed | Defined via #b.17 | | |
| #0.28 | - | C | Not programmed | Defined via #b.18 | | |
| #0.29 | - | C | Not programmed | Defined via #b.19 | | |
| #0.30 | - | C | Not programmed | Defined via #b.20, (#0.30 scaled via #b.21) | | |
| #0.31 to #0.36 | - | F | Reserved for other drive parameters | - | | |
| #0.37 | #b.23 | RW, U, P, F | Serial interface address | 0.0 to 9.9 (i.e. Group.Unit) | 1.1 | |
| #0.38 | #b.22 | RW, U, F | Initial parameter displayed selector | 0 to 50 (i.e. #0.00 to #0.50) | 10 (i.e.#0.10) | |
| #0.39 and #0.40 | - | F | Reserved for other drive parameters | - | | |
| #0.41 | #5.18 | RW, U, T, P, F | PWM switching frequency | 3 (kHz) (0), 6 (kHz) (1),<br>9 (kHz) (2), or, 12 (kHz) (3) | 3 (kHz) (0) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| #0.42 | #5.11 | RW, U, T, P, F | **Motor -** Number of poles | 2P (0) = 2 poles,<br>4P (1) = 4 poles,<br>6P (2) = 6 poles, or,<br>8P (3) = 8 poles | 4P (1) | |
| #0.43 | #5.10 | RW, U, P, F | **Motor -** rated power factor | 0.00 to 1.00 | 0.85 | |
| #0.44 | #5.09 | RW, U, F | **Motor -** rated voltage | 0.0 to 100% of supply voltage | 100% | |
| #0.45 | #5.08 | RW, U, F | **Motor -** rated full load slip (rpm) | 0 to 250rpm | 0rpm | |
| #0.46 | #5.07 | RW, U, F | **Motor -** rated current (A) | 0.0 to FLC A, where :<br>FLC = 4.3A for DIN1220075A,<br>FLC = 3.0A for DIN1220055A,<br>FLC = 2.3A for DIN1220037A,<br>FLC = 1.5A for DIN1220025A. | FLC A | |
| #0.47 | #5.06 | RW, U, F | **Motor -** rated frequency (Hz) | 0.0 to ULF Hz (see #0.02) | 50.0 or 60.0Hz | |
| #0.48 | - | F | Reserved for other drive parameters | - | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| #0.49 | - | RO, U, P, F | Security status | ‘a b c’ where:<br>a = 0 = No user security code in #b.30<br>= 1 = User security code set in #b.30<br>b = 0 = Security code unlocked/inactive<br>= 1 = Security code locked<br>c = 0 = #x.00 set to 149<br>= 1 = #x.00 not set to 149 | (00)1 | |
| #0.50 | #b.29 | RO, U, P, F | Software version | 1.00 to 9.99 | e.g.1.03 or latest version | |

## 7.4 Menu 0 Parameter Descriptions

### #0.00 Parameter 0

Parameter type: RW, U, R, P, F

Corresponds with: #x.00 (where x = any menu number from 0 to 9, A, b, c, d and E).

Adjustment range: 0 to 999

Units: -

Default value: 0

Related parameters: #b.30

The critical values are: (see Section 6.4.3 for more details)

- 149 - Allow access to extended menus
- 533 - Reset parameters to 50Hz default settings (only after a drive 'RESET')
- 544 - Reset parameters to 60Hz default settings (only after a drive 'RESET')
- 800 - Disable access to extended menus and lock user security if set via parameter #b.30)
- 900 - Memorise or store new parameter values (only after a drive 'RESET')
- xyz - Allow write access to all parameters (where xyz = a previously stored user security code set in #b.30)

### #0.01 Minimum frequency ($f_{Min}$)

| | |
|---|---|
| Parameter type: | RW, B, F |
| Corresponds with: | #1.07 |
| Adjustment range: | 0.0 to fMax (#0.02) (when [#1.08] = 0), |
| | or, -0.0 to - (ULF) (when [#1.08] = 1),, where |
| | ULF = 240Hz when #0.41 = 3 (kHz), |
| | ULF = 480Hz when #0.41 = 6 (kHz), |
| | ULF = 720Hz when #0.41 = 9 (kHz), |
| | ULF = 960Hz when #0.41 = 12 (kHz) |
| Units: | Hz |
| Default value: | 0.0 |
| Related parameters: | #0.02, #0.41, #1.08, #1.10 |

This parameter sets the given minimum frequency and depends on the settings of #1.08 and #1.10, where #1.08 is the select negative minimum frequency, and #1.10 is the select bipolar frequency reference.

With default settings of #1.08 and #1.10 (both set to 0), the adjustment range is 0.0 to [#0.02], and defines the minimum frequency for both forward and reverse operation. If #0.02 is set less than #0.01, then #0.01 will be overwritten with the minimum set value of #0.02.

If #1.10 equals 1 (bipolar frequency reference selected), parameter #0.01 is ignored, i.e. the minimum frequency is always 0.0Hz regardless of what is set in #0.01.

If #1.08 equals 1 (negative minimum frequency selected) the adjustment range becomes -0.0Hz to - (ULF) Hz, and defines a minimum frequency when operating in reverse only, i.e. [#0.01] (a negative value) ≤ (frequency demand) ≤ +[#0.02].

Whilst jogging, the minimum frequency has no effect, except if #1.08 equals 1.

Note that if #0.02 (the maximum frequency) is set less than the value of #0.01, then [#0.01] will automatically be set to the value of #0.02.

Note that this parameter cannot be adjusted when the drive is enabled.

**#0.02 Maximum frequency ($f_{Max}$)**

Parameter type: RW, U, F

Corresponds with: #1.06

Adjustment range: 0.0 to ULF where:

ULF = 240Hz when #0.41 = 3 (kHz),

ULF = 480Hz when #0.41 = 6 (kHz),

ULF = 720Hz when #0.41 = 9 (kHz),

ULF = 960Hz when #0.41 = 12 (kHz)

Units: Hz

Default value: 50.0 (when #x.00 set to 533 followed by a 'RESET'), or

60.0 (when #x.00 set to 544 followed by a 'RESET').

Related parameters: #0.01, #0.41, #1.08

This parameter sets the given maximum frequency and depends on the setting of #1.08. Please note that slip compensation (#0.45) and current limit can increase the motor frequency above the maximum frequency set.

With a default setting of #1.08 (set to 0, i.e. negative minimum frequency not selected), this parameter defines the maximum frequency for both forward and reverse operation.

If [#1.08] equals 1 (negative minimum frequency selected), this parameter defines the maximum frequency during forward operation only.

Note that if [#0.02] is set less than the value in #0.01 (the minimum frequency), then [#0.01] will automatically be set to the value of #0.02.

Note that this parameter cannot be adjusted when the drive is enabled.

### #0.03 Acceleration rate (actually Accel 1/forward accel 1 rate)

Parameter type: RW, U, F

Corresponds with: #2.11

Adjustment range: 0.0 to 999.0

Units: s/100Hz

Default value: 5.0

Related parameters: #2.09

The acceleration rate corresponds to the time to accelerate from 0 to 100Hz. The acceleration rate is effective for frequency increases in the forward or reverse directions, unless parameter #2.09 (enable reverse accel/decel) has been set to a 1, whereupon this parameter is only effective for forward acceleration (#2.15 is effective for reverse acceleration).

### #0.04 Deceleration rate (actually Decel 1/forward decel 1 rate)

Parameter type: RW, U, F

Corresponds with: #2.21

Adjustment range: 0.0 to 999.0

Units: s/100Hz

Default value: 10.0

Related parameters: #2.09

The deceleration rate corresponds to the time to decelerate from 100Hz to 0Hz. The deceleration rate is effective for frequency decreases in the forward or reverse directions, unless parameter #2.09 (enable reverse accel/decel) has been set to a 1, whereupon this parameter is only effective for forward deceleration (#2.25 is effective for reverse deceleration)..

**#0.05 Frequency reference selector**

Parameter type: RW, U, P, F

Corresponds with: #1.14

Adjustment range: 0 to 5

Units: -

Default value: 0

Related parameters: #1.41, #1.42, #1.43, #1.44, #1.49

This parameter selects the source of the frequency reference value. It has six options:

0 : Selection via digital inputs (in particular bit parameters #1.41 to #1.44)

1 : Analogue reference 1

2 : Analogue reference 2

3 : Preset reference

4 : Keypad reference

5 : Precision reference

When [#0.05] is set to 0 the reference selected depends on the state of bit parameters #1.41 to #1.44 as follows: (where x = don't care either 0 or 1)

| [#1.41] - Select analogue frequency reference 2 | [#1.42] - Select preset frequency reference | [#1.43] - Select keypad frequency reference | [#1.44] - Select precision frequency reference | Frequency Reference Selected | Selected Frequency Reference Parameter ([#1.49]) |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | Analogue reference 1 | 1 |
| 1 | 0 | 0 | 0 | Analogue reference 2 | 2 |
| x | 1 | 0 | 0 | Preset reference | 3 |
| x | x | 1 | 0 | Keypad reference | 4 |
| x | x | x | 1 | Precision reference | 5 |

The bits #1.41 to #1.44 are provided to allow control by digital inputs such that frequency references can be selected by external control such as digital inputs.

**#0.06 Current limit**

Parameter type: RW, U, F

Corresponds with: #4.07

Adjustment range: 0 to 150% x (rated drive current [FLC])/(rated motor current [#0.46]), where: FLC = 4.3A for DIN1220075A,

FLC = 3.0A for DIN1220055A,

FLC = 2.3A for DIN1220037A,

FLC = 1.5A for DIN1220025A.

Units: % of rated real/active (or power component of) current

Default value: 150

Related parameters: #0.17, #0.46, #4.13, #4.14, #b.32

If the rated motor current ([#0.46]) is set to a value less than the drive rated current (FLC or [#b.32]), it is possible to have a current limit set above 150%.

The current limit (for both motoring and regenerating) is active in both forward and reverse directions. However, it has no effect until the measured active current approaches, and tries to exceed the current limit value. (This only applies if #0.17 is set to 0 (default), frequency (/'speed') control.)

When the motoring current limit is reached, the acceleration ramp is stopped or the drive frequency is decreased via PI (proportional/integral) control (#4.13, #4.14).

Similarly, when the braking, regenerative current limit is reached, the deceleration ramp is stopped or the drive speed is increased via PI control (#4.13, #4.14).

In the torque control mode ([#0.17] = 1), the current limit is effective at all times, and adjusts the frequency to try and maintain the active measured current at the current demand level/value (i.e. the current limit).

**#0.07 Select boost mode**

Parameter type: RW, Bit, P, F

Corresponds with: #5.14

Adjustment range: 0 or 1

Units: -

Default value: 1

Related parameters: #0.08, #5.16

This bit parameter has the following options:

| #0.07 Setting | Description |
|---|---|
| 0 | Fixed boost defined by [#0.08], (or [#5.16] during jogging) |
| 1 | Auto boost, where boost is defined by [#0.08] x \|[#4.20]\|/100%, (or [#5.16] x \|[#4.20]\|/100% during jogging). (#4.20 is the percentage load.) |

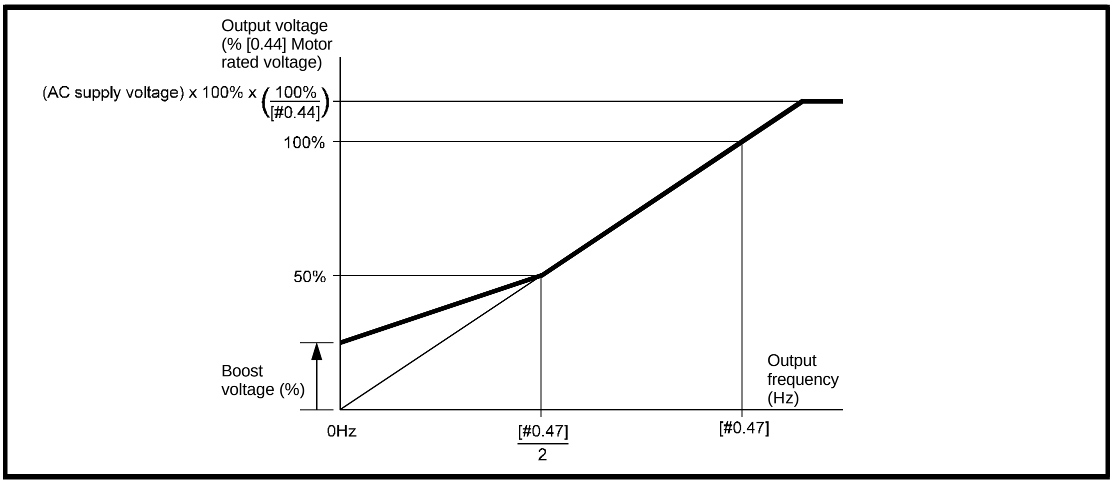



Fig. 7.2 Volt/Hz characteristic for varying boost settings

**#0.08 Boost voltage**

Parameter type: RW, U, F

Corresponds with: #5.15

Adjustment range: 0.0 to 25.5

Units: % of motor rated voltage (#0.44)

Default value: 10.0

Related parameters: #0.07, #0.44, #5.16

The boost voltage defines the motor voltage, and thus the flux and torque developed at low speed (defined by #5.16 when jogging). It is only effective from 0Hz up to 50% of motor rated frequency (50% of [#0.47]). See Fig. 7.2 in the #0.07 description above.

The actual boost voltage (in volts) is: (use [#5.16] instead of [#0.08] for jog boost voltage)

{[#0.08]/100%} x {[#0.44]/100%} x (input supply voltage)

where: #0.44 is the Motor - rated voltage

Set up recommendation: With the drive running, enter a small frequency reference (e.g. 2-3 Hz). If the motor does not rotate, the value of #0.08 should be increased until the motor turns. When the motor is turning, set up the parameter so that the motor current is minimal.

**#0.09 Select dynamic V/f**

Parameter type: RW, Bit, F

Corresponds with: #5.13

Adjustment range: 0 or 1

Units: -

Default value: 0

Related parameters: #0.07, #0.47

This bit parameter has the following options:

| #0.09 Setting | Description |
|---|---|
| 0 | Fixed linear V/f characteristic for constant load/torque applications |
| 1 | Dynamic V/f characteristic for fan/pump applications. Advantages include energy saving and less motor audible noise. |

The two V/f characteristics are illustrated in Fig. 7.3 below:

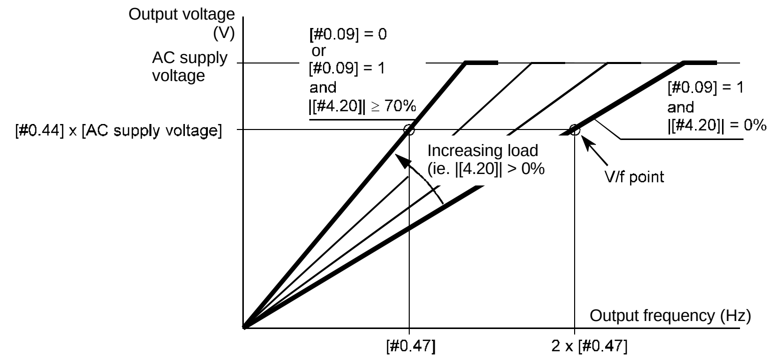



Fig. 7.3 Volt/Hz characteristic for fixed and dynamic V/f settings

If [#0.09] equals 1 (dynamic V/f), and, 0% ≤ |[#4.20]| ≤ 70%, then the effective V/f point (i.e. output frequency when 100% of #0.44 voltage is reached) is:

Effective V/f point (in Hz) = [#0.47] x {0.5 + |[#4.20]| / (2 x 70%)}

where: #0.47 is the Motor - rated frequency

#4.20 is the percentage load

Otherwise if: |[#4.20]| ≥ 70%)

Then: Effective V/f point = [#0.47]

## #0.10 Motor frequency

Parameter type: RO, B, P, F

Corresponds with: #5.01

Range: 0.0 to approx. ±[#0.02]

Units: Hz

Related parameters: #0.12

This parameter gives the output frequency of the drive. The value is calculated as follows: (i.e. the post-ramp reference plus the slip compensation term)

[#0.10] = [#0.12] + [#0.45] x ([#0.42]/120) x ([#4.20]/100%)

where: #0.12 is the post-ramp frequency reference

#0.42 is the Motor - number of poles (use values of 2, 4, 6 or 8)

#0.45 is the Motor - rated full load slip (rpm)

#4.20 is the percentage load

Therefore the range of this parameter (#0.10) is the maximum magnitude of parameters #0.01 and #0.02 plus whatever is added or subtracted for the slip compensation.

## #0.11 Pre-ramp frequency reference

Parameter type: RO, B, P, C

Corresponds with: #1.03

Range: 0.0 to ±fMax[#0.02], (or, [#0.01] to [#0.02], if [#1.08] = 1)

Units: Hz

Related parameters: -

This is the frequency reference prior to the accel/decel rates being applied. It is useful for drive set-up and fault finding.

**#0.12 Post-ramp frequency reference**

Parameter type: RO, B, P, C

Corresponds with: #2.01

Range: 0.0 to ±fMax[#0.02], (or, [#0.01] to [#0.02], if [#1.08] = 1)

Units: Hz

Related parameters: -

This is the frequency reference after the accel/decel rates have been applied. It is useful for drive set-up and fault finding. This value can be increased above the range indicated by current limit.

**#0.13 Load current (real/active component)**

Parameter type: RO, B, P, C

Corresponds with: #4.02

Range: 0.0 to {+ [#0.43] x FLC x 1.5} where FLC = [#b.32] and

FLC = 4.3A for DIN1220075A,

FLC = 3.0A for DIN1220055A,

FLC = 2.3A for DIN1220037A,

FLC = 1.5A for DIN1220025A,

Units: A

Related parameters: #0.43, #0.46, #b.32

This parameter displays the ‘torque producing’ current or load.

In a range between 15Hz and rated motor frequency ([#0.47]), the load current is nearly proportional to the given torque (T), i.e.

T ~ [#0.13]

In the field-weakening region above motor rated frequency, torque decreases inversely proportional to speed at the same active current, i.e. the following relationship applies:

T ~ [#0.13] x (motor rated frequency [#0.47])/(motor frequency [#0.10])

**#0.14 Jog frequency reference**

Parameter type: RW, U, C

Corresponds with: #1.05

Adjustment range: 0.0 to 400.0, (limited to 240.0 by #0.02 when [#0.41] = 3 (kHz))

Units: Hz

Default value: 1.5

Related parameters: #1.13

This parameter defines the frequency reference for jogging.

If a value is set which is higher than the ULF (upper limit frequency) then the actual jog reference will be limited to the ULF value. Similarly the jog reference will be limited to the maximum frequency #0.02 even though the set value could be higher than this.

**#0.15 Deceleration mode selector**

Parameter type: RW, U, T, P, C

Corresponds with: #2.04

Adjustment range: Std (0) or FSt (1)

Units: -

Default value: Std (0)

Related parameters: #0.04

This parameter has 2 settings:

| #0.15 Setting (Display) | Setting via Serial comms | Description |
|---|---|---|
| Std | 0 | Deceleration ramp held whenever braking IGBT 'on' - Standard ramp |
| FSt | 1 | Deceleration ramp unaffected by braking IGBT - Fast ramp |

In the ‘Std’ mode of operation, during deceleration, if the DC link voltage reaches the limit where the internal braking transistor is turned ‘on’, the deceleration ramp is halted.  When the DC link voltage decreases below this value, and the internal braking transistor is turned ‘off’,  the deceleration ramp is continued.  The frequency reduces in a staircase fashion.

Advantages of ‘Std’ mode:	With the simplest set up, the risk of overvoltage trips during deceleration is minimised when no braking resistor is connected.

In the ‘FSt’ mode of operation, during deceleration, the ramp rate is maintained regardless of whether the internal braking transistor is ‘on’ or ‘off’(subject to the current limits programmed). This setting is recommended when using a suitable braking resistor.

**#0.16	Stop mode selector**

Parameter type:	RW, U, T, P, C

Corresponds with:	#6.01

Adjustment range:	CSt (0), rP (1), rP.I (2),  or, dcI (3)

Units:	-

Default value:	rP (1)

Related parameters:	#1.11, #6.06, #6.07

This parameter has 4 settings:

| #0.16 Setting (Display) | Setting via Serial comms | Description |
|---|---|---|
| CSt | 0 | Coast stop |
| rP | 1 | Ramp stop |
| rP.I | 2 | Ramp stop with 1 second DC injection |
| dcI | 3 | Timed DC injection braking stop |

In the ‘CSt’ stopping mode, after applying a stop command, the output stage is disabled immediately; the drive coasts to a standstill. The drive is disabled for a minimum of 1 second before it can be enabled again.

In the ‘rP’ stopping mode, after applying a stop command, the drive ramps down to zero frequency according to the deceleration rate.  The output stage is disabled one second after reaching 0Hz.  With large inertia motor loads, the motor can still be running at low speed after this time, depending on the boost settings.

In the ‘rP.I’ stopping mode, after applying a stop command, the drive ramps down to zero frequency according to the deceleration rate.  On reaching 0Hz, a DC voltage is switched onto the motor for one second (value set via #6.06), which creates a holding torque.  With large inertia motor loads, #6.06 can be set to ensure that the motor is stationary after the 1 second DC injection period.

In the ‘dcI’ stopping mode, DC injection starts immediately after a stop command is given.  The DC injection voltage is set via #6.06, and the DC injection time is set with #6.07.

### #0.17 Select torque control

Parameter type: RW, Bit, C

Corresponds with: #4.11

Adjustment range: 0 or 1

Units: -

Default value: 0

Related parameters: #0.06, #4.03, #4.04

The bit parameter has the following settings::

| #0.17 Setting | Description |
|---|---|
| 0 | Frequency control (with PI current limit control inactive until current limit (i.e. [#0.06]) reached) |
| 1 | Torque control (PI current limit control always active to maintain current at demand value i.e. [#4.04]) |

When the drive is operated in the torque control mode,  and the torque (or current demand) is higher than the load torque (or measured active current), the drive is accelerated to 20% above the maximum frequency [#0.02], but limited by ULF.   The drive direction is controlled by the required torque polarity as follows:

| Torque (load) polarity | Frequency polarity | Direction/Power flow |
|---|---|---|
| Positive | Positive | Forward (+ve)/ Motoring |
| Positive | Negative | Reverse (-ve)/ Regenerating |
| Negative | Positive | Forward (+ve)/ Regenerating |
| Negative | Negative | Reverse (-ve)/ Motoring |

**#0.18** **Not programmed**

**#0.19**

Parameter type: C

Defined via: #b.08 (for #0.18)

#b.09 (for #0.19)

**#0.20**

**#0.21**

**#0.22**

**#0.23**

**#0.20** **Skip frequency 1**

**#0.22** **Skip frequency 2**

Parameter type: RW, U, C

Corresponds with: #1.29 (skip frequency 1)

#1.31 (skip frequency 2)

Adjustment range: 0.0 to ULF

Units: Hz

Default value: 0.0

Related parameters: #0.21, #0.23

These 2 skip frequencies are available to prevent mechanical resonances in a system, by ensuring that certain frequencies can be avoided by always ramping through them.

Setting either skip frequency to a value of 0.0Hz (as default) makes the relevant skip frequency ineffective.

See the graph below (Fig. 7.4) illustrating the action of skip frequencies and associated skip frequency bands.

**#0.21 Skip frequency band 1**

**#0.23 Skip frequency band 2**

Parameter type: RW, U, C

Corresponds with: #1.30 (skip frequency band 1)

#1.32 (skip frequency band 2)

Adjustment range: 0.0 to 5.0

Units: Hz

Default value: 0.5

Related parameters: #0.20, #0.22

These parameters allow frequency bands to be skipped in order to avoid mechanical resonances.

Frequency skipping occurs around each skip frequency (#0.20 and #0.22), and includes the skip frequency bands (#0.21 and #0.23) above and below the related skip frequency. Therefore, the frequency range over which the skip function is effective is twice the value of the appropriate skip frequency band.

The drive accelerates/decelerates through the selected skip frequency areas, without stopping.

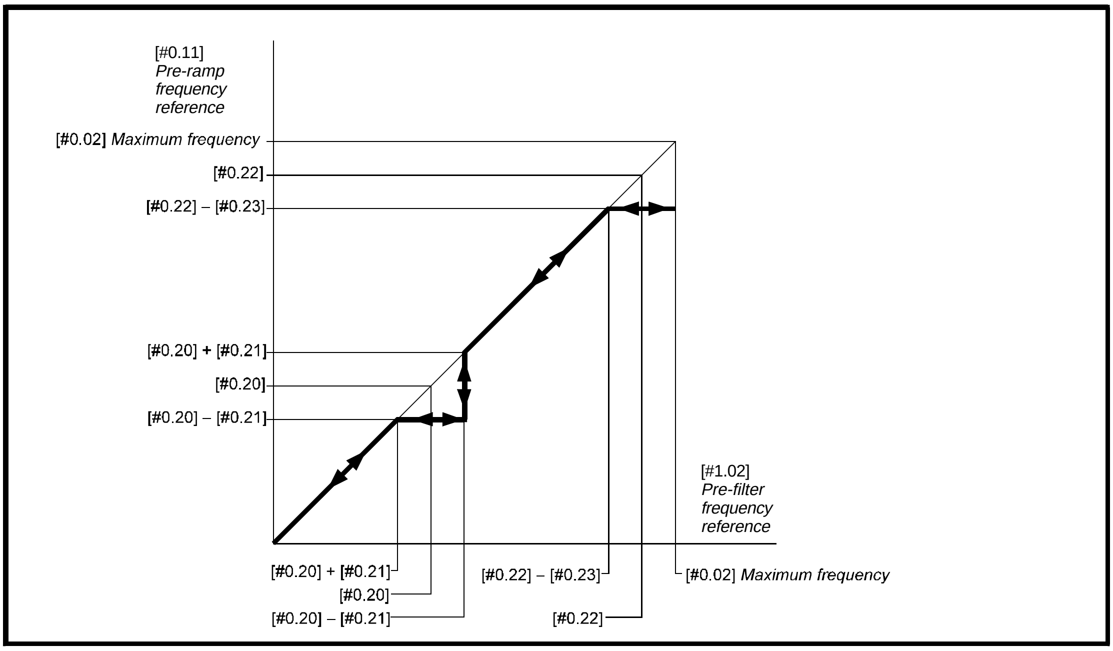



Fig. 7.4 Typical examples showing operation of skip frequencies and bands

**#0.24 Analogue input 1 (A2) mode selector**

Parameter type: RW, U, T, P, C

Corresponds with: #7.06

Adjustment range: ULt (0) or th (1)

Units: -

Default value: ULt (0)

Related parameters: #7.01, #7.08, #7.09, #7.10

The analogue input (Terminal A2) can be configured either as a voltage input (default) or as a motor thermistor input. The setting of this parameter configures the terminal for the required mode.

| #0.24 Setting (Display) | Setting via Serial comms | Description |
|---|---|---|
| ULt | 0 | Terminal A2 accepts -10V to +10V analogue voltage input |
| th | 1 | Terminal A2 accepts motor thermistor input, when configured as below: |

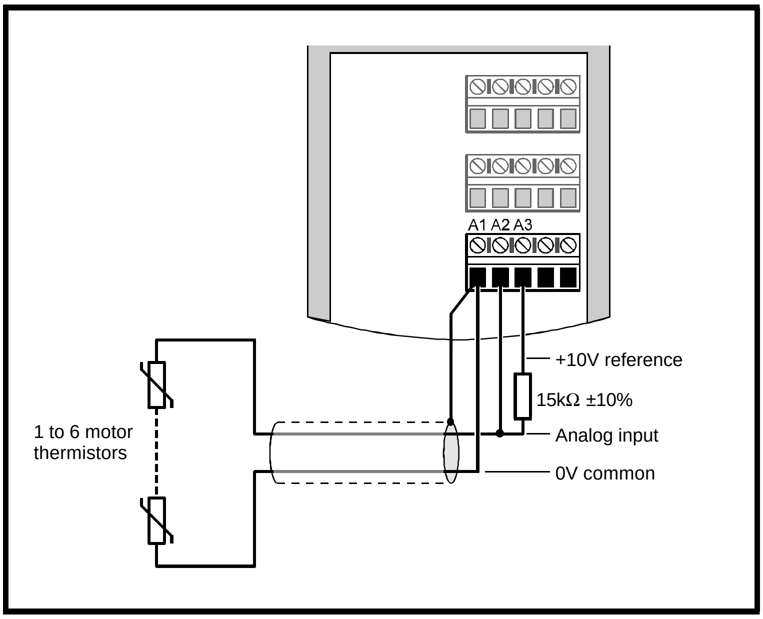



Fig. 7.5 Optional motor thermistor input arrangement for Terminal A2

The motor thermistor can be 1 to 6 250Ω standard motor thermistors connected in series. The drive will trip ('th' trip code) when the thermistor resistance is ≥ 3.3kΩ, and a reset value ≤ 1.8kΩ.

**#0.25 Analogue input 2 (C4/C5) mode selector**

Parameter type: RW, U, T, P, C

Corresponds with: #7.11

Adjustment range: ANS (0), 0.20 (1), 20.0 (2), 4.20 (3), 20.4 (4), or th (5)

Units: -

Default value: ANS (0)

Related parameters: #7.02, #7.12, #7.13, #7.14

This analogue input can be configured for different input signal types (including serial communications). Possible options are as follows:

| **#0.25 Setting (Display)** | **Setting via Serial comms** | **Description** |
|---|---|---|
| ANS | 0 | RS485 ANSI serial comms port active |
| 0.20 | 1 | Current input 0 to 20mA (20mA full scale) |
| 20.0 | 2 | Current input 20 to 0mA (0mA full scale) |
| 4.20 | 3 | Current input 4 to 20mA (20mA full scale) |
| 20.4 | 4 | Current input 20 to 4mA (4mA full scale) |
| th | 5 | Motor thermistor input, see Fig. 7.6 below for arrangement |

When the input is selected as a motor thermistor input, the input must be configured as follows:

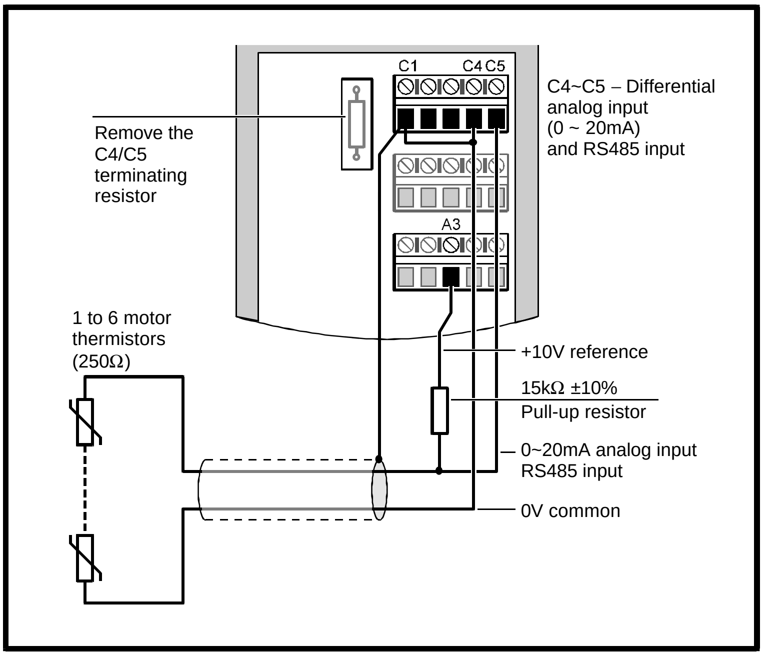



Fig. 7.6 Optional motor thermistor input arrangement for Terminals C4 and C5

The motor thermistor can be from 1 to 6 250Ω standard motor thermistors connected in series. The drive will trip (‘th’ trip code) when the thermistor resistance is ≥ 3.3kΩ, and a reset value ≤ 1.8kΩ.

For the 4.20 (3) and 20.4 (4) settings, a cable break, or an input current less than 3mA, will cause the drive to trip (‘cL’ trip code) for current loop loss.

**#0.26** **Not programmed**

**#0.27**

**#0.28**

**#0.29**

**#0.30**

Parameter type: C

Defined via: #b.16 (for #0.26)

#b.17 (for #0.27)

#b.18 (for #0.28)

#b.19 (for #0.29)

#b.20 (for #0.30)

**#0.31** **Reserved for other drive parameters**

**#0.32**

**#0.33**

**#0.34**

**#0.35**

**#0.36**

Parameter type: F

### #0.37 Serial interface address

Parameter type: RW, U, P, F

Corresponds with: #b.23

Adjustment range: 0.0 to 9.9

Units: [group.unit]

Default value: 1.1

Related parameters: #0.25, #b.26

If parameter #0.25 is set to ANS (0) (default) the serial interface is active. Parameter #0.37 defines the serial address of the drive. The address has the following format: [drive group. drive unit]. There are 9 addressable groups for each of 9 possible drive units. If address [0.0] is used, all drives are addressed simultaneously. If [x.0] is used, where x is any number from 1 to 9, all drives in group x are addressed.

Note that for this drive, the only baud rate available is 4800.

### #0.38 Initial parameter displayed selector

Parameter type: RW, U, F

Corresponds with: #b.22

Adjustment range: 0 to 50 (i.e. #0.00 to #0.50)

Units: (#0.) (Value is parameter number in Menu 0)

Default value: 10 (i.e. #0.10)

Related parameters: -

This parameter defines the parameter in Menu 0 which is selected when power is first applied to the drive (i.e. #0.10 is the default parameter displayed after 'MODE' M is pressed following power up).

**#0.39** **Reserved for other drive parameters**

**#0.40**

Parameter type: F

**#0.41** **PWM switching frequency**

Parameter type: RW, U, T, P, F

Corresponds with: #5.18

Adjustment range: 3 (0), 6 (1), 9 (2), or 12 (3)

Units: kHz

Default value: 3 (0)

Related parameters: #0.01, #0.02

This parameter sets the PWM switching frequency of the Dinverter.

| **#0.41 Setting (Display)** | **Setting via Serial comms** | **Description** |
|---|---|---|
| 3 | 0 | 3kHz PWM switching frequency (actually 2.9kHz) |
| 6 | 1 | 6kHz PWM switching frequency (actually 5.8kHz) |
| 9 | 2 | 9kHz PWM switching frequency (actually 8.8kHz) |
| 12 | 3 | 12kHz PWM switching frequency (actually 11.7kHz) |

The output frequency of the drive ([#0.10]) is limited by the switching frequency selected as follows:

| Switching frequency | Maximum output frequency (Upper limit frequency - ULF) |
|---|---|
| 3kHz | 240Hz |
| 6kHz | 480Hz |
| 9kHz | 720Hz |
| 12kHz | 960Hz |

The maximum output frequency for each switching frequency is known as the Upper Limit Frequency and is used as the maximum range of some parameters. It should be noted that if a maximum speed limit (#0.01 or #0.02) is set to an upper limit frequency, there will be no head room for the drive to increase frequency above this level to affect slip compensation. If slip compensation is required the user must ensure that a switching frequency is selected which allows the output frequency to rise enough to allow the compensation.

**#0.42 Motor - number of poles**

Parameter type: RW, U, T, P, F

Corresponds with: #5.11

Adjustment range: 2P (0), 4P (1), 6P (2), or 8P (3)

Units: Number of poles

Default value: 4P (1)

Related parameters: #0.45

The number of poles should be entered, not the number of pole-pairs.

| **#0.42 Setting (Display)** | **Setting via Serial comms** | **Description** |
|---|---|---|
| 2P | 0 | 2 Motor poles |
| 4P | 1 | 4 Motor poles |
| 6P | 2 | 6 Motor poles |
| 8P | 3 | 8 Motor poles |

It is essential that this parameter is set for the particular motor used for correct operation of the drive and all related speed and slip parameters.

Example: An induction motor has a rated speed of 1,440rpm and a rated frequency of 50Hz. Therefore, the motor is 4-pole, and this parameter is set to 4P (or 1 using serial comms).

**#0.43 Motor - rated power factor**

Parameter type: RW, U, P, F

Corresponds with: #5.10

Adjustment range: 0.00 to 0.85 x (FLC)/[#0.46]

where: FLC = drive rated current [#b.32]

#0.46 is the Motor - rated current

with a maximum possible value of 1.00

Units: -

Default value: 0.85

Related parameters: #0.06, #0.46

The motor power factor (cos φ) is used in conjunction with parameter #0.46 (motor rated current) to calculate the rated active current (i.e. rated active current = [#0.46] x [#0.43]). The rated active current is used extensively to control the drive.

It is therefore essential that this parameter is set for the particular motor used for correct operation of the drive and all related current parameters.

**#0.44 Motor - rated voltage**

Parameter type: RW, U, F

Corresponds with: #5.09

Adjustment range: 0.0 to 100.0

Units: % (of input supply voltage)

Default value: 100.0

Related parameters: #0.07, #0.08, #0.09

The motor rated voltage for the winding connection must be entered into this parameter according to the motor nameplate rated voltage

Example: Motor used : 50Hz, 230V in delta, 400V in star connection

Supply voltage available: 240VAC

Settings: The motor is operated in a delta connection where:

[#0.44] = (Motor voltage) x 100%/ (Supply voltage)

= 230 x 100%/240

= 96%

It is essential that this parameter is set for the particular motor used for correct operation of the drive and other related voltage parameters, such as dynamic V/f, boost, etc.

**#0.45 Motor - rated full load slip (rpm)**

Parameter type: RW, U, F

Corresponds with: #5.08

Adjustment range: 0 to 250

Units: rpm

Default value: 0

Related parameters: #0.10, #0.42

Entry of the motor rated full load slip activates slip compensation. The default value of 0 disables slip compensation.

By changing this parameter value, the motor can either be over or under compensated for slip as necessary (i.e. the shaft speed can be made to increase or decrease with mechanical load as necessary).

Slip compensation will not alter the frequency direction defined by the post-ramp frequency reference ([#0.12]).

The 'best guess' value to achieve good slip compensation (i.e. no shaft speed change with load) is calculated as follows:

[#0.45] = {[#0.47] x 120/[#0.42]} - (Motor nameplate full load speed in rpm)

where: #0.42 is the Motor - number of poles (use values of 2, 4, 6 or 8)

#0.47 is the Motor - rated frequency

Example: For a 50Hz 4-pole machine rated at 1,450rpm

[#0.45] = {50 x 120 / 4} - 1450

= 50 rpm

**#0.46 Motor - rated current**

Parameter type: RW, U, F

Corresponds with: #5.07

Adjustment range: 0.0 to drive rated current (FLC)

Units: A

Default value: Drive rated current (FLC) where

FLC = 4.3A for DIN1220075A,

FLC = 3.0A for DIN1220055A,

FLC = 2.3A for DIN1220037A,

FLC = 1.5A for DIN1220025A,

Related parameters: #0.06, #0.07, #0.08, #0.09, #0.45, #4.15

The value set in #0.46 should be the motor rated current from the motor nameplate, taking into account the winding connection (i.e. star or delta).

This parameter value is used in the following parameter calculations:

| | |
|---|---|
| Current limit, | parameter #0.06 |
| Motor thermal Ixt overload, | parameter #4.15 |
| Slip compensation, | parameter #0.45 |
| Dynamic V/f control, | parameter #0.09 |
| Auto boost, | parameter #0.07 |

Therefore it is essential that this parameter is set for the particular motor used for correct operation of the drive.

## #0.47 Motor - rated frequency

Parameter type: RW, U, F

Corresponds with: #5.06

Adjustment range: 0.0 to ULF, where:

ULF = 240Hz when #0.41 = 3 (kHz),

ULF = 480Hz when #0.41 = 6 (kHz),

ULF = 720Hz when #0.41 = 9 (kHz),

ULF = 960Hz when #0.41 = 12 (kHz)

Units: Hz

Default value: 50.0 (when #x.00 set to 533 followed by a ‘RESET’), or

60.0 (when #x.00 set to 544 followed by a ‘RESET’).

Related parameters: #0.44

The motor rated frequency, in conjunction with #0.44 (Motor rated voltage), is used to define the voltage to frequency characteristic applied to the motor.

Therefore it is essential that this parameter is set for the particular motor used for correct operation of the drive.

**#0.48 Reserved for other drive parameters**

Parameter type: F

**#0.49 Security status**

Parameter type: RO, U, P, F

Corresponds with: -

Range: 0 to 111

Units: -

Default value: 1

Related parameters: #x.00, #b.30

After power is applied to the drive, only access to the parameters in Menu 0 is available. Access to the extended menus, after the supply is connected, is only possible after entering a standard access code value of 149 into parameter #x.00.

The user security code is in parameter #b.30 and can be changed from its default value of 149 according to the users requirements.

Parameter #0.49 consists of 3 digits (xyz where x, y, z = 0, 1 or blank) and represents the security status:

| x (or hundreds digit) | y (or tens digit) | z (or units digit) |
|---|---|---|
| 0 or blank = no user-defined security code entered into #b.30 | 0 or blank = read/write access to all menus or no user-defined security entered | 0 = access to all menus (all menus open) (i.e.[#x.00] set to 149) |
| 1 = user defined security code set in #b.30 | 1 = user-defined security active, no write access to any menus | 1 = [#x.00] not set to 149, no access to extended menus |

The resulting value of #0.49 provides the following keypad access capability:

| Value of #0.49 | Access provided: |
|---|---|
| 100 or 0 | View and modify Menus 0 to E parameters |
| 101 or 1 | View and modify Menu 0 parameters only |
| 110 only | View Menus 0 to E parameters only |
| 111 only | View Menu 0 parameters only |

**#0.50 Software version**

Parameter type: RO, U, P, F

Corresponds with: #b.29

Range: 1.00 to 9.99

Units: -

Default value: 1.03

Related parameters: -

This parameter displays the version of the installed software. For the default value given above, the software version is V1.03.xx where xx is any number from 00 to 99 and only corresponds to software ‘bug’ fixes which do not affect the drive specification or this manual. Whereas the next version of software released V1.04.xx will have specification changes that will affect the operation of the drive and this User Guide.

# 8.0 Commissioning - Getting Started

## 8.1 Warnings

**Safety of application:**

Careful consideration must be given to safety aspects of the system in which the drive is incorporated.

The drive is a complex system containing many electronic components and software. Control Techniques has made every effort to minimise the failure rate and to eliminate programming errors. However in common with all such drives the integrity of the unit is not high enough to carry out safety-related functions without independent high-integrity protection.

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

Some common examples of functions which might be safety-related are:

- Stop/start, and emergency stop
- Auto-start
- Forward/reverse
- Maximum speed

However there may be others, depending on the exact application. These will be revealed by the risk assessment.

**Warning**

Some of the parameters have a profound effect on drive operation. They must not be altered without careful consideration to the impact on the controlled plant, and measures must be taken to prevent unwanted changes through error or tampering.

**Motor Speed/Safety**

Standard squirrel-cage AC induction motors are designed as single speed motors. If it is intended to use the capability of the drive to run the motor at speeds above its designed maximum, it is strongly recommended that the motor manufacturer is consulted first. The principal risks due to overspeeding are the destruction of the rotor by centrifugal force, or of the bearings by vibration and overheat.

Do not rely on the maximum speed setting parameter of the drive for overspeed protection. If the possibility of overspeeding is a serious problem, other means of protection must be provided.

Low speed operation may result in overheating of the motor because the effectiveness of the internal cooling fan reduces with shaft speed. Motors should be equipped with thermistor protection, and if full benefit of the use at low speeds is to be gained it may be necessary to arrange additional forced cooling for the motor.

The drive contains capacitors which remain charged to a potentially hazardous voltage after the supply is removed. A period of at least 8 minutes must be allowed between disconnecting the supply and gaining access to the connections of the drive.

The drive is capable of causing damage to machinery if incorrectly adjusted. Take care when making any adjustments. Ensure that the motor shaft is not exposed. Ensure that the motor is mounted in accordance with the manufacturers recommendations. Ensure that all personnel in the area are aware and warned that adjustments are to be made to the drive. Never work on a variable speed drive alone. Always have a fellow worker near to you to assist in the case of an emergency. Any adjustments to the drive that are performed should be recorded.

## 8.2 Initial Electrical and Mechanical Set-Up

Prior to powering the drive up for the first time, ensure that Sections 4 & 5 of this manual have been studied and the necessary recommended actions have been taken. For initial operation and set-up of the drive, it is assumed that the connections are as shown in Fig 8.1.

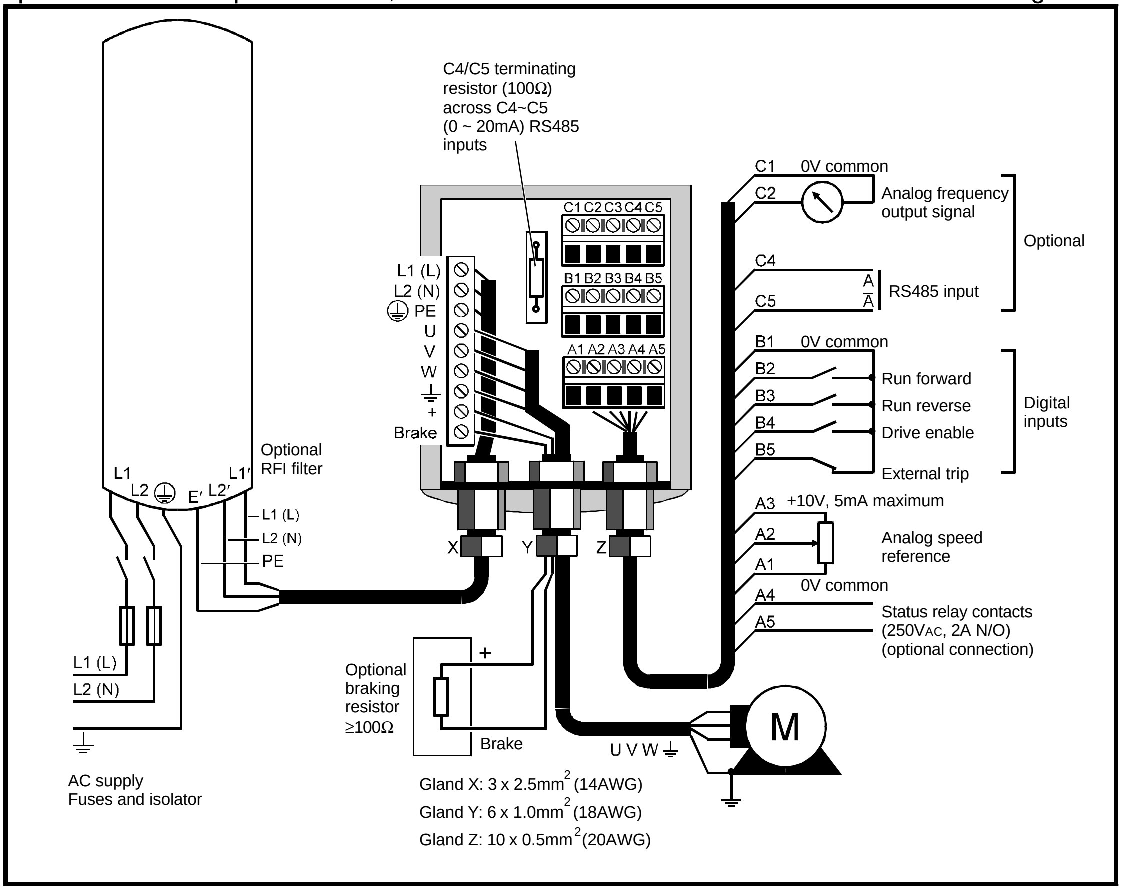



Fig. 8.1 Electrical connections for initial set-up and operation

In particular:

- Check that the wiring is correct,
- Check that the motor installation is correct and safe,
- Check that the motor shaft is not exposed,
- Check that the signal connections B2, and B3 are not connected to 0V Common (i.e. the switches/contacts are open), and B4 and B5 are connected to 0V Common (i.e. the switches/contacts are closed). This ensures that the motor will not turn when AC power is applied to the drive.
- Check that the Set Speed Potentiometer (connected to A1, A2, and A3) is set to minimum (wiper is effectively connected to 0V Common wiper).

Before switching on the power to the drive, it is important to understand the drive operating controls and their operation. If in doubt, DO NOT ADJUST this drive. Damage may occur, or lives may be put at risk. Please read the following Sections carefully.

## 8.3 Configuring Drive for Connected Motor(s)

1) With the drive wired up as described in Section 8.2 above, apply power to the input of the drive.

   - drive should power up with 'rdy' on the display.

2) If the drive is already in the default set-up (with all parameters set to the default state) bypass this step, otherwise set defaults as follows:

   (Note that the following example sets 50Hz defaults. If 60Hz defaults are required set Parameter 0 (i.e. #0.00) to a value of 544 not 533.)

   - Select Parameter 0 (i.e. #0.00)

     ( Press 'MODE' followed by pressing 'DOWN' repeatedly to move from #0.10 to #0.00)

   - Enter a value of 533 (for 60Hz motors set a value of 544)

     ( Press 'MODE' followed by pressing and holding 'UP' until a value of 533 is displayed.)

     Or:

     (Press 'MODE' followed by 'left' ('DOWN' and 'MODE' simultaneously), then 'left' again, until '_ 0' is displayed.

     Press 'UP' repeatedly until '500' is displayed.

     Press 'right' ('MODE' and 'UP' simultaneously), when '500' is displayed.

     Press 'UP' repeatedly until '530' is displayed.

     Press 'right' ('MODE' and 'UP' simultaneously), when '530' is displayed

     Press 'UP' repeatedly until '533' is displayed.)

   - Press 'STOP/RESET' to reset the drive and enter default values.

   - Store the default parameters for later use

     (Set Parameter #0.00 to 900 (as already explained above for setting [#0.00] = 533).

     Press 'STOP/RESET' to reset the drive and store default values.)

   - Default values will always be used from now on whenever the drive is first powered up, unless other parameters are changed and saved.

3) Enter the motor data into parameters #0.42 to #0.47 according to the nameplate details and supply connections.

#0.42 - Enter the number of motor poles (if different to default value of "4P".)

#0.43 - Enter motor power factor if different to default value.

#0.44 - Enter motor rated voltage if different to default value of 100% of supply voltage.

#0.45 - Enter motor full load slip in rpm if slip compensation required (otherwise leave at 0 default value).

#0.46 - Enter motor full load current if different from (but must be less than) drive full load current rating.

#0.47 - Enter motor rated frequency if different from default value of 50.0 or 60.0Hz depending on the value set in Parameter 0 for entering defaults.

Care must be taken that #0.44 and #0.47 are set correctly according to the motor rated voltage, Y or Δ connections used, motor rated frequency and drive supply voltage.

For example, if: motor rated voltage = 415V in Y

motor rated frequency = 50Hz

drive supply voltage = 240VAC

motor full load current = 2.5A

Connect motor in Δ for suitable operation.

Set: #0.44 = (415V/√3/240V) x 100%

= 100%

#0.46 = 2.5A x √3

= 4.3A

#0.47 = 50Hz x 100%/[#0.44]

= 50Hz

If motor could not be connected in Δ, only Y:

Set: #0.44 = (415V/240VAC) x 100%

= (173%) (but can only set to 100% maximum)

= 100%

#0.46 = 2.5A

#0.47 = 50Hz x 100%/[#0.44 i.e. 173%]

= 29Hz

(As a result of the settings, the drive can only provide full load torque up to 29Hz.)

## 8.4 Operating Drive Using Control Terminal Inputs

1. Select the required PWM switching frequency via #0.41, for suitable motor noise (although the default value of 3kHz (i.e. [#0.41] = 3 (kHz)) should be adequate and minimises drive power stage losses).

2. Leave acceleration and deceleration rates at their default values for the time being.

3. Disconnect the motor mechanical load if possible, as the motor direction may be incorrect.

4. Set the desired minimum and maximum frequencies (#0.01 and #0.02).

5. Set the frequency demand to its minimum values by ensuring the potentiometer connected at A2 is set at the 0V Common position.

6. Set the drive to run forward (close terminal B2):

   - Drive runs to minimum frequency.
   - Increase potentiometer setting until the motor turns slowly.
   - Check the motor direction. If wrong change the direction by terminal control (i.e. open terminal B2 and close terminal B3). (If this is not desirable, power off the drive and then when safe exchange two motor phase connections from the drive)

   Note: The Dinverter A currently operates the motor in the reverse direction to that if the a normal 3-phase AC supply is directly connected to the motor. Please check the motor rotation with the drive motor combination before progressing.

7. Run slowly through the frequency range. Slowly increase the potentiometer setting to the maximum value and observe the motor.

8. Stop the motor by opening B2 or B3 connection.

9. Power off the drive and reconnect the motor to its load.

10. With the frequency demand set to minimum again, set the drive to run. If the drive does not start at the required speed increase the boost voltage (#0.08) until it does. If this does not give suitable starting performance set #0.08 to 0.0% and set #0.07 to 0 (fixed boost). Increase #0.08 until suitable low speed running is achieved.

11. Save the parameters before proceeding further.

12. Set up the acceleration rate using #0.03. Set the potentiometer to the maximum setting when the drive is in a stop condition, and then start the motor by closing B2 or B3. If an ‘OI’ overcurrent trip occurs, the acceleration torque required is too high. This can be changed by extending the acceleration rate (i.e. increasing #0.03), or, especially for drives with large connected motor inertia, by adjusting the I (integral ) term of the current control loop via #4.14 (generally increase the value). Increasing the integral gain may cause instability. If this occurs, increase the proportional gain to re-stabilise the control.

It is useful to observe the motor frequency [#5.01] via an oscilloscope on terminal C2 (default settings). If this gives no indication as to why the ramp cannot be maintained, observe the motor percentage load [#4.20] using terminal C2 by setting [#7.19] to 4.20. Check whether the current limit [#0.06] is being reached and adjust if possible.

13. Set up the deceleration rate.

According to the application, #0.16 should be set to the required stop mode. Parameter #0.16 defines the action taken by the drive when a stop command is given (or removal of the run signal in default conditions).

Selection of type of

deceleration ramp:

The setting of parameter #0.15 (deceleration mode selector) defines the deceleration characteristic.

If a braking resistor is used, the parameter should always be on ‘FSt’. If no braking resistor is used, it is recommended to set the parameter to ‘Std’ (controlled deceleration ramp with ramp hold).

The less critical mode is ‘Std’, in that if the braking torque is too high, the deceleration ramp will be temporarily held when the DC link has risen to a level where the brake transistor is turned on. The deceleration ramp is resumed when the DC link voltage has dropped to a lower threshold when the brake is turned off. The motor will decelerate towards zero speed in a staircase fashion. Further parameter settings are not necessary. Note that in this mode the external braking resistor has less effect, since the deceleration ramp is held whenever the brake turns on.

Set up of deceleration rate:

Set the deceleration rate to the required value (#0.04).

(Note that the value for the deceleration rate relates to a ramp time from 100Hz to 0Hz.)

Run the drive at maximum speed. Now set the speed demand to zero or apply a stop signal (with #0.16 set to 'rP' or 'rP.I'). The drive will now decelerate according to the set deceleration rate. If the converter trips (e.g. 'OI' or 'OU') the braking torque is too high. Increasing the deceleration rate will help. If a deceleration ramp time is required by the application which causes tripping, a braking resistor must be installed and the parameter #0.15 needs to be set to 'FSt'.

15. The basic commissioning is now concluded.

## 8.5 Operating the Drive Using the Keypad

Note that this section assumes all parameters are at the default values.

1. Select the required PWM switching frequency via #0.41, for suitable motor noise although the default value of 3kHz (i.e. [#0.41] = 3 (kHz)) should be adequate and minimises drive power stage losses.

2. Leave acceleration and deceleration rates at their default values for the time being.

3. Disconnect the motor mechanical load if possible, as the motor direction may be incorrect.

4. Set the desired minimum and maximum frequencies (#0.01 and #0.02).

5. Set #0.05 (the frequency reference selector) to 4 to select the keypad reference for frequency/'speed' control, and . enabling the 'RUN', 'STOP' and 'FWD/REV' keys on the keypad. (Restore the display to the default parameter of #0.10 to observe the frequency adjustment.)

6. Press 'RUN' to start the drive.

7. Use the ‘UP’ and ‘DOWN’ keys to adjust the speed between the minimum and maximum settings.

8. Use the ‘FWD/REV’ key to reverse/alternate the direction of rotation.

9. Use the ‘STOP/RESET’ key to stop the drive and/or reset a trip.

10. The commissioning can be continued using this keypad mode by using the description in Section 8.4 above, but continuing from Step 6 using the keypad buttons to change speed, stop, start and alter direction etc.

## 9.0 Extended Menus (1 through to 9, A, b, c, E) Parameter Descriptions

## 9.1 General

All parameters are grouped into 14 menus. Each of the extended menus 1 through to E group together common parameter types. As listed in Section 6.4.4, the extended menus or parameter groups are as follows:

(Please note that Menu 0 is detailed in Section 7.0 and is not included in this Section, and similarly Parameter 0 is defined in Sections 6.4.3 and 7.4.)

| Menu | Description |
|---|---|
| 1 | Frequency reference selection, limits and filters<br>- All frequency reference sources are selected via this menu, together with frequency maximums and minimums, as well as skip frequencies. |
| 2 | Ramps<br>- Forward and reverse, as well as various accel/decel ramps can be independently selected as required. |
| 3 | Frequency/speed sensing thresholds<br>- Two speed/frequency thresholds are adjustable in this menu. |
| 4 | Current control<br>- Drive current/torque control and limits as well as protection modes are available in this menu. |
| 5 | Machine control<br>- Motor settings are input to configure the drive correctly. |
| 6 | Drive sequencer and run-time clock<br>- Stopping and starting modes are selected in this menu together with a clock for recording running time. |
| 7 | Analogue inputs and outputs<br>- Set-up of the analogue inputs/outputs is provided here, including where the input is destined to go for internal operation and where the output sources its level from. |
| 8 | Digital inputs and outputs<br>- Set-up of the digital inputs/outputs including destinations (for inputs) and signal sources (for outputs). |
| 9 | Programmable logic and motorised potentiometer<br>- An independent logic function where 2 digital inputs are combined to give a digital output, as well as a motorised potentiometer function. |

| | |
|---|---|
| A | Status logic and diagnostics<br><br>- All relevant internal status bits are grouped here, together with the last 10 trips information, and auto-reset control. |
| b | Miscellaneous and Menu 0 parameter selectors<br><br>- Miscellaneous functions include serial communications set-up and user security, as well as drive rating information. |
| c | Programmable threshold<br><br>- An independent threshold can be programmed as required (i.e. analogue sources to digital output). |
| d | Not used - only Parameter 0, i.e. #d.00 is available |
| E | PID controller<br><br>- An independent PID loop is available for any 2 analogue sources to produce an analogue feedback output. |

The parameter types used throughout the following menu descriptions are as follows:

RW Read/Write Read/ write parameter. (Parameters that can be set (written) by the user, as well as read.)

RO Read Only Read only parameter for displaying operating modes and parameter values. (Parameters that can be read by the user but not set by the keypad, although the drive software has read/write access to them.)

Bit Bit Bit parameter, can exist in only 2 states, 0 or 1.

B Bipolar Bipolar parameter, can have positive or negative values.

U Unipolar Unipolar parameter, can have only positive values.

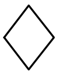
T Text Parameter has different options. Options are specified via text (or character string).

R Reset Parameter needs a RESET signal to implement value changes.

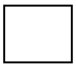
S Saved Parameter is saved automatically by mains switch off.

P Protected Parameter cannot be selected via programmable inputs and functions.

In the logic block diagrams for all the menus the following source/destination symbols have these meanings:



(*diamond)* - Read only (RO)



(*rectangle/square)* - Read/write (R/W)

**5.26** **-** Parameter #5.26

The following sections give a block diagram of each menu together with a summary of the parameters in that menu. At the end of this parameter summary, a complete description is given for each parameter.

## 9.2 Menu 1 logic block diagram - Frequency reference selection, limits and filters

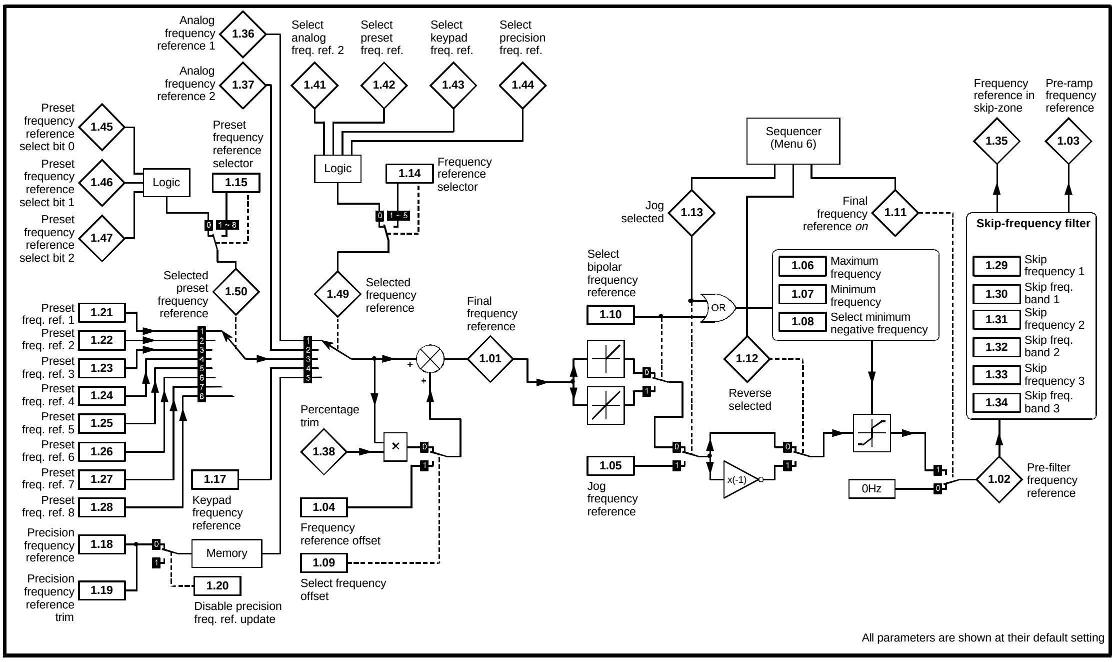



Fig. 9.1 Menu 1 logic block diagram - Frequency reference selection, limits and filters

9.2.1 Menu 1 Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #1.01 | Selected final frequency reference | RO, B, P | 0.0 to ±ULF | - | Hz |
| #1.02 | Pre-skip frequency reference | RO, B, P | 0.0 to ≈ ±[#1.06] | - | Hz |
| #1.03 | Pre-ramp frequency reference | RO, B, P | 0.0 to ≈ ±[#1.06] | - | Hz |
| #1.04 | Frequency reference offset | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.05 | Jog frequency reference | RW, U | 0.0 to 400.0 | 1.5 | Hz |
| #1.06 | Maximum frequency | RW, U | 0.0 to ULF | 50.0 or 60.0 | Hz |
| #1.07 | Minimum frequency | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.08 | Select negative minimum frequency | RW, Bit | 0/1 | 0 | - |
| #1.09 | Select frequency offset | RW, Bit | 0/1 | 0 | - |
| #1.10 | Select bipolar frequency reference | RW, Bit | 0/1 | 0 | - |
| #1.11 | Final frequency reference ‘on’ | RO, Bit, P | 0/1 | - | - |
| #1.12 | Reverse selected | RO, Bit, P | 0/1 | - | - |
| #1.13 | Jog selected | RO, Bit, P | 0/1 | - | - |
| #1.14 | Frequency reference selector | RW, U, P | 0 to 5 | 0 | - |
| #1.15 | Preset frequency reference selector | RW, U, P | 0 to 8 | 0 | - |
| #1.16 | ***Unused parameter*** | - | - | - | - |
| #1.17 | Keypad frequency reference | RO, B, S, P | 0.0 to ±[#1.06] | 0.0 | Hz |
| #1.18 | Precision frequency reference | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.19 | Precision frequency reference trim | RW, U | 0 to 99 | 0 | mHz |
| #1.20 | Disable precision reference update | RW, Bit | 0/1 | 0 | - |
| #1.21 | Preset frequency reference 1 | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.22 | Preset frequency reference 2 | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.23 | Preset frequency reference 3 | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.24 | Preset frequency reference 4 | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.25 | Preset frequency reference 5 | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.26 | Preset frequency reference 6 | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.27 | Preset frequency reference 7 | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.28 | Preset frequency reference 8 | RW, B | 0.0 to ±ULF | 0.0 | Hz |
| #1.29 | Skip frequency 1 | RW, U | 0.0 to ULF | 0.0 | Hz |

| | | | | | |
|---|---|---|---|---|---|
| #1.30 | Skip frequency band 1 | RW, U | 0.0 to 5.0 | 0.5 | Hz |
| #1.31 | Skip frequency 2 | RW, U | 0.0 to ULF | 0.0 | Hz |
| #1.32 | Skip frequency band 2 | RW, U | 0.0 to 5.0 | 0.5 | Hz |
| #1.33 | Skip frequency 3 | RW, U | 0.0 to ULF | 0.0 | Hz |
| #1.34 | Skip frequency band 3 | RW, U | 0.0 to 5.0 | 0.5 | Hz |
| #1.35 | Frequency reference in skip zone | RO, Bit, P | 0/1 | - | - |
| #1.36 | Analogue frequency reference 1 | RO, B | 0.0 to ±[#1.06] | - | Hz |
| #1.37 | Analogue frequency reference 2 | RO, B | 0.0 to ±[#1.06] | - | Hz |
| #1.38 | Percentage trim | RO, B | 0.0 to ±100.0 | - | % |
| #1.39 | ***Unused parameter*** | - | - | - | - |
| #1.40 | ***Unused parameter*** | - | - | - | - |
| #1.41 | Select analogue frequency reference 2 | RO, Bit | 0/1 | - | - |
| #1.42 | Select preset frequency reference | RO, Bit | 0/1 | - | - |
| #1.43 | Select keypad frequency reference | RO, Bit | 0/1 | - | - |
| #1.44 | Select precision frequency reference | RO, Bit | 0/1 | - | - |
| #1.45 | Preset frequency reference select bit 0 | RO, Bit | 0/1 | - | - |
| #1.46 | Preset frequency reference select bit 1 | RO, Bit | 0/1 | - | - |
| #1.47 | Preset frequency reference select bit 2 | RO, Bit | 0/1 | - | - |
| #1.48 | ***Unused parameter*** | - | - | - | - |
| #1.49 | Selected frequency reference | RO, U, P | 1 to 5 | - | - |
| #1.50 | Selected preset frequency reference | RO, U, P | 1 to 8 | - | - |

### 9.2.2 Menu 1 Parameter Descriptions

**#1.01 Selected final frequency reference**

Parameter type: RO, B, P

Range: 0.0 to ±ULF where: (ULF is the Upper Limit Frequency),

ULF = 240Hz when [#5.18] (or [#0.41]) = 3 (kHz),

ULF = 480Hz when [#5.18] (or [#0.41]) = 6 (kHz),

ULF = 720Hz when [#5.18] (or [#0.41]) = 9 (kHz),

ULF = 960Hz when [#5.18] (or [#0.41]) = 12 (kHz)

Units: Hz

Default value: -

The selected final frequency reference is useful for drive set-up and fault finding. This reference is the final reference selected from all of the possible references such as analogue references, preset references, and keypad/precision references.

**#1.02 Pre-skip frequency reference**

**#1.03 Pre-ramp frequency reference**

Parameter type: RO, B, P

Range: [#1.07] to [#1.06], or, -[#1.07] to -[#1.06],

if [#1.08] = 0 ([#1.07] ≥ 0) , or

[#1.07] to [#1.06], if [#1.08] = 1 ([#1.07] ≤ 0)

Units: Hz

Default value: -

Both the pre-ramp and pre-skip frequency references are useful for drive set-up and fault finding.

The pre-skip frequency reference is the reference following inclusion of the forward/reverse demand and minimum/maximum limits on the selected final frequency reference (#1.01).

The pre-ramp frequency reference is the outcome of the skip frequencies on the pre-skip reference.

## #1.04 Frequency reference offset

Parameter type: RW, B

Adjustment range: 0.0 to ±ULF where:

ULF = 240Hz when [#5.18] (or [#0.41]) = 3 (kHz),

ULF = 480Hz when [#5.18] (or [#0.41]) = 6 (kHz),

ULF = 720Hz when [#5.18] (or [#0.41]) = 9 (kHz),

ULF = 960Hz when [#5.18] (or [#0.41]) = 12 (kHz)

Units: Hz

Default value: 0.0

This frequency reference is added to the selected reference if the select frequency offset parameter (#1.09) is set to 1. It can be used as a trim to adjust the main reference being selected.

## #1.05 Jog frequency reference

Parameter type: RW, U

Adjustment range: 0.0 to 400.0, (limited to 240.0 by #1.06 when [#5.18] = 3 (kHz))

Units: Hz

Default value: 1.5

This parameter is the frequency reference used for jogging.

If a value is set which is higher than the ULF (upper limit frequency) then the actual jog reference will be limited to the ULF value. Similarly the jog reference will be limited to the maximum frequency (i.e.[#1.06]) even though the set value could be higher than this.

**#1.06 Maximum frequency**

Parameter type: RW, U

Adjustment range: 0.0 to ULF, where:

ULF = 240Hz when [#5.18] (or [#0.41]) = 3 (kHz),

ULF = 480Hz when [#5.18] (or [#0.41]) = 6 (kHz),

ULF = 720Hz when [#5.18] (or [#0.41]) = 9 (kHz),

ULF = 960Hz when [#5.18] (or [#0.41]) = 12 (kHz)

Units: Hz

Default value: 50.0 (when #x.00 set to 533 followed by a 'RESET'), or

60.0 (when #x.00 set to 544 followed by a 'RESET').

The maximum frequency parameter defines the absolute maximum frequency reference. However, slip compensation and current/torque limits can increase the applied motor frequency above this value.

If the select negative minimum frequency parameter (#1.08) is 0, #1.06 is a symmetrical limit in both directions of rotation. When [#1.08] is 1, this parameter is a limit in the forward direction only.

Parameter #1.06 is used as the maximum value of the analogue frequency reference 1 and 2 parameters (#1.36 and #1.37 respectively) for correct scaling of analogue inputs provided the select negative minimum frequency parameter (#1.08) is 0. If [#1.08] is 1, then the scaling for #1.36 and #1.37 is based on the largest magnitudes of either [#1.06] or [#1.07].

Note that this parameter cannot be adjusted when the drive is enabled.

**#1.07 Minimum frequency**

Parameter type: RW, B

Adjustment range: 0.0 to [#1.06] when [#1.08] = 0, or

-ULF to 0.0 when [#1.08] = 1.

Units: Hz

Default value: 0.0

If select negative minimum frequency parameter (#1.08) is 0, #1.07 is a symmetrical minimum limit in both directions of rotation. When [#1.08] is 1, #1.07 is a limit in the negative/reverse direction only.

Note that the #1.07 value can be overridden by #1.06 if [#1.06] is adjusted to be less than [#1.07].

The minimum frequency parameter is inactive if jogging or if the select bipolar frequency reference (#1.10) is set to 1, but not if [#1.08] = 1.

Note that this parameter cannot be adjusted when the drive is enabled.

**#1.08 Select negative minimum frequency**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

When the select negative minimum frequency parameter (#1.08) is 0, the minimum frequency value (#1.07) can be set to any positive value between 0 and the maximum frequency value (#1.06). Therefore, provided the minimum frequency has not been disabled (by selecting bipolar mode ([#1.10] = 1), or selecting jog ) then the drive will not run at a frequency lower than +[#1.07] in the forward direction, and a frequency lower than -[#1.07] in the reverse direction.

Setting [#1.08] to 1 alters the range of [#1.07] to 0.0 to -ULF. In this case maximum frequency for the forward direction is [#1.06] and maximum frequency for the reverse direction is [#1.07].

### #1.09 Select frequency offset

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

When the select frequency offset parameter is 0 the frequency offset added is a percentage trim derived from the selected frequency reference and the percentage trim parameter (#1.38).

When [#1.09] is set to 1, the frequency offset added is the frequency reference offset parameter (#1.04).

### #1.10 Select bipolar frequency reference

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

This parameter needs to be set to 1 if the user requires to change the direction of rotation with a bipolar frequency reference. If #1.10 is not set, (i.e. [#1.10] = 0), all negative frequency references are treated as zero.

### #1.11 Final frequency reference 'on'

### #1.12 Reverse selected

### #1.13 Jog selected

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: 0

These flags are controlled by the drive sequencer defined in Menu 6. The flags select the appropriate frequency reference as commanded by the drive sequencing logic and illustrated in the block diagram above for Menu 1.

### #1.14 Frequency reference selector

Parameter type: RW, U, P

Adjustment range: 0 to 5

Units: -

Default value: 0

This frequency reference selector parameter selects a frequency reference as follows:

[#1.14] = 0 Reference selected by states of bit parameters #1.41 to #1.44

1 Analogue reference 1 selected ([#1.49] = 1)

2 Analogue reference 2 selected ([#1.49] = 2)

3 Preset reference selected ([#1.49] = 3)

4 Keypad reference selected ([#1.49] = 4)

5 Precision reference selected ([#1.49] = 5)

Where: #1.49 is the selected frequency reference.

When [#1.14] is set to 0 the reference selected depends on the state of bit parameters #1.41 to #1.44 as follows: (where x = 0 or 1)

| [#1.41] - Select analogue frequency reference 2 | [#1.42] - Select preset frequency reference | [#1.43] - Select keypad frequency reference | [#1.44] - Select precision frequency reference | Frequency Reference Selected | Selected Frequency Reference Parameter ([#1.49]) |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | Analogue reference 1 | 1 |
| 1 | 0 | 0 | 0 | Analogue reference 2 | 2 |
| x | 1 | 0 | 0 | Preset reference | 3 |
| x | x | 1 | 0 | Keypad reference | 4 |
| x | x | x | 1 | Precision reference | 5 |

The bits #1.41 to #1.44 are provided to allow control by digital inputs such that frequency references can be selected by external control.

**#1.15 Preset frequency reference selector**

Parameter type: RW, U, P

Adjustment range: 0 to 8

Units: -

Default value: 0

This preset frequency reference selector parameter selects a preset frequency reference as follows:

[#1.15] = 0 Preset reference selected by states of bit parameters #1.45 to #1.47

1 Preset 1 selected ([#1.50] = 1)

2 Preset 2 selected ([#1.50] = 2)

3 Preset 3 selected ([#1.50] = 3)

4 Preset 4 selected ([#1.50] = 4)

5 Preset 5 selected ([#1.50] = 5)

6 Preset 6 selected ([#1.50] = 6)

7 Preset 7 selected ([#1.50] = 7)

8 Preset 8 selected ([#1.50] = 8)

Where: #1.50 is the selected preset frequency reference.

When [#1.15] is set to 0 the preset reference selected depends on the state of bit parameters #1.45 to #1.47 in a binary code as follows:

| [#1.47] - Preset frequency reference select bit 2 | [#1.46] - Preset frequency reference select bit 1 | [#1.45] - Preset frequency reference select bit 0 | Selected preset frequency reference and Parameter [#1.50] |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 2 |
| 0 | 1 | 0 | 3 |
| 0 | 1 | 1 | 4 |
| 1 | 0 | 0 | 5 |
| 1 | 0 | 1 | 6 |
| 1 | 1 | 0 | 7 |
| 1 | 1 | 1 | 8 |

The bits #1.45 to #1.47 are provided to allow control by digital inputs such that preset references can be selected by external control.

**#1.17 Keypad frequency reference**

Parameter type: RO, B, S, P

Range: [#1.07] to [#1.06] (if [#1.08] = 0 and [#1.10] = 0), ([#1.07] is positive)

0.0 to ±[#1.06] (if [#1.08] = 0 and [#1.10] = 1),

0.0 to [#1.06] (if [#1.08] = 1 and [#1.10] = 0),

[#1.07] to [#1.06] (if [#1.08] = 1 and [#1.10] = 1), ([#1.07] is negative)

Units: Hz

Default value: 0.0

If this parameter is selected as the frequency reference (i.e. [#1.49] = 4), it is adjusted by the 'UP' ▲ and 'DOWN' ▼ keys only when the display is in the Status Mode. When the drive is not enabled view the keypad reference by looking at parameter #1.17 to ensure the correct value is set before enabling the drive.

The value is saved on power down such that the keypad frequency reference does not have to be set up again on power up.

**#1.18 Precision frequency reference**

Parameter type: RW, B

Adjustment range: 0.0 to ±ULF

Units: Hz

Default value: 0.0

Setting this parameter in conjunction with the precision frequency reference trim (#1.19) allows a high resolution frequency control to be utilised. The high resolution capability is lost during acceleration/deceleration, current limit operation, and if slip compensation is enabled (i.e. [#5.08] ≠ 0rpm).

## #1.19 Precision frequency reference trim

Parameter type: RW, U

Adjustment range: 0 to 99

Units: mHz

Default value: 0

The precision frequency reference trim parameter in conjunction with the precision frequency reference (#1.18) allows a precision frequency reference to be set with a resolution of 0.001Hz or 1mHz.

Depending on the PWM switching frequency (#5.18) chosen, the drive has the following available resolutions:

0.002Hz when [#5.18] (or [#0.41]) = 3 (kHz),

0.004Hz when [#5.18] (or [#0.41]) = 6 (kHz),

0.006Hz when [#5.18] (or [#0.41]) = 9 (kHz),

0.008Hz when [#5.18] (or [#0.41]) = 12 (kHz)

Where: #5.18 (or #0.41) is the PWM switching frequency..

## #1.20 Disable precision reference update

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

When this parameter is set to 0 the precision frequency reference parameters (#1.18 and #1.19) are read and stored in internal memory. Because the precision reference has to be set in two parameters, setting [#1.20] to 1 prevents the drive from reading parameters #1.18 and #1.19 while they are being updated. In this case (when [#1.20] = 1), the drive uses the previously stored values from memory for #1.18 and #1.19, thus preventing the possibility of data skew.

**#1.21 Preset frequency reference 1**

**#1.22 Preset frequency reference 2**

**#1.23 Preset frequency reference 3**

**#1.24 Preset frequency reference 4**

**#1.25 Preset frequency reference 5**

**#1.26 Preset frequency reference 6**

**#1.27 Preset frequency reference 7**

**#1.28 Preset frequency reference 8**

| | |
|---|---|
| Parameter type: | RW, B |
| Adjustment range: | 0.0 to ±ULF |
| Units: | Hz |
| Default value: | 0.0 |

These parameters defines the 8 preset frequency references.

**#1.29 Skip frequency 1**

**#1.31 Skip frequency 2**

**#1.33 Skip frequency 3**

| | |
|---|---|
| Parameter type: | RW, U |
| Adjustment range: | 0.0 to ULF |
| Units: | Hz |
| Default value: | 0.0 |

The 3 skip frequencies are available to prevent mechanical resonances in a system, by ensuring that certain frequencies can be avoided by always ramping through them.

When any skip frequency parameter is set to 0.0 (as default) the particular skip frequency is disabled.

See the graph below illustrating the action of skip frequencies and associated skip frequency bands.

**#1.30 Skip frequency band 1**

**#1.32 Skip frequency band 2**

**#1.34 Skip frequency band 3**

| | |
|---|---|
| Parameter type: | RW, U |
| Adjustment range: | 0.0 to 5.0 |
| Units: | Hz |
| Default value: | 0.5 |

The skip frequency band parameters define the frequency either side of the corresponding skip frequency, over which the frequency reference is rejected. The actual skip frequency band is therefore twice the value in these parameters, with the skip frequency parameter defining the centre of the band.

The drive accelerates/decelerates through the selected skip frequency bands, without stopping.

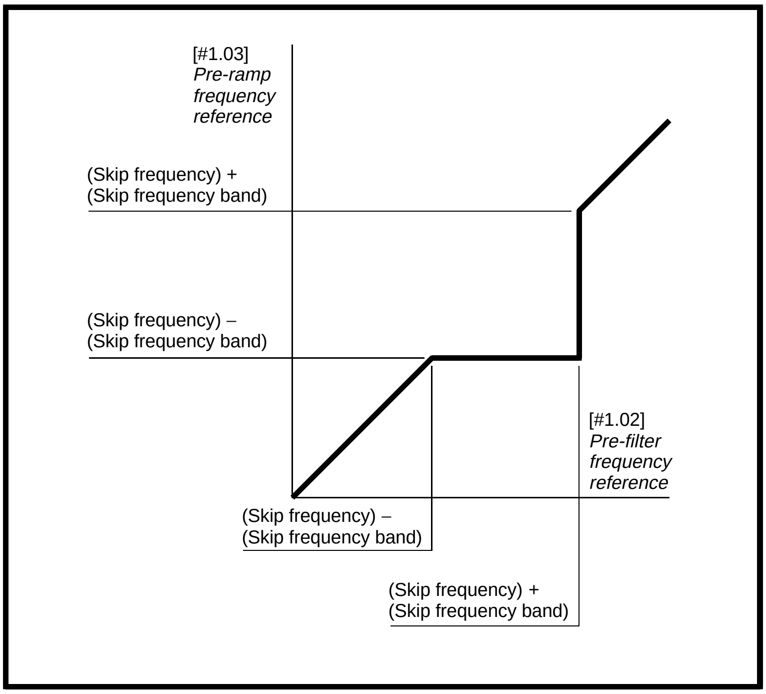



Fig. 9.2 Skip frequency operation

**#1.35 Frequency reference in skip zone**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

The frequency reference in skip zone parameter indicates that the pre-skip frequency reference is within one of the three skip frequency regions such that the motor frequency is not as demanded, i.e. the pre-skip frequency reference (#1.02) is different to the pre-ramp frequency reference (#1.03).

**#1.36 Analogue frequency reference 1**

**#1.37 Analogue frequency reference 2**

Parameter type: RO, B

Range: 0.0 to ±[#1.06] if [#1.08] = 0, or

0.0 to ±[maximum of |#1.06| and |#1.07|] if [#1.08] = 1

Units: Hz

Default value: -

These analogue frequency reference parameters are available for control by analogue inputs which are required as frequency references. Parameters #7.10 and #7.14 are programmed with the destination parameters for the 2 analogue inputs.

The analogue frequency reference parameters are automatically scaled such that 100.0% input corresponds to the set maximum frequency (#1.06 if [#1.08] = 0, or the maximum of #1.06 and #1.07 if [#1.08] = 1). Also the 0% input level corresponds to the minimum frequency level (#1.07) if bipolar operation is not selected (i.e. [#1.10] = 0), and parameter #1.08 is set to 0. See the two figures below for further details.

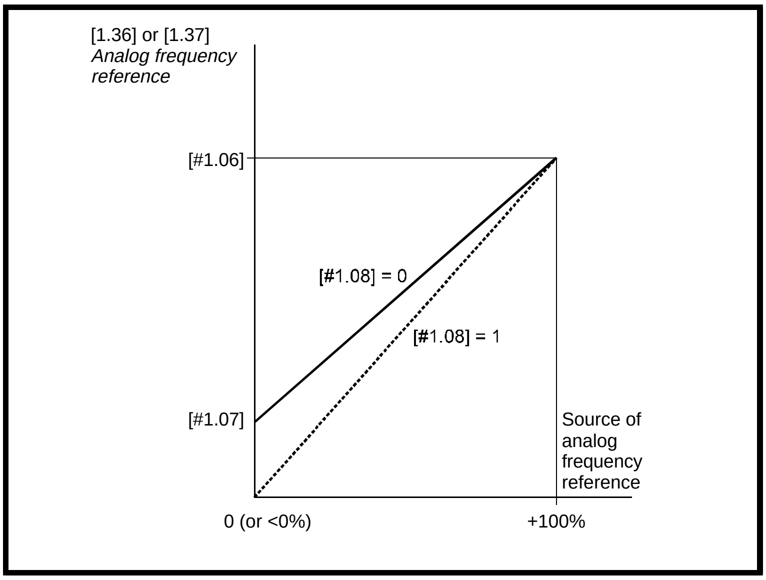



Fig. 9.3 Unipolar operation (i.e. [#1.10] = 0)

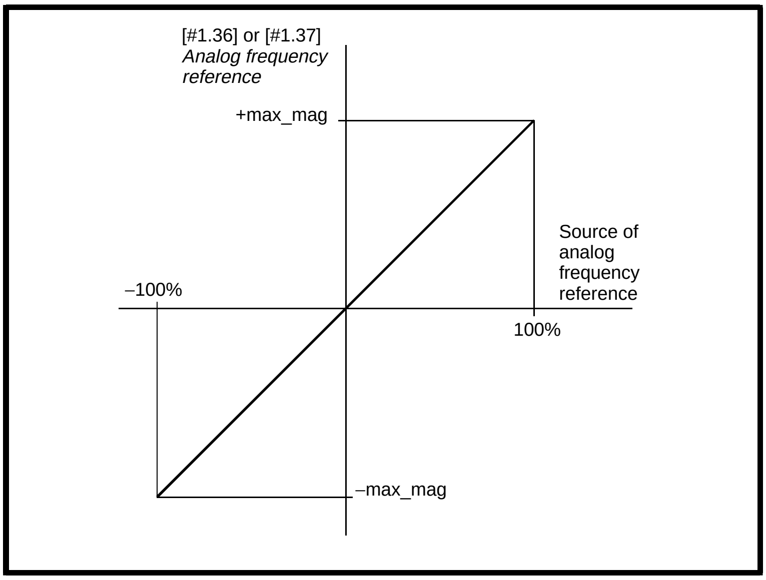



Fig. 9.4 Bipolar operation (i.e. [#1.10] = 1)

Where: (max_mag) = maximum frequency magnitude

= [#1.06] if [#1.08] = 0 or 1, but

= |[#1.07]| if [#1.08] = 1 and |[#1.07]| ≥ [#1.06]

**#1.38 Percentage trim**

Parameter type: RO, B

Range: 0.0 to ±100.0

Units: %

Default value: -

The percentage trim parameter (if selected, i.e. [#1.09] = 0) allows the selected reference to be trimmed. As an example, if an analogue input is routed to this parameter, the selected reference can be trimmed by the analogue input. In numerical terms:

[#1.01] = (Selected Reference Value) x (1 + [#1.38]/100)

where: Selected Reference Value is defined by the Selected Frequency Reference (#1.49),

#1.01 is the selected final frequency reference

**#1.39 Unused parameter**

**#1.40 Unused parameter**

**#1.41 Select analogue frequency reference 2**

**#1.42 Select preset frequency reference**

**#1.43 Select keypad frequency reference**

**#1.44 Select precision frequency reference**

**#1.45 Preset frequency reference select bit 0**

**#1.46 Preset frequency reference select bit 1**

**#1.47 Preset frequency reference select bit 2**

Parameter type: RO, Bit

Range: 0 or 1

Units: -

Default value: -

These bits are provided for control by logic inputs (e.g. digital inputs) for external reference selection (see parameters #1.14 and #1.15).

## #1.48 Unused parameter

## #1.49 Selected frequency reference

| | |
|---|---|
| Parameter type: | RO, U, P |
| Range: | 1 to 5 |
| Units: | - |
| Default value: | - |

The selected frequency reference parameter indicates the frequency reference currently being selected. See the Frequency Reference Selector parameter (#1.14) description for further details.

## #1.50 Selected preset frequency reference

| | |
|---|---|
| Parameter type: | RO, U, P |
| Range: | 1 to 8 |
| Units: | - |
| Default value: | - |

The selected preset parameter indicates the preset frequency reference currently being selected. See the Preset Frequency Reference Selector parameter (#1.15) description for further details.

## 9.3 Menu 2 logic block diagram - Ramps

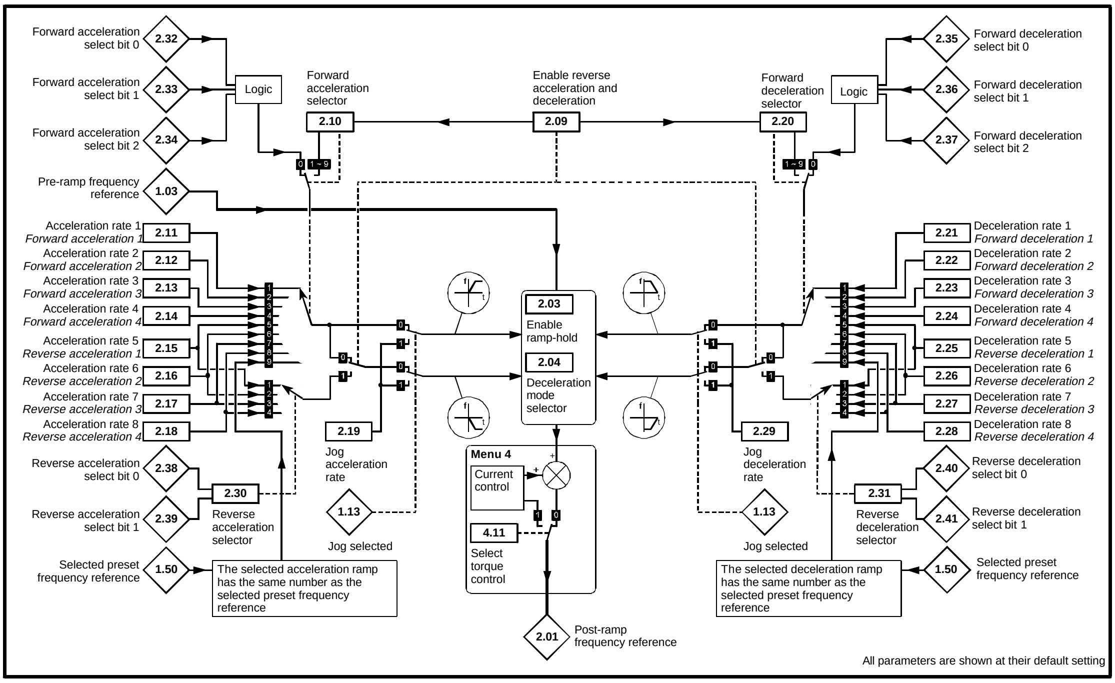



Fig. 9.5 Menu 2 logic block diagram - Ramps

9.3.1 Menu 2 Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #2.01 | Post-ramp frequency reference | RO, B, P | 0 to ≈ ±[#1.06] | - | Hz |
| #2.02 | ***Unused parameter*** | - | - | - | - |
| #2.03 | Enable ramp hold | RW, Bit | 0/1 | 0 | - |
| #2.04 | Deceleration mode selector | RW, U, T, P | Std (0) or FSt (1) | Std (0) | - |
| #2.05 | ***Unused parameter*** | - | - | - | - |
| #2.06 | ***Unused parameter*** | - | - | - | - |
| #2.07 | ***Unused parameter*** | - | - | - | - |
| #2.08 | ***Unused parameter*** | - | - | - | - |
| #2.09 | Enable reverse accel and decel | RW, Bit | 0/1 | 0 | - |
| #2.10 | Forward acceleration selector | RW, U, P | 0 to 9 | 0 | - |
| #2.11 | Accel 1/ forward accel 1 rate | RW, U | 0.0 to 999.0 | 5.0 | s/100Hz |
| #2.12 | Accel 2/ forward accel 2 rate | RW, U | 0.0 to 999.0 | 5.0 | s/100Hz |
| #2.13 | Accel 3/ forward accel 3 rate | RW, U | 0.0 to 999.0 | 5.0 | s/100Hz |
| #2.14 | Accel 4/ forward accel 4 rate | RW, U | 0.0 to 999.0 | 5.0 | s/100Hz |
| #2.15 | Accel 5/ reverse accel 1 rate | RW, U | 0.0 to 999.0 | 5.0 | s/100Hz |
| #2.16 | Accel 6/ reverse accel 2 rate | RW, U | 0.0 to 999.0 | 5.0 | s/100Hz |
| #2.17 | Accel 7/ reverse accel 3 rate | RW, U | 0.0 to 999.0 | 5.0 | s/100Hz |
| #2.18 | Accel 8/ reverse accel 4 rate | RW, U | 0.0 to 999.0 | 5.0 | s/100Hz |
| #2.19 | Jog acceleration rate | RW, U | 0.0 to 999.0 | 0.2 | s/100Hz |
| #2.20 | Forward deceleration selector | RW, U, P | 0 to 9 | 0 | - |
| #2.21 | Decel 1/ forward decel 1 rate | RW, U | 0.0 to 999.0 | 10.0 | s/100Hz |
| #2.22 | Decel 2/ forward decel 2 rate | RW, U | 0.0 to 999.0 | 10.0 | s/100Hz |
| #2.23 | Decel 3/ forward decel 3 rate | RW, U | 0.0 to 999.0 | 10.0 | s/100Hz |
| #2.24 | Decel 4/ forward decel 4 rate | RW, U | 0.0 to 999.0 | 10.0 | s/100Hz |
| #2.25 | Decel 5/ reverse decel 1 rate | RW, U | 0.0 to 999.0 | 10.0 | s/100Hz |
| #2.26 | Decel 6/ reverse decel 2 rate | RW, U | 0.0 to 999.0 | 10.0 | s/100Hz |
| #2.27 | Decel 7/ reverse decel 3 rate | RW, U | 0.0 to 999.0 | 10.0 | s/100Hz |
| #2.28 | Decel 8/ reverse decel 4 rate | RW, U | 0.0 to 999.0 | 10.0 | s/100Hz |
| #2.29 | Jog deceleration rate | RW, U | 0.0 to 999.0 | 0.2 | s/100Hz |
| #2.30 | Reverse acceleration selector | RW, U, P | 0 to 4 | 0 | - |

| | | | | | |
|---|---|---|---|---|---|
| #2.31 | Reverse deceleration selector | RW, U, P | 0 to 4 | 0 | - |
| #2.32 | Forward acceleration select bit 0 | RO, Bit | 0/1 | - | - |
| #2.33 | Forward acceleration select bit 1 | RO, Bit | 0/1 | - | - |
| #2.34 | Forward acceleration select bit 2 | RO, Bit | 0/1 | - | - |
| #2.35 | Forward deceleration select bit 0 | RO, Bit | 0/1 | - | - |
| #2.36 | Forward deceleration select bit 1 | RO, Bit | 0/1 | - | - |
| #2.37 | Forward deceleration select bit 2 | RO, Bit | 0/1 | - | - |
| #2.38 | Reverse acceleration select bit 0 | RO, Bit | 0/1 | - | - |
| #2.39 | Reverse acceleration select bit 1 | RO, Bit | 0/1 | - | - |
| #2.40 | Reverse deceleration select bit 0 | RO, Bit | 0/1 | - | - |
| #2.41 | Reverse deceleration select bit 1 | RO, Bit | 0/1 | - | - |

9.3.2 Menu 2 Parameter Descriptions

#### #2.01 Post-ramp frequency reference

| | |
|---|---|
| Parameter type: | RO, B, P |
| Range: | [#1.07] to [#1.06], or, -[#1.07] to -[#1.06], |
| | if [#1.08] = 0 ([#1.07] ≥ 0) , or |
| | [#1.07] to [#1.06], if [#1.08] = 1 ([#1.07] ≤ 0) |
| Units: | Hz |
| Default value: | - |

The post-ramp frequency reference is useful for drive set-up and fault finding. This reference is the reference following the frequency ramp control. The value of #2.01 can be outside the range because of the current limit action.

#### #2.02 Unused parameter

#### #2.03 Enable ramp hold

| | |
|---|---|
| Parameter type: | RW, Bit |
| Adjustment range: | 0 or 1 |
| Units: | - |
| Default value: | 0 |

When the enable ramp hold bit is set to a 1 the frequency ramp will be held (i.e. the ramp rate is set to 0.0Hz/s). Otherwise when this bit is 0 the frequency ramp is set at the desired value by the other ramp rate controls.

**#2.04 Deceleration mode selector**

Parameter type: RW, U, T, P

Adjustment range: Std (0) or FSt (1)

Units: -

Default value: Std (0)

The deceleration mode selector has 2 possible settings as follows:

| #2.04 Setting (Display) | Setting via Serial comms | Description |
|---|---|---|
| Std | 0 | Deceleration ramp held whenever braking IGBT 'on' - Standard ramp |
| FSt | 1 | Deceleration ramp unaffected by braking IGBT - Fast ramp |

The acceleration ramp is not affected by the deceleration mode, and the post-ramp frequency reference will rise at the programmed acceleration rate (subject to the current limits programmed).

In the 'FSt' mode the post-ramp frequency reference will fall at the programmed deceleration rate (subject to the current limits programmed). This setting is recommended when using a suitable braking resistor.

In the 'Std' mode the deceleration ramp will be held (i.e. the deceleration rate is set at 0.0Hz/s) upon detection of the braking IGBT being switched on, to prevent the DC link voltage rising further and preventing overvoltage trips when no braking resistor is connected. When the DC link voltage decreases below this value, and the internal braking transistor is turned 'off', the deceleration ramp is continued. The frequency reduces in a staircase fashion.

Advantages of 'Std' mode: With the simplest set up, the risk of overvoltage trips during deceleration is minimised when no braking resistor is connected.

**#2.05 Unused parameters**

**#2.06**

**#2.07**

**#2.08**

**#2.09 Enable reverse acceleration and deceleration**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

When the enable reverse acceleration and deceleration bit is set to 0 there are 8 acceleration and 8 deceleration rates which are operational in both the forward and reverse directions. Setting this bit to 1 splits the eight acceleration and deceleration rates into 4 forward and 4 reverse.

| #2.09 Setting | Description |
|---|---|
| 0 | #2.11 to #2.18 apply acceleration rate control in both forward and reverse frequency directions<br><br>#2.21 to #2.28 apply deceleration rate control in both forward and reverse frequency directions |
| 1 | #2.11 to #2.14 apply acceleration rate control in only the forward frequency direction<br><br>#2.15 to #2.18 apply acceleration rate control in only the reverse frequency direction<br><br>#2.21 to #2.24 apply deceleration rate control in only the forward frequency direction<br><br>#2.25 to #2.28 apply deceleration rate control in only the reverse frequency direction |

**#2.10 Forward acceleration selector**

**#2.20 Forward deceleration selector**

**#2.30 Reverse acceleration selector**

**#2.31 Reverse deceleration selector**

Parameter type: RW, U, P

Adjustment range: 0 to 9 (for #2.10 and #2.20)

0 to 4 (for #2.30 and #2.31)

Units: -

Default value: 0

These ramp rate selectors are used to select the various acceleration and deceleration rates as follows:

| | | | | Acceleration rate selected: | |
|---|---|---|---|---|---|
| | Bit parameters: | | | Enable reverse accel/decel | |
| Value of #2.10 selector↓ | [#2.34] | [#2.33] | [#2.32] | [#2.09] = 0 Forward or reverse accel rates | [#2.09] = 1 Forward accel rates only (see table below for reverse accel rates) |
| | | | | | |
| 0 | 0 | 0 | 0 | [#2.11] | [#2.11] |
| 0 | 0 | 0 | 1 | [#2.12] | [#2.12] |
| 0 | 0 | 1 | 0 | [#2.13] | [#2.13] |
| 0 | 0 | 1 | 1 | [#2.14] | [#2.14] |
| 0 | 1 | 0 | 0 | [#2.15] | [#2.11] |
| 0 | 1 | 0 | 1 | [#2.16] | [#2.12] |
| 0 | 1 | 1 | 0 | [#2.17] | [#2.13] |
| 0 | 1 | 1 | 1 | [#2.18] | [#2.14] |
| | | | | | |
| 1 | | | | [#2.11] | [#2.11] |
| 2 | | | | [#2.12] | [#2.12] |
| 3 | | | | [#2.13] | [#2.13] |
| 4 | | | | [#2.14] | [#2.14] |
| 5 | | | | [#2.15] | [#2.11] |
| 6 | | | | [#2.16] | [#2.12] |
| 7 | | | | [#2.17] | [#2.13] |
| 8 | | | | [#2.18] | [#2.14] |

| | Selected preset frequency reference [#1.50] ↓: | | | |
|---|---|---|---|---|
| 9 | | 1 | [#2.11] | [#2.11] |
| 9 | | 2 | [#2.12] | [#2.12] |
| 9 | | 3 | [#2.13] | [#2.13] |
| 9 | | 4 | [#2.14] | [#2.14] |
| 9 | | 5 | [#2.15] | [#2.11] |
| 9 | | 6 | [#2.16] | [#2.12] |
| 9 | | 7 | [#2.17] | [#2.13] |
| 9 | | 8 | [#2.18] | [#2.14] |

| Bit parameters: | | Reverse acceleration rate selected: |
|---|---|---|
| [#2.39] | [#2.38] | Enable reverse accel/decel<br>[#2.09] = 1 |
| | | |
| 0 | 0 | [#2.15] |
| 0 | 1 | [#2.16] |
| 1 | 0 | [#2.17] |
| 1 | 1 | [#2.18] |

| Bit parameters: | | Reverse deceleration rate selected: |
|---|---|---|
| [#2.41] | [#2.40] | Enable reverse accel/decel<br>[#2.09] = 1 |
| | | |
| 0 | 0 | [#2.25] |
| 0 | 1 | [#2.26] |
| 1 | 0 | [#2.27] |
| 1 | 1 | [#2.28] |

| | | | | Deceleration rate selected: | |
|---|---|---|---|---|---|
| | Bit parameters: | | | Enable reverse accel/decel | |
| Value of #2.20 selector ↓: | [#2.37] | [#2.36] | [#2.35] | [#2.09] = 0 Forward or reverse decel rates | [#2.09] = 1<br>Forward decel rates only<br>(see table above for reverse decel rates) |
| | | | | | |
| 0 | 0 | 0 | 0 | [#2.21] | [#2.21] |
| 0 | 0 | 0 | 1 | [#2.22] | [#2.22] |
| 0 | 0 | 1 | 0 | [#2.23] | [#2.23] |
| 0 | 0 | 1 | 1 | [#2.24] | [#2.24] |
| 0 | 1 | 0 | 0 | [#2.25] | [#2.21] |
| 0 | 1 | 0 | 1 | [#2.26] | [#2.22] |
| 0 | 1 | 1 | 0 | [#2.27] | [#2.23] |
| 0 | 1 | 1 | 1 | [#2.28] | [#2.24] |
| | | | | | |
| 1 | | | | [#2.21] | [#2.21] |
| 2 | | | | [#2.22] | [#2.22] |
| 3 | | | | [#2.23] | [#2.23] |
| 4 | | | | [#2.24] | [#2.24] |
| 5 | | | | [#2.25] | [#2.21] |
| 6 | | | | [#2.26] | [#2.22] |
| 7 | | | | [#2.27] | [#2.23] |
| 8 | | | | [#2.28] | [#2.24] |

| | Selected preset frequency reference [#1.50] ↓: | | | |
|---|---|---|---|---|
| 9 | | 1 | [#2.21] | [#2.21] |
| 9 | | 2 | [#2.22] | [#2.22] |
| 9 | | 3 | [#2.23] | [#2.23] |
| 9 | | 4 | [#2.24] | [#2.24] |
| 9 | | 5 | [#2.25] | [#2.21] |
| 9 | | 6 | [#2.26] | [#2.22] |
| 9 | | 7 | [#2.27] | [#2.23] |
| 9 | | 8 | [#2.28] | [#2.24] |

When parameter #2.10 is set to 0 the acceleration rate selected depends on the state of bit parameters #2.32 to #2.34, and similarly when #2.20 is set to 0 the deceleration rate selected depends on the state of bit parameters #2.35 to #2.37. (A similar arrangement also applies when either #2.30 or #2.31 is set to 0, in that the reverse direction ramp rates are controlled by the #2.38 and #2.39 digital inputs, and, #2.40 and #2.41 digital inputs respectively.) These bits are for control by digital inputs such that ramp rates can be selected by external control. The ramp rate selected depends on the binary code generated by these bits as indicated in the above tables.

When parameter #2.10 or #2.20 is set to 9 the appropriate acceleration or deceleration rate is automatically selected depending on the preset reference selected. Thus an acceleration and/or deceleration rate can be programmed to operate with each preset reference. Since the new ramp rate is selected with the new reference, the acceleration or deceleration applies towards the selected preset.

If parameter #2.09 is set to 1 such that separate reverse accelerations and decelerations are required, these parameters become forward acceleration and deceleration selectors and are only able to select the four forward acceleration and deceleration rates. If acceleration or deceleration rate 5 is selected, acceleration or deceleration rate 1 will be used, and so on up to acceleration or deceleration 8.

**#2.11 Accel 1/ forward accel 1 rate**

**#2.12 Accel 2/ forward accel 2 rate**

**#2.13 Accel 3/ forward accel 3 rate**

**#2.14 Accel 4/ forward accel 4 rate**

**#2.15 Accel 5/ reverse accel 1 rate**

**#2.16 Accel 6/ reverse accel 2 rate**

**#2.17 Accel 7/ reverse accel 3 rate**

**#2.18 Accel 8/ reverse accel 4 rate**

**#2.19 Jog acceleration rate**

**#2.21 Decel 1/ forward decel 1 rate**

**#2.22 Decel 2/ forward decel 2 rate**

**#2.23 Decel 3/ forward decel 3 rate**

**#2.24 Decel 4/ forward decel 4 rate**

**#2.25 Decel 5/ reverse decel 1 rate**

**#2.26 Decel 6/ reverse decel 2 rate**

**#2.27 Decel 7/ reverse decel 3 rate**

**#2.28 Decel 8/ reverse decel 4 rate**

**#2.29 Jog deceleration rate**

Parameter type: RW, U

Adjustment range: 0.0 to 999.0

Units: s/100Hz

Default value: 5.0 (for #2.11 to #2.18)

0.2 (for #2.20 and #2.29)

10.0 (for #2.21 to #2.28)

The drive can be set up to either have eight acceleration and deceleration rates which are used in both the forward and reverse direction, or have four acceleration and four deceleration rates in each of the frequency directions, i.e. forward acceleration, forward deceleration, reverse acceleration, and reverse deceleration. These 2 options are selectable by bit parameter #2.09. See the parameter description above for the selection process of the various ramp rates.

Parameters #2.19 and #2.29 are always used for jogging and must be set up for the required jogging acceleration and deceleration rates.

All ramp rates are expressed as time in seconds for a change of 100Hz on the ramp output. Therefore with a programmed ramp time of 5 seconds an acceleration ramp output will reach 50Hz from 0Hz in 2.5 seconds.

**#2.30 Reverse acceleration selector**

**#2.31 Reverse deceleration selector**

(For parameter descriptions see Parameter #2.10 above.)

**#2.32 Forward acceleration select bit 0**

**#2.33 Forward acceleration select bit 1**

**#2.34 Forward acceleration select bit 2**

**#2.35 Forward deceleration select bit 0**

**#2.36 Forward deceleration select bit 1**

**#2.37 Forward deceleration select bit 2**

**#2.38 Reverse acceleration select bit 0**

**#2.39 Reverse acceleration select bit 1**

**#2.40 Reverse deceleration select bit 0**

**#2.41 Reverse deceleration select bit 1**

| | |
|---|---|
| Parameter type: | RO, Bit |
| Range: | 0 or 1 |
| Units: | - |
| Default value: | - |

These bits are provided for control by logic input terminals for external ramp selection (see parameter descriptions for #2.10, #2.20, #2.30 and #2.31 above).

## 9.4 Menu 3 logic block diagram - Frequency/speed sensing thresholds

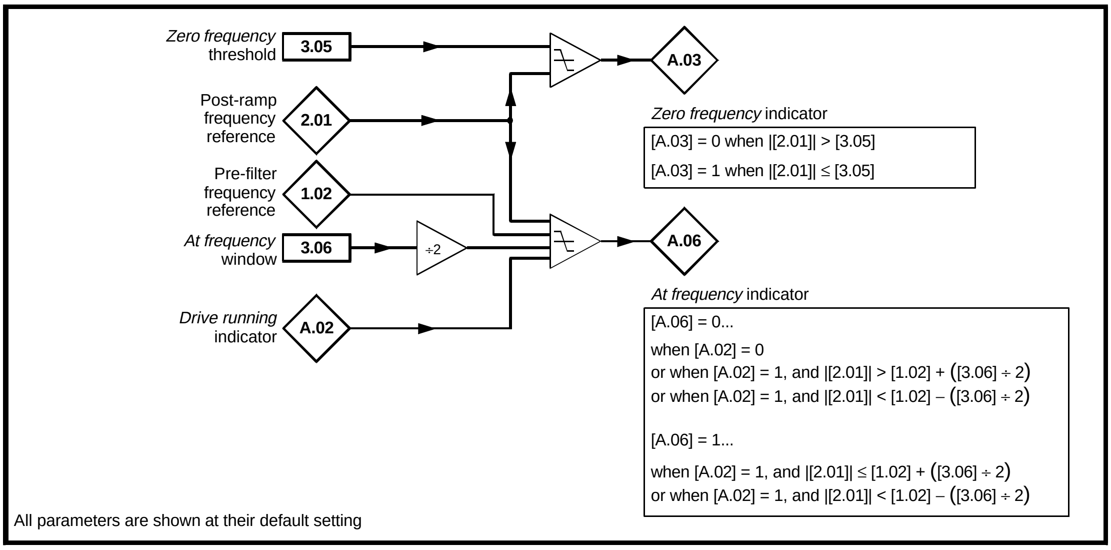



Fig. 9.6 Menu 3 logic block diagram - Frequency/speed sensing thresholds

### 9.4.1 Menu 3 Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #3.01 | ***Unused parameter*** | - | - | - | - |
| #3.02 | ***Unused parameter*** | - | - | - | - |
| #3.03 | ***Unused parameter*** | - | - | - | - |
| #3.04 | ***Unused parameter*** | - | - | - | - |
| #3.05 | Zero frequency threshold | RW, U | 0.0 to 20.0 | 1.0 | Hz |
| #3.06 | ‘At frequency’ window threshold | RW, U | 0.0 to 20.0 | 1.0 | Hz |

### 9.4.2 Menu 3 Parameter Descriptions

**#3.01** **Unused parameters**

**#3.02**

**#3.03**

**#3.04**

## #3.05 Zero frequency threshold

Parameter type: RW, U

Adjustment range: 0.0 to 20.0

Units: Hz

Default value: 1.0

If the post-ramp frequency reference (#2.01) is at or below the level defined by the zero frequency threshold parameter, regardless of the direction, the zero frequency indicator (#A.03) is set to 1, otherwise [#A.03] is 0.

## #3.06 ‘At frequency’ window threshold

Parameter type: RW, U

Adjustment range: 0.0 to 20.0

Units: Hz

Default value: 1.0

The ‘at frequency’ window threshold defines the frequency window around the post-ramp frequency reference (#2.01) in which the 'at frequency' indication is given (i.e. [#A.06] = 1). The 'at frequency' window is thus defined as |[#2.01]| ± ([#3.06] / 2).

## 9.5 Menu 4 logic block diagram - Current control

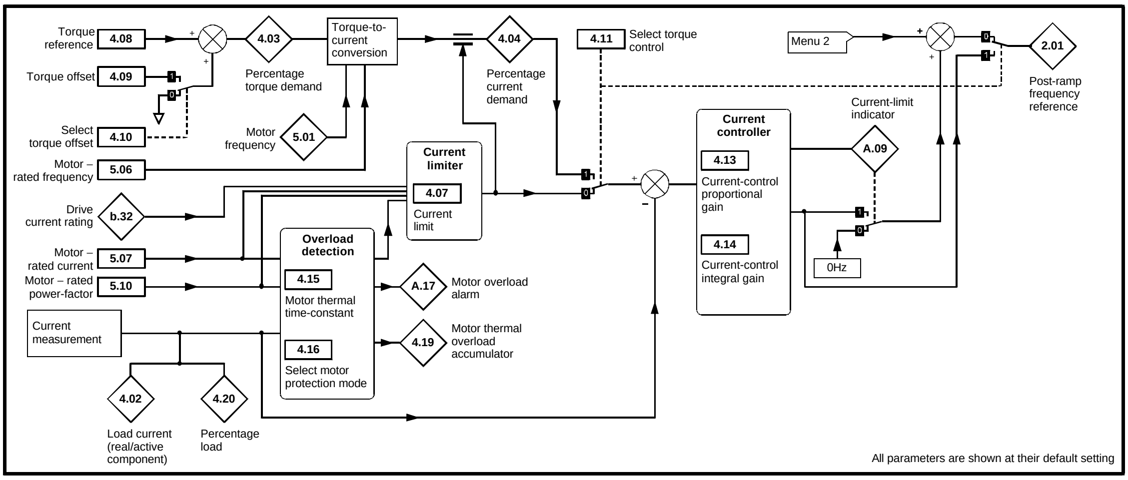



Fig. 9.7 Menu 4 logic block diagram - Current control

### 9.5.1 Menu 4 Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #4.01 | ***Unused parameter*** | - | - | - | - |
| #4.02 | Load current (real/active component) | RO, B, P | 0.0 to {± [#b.32] x [#5.10] x 1.5} | - | A |
| #4.03 | Percentage torque demand | RO, B, P | 0.0 to {± 150.0 x [#b.32] / [#5.07]} | - | % |
| #4.04 | Percentage current demand | RO, B, P | 0.0 to {± 150.0 x [#b.32] / [#5.07]} | - | % |
| #4.05 | ***Unused parameter*** | - | - | - | - |
| #4.06 | ***Unused parameter*** | - | - | - | - |
| #4.07 | Current limit | RW, U | 0.0 to {150.0 x [#b.32] / [#5.07]} | 150.0 | % |
| #4.08 | Torque reference | RW, B | 0.0 to {± 150.0 x [#b.32] / [#5.07]} | 0.0 | % |
| #4.09 | Torque offset | RW, B | 0.0 to {± 150.0 x [#b.32] / [#5.07]} | 0.0 | % |
| #4.10 | Select torque offset | RW, Bit | 0/1 | 0 | - |
| #4.11 | Select torque control | RW, Bit, P | 0/1 | 0 | - |
| #4.12 | ***Unused parameter*** | - | - | - | - |
| #4.13 | Current control proportional gain | RW, U | 0 to 250 | 50 | - |
| #4.14 | Current control integral gain | RW, U | 0 to 250 | 50 | - |
| #4.15 | Motor thermal time constant | RW, U | 0 to 250 | 89 | s |
| #4.16 | Select motor protection mode | RW, Bit | 0/1 | 0 | - |
| #4.17 | ***Unused parameter*** | - | - | - | - |
| #4.18 | ***Unused parameter*** | - | - | - | - |
| #4.19 | Motor thermal overload accumulator | RO, U, P | 0.0 to 100.0 | - | % |
| #4.20 | Percentage load | RO, B, P | 0.0 to {150.0 x [#b.32] / [#5.07]} | - | % |

**#4.01 Unused parameter**

**#4.02 Load current (real/active component)**

Parameter type: RO, B, P

Range: 0.0 to {± [#b.32] x [#5.10] x 1.5}

Units: A

Default value: -

This parameter gives an approximate indication of the load current, or real/active component of the current, as measured by the drive.

In a range between 15Hz and rated motor frequency ([#5.06]), the load current is nearly proportional to the given torque (T), i.e.

T ~ [#4.02] (or [#4.20])

Where: #4.20 is the percentage load

In the field-weakening region above motor rated frequency, torque decreases inversely proportional to speed at the same active current, i.e. the following relationship applies:

T ~ [#4.02] x (motor rated frequency [#5.06])/(motor frequency [#5.01])

### #4.03 Percentage torque demand

Parameter type: RO, B, P

Range: 0.0 to {± 150.0 x [#b.32] / [#5.07]}

Units: % (of torque)

Default value: -

The percentage torque demand is the sum of the torque reference (#4.08) and the torque offset (#4.09), if enabled. The torque demand passes through a torque to current conversion before being limited (by #4.07) and used as the (active) current demand (#4.04). Therefore, in torque control (i.e. [#4.11] = 1), the torque demand represents torque both below and above the machine base speed (#5.06, the machine rated frequency).

The units of the torque demand are % of rated torque. 100% rated torque is defined by the settings of the drive parameters as shown in the following example:

Motor rated current (#5.07) = 4A (set by user)

Motor rated power factor (#5.10) = 0.85 (set by user)

If the motor frequency (#5.01) is below the point where the voltage limit is reached (i.e. less than the motor rated frequency (#5.06)):

Rated load current (100% value of [ #4.02]) = [#5.07] x [#5.10] = 4 x 0.85 = 3.4A

At 100% torque demand ([#4.03] = 100%), load current = [#4.02] = 3.4A

Percentage torque demand (#4.03) = Percentage current demand (#4.04)

If the motor frequency (#5.01) is above the motor rated frequency (#5.06), the torque to current conversion is carried out by the following calculation:

Percentage current demand (#4.04) = {Percentage torque demand [#4.03]} x [#5.01] / [#5.06]

A positive value of torque demand indicates motoring torque in the forward direction, or regenerating torque in the reverse direction. A negative value indicates regenerative torque in the forward direction and motoring torque in the reverse direction.

**#4.04 Percentage current demand**

Parameter type: RO, B, P

Range: 0.0 to {± 150.0 x [#b.32] / [#5.07]}

Units: % (of load current)

Default value: -

The percentage current demand is derived from the percentage torque demand as described in parameter #4.03 above and is subject to the current limits (#4.07). If the torque control mode is selected ([#4.11] = 1), the current demand controls the post-ramp frequency reference (#2.01) via a proportional/integral control loop. Otherwise if torque control is not selected (i.e. frequency control mode [#4.11] = 0), the current demand is purely available for monitoring purposes.

The current demand is shown as percentage of rated active current which is defined by the user set up of the drive. Below the frequency where the output voltage is limited, the 100% rated torque and active current are the same. Above the point where the voltage limit is active, the torque and current are related by the equation given in the description of parameter #4.03.

**#4.05 Unused parameters**

**#4.06**

**#4.07 Current limit**

Parameter type: RW, U

Adjustment range: 0.0 to {+ 150.0 x [#b.32] / [#5.07]}

Units: % (of load current)

Default value: 150.0

This parameter defines the current limit as a percentage of rated active current. The range of this parameter (and #4.03, #4.04) is dependent on the motor rated current set-up by the user (#5.07) and the drive current rating (#b.32). The maximum value allowed for the motor rated current is the drive rated current. The maximum current limit parameter is given by:

maximum current limit (maximum of [#4.07]) = 150% x [#b.32] / [#5.07]

Therefore by setting the motor rated current (#5.07) below the drive rated current (#b.32) it is possible to have a current limit higher than 150%.

In frequency control mode ([#4.11] = 0), the drive output frequency (in particular the post-ramp frequency reference (#2.01)) is modified, if necessary, to keep the active current (#4.02 and/or #4.20) within the current limit (#4.07) as shown below:

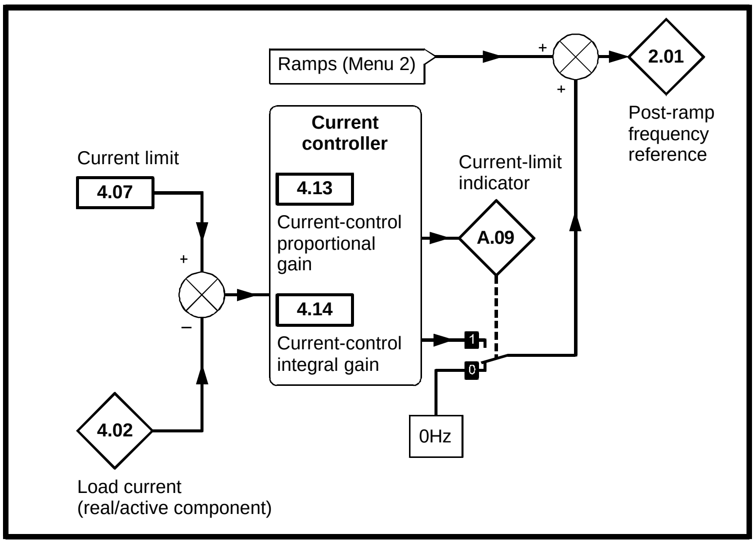



Fig. 9.8 Current limit operation in frequency control mode

The current limit is compared with the active current (ignoring the current polarity i.e. motoring or regenerating) and if the current exceeds the limit (i.e. |[#4.20]| ≥ [#4.07]) the error value passes through the PI controller to give a frequency component which is used to modify the ramp output. The direction of the frequency modification is to reduce the frequency to zero if the active current is motoring, or to increase the frequency towards the maximum if the active current is regenerating. (*Even when the current limit is active the ramp still operates, therefore the proportional and integral gains (#4.13 and #4.14 respectively) must be high enough to counter the effects of the ramp*.) For correct setting of the PI gains see the parameter descriptions for #4.13 and #4.14.

In the torque control mode ([#4.11] = 1) the current demand directly and continuously controls the post-ramp frequency reference within the current limits. For further details of this mode of operation see the parameter description for #4.11.

In both the above modes of operation, the current/torque controller operates on a 2 ms iteration, i.e. 500Hz repetition rate.

**#4.08 Torque reference**

Parameter type: RW, B

Adjustment range: 0.0 to {± 150.0 x [#b.32] / [#5.07]}

Units: % (of load current)

Default value: 0.0

The torque reference is the main parameter that the user needs for torque control.

**#4.09 Torque offset**

Parameter type: RW, B

Adjustment range: 0.0 to {± 150.0 x [#b.32] / [#5.07]}

Units: % (of load current)

Default value: 0.0

The torque offset can be added to the torque reference (#4.08) but only if the select torque offset (#4.10) is set to 1.

**#4.10 Select torque offset**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

The select torque offset parameter must be set to a 1 if the torque offset (#4.09) is to be added to the torque reference (#4.08).

## #4.11 Select torque control

Parameter type: RW, Bit, P

Adjustment range: 0 or 1

Units: -

Default value: 0

If the select torque control parameter is set to 0 normal frequency control is used with an overriding current limit control. Further details are given in the parameter description #4.07.

If the select torque control parameter is set to 1 the current demand (#4.04) controls the post-ramp frequency reference (#2.01) with feedback from the actual current measurement (#4.20) via the PI current controller. This provides continuous closed loop torque/current demand as illustrated in the Fig. 9.9 below. The current error is passed through proportional and integral terms to give a frequency reference (#2.01) which is only limited by the maximum frequencies (in particular, #1.06, and #1.07 depending on #1.08 with a 20% margin provided the frequencies are within the ULF range). The drive direction is controlled by the required torque polarity as follows:

| **Torque (load) polarity** | **Frequency polarity** | **Direction/Power flow** |
|---|---|---|
| Positive | Positive | Forward (+ve)/ Motoring |
| Positive | Negative | Reverse (-ve)/ Regenerating |
| Negative | Positive | Forward (+ve)/ Regenerating |
| Negative | Negative | Reverse (-ve)/ Motoring |

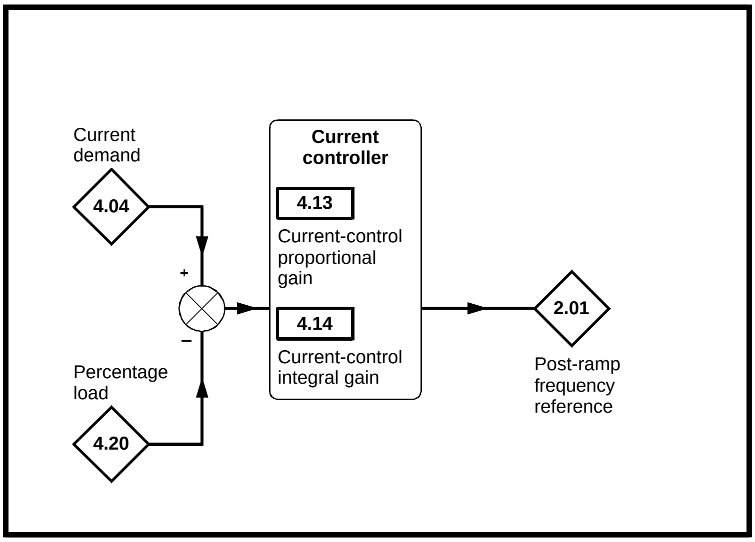



Fig. 9.9 Torque control operation

In both the above modes of operation, the current/torque controller operates on a 2 ms iteration, i.e. 500Hz repetition rate.

## #4.12 Unused parameter

## #4.13 Current control proportional gain

## #4.14 Current control integral gain

| | |
|---|---|
| Parameter type: | RW, U |
| Adjustment range: | 0 to 250 |
| Units: | - |
| Default value: | 50 |

The proportional and integral current controller gains define the steady state and transient response of the current controller whenever it is in operation. As described in the parameter descriptions for #4.07 and #4.11 above, the current controller either provides current limits or closed loop torque control by modifying the drive output frequency.

Although the default settings for the proportional and integral gains have been chosen to give suitable gains for most applications it may be necessary for the user to adjust the gains for a more demanding application. The following is a guide to setting the gains for different applications.

**Current limit operation**

The current controller will normally operate with an integral term only (i.e. proportional gain #4.13 set to 0), particularly below the point where field weakening begins (i.e. when |[#2.01]| ≤ [#5.06]). (The proportional term is inherent in the loop.) The integral gain must be large enough to counter the effect of the ramp which is still active even in current limit (i.e.[#A.09] = 1).

For example, if the drive is operating at constant frequency and is overloaded when motoring the current limit control will try to reduce the output frequency to reduce the load. At the same time, the ramp will try to increase the frequency back up to the demand level. The integral gain needs to be set to a level to compensate for this effect. If the integral gain is increased too much, the first signs of instability will occur when the motor frequency (#2.01) approaches the field weakening frequency (#5.06). This instability can be reduced by increasing the proportional gain.

**Torque control operation**

As for current limit operation, the current controller will normally operate with an integral term only, particularly below the point where field weakening begins. The first signs of instability will appear around base speed (#5.06), and can be reduced by increasing the proportional gain. The controller tends to be less stable in torque control mode than when it is used for current limiting. This is because motor load helps to stabilise the controller. Therefore under torque control, the motor may be operating under light load, whereas under current limit control the motor is usually under heavy load conditions unless the current limit (#4.07) is set to a low value.

## #4.15 Motor thermal time constant

Parameter type: RW, U

Adjustment range: 0 to 250

Units: s

Default value: 89

The motor can be modelled thermally in a way that is equivalent to the electrical circuit shown below, where the voltage across the capacitor represents the motor temperature and the square of the motor load current (#4.02) produces the current **I** in the circuit.

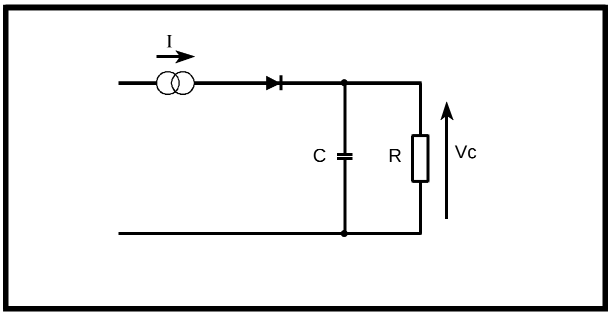



Fig. 9.10 Thermal motor model where heat is represented by current

The response of this circuit to an input step of current **I** is:

$$v_C = R\mathbf{I}\,(1 - e^{-t/\tau})$$

where: $v_C$ is the capacitor voltage (equivalent to the motor temperature)

R is equivalent to the cooling effect of the motor

**I** is equivalent to the heating effect of the motor

t is time

$\tau$ is the RC time constant equivalent to the thermal time constant of the motor

Converting the above equation back to the thermal equivalent:

$$\text{Motor temperature} = Ki^2 (1 - e^{-t/\tau})$$

where: K is a thermal constant

i is the motor active current relative to the rated motor active current (i.e. [#4.02]/{[#5.07] x [#5.10]}) ($i^2$ because the heating effect is proportional to current squared)

t is time

$\tau$ is the thermal time constant of the motor (given by #4.15)

The trip threshold within the drive motor thermal model software is defined as 105% of the motor rated active current (i.e. [#5.07] x [#5.10] x 1.05) on a continuous basis. Therefore, the drive will trip (when time t is very large) if the following is true:

$$\text{Motor temperature to trip} = i^2 (1 - e^{-t/\tau}) = ([\#5.07] \times [\#5.10] \times 1.05)^2$$

However, the drive is rated to give 150% rated current for 60 seconds before tripping on motor temperature. Therefore the motor thermal time constant time ($\tau$ or [#4.15]) can be calculated for the motor thermal model:

$$\text{Motor temperature to trip} = i^2 (1 - e^{-t/\tau}) = ([\#5.07] \times [\#5.10] \times 1.50)^2 (1 - e^{-60/\tau})$$

Solving the two above equations gives a value of $\tau$ or [#4.15] of 89.1 seconds. Hence, if [#4.15] is set to 89 seconds (default) the drive will trip in 60 seconds when the motor load current (#4.20) is at 150% rated current (150% of [#5.07] x [#5.10]).

If a different value for the motor thermal time constant is required it can be determined by any of the following 3 options:

1. Input [#4.15] directly as the motor manufacturers motor thermal time constant in seconds.

2. If a specified overload time (time to trip) and current level are known, (e.g. 60s at 150% current), then:

$$[\#4.15] = (-1) \times (\text{overload time}) / \ln[1 - (105\%)^2 / (\text{current level in } \%)^2]$$

3. If the motor cooling time is known from a thermal overload trip situation to when the motor temperature is within 1% of the ambient temperature, then:

[#4.15] = (0.2) x (motor cooling time)

There are two possible modes of operation for motor thermal protection as defined by parameter #4.16. See parameter description below for further details.

**#4.16 Select motor protection mode**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

The motor protection mode bit provides two modes of operation for the motor thermal protection.

[#4.16] = 0 The drive will trip when the motor thermal protection trip level is reached.

[#4.16] = 1 As the motor thermal protection trip level is approached, the current limit (#4.07) is automatically reduced to keep the load current (#4.02) at the 100% rated current ([#5.07] x [#5.10]) so that the trip level is never reached. 5% hysteresis is included in this case.

**#4.17 Unused parameters**

**#4.18**

**#4.19 Motor thermal overload accumulator**

Parameter type: RO, U, P

Adjustment range: 0.0 to 100.0

Units: % (of trip level)

Default value: -

The motor thermal overload accumulator gives an indication of motor temperature at any time as a percentage of the trip level (i.e. 100%).

The accumulator value is given as:

$$[\#4.19] = ([\#4.02])^2 \times (1 - e^{-t/[\#4.15]}) \times 100\% / (1.05 \times [\#5.07] \times [\#5.10])^2$$

or: $$[\#4.19] = ([\#4.20]/100\%)^2 \times (1 - e^{-t/[\#4.15]}) \times 100\% / (1.05)^2$$

where: #4.02 is the load current (real/active component)

#4.20 is the percentage load

#4.15 is th motor thermal time constant

#5.07 is the Motor - rated current

#5.10 is the Motor - rated power factor

When the accumulator value (#4.19) reaches 100%, the drive will give an 'Ixt' trip (if [#4.16] = 0) or apply a restriction on the current limit (if [#4.16] = 1).

**#4.20 Percentage load**

| | |
|---|---|
| Parameter type: | RO, B, P |
| Range: | 0.0 to {± 150.0 x [#b.32] / [#5.07]} |
| Units: | % (of load current) |
| Default value: | - |

This parameter indicates the drive loading as a percentage of rated active current, where the 100% rated active current is [#5.07] x [#5.10]. Therefore:

$$[\#4.20] = [\#4.02] \times 100\% / ([\#5.07] \times [\#5.10])$$

where: #4.02 is the load current (real/active component)

#5.07 is the Motor - rated current

#5.10 is the Motor - rated power factor

A positive value in this parameter indicates motoring load and a negative value indicates a regenerating load.

## 9.6 Menu 5 logic block diagram - Machine control

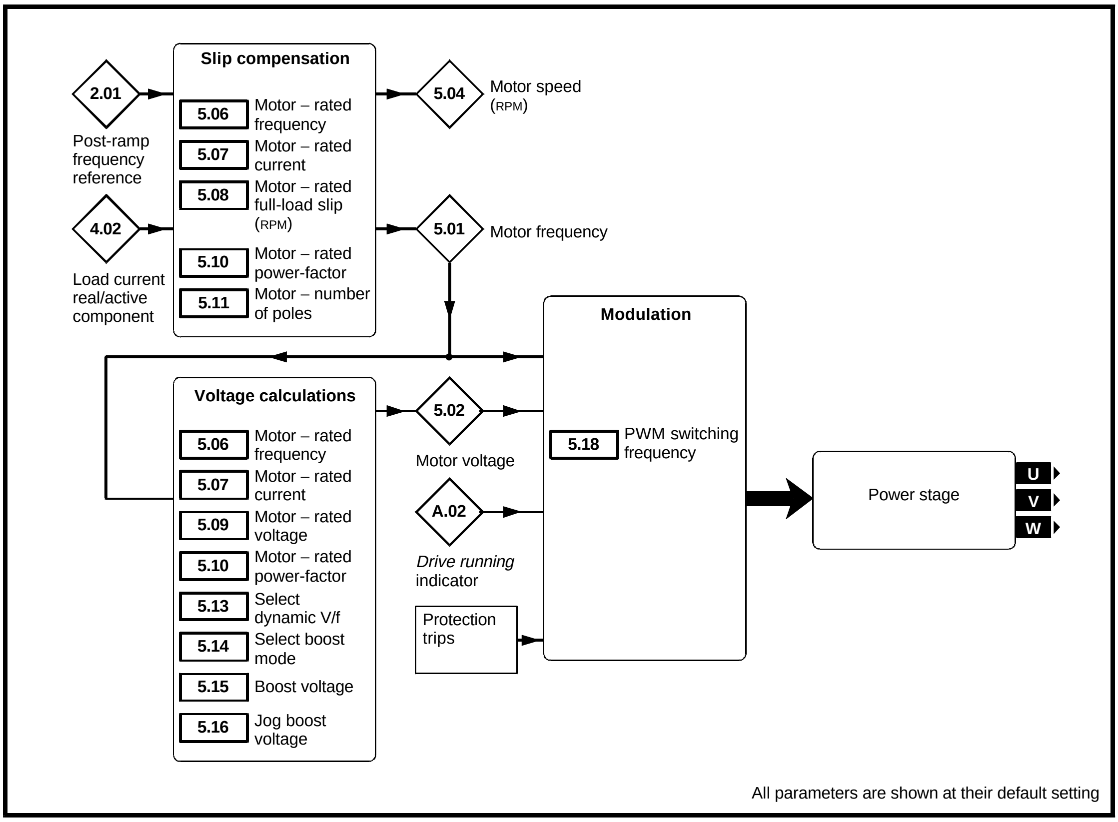



Fig. 9.11 Menu 5 logic block diagram - Machine control

9.6.1 Menu 5 Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #5.01 | Motor frequency | RO, B, P | 0.0 to ≈ ±[#1.06] | - | Hz |
| #5.02 | Motor voltage | RO, U, P | 0.0 to 100.0 | - | % |
| #5.03 | ***Unused parameter*** | - | - | - | - |
| #5.04 | Motor speed (rpm) | RO, B, P | 0.0 to ±9990 | - | rpm |
| #5.05 | ***Unused parameter*** | - | - | - | - |
| #5.06 | Motor - rated frequency | RW, U | 0.0 to ULF | 50.0 or 60.0 | Hz |
| #5.07 | Motor - rated current | RW, U | 0.0 to FLC | FLC | A |
| #5.08 | Motor - rated full load slip (rpm) | RW, U | 0 to 250 | 0 | rpm |
| #5.09 | Motor - rated voltage | RW, U | 0.0 to 100.0 | 100.0 | % |
| #5.10 | Motor - rated power factor | RW, U, P | 0.00 to 1.00 | 0.85 | - |
| #5.11 | Motor - number of poles | RW, U, T, P | 2P(0) to 8P(3) | 4P(1) | poles |
| #5.12 | ***Unused parameter*** | - | - | - | - |
| #5.13 | Select dynamic V/f | RW, Bit | 0/1 | 0 | - |
| #5.14 | Select boost mode | RW, Bit, P | 0/1 | 1 | - |
| #5.15 | Boost voltage | RW, U | 0.0 to 25.0 | 10.0 | % |
| #5.16 | Jog boost voltage | RW, U | 0.0 to 25.0 | 10.0 | % |
| #5.17 | General boost voltage | RW, U | 0.0 to 25.0 | 10.0 | % |
| #5.18 | PWM switching frequency | RW, U, T, P | 3 (0) to 12 (0) | 3 (0) | kHz |

**#5.01 Motor frequency**

Parameter type: RO, B, P

Range: 0.0 to approximately ±[#1.06]

Units: Hz

Default value: -

This parameter gives the output frequency of the drive, i.e. the motor frequency. The value is calculated as follows: (i.e. the post-ramp reference plus the slip compensation term)

[#5.01] = [#2.01] + [#5.08] x ([#5.11 i.e. the number of poles]/120) x ([#4.20]/100%)

where: #2.01 is the post-ramp frequency reference

#5.11 is the Motor - number of poles (use values of 2, 4, 6 or 8)

#5.08 is the Motor - rated full load slip (rpm)

#4.20 is the percentage load

Therefore the range of this parameter (#5.01) is the maximum magnitude of parameters #1.06 and #1.07 plus whatever is added or subtracted for the slip compensation.

**#5.02 Motor voltage**

Parameter type: RO, U, P

Range: 0.0 to 100.0

Units: % (of motor rated voltage (#5.09))

Default value: -

This parameter gives the output voltage of the drive, i.e. the motor voltage. The value is

a percentage of the motor rated voltage (#5.09).

### #5.03 Unused parameter

### #5.04 Motor speed (rpm)

Parameter type: RO, B, P

Range: 0.0 to ± 9990.

Units: rpm

Default value: -

This parameter gives the output speed of the motor, in rpm. The value is calculated from the post- frequency reference (#2.01) as follows:

[#5.04] = 120 x [#2.01] / [#5.11 i.e. the number of poles 2, 4, 6 or 8]

The parameter value will be fairly accurate provided the slip compensation has been set up correctly with the rated full load rpm parameter (#5.08).

Below 1,000rpm the parameter is displayed as rpm without a decimal place. Above 999rpm the parameter is displayed as krpm or 1000's of rpm. For example, 1,500rpm will be displayed as ‘1.50’ krpm.

### #5.05 Unused parameter

### #5.06 Motor - rated frequency

Parameter type: RW, U

Adjustment range: 0 to ULF, where:

ULF = 240Hz when [#5.18] = 3 (kHz),

ULF = 480Hz when [#5.18] = 6 (kHz),

ULF = 720Hz when [#5.18] = 9 (kHz),

ULF = 960Hz when [#5.18] = 12 (kHz)

Units: Hz

Default value: 50.0 (when #x.00 set to 533 followed by a ‘RESET’), or

60.0 (when #x.00 set to 544 followed by a ‘RESET’).

The motor rated frequency is used to define the voltage to frequency characteristic applied to the drive (see parameter description for #5.14).

Therefore it is essential that this parameter is set for the particular motor used for correct operation of the drive.

### #5.07 Motor - rated current

Parameter type: RW, U

Adjustment range: 0 to FLC (drive full load current [#b.32]), where:

FLC = 4.3A for DIN1220075A,

FLC = 3.0A for DIN1220055A,

FLC = 2.3A for DIN1220037A,

FLC = 1.5A for DIN1220025A

Units: A

Default value: FLC as above

The motor rated current should be set at the machine nameplate value for rated current.

This parameter value is used in the following parameter calculations:

| | |
|---|---|
| Current limit, | parameter #4.07 |
| Motor thermal Ixt overload, | parameter #4.15 |
| Slip compensation, | parameter #5.08 |
| Dynamic V/f control, | parameter #5.13 |
| Auto boost, | parameter #5.14 |

Therefore it is essential that this parameter is set for the particular motor used for correct operation of the drive.

### #5.08 Motor - rated full load slip (rpm)

Parameter type: RW, U

Adjustment range: 0 to 250

Units: rpm

Default value: 0

The motor rated full load slip (in rpm) is used with the number of motor poles (#5.11) to calculate the rated slip of the induction motor in Hz.

motor rated slip (in Hz) = [#5.11 i.e. the number of poles 2, 4, 6 or 8] x [#5.08] / 120

The motor rated slip (in Hz) is used to calculate the frequency adjustment required to compensate for slip from the following equation:

slip compensation (in Hz) = [motor rated slip (in Hz)] x [active current] / [rated active current]

= [motor rated slip (in Hz)] x [#4.02] / {[#5.07] x [#5.10]}

where: #5.07 is the Motor - rated current

#5.10 is the Motor - rated power factor

If parameter #5.08 is set to 0 slip compensation is disabled.

If slip compensation is required #5.08 should be set from the motor nameplate value for rated speed as follows:

[#5.08] = {[Rated frequency] x 120 / [number of motor poles]} - [Rated motor full load speed]

= {[#5.06] x 120 / [#5.11 i.e. the number of poles 2, 4, 6 or 8]} - [Motor nameplate full load speed]

Example: For a 50Hz 4-pole machine rated at 1,450rpm

[#5.08] = {50 x 120 / 4} - 1450

= 50 rpm

Sometimes it will be necessary to adjust parameter #5.08 when the drive is commissioned because the motor nameplate value could be inaccurate. Slip compensation will operate correctly both below base speed (#5.06) and above base speed, in the field weakening region. However, by changing this parameter value, the motor can either be over or under compensated for slip as necessary (i.e. the shaft speed can be made to increase or decrease with mechanical load as necessary).

Slip compensation will not alter the frequency direction defined by the post-ramp frequency reference.

## #5.09 Motor - rated voltage

| | |
|---|---|
| Parameter type: | RW, U |
| Adjustment range: | 0.0 to 100.0 |
| Units: | % (of input supply voltage) |
| Default value: | 100.0 |

The motor rated voltage should be set up according to the motor nameplate rated voltage. In particular:

[#5.09] = 100% x [motor nameplate voltage] / [drive input supply voltage]

Example: Motor used : 50Hz, 230V in delta, 400V in star connection

Supply voltage available: 240VAC

Settings: The motor is operated in a delta connection where:

[#5.09] = (Motor voltage) x 100%/ (Supply voltage)

= 230 x 100%/240

= 96%

It is essential that this parameter is set for the particular motor used for correct operation of the drive and other related voltage parameters, such as dynamic V/f, boost, etc.

**#5.10 Motor - rated power factor**

Parameter type: RW, U, P

Adjustment range: 0.00 to 0.85 x [#b.32]/[#5.07] (with a maximum of 1.00)

Units: -

Default value: 0.85

The motor rated power factor is used in conjunction with the motor rated current (#5.07) to calculate the rated active current (100% value for #4.02) (i.e. [100% of #4.02] = [#5.07] x [#5.10]).. The rated active current is used extensively to control the drive.

It is therefore essential that this parameter is set for the particular motor used for correct operation of the drive and all related current parameters.

**#5.11 Motor - number of poles**

Parameter type: RW, U, T, P

Adjustment range: 2P (0), 4P (1), 6P (2), or 8P (3)

Units: Number of poles

Default value: 4P (1)

Set this parameter to the number of poles (not the number of pole pairs) for the motor being used, with the aid of the text options provided.

| **#5.11 Setting (Display)** | **Setting via Serial comms** | **Description** |
|---|---|---|
| 2P | 0 | 2 Motor poles |
| 4P | 1 | 4 Motor poles |
| 6P | 2 | 6 Motor poles |
| 8P | 3 | 8 Motor poles |

It is essential that this parameter is set for the particular motor used for correct operation of the drive and all related speed and slip parameters.

Example: An induction motor has a rated speed of 1,440rpm and a rated frequency of 50Hz. Therefore, the motor is 4-pole, and this parameter is set to 4P (or 1 using serial comms).

**#5.12 Unused parameter**

**#5.13 Select dynamic V/f**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

If the select dynamic V/f bit is set to 0, the V/f characteristic is fixed.

Setting the select dynamic V/f bit to a 1 enables the dynamic voltage to frequency mode of operation. This mode is intended for applications where power loss should be kept to a minimum under light load conditions and motor audible noise is to be minimised. The voltage to frequency ratio is modified with load as follows:

If: |active current| < 0.7 x [rated active current]

(|[#4.02]| < 0.7 x [#5.07] x [#5.10], or, |[#4.20]| < 70%)

where: #4.02 is the load current (real/active component

#5.07 is the Motor - rated current

#5.10 is the Motor - rated power factor

#4.20 is the percentage load

Then:

V/f ratio = [normal V/f ratio] x {0.5 + |[#4.20]|/ (140%)}

Otherwise if:

|active current| ≥ 0.7 x [rated active current] , or, |[#4.20]| ≥ 70%)

Then:

V/f ratio = [normal V/f ratio]

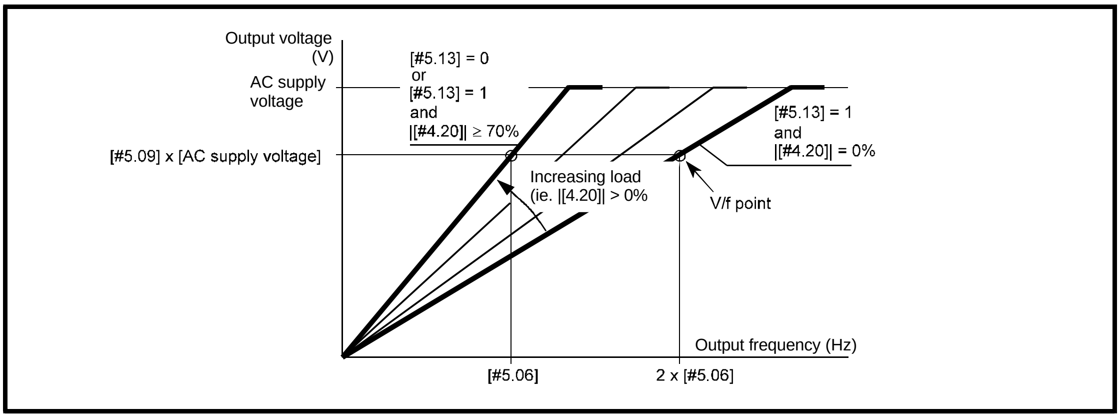



Fig. 9.12 Volt/Hz characteristic for fixed and dynamic V/f settings

### #5.14 Select boost mode

Parameter type: RW, Bit, P

Adjustment range: 0 or 1

Units: -

Default value: 1

The select boost mode enables the selection of a fixed boost V/f characteristic when set to 0, and an auto boost characteristic when set to 1. In both cases the following V/f characteristic is used.

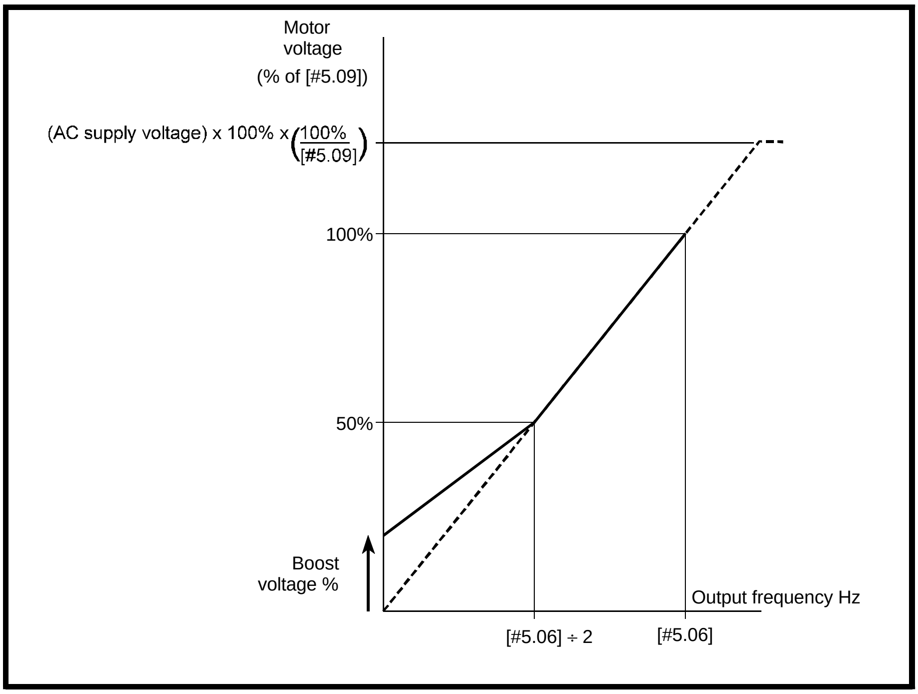



Fig. 9.13 Volt/Hz characteristic for varying boost settings

If fixed boost is selected ([#5.14] = 0) the voltage boost is that set by the user in parameter #5.15 (or #5.16 when jogging). In auto boost mode ([#5.14] = 1) the voltage boost is load dependent and is set to the boost parameter value (#5.15 or #5.16) when the load (|[#4.20]|) is at 100%. For more or less load the voltage boost is directly scaled, e.g. 50% load will produce a voltage boost equal to 50% of #5.15 or #5.16.

**#5.15 Boost voltage**

Parameter type: RW, U

Adjustment range: 0.0 to 25.0

Units: % (of motor rated voltage (#5.09))

Default value: 10.0

The boost voltage level for the voltage frequency characteristic during normal operation (not jogging) is defined by this parameter. The boost level is relevant for both fixed boost ([#5.14] = 0), and auto boost operation ([#5.14] = 1). The voltage frequency characteristic is further defined in parameter descriptions #5.13 and #5.14. See Fig. 9.13 above for further details.

The actual boost voltage (in volts) is:

{[#5.15]/100%} x {[#5.09]/100%} x (input supply voltage)

where: #5.09 is the Motor - rated voltage

### #5.16 Jog boost voltage

| | |
|---|---|
| Parameter type: | RW, U |
| Adjustment range: | 0.0 to 25.0 |
| Units: | % (of motor rated voltage (#5.09)) |
| Default value: | 10.0 |

If the jog preset speed is active ([#1.13] = 1), the jog boost voltage parameter is used instead of the normal boost level set by parameter #5.15 for defining the boost voltage level for the V/f characteristic. See Fig. 9.13 and parameter description #5.15 above for further details.

The actual jog boost voltage (in volts) is:

{[#5.16]/100%} x {[#5.09]/100%} x (input supply voltage)

where: #5.09 is the Motor - rated voltage

## #5.17 General boost voltage

Parameter type: RW, U

Adjustment range: 0.0 to 25.0

Units: % (of motor rated voltage (#5.09))

Default value: 8.0

The general boost voltage level defines the amount of lad dependent boost applied across the frequency range (subject to the maximum output voltage limit of 100% of [#5.09]). The voltage frequency characteristic is further defined in parameter descriptions #5.13, #5.14 and #5.15. See Fig. 9.13 above for further details.

The actual general boost voltage (in volts) is:

{[#5.17]/100%} x {[#5.09]/100%} x {|[#4.20]|/100%} x (input supply voltage)

where: #5.09 is the Motor - rated voltage

#4.20 is the percentage load

## #5.18 PWM switching frequency

Parameter type: RW, U, T, P

Adjustment range: 3 (0), 6 (1), 9 (2), or 12 (3)

Units: kHz

Default value: 3 (0)

This parameter sets the available PWM switching frequencies of the Dinverter. In particular:

| #5.18 Setting (Display) | Setting via Serial comms | Description |
|---|---|---|
| 3 | 0 | 3kHz PWM switching frequency (actually 2.9kHz) |
| 6 | 1 | 6kHz PWM switching frequency (actually 5.8kHz) |
| 9 | 2 | 9kHz PWM switching frequency (actually 8.8kHz) |
| 12 | 3 | 12kHz PWM switching frequency (actually 11.7kHz) |

The output frequency of the drive ([#5.01]) is limited by the switching frequency selected as follows:

| Switching frequency | Maximum output frequency (Upper limit frequency - ULF) |
|---|---|
| 3kHz | 240Hz |
| 6kHz | 480Hz |
| 9kHz | 720Hz |
| 12kHz | 960Hz |

The maximum output frequency for each switching frequency is known as the Upper Limit Frequency and is used as the maximum range of some parameters. It should be noted that if a maximum speed limit (#1.06 or #1.07) is set to an upper limit frequency, there will be no head room for the drive to increase frequency above this level to affect slip compensation. If slip compensation is required the user must ensure that a switching frequency is selected which allows the output frequency to rise enough to allow the compensation.

## 9.7 Menu 6 logic block diagram - Drive sequencer and run-time clock

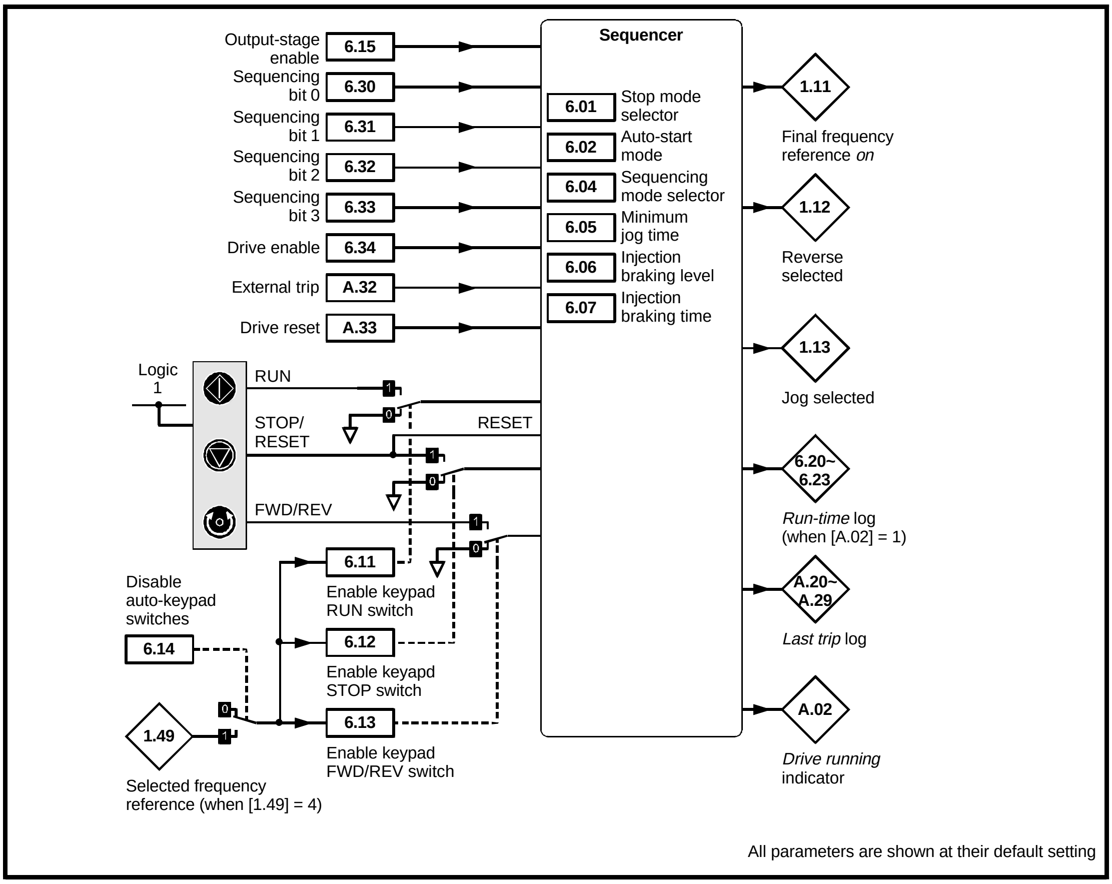



Fig. 9.14 Menu 6 logic block diagram - Drive sequencer and run-time clock

9.7.1 Menu 6 Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #6.01 | Stop mode selector | RW, U, T, P | CSt (0) to dcI (3) | rP (1) | - |
| #6.02 | Auto start mode selector | RW, U, T, P | diS (0) to Pd.d (2) | diS (0) | - |
| #6.03 | ***Unused parameter*** | - | - | - | - |
| #6.04 | Sequencing mode selector | RW, U, P | 0 to 4 | 2 | - |
| #6.05 | Minimum jog time | RW, U | 0.0 to 25.0 | 0.0 | s |
| #6.06 | Injection braking level | RW, U | 0.0 to 25.0 | 10.0 | % |
| #6.07 | Injection braking time | RW, U | 0.0 to 25.0 | 5.0 | s |
| #6.08 | ***Unused parameter*** | - | - | - | - |
| #6.09 | ***Unused parameter*** | - | - | - | - |
| #6.10 | ***Unused parameter*** | - | - | - | - |
| #6.11 | Enable keypad run switch | RW, Bit | 0/1 | 0 | - |
| #6.12 | Enable keypad stop switch | RW, Bit | 0/1 | 0 | - |
| #6.13 | Enable keypad fwd/rev switch | RW, Bit | 0/1 | 0 | - |
| #6.14 | ***Unused parameter*** | - | - | - | - |
| #6.15 | Output stage enable | RW, Bit | 0/1 | 1 | - |
| #6.16 | ***Unused parameter*** | - | - | - | - |
| #6.17 | ***Unused parameter*** | - | - | - | - |
| #6.18 | ***Unused parameter*** | - | - | - | - |
| #6.19 | ***Unused parameter*** | - | - | - | - |
| #6.20 | Run time log: years | RO, U, S, P | 250 | - | years |
| #6.21 | Run time log: days | RO, U, S, P | 364 | - | days |
| #6.22 | Run time log: hours | RO, U, S, P | 23 | - | hours |
| #6.23 | Run time log: minutes | RO, U, S, P | 59 | - | minutes |
| #6.24 | ***Unused parameter*** | - | - | - | - |
| #6.25 | ***Unused parameter*** | - | - | - | - |
| #6.26 | ***Unused parameter*** | - | - | - | - |
| #6.27 | ***Unused parameter*** | - | - | - | - |
| #6.28 | ***Unused parameter*** | - | - | - | - |
| #6.29 | ***Unused parameter*** | - | - | - | - |
| #6.30 | Sequencing bit 0 | RW, Bit | 0/1 | - | - |
| #6.31 | Sequencing bit 1 | RW, Bit | 0/1 | - | - |
| #6.32 | Sequencing bit 2 | RW, Bit | 0/1 | - | - |
| #6.33 | Sequencing bit 3 | RW, Bit | 0/1 | - | - |
| #6.34 | Drive enable | RW, Bit | 0/1 | - | - |

**#6.01 Stop mode selector**

Parameter type: RW, U, T, P

Adjustment range: CSt (0), rP (1), rP.I (2), or, dcI (3)

Units: -

Default value: rP (1)

This parameter has 4 settings:

| **#6.01 Setting (Display)** | **Setting via Serial comms** | **Description** |
|---|---|---|
| CSt | 0 | Coast stop |
| rP | 1 | Ramp stop |
| rP.I | 2 | Ramp stop with 1 second DC injection |
| dcI | 3 | Timed DC injection braking stop |

In the 'CSt' stopping mode, after applying a stop command, the output IGBT stage is disabled immediately and the motor coasts to a standstill. The output IGBT stage is disabled for a minimum of 1 second before it can be enabled again.

In the 'rP' stopping mode, after applying a stop command, the drive ramps down to zero frequency according to the deceleration rate. The output stage is disabled one second after reaching 0Hz. With a large inertia motor load, the motor can still be turning at low speed after this time, depending on the boost settings.

In the 'rP.I' stopping mode, after applying a stop command, the drive ramps down to zero frequency according to the deceleration rate. On reaching 0Hz, a DC voltage is switched onto the motor for one second (a fixed boost value set via #6.06), which creates a holding torque. With large inertia motor loads, #6.06 can be set to ensure that the motor is stationary after the 1 second DC injection period.

In the 'dcI' stopping mode, DC injection starts immediately after a stop command is given. The DC injection voltage is set via #6.06, and the DC injection time is set with #6.07.

**#6.02 Auto start mode selector**

Parameter type: RW, U, T, P

Adjustment range: diS (0), ALS (1), or Pd.d (2)

Units: -

Default value: diS (0)

This parameter has 3 settings:

| **#6.02 Setting (Display)** | **Setting via Serial comms** | **Description** |
|---|---|---|
| diS | 0 | Auto start disabled |
| ALS | 1 | Auto start mode always enabled |
| Pd.d | 2 | Auto start mode enabled but dependent on running condition on supply removal |

In the 'diS' auto start mode the drive will never automatically start at power up, unless the sequencing control inputs are configured to do so. (The 'diS' mode will only have an effect on sequencing modes 0 and 1 as described below in Parameter #6.04).

In the 'ALS' auto start mode the drive will always start at power up (or following an undervoltage trip) only in sequencing modes 0 or 1, provided the Drive enable bit parameter #6.34 is set to 1.

In the 'Pd.d' auto start mode the drive **may** start at power up (or following an undervoltage trip) only in sequencing modes 0 or 1, provided the Drive enable bit parameter #6.34 is set to 1. In this power down dependent mode the drive will **only** start at power up if it was running (i.e. not stopping) when power was last removed from the drive.

**#6.03 Unused parameter**

**#6.04 Sequencing mode selector**

Parameter type: RW, U, P

Adjustment range: 0 to 4

Units: -

Default value: 2

The drive sequencer controls the operation of the drive in terms of deciding the operating states from the various inputs. There are a number of operating states which are indicated on the display in the status mode. These various states are described in Section 10.1.

The drive sequencer has 5 modes of operation which are controlled by the following inputs: (however, keypad control (i.e.[#1.49] = 4) overrrides these sequencing modes)

Sequencing bit 0 (#6.30)

Sequencing bit 1 (#6.31)

Sequencing bit 2 (#6.32)

Sequencing bit 3 (#6.33)

Drive enable (#6.34)

Output stage enable (#6.15)

'RUN' key (on keypad)

'STOP/RESET' key (on keypad)

'FWD/REV' key (on keypad)

The first 5 bit parameters above can be controlled from any input terminal or over the serial interface. The output stage enable bit (#6.15) must be set to a 1 for drive operation, otherwise if set to 0 will disable drive operation. In a similar fashion, the drive must not be in a 'trP' state as this will not allow drive operation either. See Section 9.11 for details. The function of each of these 5 bits depends on which of the 5 sequencing modes is selected. The sequencing modes are:

| **Sequencing mode (i.e. value of #6.04)** | **Operating type interface** |
|---|---|
| 0 | 'Momentary pushbutton' type interface |
| 1 | 'Mentor' drive type interface |
| 2 | 'Wire-proof' type interface |
| 3 | PLC (Programmable logic controller) type interface |
| 4 | 'Wire-proof' PLC type interface |

In addition there is also a sequencing mode when the keypad frequency reference is selected:

| Sequencing mode (i.e. value of #1.49) | Operating type interface |
|---|---|
| 4 | 'Keypad' type interface |

The operation of each of the 5 control bits mentioned above for each of the sequencing modes is as follows:

| Sequencing mode →:<br>Control bits ↓: | [#6.04] = 0<br>'Momentary pushbutton' | [#6.04] = 1<br>'Mentor' drive | [#6.04] = 2<br>'Wire-proof' | [#6.04] = 3<br>PLC | [#6.04] = 4<br>'Wire-proof' PLC | [#1.49] = 4<br>'Keypad' |
|---|---|---|---|---|---|---|
| [#6.30] Sequencing bit 0 | Run (latching) | Run forward (latching) | Run forward | Run | Run forward | No function |
| [#6.31] Sequencing bit 1 | Jog | Jog forward | Jog | Jog | Jog | No function |
| [#6.32] Sequencing bit 2 | Reverse | Run reverse (latching) | Run reverse | Reverse | Run reverse | No function |
| [#6.33] Sequencing bit 3 | No function | Jog reverse | No function | No function | No function | No function |
| [#6.34] Drive enable | Run permit/not stop | Run permit/not stop | Enable | No function | No function | Enable |

Further details about each of the 4 sequencing modes and the action of the above control bits are detailed below.

**‘Momentary pushbutton’ Sequencing mode 0 ([#6.04] = 0)**

| Bit value →:<br><br>Control bits ↓: | 0 | 1 |
|---|---|---|
| [#6.30] Sequencing bit 0<br>Run (latching) | No action | (Momentarily only)<br>Start/run |
| [#6.31] Sequencing bit 1<br>Jog | No jogging<br>(stop) | Jog |
| [#6.32] Sequencing bit 2<br>Reverse | Forward<br>(Running or jogging) | Reverse<br>(Running or jogging) |
| [#6.33] Sequencing bit 3<br>No function | - | - |
| [#6.34] Drive enable<br>Run permit/not stop | Stop | Allow to run |

Sequencing bits 0 and 2 are overridden by the keypad ‘RUN’ and ‘FWD/REV’ keys, respectively, if they are enabled via #6.11 and #6.13. The ‘STOP/RESET’ key can stop the drive if it is enabled via #6.12 except if jogging. A jog command will only be accepted in the ‘rdy’ ready state. Start/run commands override jog commands.

**‘Mentor’ drive Sequencing mode 1 ([#6.04] = 1)**

| Bit value →:<br><br>Control bits ↓: | 0 | 1 |
|---|---|---|
| [#6.30] Sequencing bit 0<br>Run forward (latching) | No action | (Momentarily only)<br>Run forward |
| [#6.31] Sequencing bit 1<br>Jog forward | No jogging forward | Jog forward |
| [#6.32] Sequencing bit 2<br>Run reverse (latching) | No action | (Momentarily only)<br>Run reverse |
| [#6.33] Sequencing bit 3<br>Jog reverse | No jogging reverse | Jog reverse |
| [#6.34] Drive enable<br>Run permit/not stop | Stop | Allow to run |

The ‘RUN’ key can also latch a run state if it is enabled via #6.11, and the ‘FWD/REV’ key can change direction if it is enabled via #6.13 (unless one of the sequencing bits is being held in logic state 1, in which case the sequencing bit has priority). The ‘STOP/RESET’ key can also stop the drive if it is enabled via #6.12, and a run or jog condition is not being forced by the sequencing bits. Any jog command received will only be accepted in the ‘rdy’ ready state. Run commands override jog commands.

**‘Wire-proof’ Sequencing mode 2 ([#6.04] = 2)**

| Bit value →:<br>Control bits ↓: | 0 | 1 |
|---|---|---|
| [#6.30] Sequencing bit 0<br>Run forward | No running/jogging forward - stop | Run/jog forward<br>(if run reverse also - stop) |
| [#6.31] Sequencing bit 1<br>Jog | No jogging<br>(stop) | Jog |
| [#6.32] Sequencing bit 2<br>Run reverse | No running/jogging reverse - stop | Run/jog reverse<br>(if run forward also - stop) |
| [#6.33] Sequencing bit 3<br>No function | - | - |
| [#6.34] Drive enable<br>Enable | ‘Inh’ Inhibit | Allow to run |

The Drive enable bit (#6.34), and either Run forward (#6.30) or Run reverse (#6.32) (but not both) must be at set to 1 before the drive will run. For terminal control, this requires that at least 2 terminals must be made active on the drive, one controlling the Drive enable (#6.34) and the other programmed to control either Run forward (#6.30) or Run reverse (#6.32).

To jog forward or reverse the jog bit (#6.31) must be set to a 1 prior to the appropriate direction bit using Run forward (#6.30) or Run reverse (#6.32) being set. Any jog command received will only be accepted in the ‘rdy’ ready state.

In this sequencing mode the ‘RUN’, ‘STOP/RESET’ and ‘FWD/REV’ keys on the keypad are not operational regardless as to whether they are enabled or not via #6.11, #6.12 and #6.13.

**PLC Sequencing mode 3 ([#6.04] = 3)**

| Bit value →:<br><br>Control bits ↓: | 0 | 1 |
|---|---|---|
| [#6.30] Sequencing bit 0<br>Run | No running/jogging - stop | Start/run |
| [#6.31] Sequencing bit 1<br>Jog | No jogging<br>(stop) | Jog |
| [#6.32] Sequencing bit 2<br>Reverse | Forward<br>(Running or jogging) | Reverse<br>(Running or jogging) |
| [#6.33] Sequencing bit 3<br>No function | - | - |
| [#6.34] Drive enable<br>No function | - | - |

To jog forward or jog reverse the jog bit (#6.31) must be set to a 1 followed by the run bit ([#6.30] = 1) and the appropriate direction selected by #6.32. A jog command will only be accepted in the 'rdy' ready state.

In this sequencing mode the 'RUN' , 'STOP/RESET' and 'FWD/REV' keys on the keypad are not operational regardless as to whether they are enabled or not via #6.11, #6.12 and #6.13.

**‘Wire-proof’ PLC Sequencing mode 4 ([#6.04] = 4)**

| Bit value →:<br><br>Control bits ↓: | 0 | 1 |
|---|---|---|
| [#6.30] Sequencing bit 0<br>Run forward | No running/jogging forward - stop | Run/jog forward<br>(if run reverse also - stop) |
| [#6.31] Sequencing bit 1<br>Jog | No jogging<br>(stop) | Jog |
| [#6.32] Sequencing bit 2<br>Run reverse | No running/jogging reverse - stop | Run/jog reverse<br>(if run forward also - stop) |
| [#6.33] Sequencing bit 3<br>No function | - | - |
| [#6.34] Drive enable<br>No function | - | - |

Either Run forward (#6.30) or Run reverse (#6.32) (but not both) must be at set to 1 before the drive will run. For terminal control, this requires that at least 1 terminal must be made active on the drive, one to control either Run forward (#6.30) or Run reverse (#6.32).

To jog forward or reverse the jog bit (#6.31) must be set to a 1 prior to the appropriate direction bit using Run forward (#6.30) or Run reverse (#6.32) being set. Any jog command received will only be accepted in the ‘rdy’ ready state.

In this sequencing mode the ‘RUN’, ‘STOP/RESET’ and ‘FWD/REV’ keys on the keypad are not operational regardless as to whether they are enabled or not via #6.11, #6.12 and #6.13.

**‘Keypad’ Sequencing mode ([#1.49] = 4)**

| Bit value →:<br><br>Control bits ↓: | 0 | 1 |
|---|---|---|
| [#6.30] Sequencing bit 0<br>No function | - | - |
| [#6.31] Sequencing bit 1<br>No function | - | - |
| [#6.32] Sequencing bit 2<br>No function | - | - |
| [#6.33] Sequencing bit 3<br>No function | - | - |
| [#6.34] Drive enable<br>Enable | ‘Inh’ Inhibit | Allow to run |

The Drive enable (#6.34) must be at set to 1 before the drive will run.

In this sequencing mode the ‘RUN’, ‘STOP/RESET’ and ‘FWD/REV’ keys on the keypad are operational regardless as to whether they are enabled or not via #6.11, #6.12 and #6.13.

### #6.05 Minimum jog time

Parameter type: RW, U

Adjustment range: 0.0 to 25.0

Units: s

Default value: 0.0

The minimum jog time can be used to define a minimum jog period such that the motor will rotate by a fixed amount when a jog command (shorter than the minimum period) is received.

This parameter is not operational in the ‘Wire-proof’, PLC and ‘Wire-proof’ PLC sequencing modes 2, 3 and 4 because removing the jog command whilst leaving the run command active causes the drive to select the running mode instead of the desired jogging mode.

### #6.06 Injection braking level

Parameter type: RW, U

Adjustment range: 0.0 to 25.0

Units: % (of motor rated voltage (#5.09))

Default value: 10.0

The injection braking level defines the boost voltage level used for injection braking when selected via the relevant stop modes (i.e. [#6.01] = 2 or 3).

### #6.07 Injection braking time

Parameter type: RW, U

Adjustment range: 0.0 to 25.0

Units: s

Default value: 5.0

The injection braking time defines the time used for injection braking when selected via the ‘dcI’ stop mode (i.e. [#6.01] = 3).

**#6.08 Unused parameters**

**#6.09**

**#6.10**

**#6.11 Enable keypad run switch**

**#6.12 Enable keypad stop switch**

**#6.13 Enable keypad fwd/rev switch**

| | |
|---|---|
| Parameter type: | RW, Bit |
| Adjustment range: | 0 or 1 |
| Units: | - |
| Default value: | 0 |

The 3 keypad enable switches (#6.11, #6.12 and #6.13) enable the run function of the 'RUN' key, the stop function of the 'STOP/RESET' key and the forward/reverse function of the 'FWD/REV' key respectively when each bit is set to a 1.

However, when the keypad frequency reference is selected (i.e. [#1.49] = 4), then the 3 switches are enabled regardless of the state of the 3 keypad enable switches (#6.11, #6.12 and #6.13).

**#6.14 Unused parameter**

**#6.15 Output stage enable**

| | |
|---|---|
| Parameter type: | RW, Bit |
| Adjustment range: | 0 or 1 |
| Units: | - |
| Default value: | 1 |

The output stage enable parameter must be set to a 1 for the drive to run, regardless of the operation of the drive sequencer explained in parameter description #6.04 above.

Setting output stage enable(#6.15) to a 0 will immediately disable the drive and indicate 'inh' on the display in Status Mode.

**#6.16 Unused parameters**

**#6.17**

**#6.18**

**#6.19**

**#6.20 Run time log: years**

**#6.21 Run time log: days**

**#6.22 Run time log: hours**

**#6.23 Run time log: minutes**

| | | |
|---|---|---|
| Parameter type: | RO, U, S, P | |
| Adjustment range: | 0 or 250 (for #6.20 years) | |
| | 0 or 364 (for #6.21 days) | |
| | 0 or 23 (for #6.22 hours) | |
| | 0 or 59 (for #6.23 minutes) | |
| Units: | years | (for #6.20) |
| | days | (for #6.21) |
| | hours | (for #6.22) |
| | minutes | (for #6.23) |
| Default value: | - | |

These 4 run time log parameters record the total amount of time the drive has been running (i.e. Drive running indicator bit #A.02 set to 1) since the drive left the manufacturing plant.

The run time log will only increment for each whole minute of operation, and does not retain details of fractions of minutes. Therefore if the drive is only ‘running’ for a period of 59 seconds between power applied and removed, the run time log will not alter.

**#6.24** **Unused parameters**

**#6.25**

**#6.26**

**#6.27**

**#6.28**

**#6.29**

**#6.30** **Sequencing bit 0**

**#6.31** **Sequencing bit 1**

**#6.32** **Sequencing bit 2**

**#6.33** **Sequencing bit 3**

**#6.34** **Drive enable**

| | |
|---|---|
| Parameter type: | RW, Bit |
| Adjustment range: | 0 or 1 |
| Units: | - |
| Default value: | - |

The drive sequencer uses these 5 bits as inputs. This allows the user to programme the various digital terminal inputs according to the application needs. (See Section 9.9 for further details about assigning digital inputs to these bits.)

The function of the 5 sequencing bits is fully explained in the parameter description for #6.04 above.

Although these parameters are R/W, they are not stored at power down. Every time the drive is powered up they will be all be set to 0, until controlled by the various digital inputs or serial comms etc. .

## 9.8 Menu 7 logic block diagram - Analogue inputs and outputs

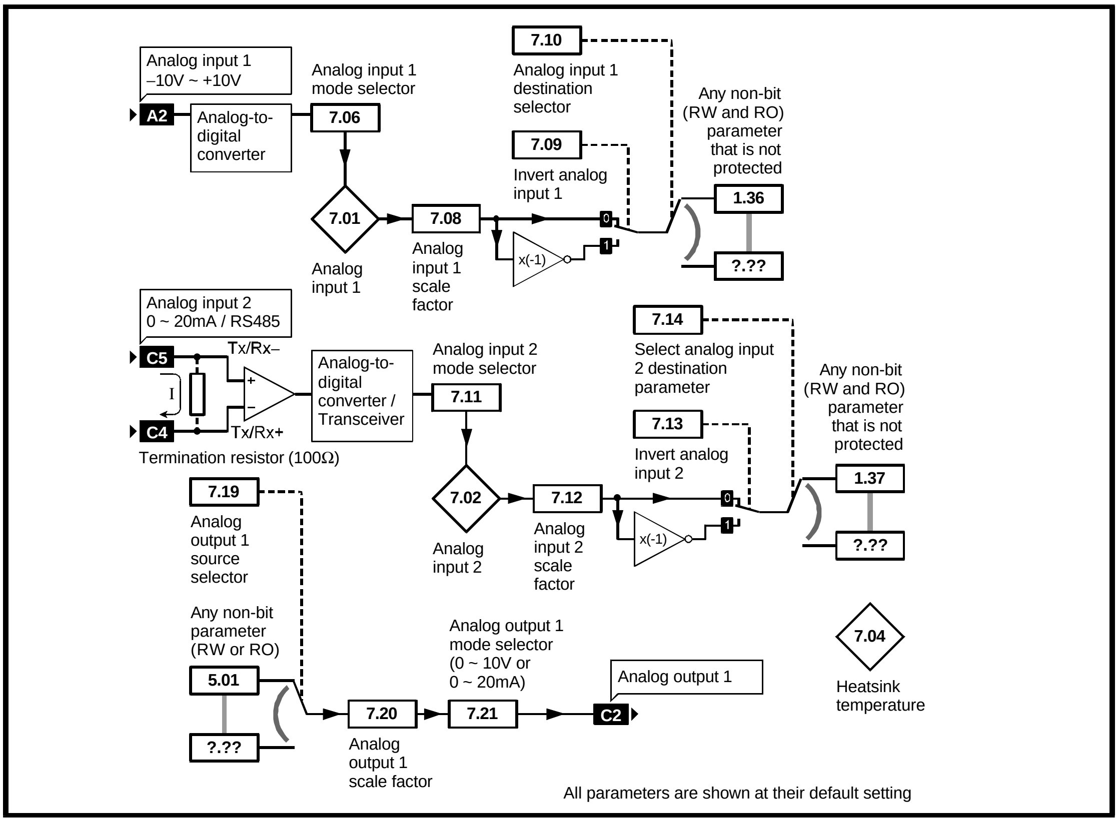



Fig. 9.15 Menu 7 logic block diagram - Analogue inputs and outputs

9.8.1 Menu 7 Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #7.01 | Analogue input 1 (A2) | RO, B, P | 0.0 to ±100.0 | - | % |
| #7.02 | Analogue input 2 (C4/C5) | RO, U, P | 0.0 to 100.0 | - | % |
| #7.03 | ***Unused parameter*** | - | - | - | - |
| #7.04 | Heatsink temperature | RO, U, P | 0 to 100 | - | °C |
| #7.05 | ***Unused parameter*** | - | - | - | - |
| #7.06 | Analogue input 1 (A2) mode selector | RW, U, T, P | ULt (0) or th (1) | ULt (0) | - |
| #7.07 | ***Unused parameter*** | - | - | - | - |
| #7.08 | Analogue input 1 (A2) scale factor | RW, U | 0.00 to 2.50 | 1.00 | - |
| #7.09 | Invert analogue input 1 (A2) | RW, Bit | 0/1 | 0 | - |
| #7.10 | Analogue input 1 (A2) destination selector | RW, U, R, P | (#) 0.00 to E.50 | (#)1.36 | (#) |
| #7.11 | Analogue input 2 (C4/C5) mode selector | RW, U, T, P | ANS (0) to th (5) | ANS (0) | - |
| #7.12 | Analogue input 2 (C4/C5) scale factor | RW, U | 0.00 to 2.50 | 1.00 | - |
| #7.13 | Invert analogue input 2 (C4/C5) | RW, Bit | 0/1 | 0 | - |
| #7.14 | Analogue input 2 (C4/C5) destination selector | RW, U, R, P | (#) 0.00 to E.50 | (#)1.37 | (#) |
| #7.15 | ***Unused parameter*** | - | - | - | - |
| #7.16 | ***Unused parameter*** | - | - | - | - |
| #7.17 | ***Unused parameter*** | - | - | - | - |
| #7.18 | ***Unused parameter*** | - | - | - | - |
| #7.19 | Analogue output 1 (C2) source selector | RW, U, P | (#) 0.00 to E.50 | (#)5.01 | (#) |
| #7.20 | Analogue output 1 (C2) scale factor | RW, U | 0.00 to 2.50 | 1.00 | - |
| #7.21 | Analogue output 1 (C2) mode selector | RW, U, T, P | ULt(0) to 4.20 (2) | ULt(0) | - |

## 9.8.2 Menu 7 Parameter Descriptions

### #7.01 Analogue input 1 (A2)

| | |
|---|---|
| Parameter type: | RO, B, P |
| Range: | 0.0 to ±100.0 |
| Units: | % (of input 1 (A2) full scale i.e. +10V) |
| Default value: | - |

This analogue input 1 (A2) parameter gives the level of the analogue signal present at terminal A2. Analogue input 1 is a bipolar voltage input having a range of -10V to +10V which is converted to ±100.0%, the resolution is 10 bit plus sign (i.e. + or - 0.1V). The sample time is every 16ms.

### #7.02 Analogue input 2 (C4/C5)

| | |
|---|---|
| Parameter type: | RO, U, P |
| Range: | 0.0 to 100.0 |
| Units: | % (of input 2 (C4/C5) full scale i.e. +20mA) |
| Default value: | - |

This analogue input 2 (C4/C5) parameter gives the level of the differential analogue signal between terminals C5 and C4. Analogue input 2 is a unipolar current input having a range of 0 to 20mA. Using parameter #7.11 (analogue input 2 mode selector), the drive can be programmed to convert the measured current to any one of the following ranges:

| | | | |
|---|---|---|---|
| 0 - 20 mA | ([#7.11] = 1) | 0mA = 0%, | 20mA = 100% |
| 20 - 0 mA | ([#7.11] = 2) | 0mA = 100%, | 20mA = 0% |
| 4 - 20 mA | ([#7.11] = 3) | 4mA = 0%, | 20mA = 100% |
| 20 - 4 mA | ([#7.11] = 4) | 4mA = 100%, | 20mA = 0% |

The measurement resolution is 10 bit (i.e. 0.2mA). The sample time is every 16ms.

### #7.03 Unused parameter

**#7.04 Heatsink temperature**

Parameter type: RO, U, P

Range: 0 to 100

Units: °C

Default value: -

This parameter displays the temperature currently being measured on the heat sink. If this parameter reaches 100ºC the drive will trip (‘Oh2’ on the display in Trip Mode) and will not allow a reset until the temperature falls below 90ºC. The alarm level (‘hot’ on the display) is at 95°C and above.

**#7.05 Unused parameter**

**#7.06 Analogue input 1 (A2) mode selector**

Parameter type: RW, U, T, P

Adjustment range: ULt (0) or th (1)

Units: -

Default value: ULt (0)

The Terminal A2 analogue input can be configured either as a voltage input (default) or as a motor thermistor input. The setting of this parameter configures the terminal for the required mode.

| #7.06 Setting (Display) | Setting via Serial comms | Description |
|---|---|---|
| ULt | 0 | Terminal A2 accepts -10V to +10V analogue voltage input |
| th | 1 | Terminal A2 accepts motor thermistor input, when configured as below: |

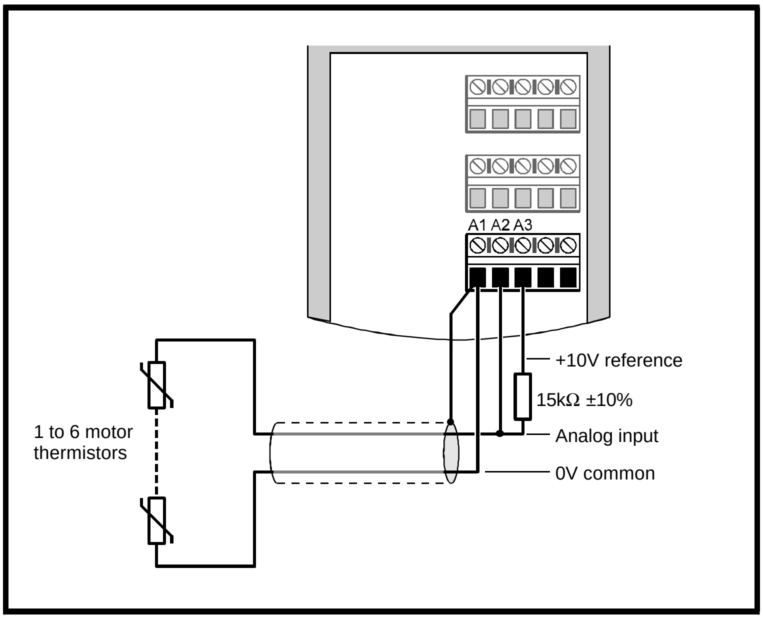



Fig. 9.16 Optional motor thermistor input arrangement for Terminal A2

The motor thermistor can be from 1 to 6 250Ω standard motor thermistors connected in series. The drive will trip (‘th’ trip code) when the thermistor resistance is ≥ 3.3kΩ, and a reset value ≤ 1.8kΩ.

**#7.07 Unused parameter**

**#7.08 Analogue input 1 (A2) scale factor**

**#7.12 Analogue input 2 (C4/C5) scale factor**

Parameter type: RW, U

Adjustment range: 0.00 to 2.50

Units: -

Default value: 1.00

These parameters can be used to scale an input if required. However in most cases it is not necessary as each input is automatically scaled such that for 100.0% input the destination parameter (defined by #7.10 and #7.14) will be at maximum.

The resulting scaled values are calculated as follows:

[Destination parameter defined by #7.10] = [#7.01] x [#7.08] in %

( = [#[#7.10]])

where: full scale of destination parameter relates to a value of 100%

#7.01 is the Analogue input 1 (A2)

[Destination parameter defined by #7.14] = [#7.02] x [#7.12] in %

( = [#[#7.14]])

where full scale of destination parameter relates to a value of 100%

#7.02 is the Analogue input 2 (C4/C5)

**#7.09 Invert analogue input 1 (A2)**

**#7.13 Invert analogue input 2 (C4/C5)**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

These parameters can be used to invert (i.e. multiply input scaling result by -1) the input references.

**#7.10 Analogue input 1 (A2) destination selector**

**#7.14 Analogue input 2 (C4/C5) destination selector**

Parameter type: RW, U, R, P

Adjustment range: (#) 0.00 to E.50

Units: (#) (i.e. #(menu number).(parameter number))

Default value: (#)1.36 for #7.10

(#)1.37 for #7.14

These parameters define the destination of the relevant analogue inputs. Therefore these parameters can be used to select certain internal parameters which need to be controlled by an analogue input. For the defaults setting given above:

[#7.10] = 1.36 Analogue input 1 routed to parameter #1.36 (Analogue frequency reference 1)

[#7.14] = 1.37 Analogue input 2 routed to parameter #1.37 (Analogue frequency reference 2)

Only non-bit parameters (parameter types RW and RO) which are not protected (parameter type P) can be controlled by analogue inputs. If a non valid parameter is the destination of an analogue input, the input is not routed anywhere.

#### #7.11 Analogue input 2 (C4/C5) mode selector

Parameter type: RW, U, T, P

Adjustment range: ANS (0), 0.20 (1), 20.0 (2), 4.20 (3), 20.4 (4), or th (5)

Units: -

Default value: ANS (0)

Analogue input 2 (C4/C5) can be configured for different input signal types (including serial communications). The setting of this parameter configures the terminals for the required mode of operation as follows:

| **#7.11 Setting (Display)** | **Setting via Serial comms** | **Description** |
|---|---|---|
| ANS | 0 | RS485 ANSI serial comms port active |
| 0.20 | 1 | Current input 0 to 20mA (20mA full scale) |
| 20.0 | 2 | Current input 20 to 0mA (0mA full scale) |
| 4.20 | 3 | Current input 4 to 20mA (20mA full scale) |
| 20.4 | 4 | Current input 20 to 4mA (4mA full scale) |
| th | 5 | Motor thermistor input, see Fig. 9.17 below for arrangement |

When the input is selected as a motor thermistor input, the input must be configured as follows:

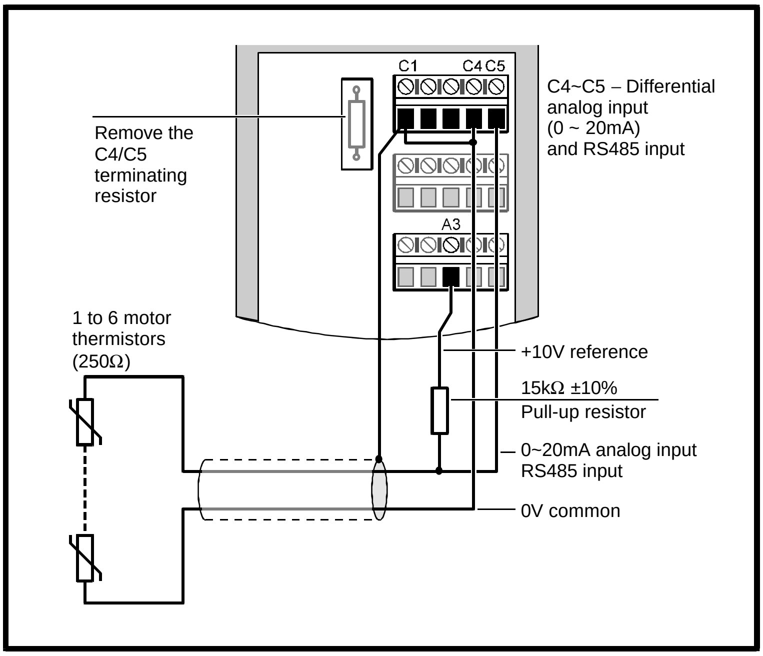



Fig. 9.17 Optional motor thermistor input arrangement for Terminals C4 and C5

The motor thermistor can be from 1 to 6 250Ω standard motor thermistors connected in series. The drive will trip (‘th’ trip code) when the thermistor resistance is ≥ 3.3kΩ, and a reset value ≤ 1.8kΩ.

For the 4.20 (3) and 20.4 (4) settings, a cable break, or an input current less than 3mA, will cause the drive to trip (‘cL’ trip code) for current loop loss.

**#7.15 Unused parameters**

**#7.16**

**#7.17**

**#7.18**

**#7.19 Analogue output 1 (C2) source selector**

Parameter type: RW, U, P

Adjustment range: (#) 0.00 to E.50

Units: (#) (i.e. #(menu number).(parameter number))

Default value: (#)5.01

This parameter defines the source of the relevant value to be output as an analogue signal at terminal C2. Therefore this parameter can be used to enable certain internal parameters to be monitored as an analogue output. For the default setting given above:

[#7.19] = 5.01 Parameter #5.01 (Motor frequency) value routed to Analogue output 1 (C2)

Only non-bit parameters (parameter types RW and RO) can be programmed as a source. If a non valid parameter is programmed as the source, the output value is 0. If a bipolar parameter is programmed as a source, the absolute value is fed to the analogue output.

**#7.20 Analogue output 1 (C2) scale factor**

Parameter type: RW, U

Adjustment range: 0.00 to 2.50

Units: -

Default value: 1.00

This parameter can be used to scale an output if required. However in most cases it is not necessary as the analogue output is automatically scaled such that for the maximum value of the source parameter, the analogue output will be at full scale (100.0%).

The resulting scaled value is calculated as follows:

[Percentage analogue output at C2] = [Source parameter defined by #7.19 in %] x [#7.20]

= [#[#7.19]] x [#7.20]

where full scale of source parameter relates to a value of 100%

For default settings:

0V at analogue output (C2) when source parameter defined by #7.19 ([#5.01 - Motor frequency] = 0Hz)

+10V at analogue output (C2) when source parameter defined by #7.19 ([#5.01 - Motor frequency] ) is at maximum (50Hz) as defined by the parameter #1.06 (maximum frequency ).

#### #7.21 Analogue output 1 (C2) mode selector

Parameter type: RW, U, T, P

Adjustment range: ULt (0), 0.20 (1) or 4.20 (2)

Units: -

Default value: ULt (0)

Analogue output 1 (C2) can be configured for different output ranges. The setting of this parameter configures the terminal for the required output mode as follows:

| **#7.21 Setting (Display)** | **Setting via Serial comms** | **Description** |
|---|---|---|
| ULt | 0 | Voltage output, range of 0V to +10V (+10V full scale) |
| 0.20 | 1 | Current output, range of 0mA to 20mA (20mA full scale) |
| 4.20 | 2 | Current output, range of 4mA to 20mA (20mA full scale) |

The analogue output is updated every 32ms.

## 9.9 Menu 8 logic block diagram - Digital inputs and outputs

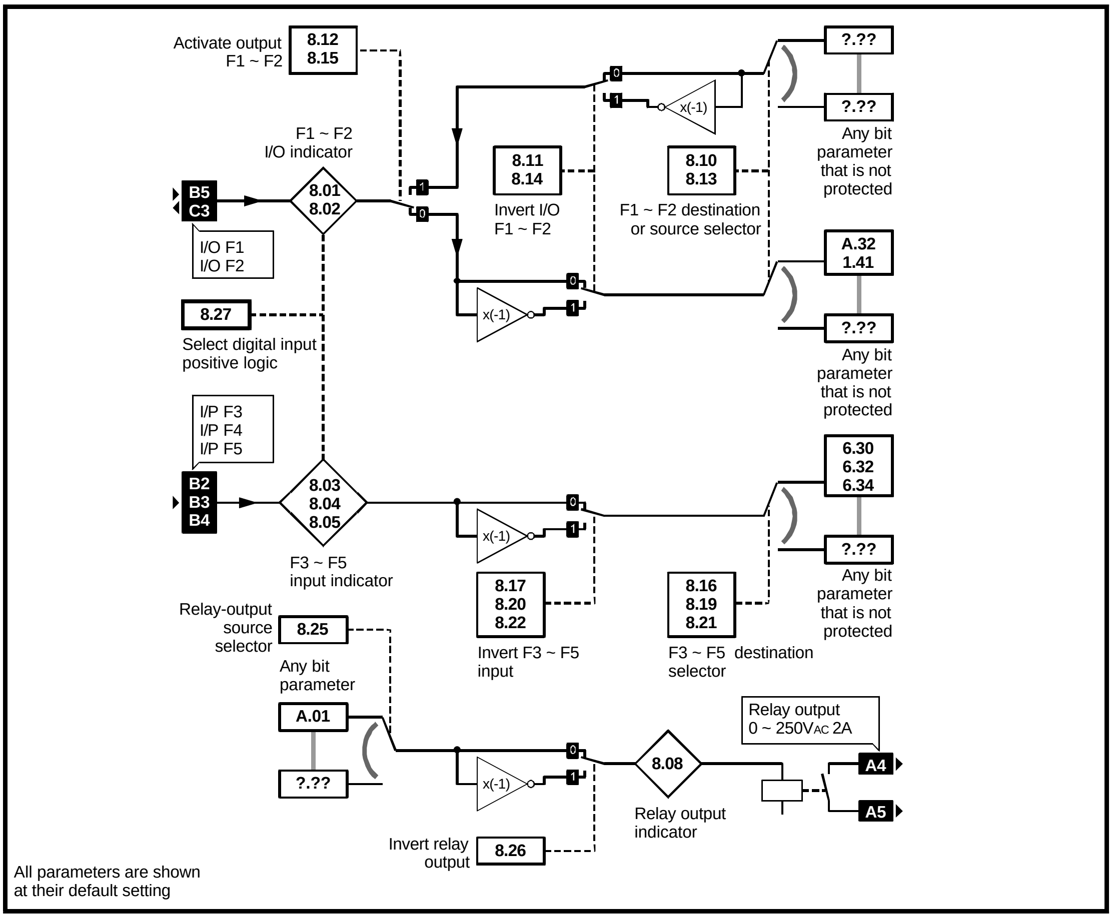



Fig. 9.18 Menu 8 logic block diagram - Digital inputs and outputs

9.9.1 Menu 8 Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #8.01 | Digital input F1/output 1 (B5) indicator | RO, Bit, P | 0/1 | - | - |
| #8.02 | Digital input F2/output 2 (C3) indicator | RO, Bit, P | 0/1 | - | - |
| #8.03 | Digital input F3 (B2) indicator | RO, Bit, P | 0/1 | - | - |
| #8.04 | Digital input F4 (B3) indicator | RO, Bit, P | 0/1 | - | - |
| #8.05 | Digital input F5 (B4) indicator | RO, Bit, P | 0/1 | - | - |
| #8.06 | ***Unused parameter*** | - | - | - | - |
| #8.07 | ***Unused parameter*** | - | - | - | - |
| #8.08 | Relay output (A4/A5) indicator | RO, Bit, P | 0/1 | - | - |
| #8.09 | ***Unused parameter*** | - | - | - | - |
| #8.10 | F1 input (B5) destination/output source selector | RW, U, R*, P (* only if input) | (#) 0.00 to E.50 | (#)A.32 | (#) |
| #8.11 | Invert F1 input/output (B5) | RW, Bit | 0/1 | 1 | - |
| #8.12 | Activate output 1 (B5) | RW, Bit, R | 0/1 | 0 | - |
| #8.13 | F2 input (C3) destination/output source selector | RW, U, R*, P (* only if input) | (#) 0.00 to E.50 | (#)1.41 | (#) |
| #8.14 | Invert F2 input/output (C3) | RW, Bit | 0/1 | 0 | - |
| #8.15 | Activate output 2 (C3) | RW, Bit, R | 0/1 | 0 | - |
| #8.16 | F3 input (B2) destination selector | RW, U, R, P | (#) 0.00 to E.50 | (#)6.30 | (#) |
| #8.17 | Invert F3 input (B2) | RW, Bit | 0/1 | 0 | - |
| #8.18 | ***Unused parameter*** | - | - | - | - |
| #8.19 | F4 input destination (B3) selector | RW, U, R, P | (#) 0.00 to E.50 | (#)6.32 | (#) |
| #8.20 | Invert F4 input (B3) | RW, Bit | 0/1 | 0 | - |
| #8.21 | F5 input destination (B4) selector | RW, U, R, P | (#) 0.00 to E.50 | (#)6.34 | (#) |
| #8.22 | Invert F5 input (B4) | RW, Bit | 0/1 | 0 | - |
| #8.23 | ***Unused parameter*** | - | - | - | - |
| #8.24 | ***Unused parameter*** | - | - | - | - |
| #8.25 | Relay output (A4/A5) source selector | RW, U, P | (#) 0.00 to E.50 | (#)A.01 | (#) |
| #8.26 | Invert relay output (A4/A5) | RW, Bit | 0/1 | 0 | - |
| #8.27 | Select digital input (B2/B3/B4/B5/C3) positive logic | RW, Bit, R, P | 0/1 | 0 | - |

**Summary of digital inputs and outputs**

Terminals B5 and C3 (F1 and F2 respectively) can be independently set up as either digital inputs or outputs, whilst terminals B2, B3 and B4 (F3, F4 and F5 respectively) can be digital inputs only. All digital inputs and/or outputs are completely programmable in terms of their function. Digital inputs are sampled, and digital outputs updated, every 8ms. The relay output (A4/A5) is updated every 8ms.

**#8.01 Digital input F1/output 1 (B5) indicator**

**#8.02 Digital input F2/output 2 (C3) indicator**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

These 2 parameters indicate the input state of the respective terminal if they are set up as inputs (i.e. B5 is an input if [#8.12] = 0, C3 is an input if [#8.15] =0), or the output state if they are set up as outputs (i.e. B5 is an output if [#8.12] = 1, C3 is an output if [#8.15] =1).

For digital inputs, the value of the parameter is as follows:

0 when: [#8.27] = 0 and input high (inactive), or
[#8.27] = 1 and input low (inactive).

1 when [#8.27] = 0 and input low (active), or
[#8.27] = 1 and input high (active).

where: #8.27 is select digital input (B2/B3/B4/B5/C3) positive logic

For digital outputs, the value of the parameter will cause the following:

0 disables the current sinking capability (independent of #8.27)

1 enables the current sinking capability (independent of #8.27)

**#8.03 Digital input F3 (B2) indicator**

**#8.04 Digital input F4 (B3) indicator**

**#8.05 Digital input F5 (B4) indicator**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

These 3 parameters indicate the input state of the respective terminals.

The value of the parameter is as follows:

0 when: [#8.27] = 0 and input high (inactive), or
[#8.27] = 1 and input low (inactive).

1 when [#8.27] = 0 and input low (active), or
[#8.27] = 1 and input high (active).

where: #8.27 is select digital input (B2/B3/B4/B5/C3) positive logic

**#8.06 Unused parameters**

**#8.07**

**#8.08 Relay output (A4/A5) indicator**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

This parameters indicates the output state of the control relay (Normally Open contact) across terminals A4/A5.

The value of the parameter indicates the following:

0 control relay de-energised, contact across A4/A5 open (independent of #8.27)

1 control relay energised, contact across A4/A5 closed (independent of #8.27)

where: #8.27 is select digital input (B2/B3/B4/B5/C3) positive logic

**#8.09 Unused parameter**

**#8.10 F1 input (B5) destination/output source selector**

**#8.13 F2 input (C3) destination/output source selector**

**#8.16 F3 input (B2) destination selector**

**#8.19 F4 input (B3) destination selector**

**#8.21 F5 input (B4) destination selector**

**#8.25 Relay output (A4/A5) source selector**

Parameter type: RW, U, R, P except:

RW, U, P for #8.25 (and, #8.10 and #8.13 if outputs)

Adjustment range: (#) 0.00 to E.50

Units: (#) (i.e. #(menu number).(parameter number))

Default value: (#)A.32 for #8.10

(#)1.41 for #8.13

(#)6.30 for #8.16

(#)6.32 for #8.19

(#)6.34 for #8.21

(#)A.01 for #8.25

The above destination selector parameters (excluding #8.25) define the destination of the relevant digital input signal. Therefore these parameters can be used to control certain internal bit parameters which need to be controlled. Only bit parameters (Bit) which are not protected (P) can be controlled by programmable digital inputs (i.e. destination selector parameters). If a non valid parameter is selected as the destination the input is not routed anywhere.

For the default settings:

[#8.10] = A.32 - Digital input B5, (B5 is an input if [#8.12] = 0), value routed to External Trip bit (#A.32)

[#8.13] = 1.41 - Digital input C3, (C3 is an input if [#8.15] = 0), value routed to Select analogue frequency reference 2 bit (#1.41)

[#8.16] = 6.30 - Digital input B2 value routed to Sequencing bit 0 (#6.30) which in sequencing mode 2 (i.e. [#6.04] = 2) corresponds to Run Forward

[#8.19] = 6.32 - Digital input B3 value routed to Sequencing bit 2 (#6.32) which in sequencing mode 2 (i.e. [#6.04] = 2) corresponds to Run Reverse

[#8.21] = 6.34 - Digital input B4 value routed to Drive enable bit (#6.34) which in sequencing mode 2 (i.e. [#6.04] = 2) corresponds to Enable

where: #8.12 is the activate output 1 (B5)

#8.15 is the activate output 2 (C3)

The above source selector parameters (i.e. #8.25, #8.10 when [#8.12] = 1, and #8.13 when [#8.15] = 1) define the source of the relevant bit value to be output as a digital signal at the relevant terminals. Therefore these parameters can be used to enable certain internal bit parameters to be monitored as digital outputs. Only bit parameters (Bit) can be selected as the source for a programmable digital output. If a non valid parameter is selected as the source the output terminal will be in the inactive state and the relay will be de-energised.

For the default settings:

[#8.25] = A.01 - The drive healthy indicator bit value [#A.01] is routed to the relay output

**#8.11 Invert F1 input/output (B5)**

**#8.14 Invert F2 input/output (C3)**

**#8.17 Invert F3 input (B2)**

**#8.20 Invert F4 input (B3)**

**#8.22 Invert F5 input (B4)**

**#8.26 Invert relay output (A4/A5)**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 1 for #8.11

0 for #8.14, #8.17, #8.20, #8.22 and #8.26

These invert parameters enable an inversion of a digital input (or output) bit value.

For digital inputs:

| Input bit value (e.g. [#8.03]) | Invert bit value (e.g. [#8.17]) | Destination bit value (e.g. [#6.30]) |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 0 |

For digital outputs:

| Source bit value (e.g. [#A.01]) | Invert bit value (e.g. [#8.26]) | Output bit value (e.g. [#8.25]) |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 0 |

**#8.12 Activate output 1 (B5)**

**#8.15 Activate output 2 (C3)**

Parameter type: RW, Bit, R

Adjustment range: 0 or 1

Units: -

Default value: 0

These activate output bit parameters enable the Input/Output terminals (B5 and C3 only) to be configured as either an input or an output.  A bit value of 1 sets the relevant terminal as an output and a 0 as an input.

**#8.18** **Unused parameters**

**#8.23**

**#8.24**

**#8.27** **Select digital input (B2/B3/B4/B5/C3) positive logic**

| | |
|---|---|
| Parameter type: | RW, Bit, R, P |
| Adjustment range: | 0 or 1 |
| Units: | - |
| Default value: | 0 |

The select digital input positive logic bit sets the digital input to be either configured for positive logic or negative logic. In default settings (i.e.[#8.27] = 0) the digital inputs are configured for negative logic which requires the digital inputs to be pulled low (i.e. connected to 0V Common) to activate the input (i.e. [digital input] = 1). Otherwise the digital input will float high (i.e. [digital input] = 0).

When the select digital input positive logic bit is set to 1, the digital inputs are configured for positive logic which requires the digital inputs to be pulled high (i.e. connected to +24V) to activate the input (i.e. [digital input] = 1). Otherwise the digital input will float low (i.e. [digital input] = 0).

## 9.10 Menu 9 logic block diagram - Programmable logic and motorised potentiometer

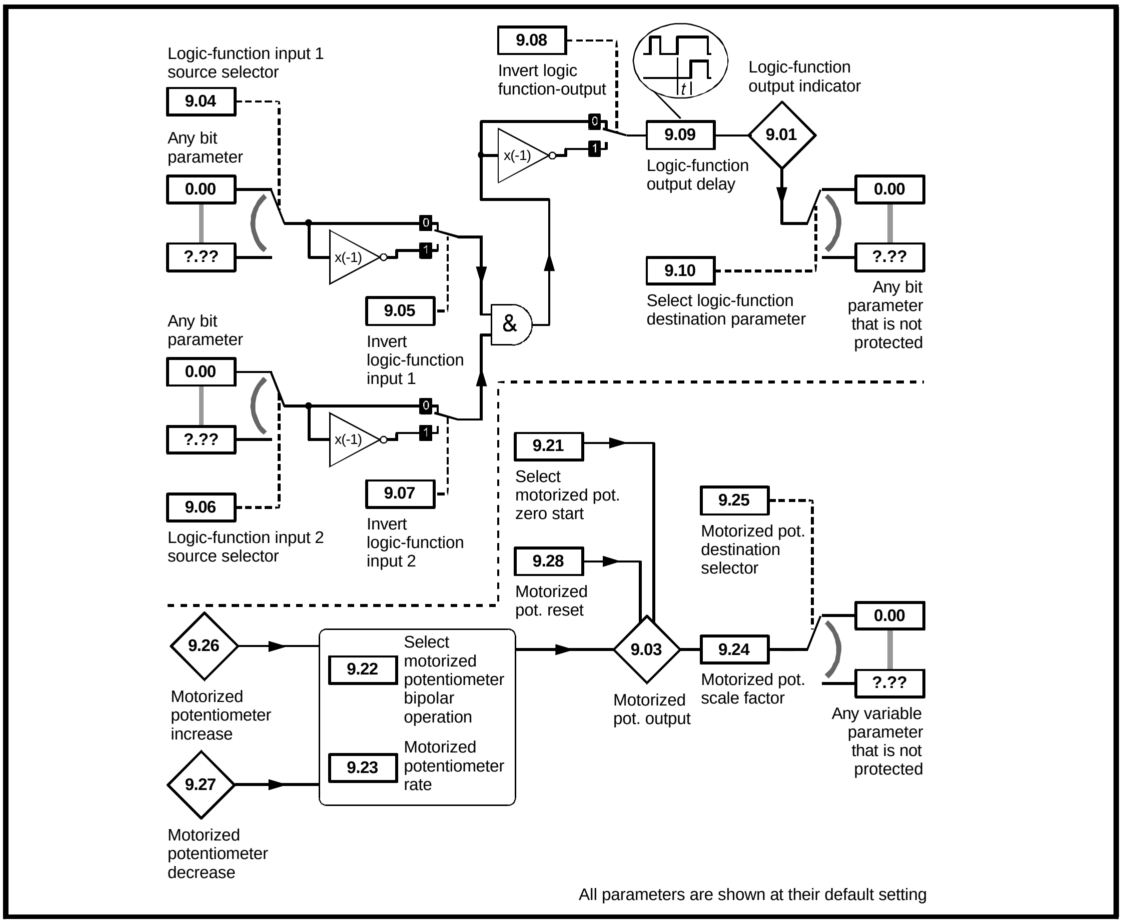



Fig. 9.19 Menu 9 logic block diagram - Programmable logic and motorised potentiometer

9.10.1 Menu 9 Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #9.01 | Logic function output indicator | RO, Bit, P | 0/1 | - | - |
| #9.02 | ***Unused parameter*** | - | - | - | - |
| #9.03 | Motorised potentiometer output | RO, B, S, P | 0.0 to ±100.0 | - | % |
| #9.04 | Logic function input 1 source selector | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #9.05 | Invert logic function input 1 | RW, Bit | 0/1 | 0 | - |
| #9.06 | Logic function input 2 source selector | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #9.07 | Invert logic function input 2 | RW, Bit | 0/1 | 0 | - |
| #9.08 | Invert logic function output | RW, Bit | 0/1 | 0 | - |
| #9.09 | Logic function output delay | RW, U | 0.0 to 25.0 | 0.0 | s |
| #9.10 | Logic function output destination selector | RW, U, R, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #9.11 to #9.20 | ***Unused parameters*** | - | - | - | - |
| #9.21 | Select motorised potentiometer zero start | RW, Bit | 0/1 | 0 | - |
| #9.22 | Select motorised potentiometer bipolar operation | RW, Bit | 0/1 | 0 | - |
| #9.23 | Motorised potentiometer rate | RW, U | 0 to 250 | 20 | s/100% |
| #9.24 | Motorised potentiometer scale factor | RW, U | 0.00 to 2.50 | 1.00 | - |
| #9.25 | Motorised potentiometer output destination selector | RW, U, R, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #9.26 | Motorised potentiometer increase | RO, Bit | 0/1 | - | - |
| #9.27 | Motorised potentiometer decrease | RO, Bit | 0/1 | - | - |
| #9.28 | Motorised potentiometer reset | RW, Bit | 0/1 | 0 | - |

**Summary of the programmable logic function and motorised potentiometer**

The programmable logic function can be used to generate a digital logic signal or action which cannot be achieved with the drives standard parameter set but can be derived from 2 drive bit parameters. An example might be in an application where a ‘stall’ signal is required, i.e. the motor is stalled, stationary but under current limit. The digital inputs could be parameters #A.03 (Zero frequency indicator) and #A.09 (Current limit indicator) with an appropriate delay programmed to ensure that the output signal does not change through momentary changes of the input signals.

The motorised potentiometer function enables any unprotected non-bit parameter to be varied up or down via digital inputs. Viewing the block diagram of Menu 9 in Section 9.10 will help in understanding this function and its associated parameters.

**#9.01 Logic function output indicator**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

The logic function output indicator bit indicates the output value or state of the programmable logic function. Use parameter #9.10 (logic function output destination selector) to direct this bit value to an internal bit parameter. If #9.01 is to appear as a digital output on one of the control terminals, then use the appropriate digital output source selector parameter to point to parameter #9.01 (e.g. [#8.10], [#8.13], or [#8.25] = 9.01).

**#9.02 Unused parameter**

## #9.03 Motorised potentiometer output

| | |
|---|---|
| Parameter type: | RO, B, S, P |
| Range: | 0.0 to ±100.0 |
| Units: | % |
| Default value: | - |

The motorised potentiometer output parameter value gives the output level of the motorised potentiometer prior to final scaling (via #9.24).

If parameter #9.21 (select motorised potentiometer zero start) is set to 1, #9.03 is set to 0.0 at power up, otherwise (if [#9.21] = 0) #9.03 retains the value prior to power down.

Whenever parameter #9.28 (motorised potentiometer reset) is set to 1, #9.03 is set to 0.0.

The resolution of #9.03 is 0.1%.

## #9.04 Logic function input 1 source selector

## #9.06 Logic function input 2 source selector

| | |
|---|---|
| Parameter type: | RW, U, P |
| Adjustment range: | (#) 0.00 to E.50 |
| Units: | (#) (i.e. #(menu number).(parameter number)) |
| Default value: | (#)0.00 (not defined as any particular parameter) |

These 2 source selector parameters define the source of the relevant bit values to be used as digital inputs to the programmable logic function. Only bit parameters (Bit) can be selected as the source for the programmable logic function. If both source parameters for the logic function are non valid parameters, the logic output value will always be 0. If only one of the source parameter is non valid, the input to the AND gate for that input is taken as logic 1 such that the valid input passes through the logic function.

#### #9.05 Invert logic function input 1

#### #9.07 Invert logic function input 2

#### #9.08 Invert logic function output

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

These invert parameters enable an inversion of the digital input (or output) bit values within the programmable logic function. A bit value of 0 does not invert the relevant digital input or output, whereas a value of 1 inverts the relevant input or output.

#### #9.09 Logic function output delay

Parameter type: RW, U

Adjustment range: 0.0 to 25.0

Units: s

Default value: 0.0

The logic function output delay parameter provides a delay on the 0 to 1 transitions only, such that there is a delay on the logic function output becoming active (1) but not on the output becoming inactive (0). The delay parameter is primarily there to ensure that the output logic state is a genuine condition (by being present for the logic function delay period) and not just a temporary one.

#### #9.10 Logic function output destination selector

#### #9.25 Motorised potentiometer output destination selector

Parameter type: RW, U, R, P

Adjustment range: (#) 0.00 to E.50

Units: (#) (i.e. #(menu number).(parameter number))

Default value: (#)0.00 (not defined as any particular parameter)

These destination selector parameters define the destination parameters of the logic function output and the motorised potentiometer output. Therefore these parameters can be used to control certain internal parameters. Only bit parameters (Bit) which are not protected (P) can be set-up as destinations for the logic function output. Similarly, only non-bit parameters (RW and RO) which are not protected (P) can be used as destinations for the motorised potentiometer function output. If a non valid parameter is used the outputs are not routed anywhere.

The output of the logic function (#9.01) can also be routed to a terminal, for example, by setting the appropriate digital output source selector (e.g. [#8.10], [#8.13], or [#8.25] = 9.01). The logic function output destination selector (#9.10) can be left at the default value in this case.

**#9.11 Unused parameters**

**#9.12**

**#9.13**

**#9.14**

**#9.15**

**#9.16**

**#9.17**

**#9.18**

**#9.19**

**#9.20**

**#9.21 Select motorised potentiometer zero start**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

If the select motorised potentiometer zero start parameter is set to 1, then the motorised potentiometer output will be set to zero (i.e. [#9.03] = 0) each time the drive is powered up. Otherwise (when [#9.21] = 0) the motorised potentiometer output value ([#9.03]) will be at the same level at power up as it was when power was removed.

**#9.22 Select motorised potentiometer bipolar operation**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

If the select motorised potentiometer bipolar operation bit is set to 1, then the motorised potentiometer output (#9.03) will vary anywhere between -100.0% to +100.0%. Otherwise (when [#9.22] = 0) the motorised potentiometer output value ([#9.03]) will only vary between 0.0% and +100.0%.

## #9.23 Motorised potentiometer rate

Parameter type: RW, U

Adjustment range: 0 to 250

Units: s/100% (time to ramp 100%)

Default value: 20

The motorised potentiometer rate parameter defines the time taken for the motorised potentiometer function to increase or decrease by 100.0 %. Therefore the default value will require the motorised potentiometer increase bit (i.e.[#9.26] = 1) for a period of 10 seconds to ramp from 0.0% to 50.0%.

Twice the value of #9.23 will be required to increase the motorised potentiometer output (#9.03) from -100.0% to +100.0% when [#9.26] = 1 and [#9.22] = 1.

## #9.24 Motorised potentiometer scale factor

Parameter type: RW, U

Adjustment range: 0.00 to 2.50

Units: -

Default value: 1.00

The motorised potentiometer scale factor parameter can be used to scale the motorised potentiometer output (#9.03) if required. However in most cases it is not necessary as the motorised potentiometer output is automatically scaled such that 100.0% corresponds to the maximum value of the destination parameter (defined by #9.25).

The resulting scaled value is calculated as follows:

[Destination parameter defined by #9.25] = [#9.03] x [#9.24] in %

( = [#[#9.25]])

where full scale of destination parameter relates to a value of 100%

This scale factor can be used to restrict the output of the motorised potentiometer to operate over a reduced range so that it can be used as a trim for example.

**#9.26 Motorised potentiometer increase**

**#9.27 Motorised potentiometer decrease**

Parameter type: RO, Bit

Range: 0 or 1

Units: -

Default value: -

Two digital input terminals must be programmed to control these parameters to implement the motorised potentiometer. Typically set [#8.10], [#8.13], [#8.16], [#8.19] or [#8.21] = 9.26 and similarly set one of the remaining digital input destinations equal to 9.27.

Momentarily setting #9.26 or #9.27 to 1 via a digital input will cause the motorised potentiometer value (#9.03) to increase or decrease respectively at the rate defined by #9.23. If [#9.26] = [#9.27] = 0 or 1, then the motorised potentiometer value (#9.03) will be held at its previous value.

**#9.28 Motorised potentiometer reset**

Parameter type: RW, Bit

Range: 0 or 1

Units: -

Default value: 0

Whenever parameter #9.28 (motorised potentiometer reset) is set to 1, #9.03 is set to 0.0, otherwise ([#9.28] = 0) has no effect on the motorised potentiometer output. .

9.11 Menu A logic block diagram - Status logic and diagnostics

9.11.1 Menu A Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #A.01 | Drive healthy indicator | RO, Bit, P | 0/1 | - | - |
| #A.02 | Drive running indicator | RO, Bit, P | 0/1 | - | - |
| #A.03 | Zero frequency indicator | RO, Bit, P | 0/1 | - | - |
| #A.04 | ‘At minimum’ speed indicator | RO, Bit, P | 0/1 | - | - |
| #A.05 | Below set speed indicator | RO, Bit, P | 0/1 | - | - |
| #A.06 | ‘At frequency’ indicator | RO, Bit, P | 0/1 | - | - |
| #A.07 | Above set speed indicator | RO, Bit, P | 0/1 | - | - |
| #A.08 | Load reached indicator | RO, Bit, P | 0/1 | - | - |
| #A.09 | Current limit indicator | RO, Bit, P | 0/1 | - | - |
| #A.10 | Regenerating indicator | RO, Bit, P | 0/1 | - | - |
| #A.11 | Dynamic brake active | RO, Bit, P | 0/1 | - | - |
| #A.12 | ***Unused parameter*** | - | - | - | - |
| #A.13 | Direction commanded indicator | RO, Bit, P | 0/1 | - | - |
| #A.14 | Direction running indicator | RO, Bit, P | 0/1 | - | - |
| #A.15 | ***Unused parameter*** | - | - | - | - |
| #A.16 | Motor thermistor over temperature trip | RO, Bit, P | 0/1 | - | - |
| #A.17 | Motor overload alarm | RO, Bit, P | 0/1 | - | - |
| #A.18 | Heatsink temperature alarm | RO, Bit, P | 0/1 | - | - |
| #A.19 | ***Unused parameter*** | - | - | - | - |
| #A.20 | Last trip | RO, U, T, S, P | [trip code] | - | - |
| #A.21 | Second to last trip | RO, U, T, S, P | [trip code] | - | - |
| #A.22 | Third to last trip | RO, U, T, S, P | [trip code] | - | - |
| #A.23 | Fourth to last trip | RO, U, T, S, P | [trip code] | - | - |
| #A.24 | Fifth to last trip | RO, U, T, S, P | [trip code] | - | - |
| #A.25 | Sixth to last trip | RO, U, T, S, P | [trip code] | - | - |

| | | | | | |
|---|---|---|---|---|---|
| #A.26 | Seventh to last trip | RO, U, T, S, P | [trip code] | - | - |
| #A.27 | Eighth to last trip | RO, U, T, S, P | [trip code] | - | - |
| #A.28 | Ninth to last trip | RO, U, T, S, P | [trip code] | - | - |
| #A.29 | Tenth to last trip | RO, U, T, S, P | [trip code] | - | - |
| #A.30 | ***Unused parameter*** | - | - | - | - |
| #A.31 | ***Unused parameter*** | - | - | - | - |
| #A.32 | External trip | RW, Bit | 0/1 | 0 | - |
| #A.33 | Drive reset | RW, Bit | 0/1 | 0 | - |
| #A.34 | Number of auto reset attempts | RW, U | 0 to 5 | 0 | - |
| #A.35 | Auto reset delay | RW, U | 0.0 to 25.0 | 1.0 | s |
| #A.36 | Hold drive healthy until last attempt | RW, Bit | 0/1 | 0 | - |
| #A.37 | Stop drive on non-important trips | RW, Bit | 0/1 | 0 | - |
| #A.38 | User trip | RW, U, P | 0 to 100 | 0 | - |
| #A.39 | ***Unused parameter*** | - | - | - | - |
| #A.40 | Status word | RO, U, P | 0 to 511 | 0 | - |

9.11.2 Menu A Parameter Descriptions

**#A.01 Drive healthy indicator**

| | |
|---|---|
| Parameter type: | RO, Bit, P |
| Range: | 0 or 1 |
| Units: | - |
| Default value: | - |

The drive has not tripped (i.e. is healthy) when [#A.01] = 1. If parameter #A.36 (hold drive healthy until last attempt) is set to 1, [#A.01] will be 1 in a tripped state if an auto reset is going to occur. An auto reset will occur if [#A.35] (number of auto reset attempts) is not 0, and the drive still has auto reset attempts remaining. Once the programmed number of auto resets have occurred, the next trip will cause [#A.01] = 0.

**#A.02 Drive running indicator**

| | |
|---|---|
| Parameter type: | RO, Bit, P |
| Range: | 0 or 1 |
| Units: | - |
| Default value: | - |

The IGBT inverter bridge is active and could be turning the motor when [#A.02] = 1. If [#A.02] = 0 then the inverter bridge is inactive and is not turning a motor.

**#A.03 Zero frequency indicator**

| | |
|---|---|
| Parameter type: | RO, Bit, P |
| Range: | 0 or 1 |
| Units: | - |
| Default value: | - |

The zero frequency indicator bit is set to 1 whenever the absolute value of the post-ramp frequency reference (|[#2.01]|) is less than or equal to the threshold programmed into parameter #3.05 (zero frequency threshold). If |[#2.01]| > [#3.05], then [#A.03] = 0.

## #A.04 'At minimum' speed indicator

| | |
|---|---|
| Parameter type: | RO, Bit, P |
| Range: | 0 or 1 |
| Units: | - |
| Default value: | - |

In bipolar reference mode ([#1.10] = 1), this 'at minimum' speed indicator will have the same value as the zero frequency indicator (#A.03).

In unipolar reference mode ([#1.10] = 0):

| | | |
|---|---|---|
| [#A.04] = 1 | if | \|[#2.01]\| ≤ {[#1.07] + 0.5 Hz} and [#A.02] = 1 |
| [#A.04] = 0 | if | \|[#2.01]\| > {[#1.07] + 0.5 Hz} or [#A.02] = 0 |

where: #2.01 is the post-ramp frequency reference

#1.07 is the minimum frequency

#A.02 is drive running indicator

## #A.05 Below set speed indicator

| | |
|---|---|
| Parameter type: | RO, Bit, P |
| Range: | 0 or 1 |
| Units: | - |
| Default value: | - |

The below set speed indicator is defined as follows:

| | | |
|---|---|---|
| [#A.05] = 1 | if | \|[#2.01]\| < {\|[#1.02]\| - [#3.06]/2} and [#A.02] = 1 |
| [#A.05] = 0 | if | \|[#2.01]\| ≥ {\|[#1.02]\| - [#3.06]/2} or [#A.02] = 0 |

where: #2.01 is the post-ramp frequency reference

#1.02 is the pre-skip frequency reference

#3.06 is the 'at frequency' window

#A.02 is the drive running indicator

## #A.06 ‘At frequency’ indicator

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

The ‘at frequency’ indicator parameter is defined as follows:

[#A.06] = 1 if {|[#1.02]| - [#3.06]/2} ≤ |[#2.01]| ≤ {|[#1.02]| + [#3.06]/2}

and

[#A.02] = 1

[#A.06] = 0 if |[#2.01]| < {|[#1.02]| - [#3.06]/2}, or

|[#2.01]| > {|[#1.02]| + [#3.06]/2}, or

[#A.02] = 0

where: #2.01 is the post-ramp frequency reference

#1.02 is the pre-skip frequency reference

#3.06 is the ‘at frequency’ window

#A.02 is the drive running indicator

## #A.07 Above set speed indicator

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

The above set speed indicator is defined as follows:

[#A.07] = 1 if $|[\#2.01]| > \{|[\#1.02]| + [\#3.06]/2\}$ and [#A.02] = 1

[#A.07] = 0 if $|[\#2.01]| \leq \{|[\#1.02]| + [\#3.06]/2\}$ or [#A.02] = 0

where: #2.01 is the post-ramp frequency reference

#1.02 is the pre-skip frequency reference

#3.06 is the ‘at frequency’ window

#A.02 is the drive running indicator

**#A.08 Load reached indicator**

| | |
|---|---|
| Parameter type: | RO, Bit, P |
| Range: | 0 or 1 |
| Units: | - |
| Default value: | - |

The load reached indicator is defined as follows:

[#A.08] = 1 if $[\#4.02] \geq [\#5.07] \times [\#5.10]$

[#A.08] = 0 if $[\#4.02] < [\#5.07] \times [\#5.10]$

where: #4.02 is the motor active current

#5.07 is the motor rated current

#5.10 is the motor rated power factor

**#A.09 Current limit indicator**

| | |
|---|---|
| Parameter type: | RO, Bit, P |
| Range: | 0 or 1 |
| Units: | - |
| Default value: | - |

The current limit indicator parameter is defined as follows:

[#A.09] = 1 if [#4.02] ≥ [#4.07] x [#5.07] x [#5.10]/100%

[#A.09] = 0 if [#4.02] < [#4.07] x [#5.07] x [#5.10]/100%

where: #4.02 is the motor active current

#4.07 is the current limit value in %

#5.07 is the motor rated current

#5.10 is the motor rated power factor

**#A.10 Regenerating indicator**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

The drive is regenerating when power is being transferred from the motor to the drive.

The regenerating indicator is defined as follows:

[#A.10] = 1 if [#4.02] > 0 and [#2.01] < 0, or

[#4.02] < 0 and [#2.01] > 0, or

braking transistor is on

[#A.10] = 0 if none of the above are true

where: #2.01 is the post-ramp frequency reference

#4.02 is the motor active current

### #A.11 Dynamic brake active

| | |
|---|---|
| Parameter type: | RO, Bit, P |
| Range: | 0 or 1 |
| Units: | - |
| Default value: | - |

The dynamic brake active parameter is defined as follows:

| | | |
|---|---|---|
| [#A.11] = 1 | if | braking transistor is on |
| [#A.11] = 0 | if | braking transistor is off |

Power will be dumped in the optional braking resistor whenever this bit parameter is set to 1.

### #A.12 Unused parameter

### #A.13 Direction commanded indicator

| | |
|---|---|
| Parameter type: | RO, Bit, P |
| Range: | 0 or 1 |
| Units: | - |
| Default value: | - |

The direction commanded indicator is defined as follows:

| | | |
|---|---|---|
| [#A.13] = 1 | if | [#1.02] < 0 (i.e. reverse) and [#1.11] = 1 |
| [#A.13] = 0 | if | [#1.02] ≥ 0 (i.e. forward) and [#1.11] = 1 |

where: #1.02 is the pre-skip frequency reference

#1.11 is the Final frequency reference 'on'

If [#1.11] = 0, then the value of #A.13 must be determined from the logic block diagram as shown in Fig. 9.1 in Section 9.2.

**#A.14 Direction running indicator**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

The direction running indicator is defined as follows:

[#A.14] = 1 if [#2.01] < 0 (i.e. reverse)

[#A.14] = 0 if [#2.01] ≥ 0 (i.e. forward)

where: #2.01 is the post-ramp frequency reference

**#A.15 Unused parameter**

**#A.16 Motor thermistor over temperature trip**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

The motor thermistor over temperature trip parameter is defined as follows:

[#A.16] = 1 if Either analogue input set up for motor thermistor and input resistance ≥ 3.3kΩ

[#A.16] = 0 if Either analogue input set up for motor thermistor and input resistance ≤ 1.8kΩ, or

neither analogue inputs set up for motor thermistor.

**#A.17 Motor overload alarm**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

The motor overload alarm parameter is defined as follows:

[#A.17] = 1 if [#4.20] > 105% and [#4.19] > 75%

[#A.17] = 0 if [#4.20] ≤ 105% or [#4.19] ≤ 75%

where: #4.20 is the percentage load

#4.19 is the overload accumulator

This alarm bit is set to warn that if the motor current is not reduced the drive will trip on an Ixt overload.

**#A.18 Heatsink temperature alarm**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

The heatsink temperature alarm parameter is defined as follows:

[#A.18] = 1 if [#7.04] > $95^{o}$C

[#A.18] = 0 if [#7.04] ≤ $95^{o}$C

where: #7.04 is the heatsink temperature

**#A.19 Unused parameter**

**#A.20 Last trip**

**#A.21 Second to last trip**

**#A.22 Third to last trip**

**#A.23 Fourth to last trip**

**#A.24 Fifth to last trip**

**#A.25 Sixth to last trip**

**#A.26 Seventh to last trip**

**#A.27 Eighth to last trip**

**#A.28 Ninth to last trip**

**#A.29 Tenth to last trip**

| | |
|---|---|
| Parameter type: | RO, U, T, S, P |
| Range: | [trip code] (0 to 99) |
| Units: | - |
| Default value: | - (trip codes are not affected by setting defaults) |

The ten parameters #A.20 to #A.29 contain the last 10 trips of the drive in sequential order. Further details about the causes of some of these trips are given in Section 10.3.

The possible trip codes are listed in the table below:

| **#A.20 to #A.29 Display** | **Value read via Serial comms** | **Description of Trip Code** |
|---|---|---|
| - | 0 | No trip recorded |
| UU | 1 | DC link undervoltage |
| OU | 2 | DC link overvoltage |
| OI | 3 | Instantaneous overcurrent (at inverter or brake) |
| PS | 4 | Power supply |
| Et | 5 | External trip |
| O.SP | 6 | Overspeed |
| It | 7 | Motor Ixt overload |
| cL | 8 | Current loop loss when in 4 to 20 or 20 to 4 mA input modes |
| Oh2 | 9 | Heatsink overtemperature |
| EEF | 10 | EEPROM fault |
| th | 11 | Motor thermistor overtemperature |
| Er1 | 12 | Load current offset too great at power up (should be 0) |
| Er2 | 13 | Microprocessor oscillator faulty |
| Er3 | 14 | Microprocessor software not functioning correctly |
| Er4 | 15 | Keypad button depressed at power up |
| t16 to t99 | 16 to 99 | User trips where the number is the trip number |

Please note that the 4 trips ‘Er1’, ‘Er2’, ‘Er3’ and ‘Er4’ can only be reset by powering off the drive.

**#A.30 Unused parameters**

**#A.31**

**#A.32 External trip**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

If the external trip bit is set to 1 then the drive will trip (Et (5)). When the bit is set to 0 no action occurs.

Users requiring an external trip function via a digital input terminal should set the destination of the relevant input (i.e. with default settings #8.10 - terminal B5) to A.32 together with an inversion (i.e. [#8.11] = 1) such that the B5 input terminal must be active ([#8.01] = 1) to prevent a trip ([#A.32] = 0).

**#A.33 Drive reset**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

If the drive reset bit has a 0 to 1 transition then the drive will start a reset action. When the bit is set to 0 or 1 no action occurs (it is only the 0 to 1 transition that causes a reset).

If a drive reset terminal is required on the drive the digital input terminal destination should be set (e.g. #8.13 - terminal C3) to A.33 with no inversion (i.e. [#8.14] = 0) such that the C3 input terminal on a inactive/active transition (e.g. [#8.02] = 0 to 1) to reset a trip.

The drive reset always provides a minimum 1 second delay between the reset command and the drive resetting.

Please note that the 4 trips ‘Er1’, ‘Er2’, ‘Er3’ and ‘Er4’ can only be reset by powering off the drive.

### #A.34 Number of auto reset attempts

| | |
|---|---|
| Parameter type: | RW, U |
| Adjustment range: | 0 to 5 |
| Units: | - |
| Default value: | 0 |

With the default value for the number of auto reset attempts, then no auto resets will ever occur. Any other value for this parameter will cause the drive to automatically reset following a trip for the number of reset attempts set. Parameter #A.35 (auto reset delay) defines the time between the trip and the auto reset action. The internal auto reset counter (not #A.34) is only incremented (starting at 0) when the new trip type is the same as the previous trip type, otherwise it is reset to 0. When the internal auto reset counter reaches the value in #A.34, any further trips of the same type will not incur an auto-reset. The drive will therefore not reset at this point.

If there have been no trips for 10 minutes then the internal auto reset counter is set back to 0.

The auto reset action will not occur on an external trip (Et (5)).

### #A.35 Auto reset delay

| | |
|---|---|
| Parameter type: | RW, U |
| Adjustment range: | 0.0 to 25.0 |
| Units: | s |
| Default value: | 1.0 |

The auto reset delay parameter defines the time between a trip and the auto reset occurring, (as set in #A.34), except for overcurrent trips (OI) where the minimum delay is 1 second to allow the inverter power stage to thermally recover from the excessive currents it may have endured.

**#A.36 Hold drive healthy until last attempt**

| | |
|---|---|
| Parameter type: | RW, Bit |
| Adjustment range: | 0 or 1 |
| Units: | - |
| Default value: | 0 |

If this parameter has a value of 0 then parameter #A.01 (drive healthy indicator) is set to 0 (from 1 corresponding to drive healthy) every time the drive trips regardless of any auto-reset that may occur.

When [#A.36] = 1 parameter #A.01 (drive healthy indicator) is not set to 0 on a trip if an auto-reset is going to occur, but will be set to 0 when the final trip in an auto-reset/trip sequence occurs.

**#A.37 Stop drive on non-important trips**

| | |
|---|---|
| Parameter type: | RW, Bit |
| Adjustment range: | 0 or 1 |
| Units: | - |
| Default value: | 0 |

If this parameter is set to 1, the drive will stop before tripping on non-important trips. Otherwise when at the default value of 0, a trip will immediately disable the drive output.

Non-important trips are the following: It (7), cL (8), Oh2 (9) and EEF (10).

## #A.38 User trip

Parameter type: RW, U, P

Adjustment range: 0 to 100

Units: -

Default value: 0 (no trip action)

This user trip parameter allows the user to generate trips (e.g. trip codes t16 to t99). This should normally be done via serial comms, as it is impractical to set it via the keypad as the trip will occur as soon as the value is adjusted from 0. The most appropriate values to set are numbers between 16 and 99 inclusive. Setting a user trip value between 1 to 16 causes that relevant trip to occur. User generated trips will be indicated by txx in the trip log (i.e. #A.20 to #A.29) where xx is value set in #A.38.

Users can also reset the drive via serial comms by setting [#A.38] = 100.

## #A.39 Unused parameter

## #A.40 Status word

Parameter type: RO, U, P

Range: 0 to 511

Units: -

Default value: 0

The status word parameter is mainly for use with serial comms. The value of this parameter is defined as follows:

[#A.40] = [#A.01] x 1 + [#A.02] x 2 + [#A.03] x 4 + [#A.04] x 8 +
[#A.05] x 16 + [#A.06] x 32 + [#A.07] x 64 + [#A.08] x 128 +
[#A.09] x 256

where:
#A.01 is the drive healthy indicator
#A.02 is the drive running indicator
#A.03 is the zero frequency indicator
#A.04 is the ‘at minimum’ speed indicator
#A.05 is the below set speed indicator
#A.06 is the ‘at frequency’ indicator
#A.07 is the above set speed indicator
#A.08 is the load reached indicator
#A.09 is the current limit indicator

## 9.12 Menu b - Miscellaneous and Menu 0 parameter selectors

### 9.12.1 Menu b Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #b.01 | Define parameter #0.11 | RW, U, P | (#) 0.00 to E.50 | (#)1.03 | (#) |
| #b.02 | Define parameter #0.12 | RW, U, P | (#) 0.00 to E.50 | (#)2.01 | (#) |
| #b.03 | Define parameter #0.13 | RW, U, P | (#) 0.00 to E.50 | (#)4.02 | (#) |
| #b.04 | Define parameter #0.14 | RW, U, P | (#) 0.00 to E.50 | (#)1.05 | (#) |
| #b.05 | Define parameter #0.15 | RW, U, P | (#) 0.00 to E.50 | (#)2.04 | (#) |
| #b.06 | Define parameter #0.16 | RW, U, P | (#) 0.00 to E.50 | (#)6.01 | (#) |
| #b.07 | Define parameter #0.17 | RW, U, P | (#) 0.00 to E.50 | (#)4.11 | (#) |
| #b.08 | Define parameter #0.18 | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #b.09 | Define parameter #0.19 | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #b.10 | Define parameter #0.20 | RW, U, P | (#) 0.00 to E.50 | (#)1.29 | (#) |
| #b.11 | Define parameter #0.21 | RW, U, P | (#) 0.00 to E.50 | (#)1.30 | (#) |
| #b.12 | Define parameter #0.22 | RW, U, P | (#) 0.00 to E.50 | (#)1.31 | (#) |
| #b.13 | Define parameter #0.23 | RW, U, P | (#) 0.00 to E.50 | (#)1.32 | (#) |
| #b.14 | Define parameter #0.24 | RW, U, P | (#) 0.00 to E.50 | (#)7.06 | (#) |
| #b.15 | Define parameter #0.25 | RW, U, P | (#) 0.00 to E.50 | (#)7.11 | (#) |
| #b.16 | Define parameter #0.26 | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #b.17 | Define parameter #0.27 | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #b.18 | Define parameter #0.28 | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #b.19 | Define parameter #0.29 | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #b.20 | Define parameter #0.30 | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #b.21 | Parameter #0.30 scale factor | RW, U | 0.00 to 2.50 | 1.00 | - |
| #b.22 | Initial parameter displayed selector | RW, U | 0 to 50 | 10 | (#0.) |
| #b.23 | Serial interface address | RW, U, P | 0.0 to 9.9 | 1.1 | grp.unit |
| #b.24 | ***Unused parameter*** | - | - | - | - |
| #b.25 | ***Unused parameter*** | - | - | - | - |
| #b.26 | Serial transmit delay time | RW, U | 0 to 250 | 20 | ms |
| #b.27 | ***Unused parameter*** | - | - | - | - |
| #b.28 | ***Unused parameter*** | - | - | - | - |
| #b.29 | Software version | RO, U, P | 1.00 to 9.99 | 1.03 | - |
| #b.30 | User security code | RW, U, S, P | 0 to 255 | 149 | - |
| #b.31 | ***Unused parameter*** | - | - | - | - |
| #b.32 | Drive current rating | RO, U, P | 1.50 to 4.30 | - | A |

### 9.12.2 Menu b Parameter Descriptions

**#b.01 Define parameter #0.11**

**#b.02 Define parameter #0.12**

**#b.03 Define parameter #0.13**

**#b.04 Define parameter #0.14**

**#b.05 Define parameter #0.15**

**#b.06 Define parameter #0.16**

**#b.07 Define parameter #0.17**

**#b.08 Define parameter #0.18**

**#b.09 Define parameter #0.19**

**#b.10 Define parameter #0.20**

**#b.11 Define parameter #0.21**

**#b.12 Define parameter #0.22**

**#b.13 Define parameter #0.23**

**#b.14 Define parameter #0.24**

**#b.15 Define parameter #0.25**

**#b.16 Define parameter #0.26**

**#b.17 Define parameter #0.27**

**#b.18 Define parameter #0.28**

**#b.19 Define parameter #0.29**

**#b.20 Define parameter #0.30**

Parameter type: RW, U, P

Adjustment range: (#) 0.00 to E.50

Units: (#) (i.e. #(menu number).(parameter number))

Default value: (#) 1.03 for #b.01

(#) 2.01 for #b.02

(#) 4.02 for #b.03

(#) 1.05 for #b.04

(#) 2.04 for #b.05

(#) 6.01 for #b.06

(#) 4.11 for #b.07

(#) 0.00 for #b.08 and #b.09

(#) 1.29 for #b.10

(#) 1.30 for #b.11

(#) 1.31 for #b.12

(#) 1.32 for #b.13

(#) 7.06 for #b.14

(#) 7.11 for #b.15

(#) 0.00 for #b.16, #b.17, #b.18, #b.19 and #b.20

These Menu 0 set-up parameters define the parameters that reside in the customer/user assigned part of Menu 0, i.e. parameters #0.11, #0.12 through to #0.30.

If any of the parameters (#b.01 through to #b.20) are set at 0.00, the corresponding Menu 0 parameter is not assigned to any drive parameter. Therefore when using the display and keypad to view Menu 0, any Menu 0 parameters not assigned will be skipped over automatically.

The default settings above give the following Menu 0 parameter assignments:

| **Menu 0 parameter:** | **Assigned parameter:** | **Parameter description:** |
|---|---|---|
| #0.11 | #1.03 | Pre-ramp frequency reference |
| #0.12 | #2.01 | Post-ramp frequency reference |
| #0.13 | #4.02 | Load current (real/active component) |
| #0.14 | #1.05 | Jog frequency reference |
| #0.15 | #2.04 | Deceleration mode selector |
| #0.16 | #6.01 | Stop mode selector |
| #0.17 | #4.11 | Select torque control |
| #0.18 and #0.19 | - | No parameter assigned |
| #0.20 | #1.29 | Skip frequency 1 |
| #0.21 | #1.30 | Skip frequency band 1 |
| #0.22 | #1.31 | Skip frequency 2 |
| #0.23 | #1.32 | Skip frequency band 2 |
| #0.24 | #7.06 | Analogue input 1 (A2) mode selector |
| #0.25 | #7.11 | Analogue input 2 (C4/C5) mode selector |
| #0.26, #0.27, #0.28, #0.29 and #0.30 | - | No parameter assigned |

### #b.21 Parameter #0.30 scale factor

Parameter type: RW, U

Adjustment range: 0.00 to 2.50

Units: -

Default value: 1.00

If the parameter assigned to Menu 0 parameter #0.30 is RO (read only) then a scale factor ([#b.21]) can be applied to it, such that parameter #0.30 can indicate a scaled value of the assigned parameter in some meaningful units such as cans/hour. In particular:

[#0.30] = [#b.21] x {value of parameter defined by #b.20}

= [#b.21] x [#[#b.20]]

provided the parameter type defined by #b.20 (define parameter #0.30) is RO

### #b.22 Initial parameter displayed selector

Parameter type: RW, U

Adjustment range: 0 to 50

Units: (#0.) (Value is parameter number in Menu 0)

Default value: 10 (i.e. #0.10)

This parameter defines the parameter in menu 0 which is to be displayed at power up. In particular the parameter value when first entering Status mode and the parameter number when first entering Parameter mode.

For the default setting of #b.22, the parameter displayed at power up is #0.10, which corresponds to #5.01 the motor frequency.

### #b.23 Serial interface address

Parameter type: RW, U, P

Adjustment range: 0.0 to 9.9

Units: grp.unit (i.e. [group number].[unit number])

Default value: 1.1

Used when terminals C4/C5 are configured in default (i.e. [#7.11] = ANS (0) Analogue input 2 mode selector) to enable the serial interface. Parameter #b.23 defines the serial address of the drive. The address has the following format: [drive group. drive unit]. There are 9 addressable groups for each of 9 possible drive units. If address [0.0] is used, all drives are addressed simultaneously. If [x.0] is used, where x is any number from 1 to 9, all drives in group x are addressed.

Note that for this drive, the only baud rate available is 4800.

### #b.24 Unused parameters

### #b.25

### #b.26 Serial transmit delay time

Parameter type: RW, U

Adjustment range: 0 to 250

Units: ms

Default value: 20 (milliseconds)

The serial transmit delay time defines the minimum time before the drive will enable its RS485 transmit buffer and transmit data in response to a message from the host. (Prior to this time the Dinverter RS485 transmit buffer is disabled to enable the host to transmit a message to the drive receive buffer.) This delay provides the host software with sufficient time to disable its own transmit buffer after transmitting data to the drive. If the host does not disable the transmit buffer within the delay provided, the message transmitted from the drive to the host will be lost because of the contention with both the host and drive transmit buffers enabled.

This delay is essential for successful operation of the 2-wire half duplex protocol where the transmit and receive data is sent via the same differential pair of wires.

**#b.27 Unused parameters**

**#b.28**

**#b.29 Software version**

Parameter type: RO, U, P

Range: 1.00 to 9.99

Units: -

Default value: 1.03

This software version parameter displays the version of the installed software. For the default value given above, the software version is V1.03.xx, where xx is any number from 00 to 99 and only corresponds to software ‘bug’ fixes which do not affect the drive specification or this manual. Whereas the next version of software released V1.04.xx will have specification changes that will affect the operation of the drive and this User Guide.

**#b.30 User security code**

Parameter type: RW, U, S, P

Adjustment range: 0 to 250

Units: -

Default value: 149

If any value other than 149 is set in the user security code, a user defined security will be active. The parameter value can only be seen on the display while it is being edited in Edit mode, otherwise the value displayed is 149 so that the actual user security code cannot be found using the display and keypad. Activating the user security code (i.e.[#b.30] $\neq$ 149) protects all parameters from being adjusted until the correct value (the value set in #b.30) has been entered in parameter #x.00.

Do not use a security code of 0, as 0 is the default value for parameter #x.00, the parameter used for unlocking security.

**#b.31 Unused parameter**

#### #b.32 Drive current rating

Parameter type: RO, U, P

Range: 1.50, 2.30, 3.00 or 4.30

Units: A

Default value: 1.50 for DIN1220025A

2.30 for DIN1220037A

3.00 for DIN1220055A

4.30 for DIN1220075A

This drive current rating parameter gives the value of the continuous current rating in amps of the drive. It is also helpful in indicating the drive size when the rating label is not easily visible.

## 9.13 Menu c logic block diagram - Programmable threshold

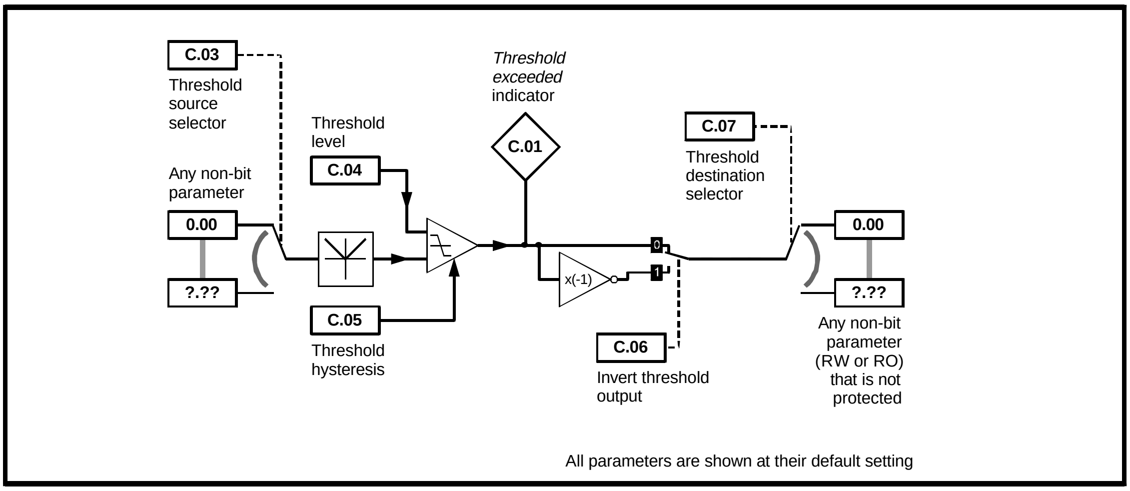



Fig. 9.20 Menu c logic block diagram - Programmable threshold

### 9.13.1 Menu c Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #c.01 | Threshold exceeded indicator | RO, Bit, P | 0/1 | - | - |
| #c.02 | ***Unused parameter*** | - | - | - | - |
| #c.03 | Threshold source selector | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #c.04 | Threshold level | RW, U | 0.0 to 100.0 | 0.0 | % |
| #c.05 | Threshold hysteresis | RW, U | 0.0 to 25.0 | 0.0 | % |
| #c.06 | Invert threshold output | RW, Bit | 0/1 | 0 | - |
| #c.07 | Threshold destination selector | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |

**Summary of the programmable threshold**

This menu contains parameters which define a programmable threshold comparator. The output of the comparator can be used to change the drives action or output a signal at a predetermined level of the input signal. For example, the threshold comparator can be used to change a ramp rate at a certain frequency.

Viewing the block diagram of Menu c in Section 9.13 will help in understanding the functions of the following parameters.

**#c.01 Threshold exceeded indicator**

Parameter type: RO, Bit, P

Range: 0 or 1

Units: -

Default value: -

The threshold exceeded indicator bit indicates whether the threshold input variable is above or below the programmed threshold as follows:.

[#c.01] = 1 if |[#[#c.03]]| ≥ {[#c.04] + [#c.05]/2}

[#c.01] = 0 if |[#[#c.03]]| ≤ {[#c.04] - [#c.05]/2}

[#c.01] = 0 or 1 if {[#c.04] - [#c.05]/2} < |[#[#c.03]]| < {[#c.04] + #c.05]/2} depending on the **previous** threshold exceeded, as per the figure below:

where: #c.03 is the threshold source selector, and |[#[#c.03]]| is a % value of the maximum of the threshold source parameter

#c.04 is the threshold level

#c.05 is the threshold hysteresis

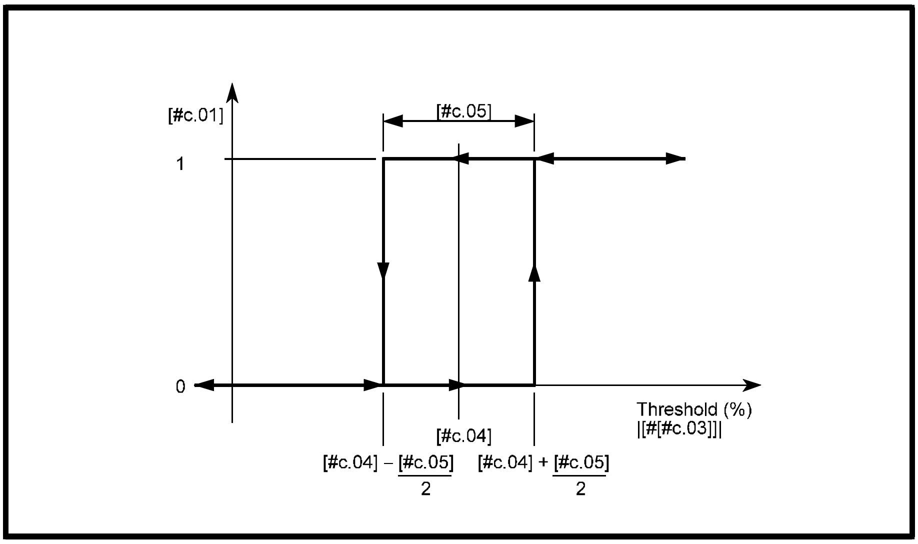



Fig. 9.21 Programmable threshold hysteresis operation

**#c.02 Unused parameter**

**#c.03 Threshold source selector**

Parameter type: RW, U, P

Adjustment range: (#) 0.00 to E.50

Units: (#) (i.e. #(menu number).(parameter number))

Default value: (#) 0.00 (no source parameter defined)

The threshold source selector parameter defines the source of the relevant value to be used as the analogue input signal to the programmable threshold . Only non-bit parameters (parameter types RW and RO) can be programmed as a source. If a non valid parameter is programmed as the source, the input value is 0.0. If a bipolar parameter is programmed as a source, the absolute value is used as the comparator input.

**#c.04 Threshold level**

Parameter type: RW, U

Adjustment range: 0.0 to 100.0

Units: % (of threshold source parameter maximum)

Default value: 0.0

The threshold level value must be set as a percentage of the threshold source parameter maximum value.

### #c.05 Threshold hysteresis

| | |
|---|---|
| Parameter type: | RW, U |
| Adjustment range: | 0.0 to 25.0 |
| Units: | % (of threshold source parameter maximum) |
| Default value: | 0.0 |

The threshold hysteresis defines the band within which no change will occur on the threshold comparator output (#c.01). The upper threshold limit for switching is {[#c.04] + [#c.05]/2} and the lower threshold level is {[#c.04] - [#c.05]/2}.

### #c.06 Invert threshold output

| | |
|---|---|
| Parameter type: | RW, Bit |
| Adjustment range: | 0 or 1 |
| Units: | - |
| Default value: | 0 |

The invert threshold output parameter enables an inversion of the threshold output bit value (i.e. [#c.01]). A bit value of 0 does not invert the threshold output, whereas a value of 1 inverts the output.

### #c.07 Threshold destination selector

| | |
|---|---|
| Parameter type: | RW, U, P |
| Adjustment range: | (#) 0.00 to E.50 |
| Units: | (#) (i.e. #(menu number).(parameter number)) |
| Default value: | (#) 0.00 (no destination parameter defined) |

The threshold destination selector parameter defines the destination of the threshold output bit value. Therefore this parameter enables the threshold comparator to be used to control certain internal bit parameters. Only bit parameters (Bit) which are not protected (P) can be used as destination parameters. If a non valid parameter is selected as the destination the output is not routed anywhere.

## 9.14 Menu E logic block diagram - PID controller

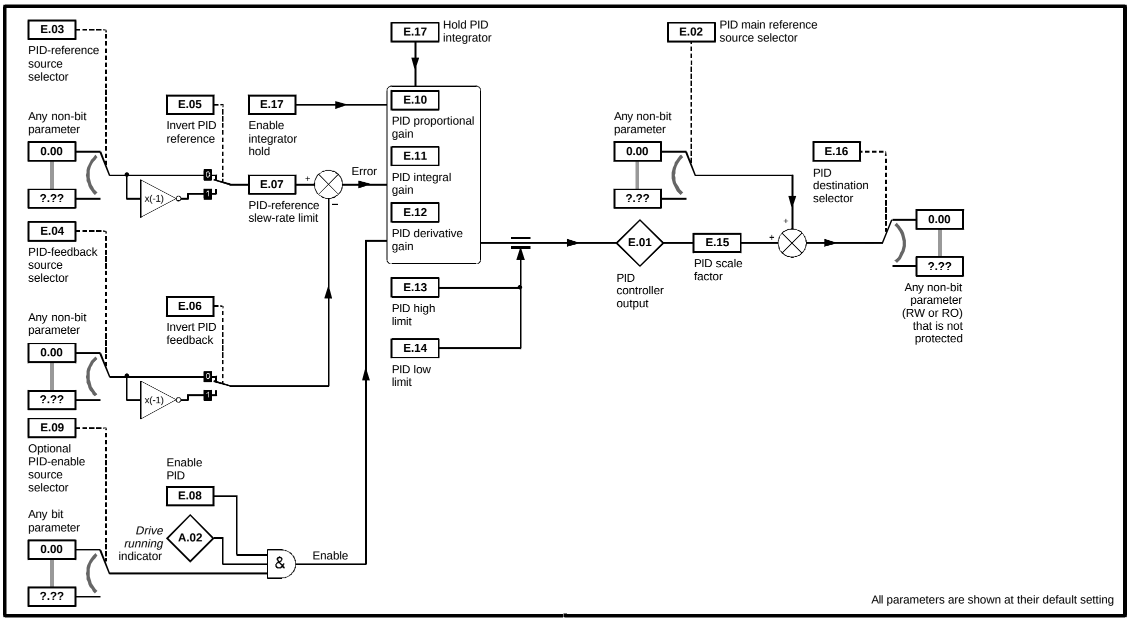



Fig. 9.22 Menu E logic block diagram - PID controller

### 9.14.1 Menu E Parameter List

| Parameter | Description | Type | Range | Default | Units |
|---|---|---|---|---|---|
| #E.01 | PID controller output | RO, B, P | 0.0 to ±100.0 | - | % |
| #E.02 | PID main reference source selector | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #E.03 | PID reference source selector | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #E.04 | PID feedback source selector | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #E.05 | Invert PID reference | RW, Bit | 0/1 | 0 | - |
| #E.06 | Invert PID feedback | RW, Bit | 0/1 | 0 | - |
| #E.07 | PID reference slew rate limit | RW, U | 0.0 to 999.0 | 0.0 | s |
| #E.08 | Enable PID | RW, Bit | 0/1 | 0 | - |
| #E.09 | Optional PID enable source selector | RW, U, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #E.10 | PID proportional gain | RW, U | 0.00 to 2.50 | 1.00 | - |
| #E.11 | PID integral gain | RW, U | 0.00 to 2.50 | 0.50 | - |
| #E.12 | PID derivative gain | RW, U | 0.00 to 2.50 | 0.00 | - |
| #E.13 | PID high limit | RW, U | 0.0 to 100.0 | 100.0 | % |
| #E.14 | PID low limit | RW, B | 0.0 to ±100.0 | -100.0 | % |
| #E.15 | PID scale factor | RW, U | 0.00 to 2.50 | 1.00 | - |
| #E.16 | PID output destination selector | RW, U, R, P | (#) 0.00 to E.50 | (#)0.00 | (#) |
| #E.17 | Hold PID integrator | RW, Bit | 0/1 | 0 | - |

**Summary of the PID controller**

This menu contains parameters for a PID (proportional/integral/derivative) feedback controller. The resulting output of the controller can be used to control the drive action or output a control signal via an analogue output. For example, the PID controller can be used to control the drive speed/frequency by comparing an input analogue reference (for required pressure) to a feedback pressure transducer using another analogue input.

Viewing the block diagram of Menu E in Section 9.14 will help in understanding the functions of the following parameters.

**#E.01 PID controller output**

Parameter type: RO, B, P

Range: 0.0 to ±100.0

Units: %

Default value: -

Th PID controller output parameter is the output of the PID controller before scaling is applied. Subject to the PID output limits the PID output is given by:

[#E.01] = P.e + I.e/s + D.e.s

where:
- P is the proportional gain value [#E.10]
- I is the integral gain value [#E.11]
- D is the derivative gain value [#E.12]
- e is the input error to the PID which equals {[#[#E.03]] x {(-2) x [#E.05] +1} - [#[#E.04]] x {(-2) x [#E.06] +1}}
- s is the Laplace operator

This parameter is updated every 32ms.

**#E.02 PID main reference source selector**

**#E.03 PID reference source selector**

**#E.04 PID reference source selector**

| | |
|---|---|
| Parameter type: | RW, U, P |
| Adjustment range: | (#) 0.00 to E.50 |
| Units: | (#) (i.e. #(menu number).(parameter number)) |
| Default value: | (#) 0.00 (no source parameter defined) |

These 3 source parameters define the variables which are to be used as input variables to the PID controller. Only non-bit parameters (parameter types RW and RO) can be selected as a source. If a non valid parameter is selected as the source, the input value is 0.0. All variable inputs to the PID are automatically scaled to variables having the range -100.0% to +100% for bipolar parameter types (type B), or 0 to +100.0% if they are unipolar types (type U). In both cases the 100% value corresponds to the maximum value of the relevant source parameter.

**#E.05 Invert PID reference**

**#E.06 Invert PID feedback**

| | |
|---|---|
| Parameter type: | RW, Bit |
| Adjustment range: | 0 or 1 |
| Units: | - |
| Default value: | 0 |

These 2 invert parameters can be used to invert the PID reference (i.e. [#[#E.03]]) and feedback (i.e. [#[#E.04]]) variables respectively when set to a value of 1. When set to a value of 0 the PID reference and feedback variables pass directly to the PID controller without inversion.

**#E.07 PID reference slew rate limit**

| | |
|---|---|
| Parameter type: | RW, U |
| Adjustment range: | 0.0 to 999.0 |
| Units: | s |
| Default value: | 0.0 |

The PID reference slew rate limit defines the minimum time taken for the PID reference (i.e.[#[#E.03]]) to ramp from 0.0 to 100.0% following a 0 to 100% step change in input. For bipolar type inputs, changes from -100.0% to +100.0% will take twice this time.

**#E.08 Enable PID**

Parameter type: RW, Bit

Adjustment range: 0 or 1

Units: -

Default value: 0

The enable PID bit must be a value of 1 for the PID controller to operate, provided the drive is healthy (i.e. [#A.01] = 1) and the optional PID enable is set to a 1 (i.e. [#[#E.09]] = 1) . If the enable PID bit is set to 0, or [#A.01] = 0, or [#[#E.09]] = 0 then the PID controller output will be 0.0 (i.e. [#E.01] = 0.0).

**#E.09 Optional PID enable source selector**

Parameter type: RW, U, P

Adjustment range: (#) 0.00 to E.50

Units: (#) (i.e. #(menu number).(parameter number))

Default value: (#) 0.00 (no source parameter defined)

Only bit parameters (type Bit) can be selected as the source for the optional PID enable. If a non valid parameter is selected the input to the AND gate is taken as 1 (e.g. the default value of 0.00). As with the enable PID (#E.08) above, the optional enable must be set at 1 for the PID controller to operate (i.e. [#[#E.09]] = 1). If [#[#E.09]] = 0 then the PID controller output will be 0.0 (i.e. [#E.01] = 0.0).

**#E.10 PID proportional gain**

Parameter type: RW, U

Adjustment range: 0.00 to 2.50

Units: -

Default value: 1.00

This parameter is the proportional gain applied to the PID error. The proportional term is therefore:

(Proportional term) = [#E.10] x {[#[#E.03]] x {(-2) x [#E.05] +1} - [#[#E.04]] x {(-2) x [#E.06] +1}}

where: #E.03 is the PID reference source selector

#E.05 is the invert PID reference

#E.04 is the PID feedback source selector

#E.06 is the invert PID feedback

### #E.11 PID integral gain

Parameter type: RW, U

Adjustment range: 0.00 to 2.50

Units: -

Default value: 0.50

This parameter is the gain applied to the PID error before being integrated. The integration process is performed by summing the previous integral error with the current integral error, where the errors are sampled every 32ms. Therefore the integral term is derived as follows:

(Current integral error term) = [#E.11] x (0.033) x

{[#[#E.03]] x {(-2) x [#E.05] +1} - [#[#E.04]] x {(-2) x [#E.06] +1}}

provided [#E.17] = 0

or: = 0 if [#E.17] = 1.

where: #E.03 is the PID reference source selector

#E.05 is the invert PID reference

#E.04 is the PID feedback source selector

#E.06 is the invert PID feedback

#E.17 is the hold PID integrator bit

(0.033) gain is such that if the error term is 1.0, then the integral term will increase by 1.0 over a 1.0 second interval.

(integral term) = (Current integral error term) + (32ms previous integral error term)

The initial integral term will be 0.0 at power up regardless of the value at power down.

**#E.12 PID derivative gain**

Parameter type: RW, U

Adjustment range: 0.00 to 2.50

Units: -

Default value: 0.00

This parameter is the gain applied to the PID error before being differentiated. The differentiation process is performed by subtracting the previous differential error from the current differential error, where the errors are sampled every 32ms. Therefore the derivative term is derived as follows:

(Current differential error term) = [#E.12] x (30.5) x
{[#[#E.03]] x [(-2) x [#E.05] +1] - [#[#E.04]] x [(-2) x [#E.06] +1]}

where: #E.03 is the PID reference source selector

#E.05 is the invert PID reference

#E.04 is the PID feedback source selector

#E.06 is the invert PID feedback

(30.5) gain is such that if the error term linearly increase by 1.0 over a 1.0 second interval, then the differential term will be a constant value of 1.0 over the 1.0 second interval.

(derivative term) = (Current differential error term) - (32ms previous differential error term)

**#E.13 PID high limit**

Parameter type: RW, U

Adjustment range: 0.0 to 100.0

Units: %

Default value: 100.0

The maximum positive PID output (i.e. [#E.01]) is limited by the value of the PID high limit.

#### #E.14 PID low limit

Parameter type: RW, B

Adjustment range: 0.0 to ±100.0

Units: %

Default value: -100.0

The maximum negative or the minimum positive PID output (i.e. [#E.01]) is limited by the value of the PID low limit.

#### #E.15 PID scale factor

Parameter type: RW, U

Adjustment range: 0.00 to 2.50

Units: -

Default value: 1.00

The PID controller output (#E.01) is scaled by the PID scale factor before being added to the PID main reference source selector (#E.02). After the addition to the main reference, the resulting output is automatically scaled to match the range of the destination parameter (i.e. [#[#E.16]]).

#### #E.16 PID output destination selector

Parameter type: RW, U, R, P

Adjustment range: (#) 0.00 to E.50

Units: (#) (i.e. #(menu number).(parameter number))

Default value: (#) 0.00 (no source parameter defined)

The PID output destination selector parameter defines the destination parameter of the PID controller. Therefore the PID controller can be used to control certain internal parameters. Only non-bit parameters (types RW and RO) which are not protected (type P) can be used as a destination. If a non valid parameter is used the output is not routed anywhere.

If the PID controller is to control speed then it is suggested that one of the preset frequency parameters (i.e. #1.21, #1.22, ... to #1.28) is used as the destination selector parameter (i.e. [#E.16] = 1.21, 1.22, ..or 1.28). If the PID is to trim speed then it is suggested that the frequency reference offset (#1.04) is used as the destination selector parameter (i.e. [#E.16] = 1.04).

## #E.17 Hold PID integrator

| | |
|---|---|
| Parameter type: | RW, Bit |
| Adjustment range: | 0 or 1 |
| Units: | - |
| Default value: | 0 |

The hold PID integrator parameter is for applications where there may be disturbances with the PID input variables, and these disturbances should not affect the integrator output level.  Setting [#E.17] = 1 (by a digital input if required) will hold the integrator value such that it does not stray from its steady state value during the disturbance.

## 10.0 Diagnostics/Fault Indications

The following sub-sections detail all the various alphanumeric display indications during both normal and fault conditions together with their meanings. There are 3 basic display indications:

| Display mode: | Display indications: | Drive status: |
|---|---|---|
| Status mode only | Not flashing | Normal 'running' |
| Any mode | Flashing | Warning (still 'running') |
| Trip mode only | Flashing | Tripped |

## 10.1 Normal Status Display Indicators

In the display status mode the drive status is shown on the display, or the value of the last accessed parameter. The following alphanumeric display indications will appear, under the conditions described:

| **Display** | **Dinverter output** | **Drive conditions** |
|---|---|---|
| rdy | disabled | Ready - waiting for enable/run signal, motor stationary or possibly coasting. The drive output stage is disabled. |
| (number or text not given in this column) | enabled | Motor under control by drive power stage and possibly rotating. The number/text corresponds to value of parameter last accessed. |
| inh | disabled | Inhibited - motor stationary or coasting to a halt, possibly undergoing a reset. The drive output stage is disabled. |
| dEC | enabled | Decelerating - motor is being braked by a stop command. |
| trP | disabled | Tripped - motor stationary, stopping or coasting by a trip. Trip code will be displayed in Trip Mode (see Section 10.3 for the trip codes). The drive output stage is disabled. |
| dc | enabled | DC injection - motor braked by DC injection after a stop command |

## 10.2 Warning Display Indicators

If a critical condition is reached, the drive will remain enabled, but the display shows a flashing warning in all of the display modes. The warning condition will be indicated on the display by alternating between the warning and the normal display number/text. This condition will eventually lead to a trip if no corrective measures are taken.

The following alphanumeric warnings will appear in the display, under the conditions described:

| Display | Drive warning conditions |
|---|---|
| OUL | Overload - Motor overload, approaching Ixt trip (‘It’), unless load reduced.<br><br>The output current of the drive is higher than the rated motor current and the overload accumulator value has reached 75%, i.e. [#4.20] > 105% and [#4.19] > 75%.<br><br>Motor overload alarm [#A.17] = 1. |
| hot | Hot - Heatsink approaching overtemperature trip (‘Oh2’), unless output current reduced, ambient reduced or switching frequency reduced.<br><br>The heatsink has exceeded a temperature of 95°C, i.e. [#7.04] > 95°C.<br><br>Heatsink temperature alarm [#A.18] = 1. |

## 10.3 Trip Display Indicators

In the event of a trip occurring, the drive output will be immediately disabled and the motor will coast to a standstill. However, if [#A.37] = 1 (stop drive on non-important trips), a non-important trip will cause the drive to stop first before disabling the drive and then tripping. Once tripped the display will show a flashing trip indicating the cause of the trip. (The serial interface can also be used to read the trip through the trip log parameters #A.20 to #A.29).

Please note that the 4 trips ‘Er1’, ‘Er2’, ‘Er3’ and ‘Er4’ can only be reset by powering off the drive, whereas all other trips can be reset via the Drive reset bit #A.33.

The following trips are possible:

| **Display**<br>**(and also the last trip parameters #A.20 to #A.29)** | **Value read via serial comms for #A.20 to #A.29** | **Drive trip conditions, reasons, and help** |
|---|---|---|
| UU | 1 | DC link undervoltage<br>Possible reason: Normal AC supply switched off or supply voltage low. |
| OU | 2 | DC link overvoltage<br>Possible reason: Braking torque too high during deceleration.<br>Help: Use braking resistor, extend deceleration rate. |
| OI | 3 | Instantaneous overcurrent (at inverter or brake)<br>Possible reasons: Acceleration or braking ramp too short, P-term of the current controller (#4.13) too small, short circuit at output or brake (at the drive output or motor), faulty motor cable.<br>Help: Extend ramps, optimise current controller, check drive output, motor cable, motor terminal block, brake resistor and cabling. |
| PS | 4 | Power supply<br>Possible reasons: Dirt shorting internal drive circuits, faulty unit.<br>Help: Switch AC supply on and off. If trip persists, consult supplier. |
| Et | 5 | External trip ([#A.32] = 1 momentarily)<br>Possible reasons: Fault in external fault chain, terminal B5 open (in default settings)<br>Help: Check external fault chain, check terminal B5 |
| O.SP | 6 | Overspeed<br>Possible reasons: Speed/frequency too high during regeneration and in current limit.<br>Help: Remove/reduce overhauling load. Increase the current limit (#4.07) if possible or use a drive with a larger current rating. |
| It | 7 | Motor Ixt overload<br>Possible reasons: Motor overloaded.<br>Help: Reduce load or use larger drive (and motor) rating. |
| cL | 8 | Current loop loss when in 4 to 20 or 2 to 4 mA analogue input modes<br>Possible reasons: Input current less than 3mA when in 4 to 20mA or 20 to 4mA modes.<br>Help: Check parameter setting (#7.11), check current loops. |

| | | |
|---|---|---|
| Oh2 | 9 | Heatsink overtemperature<br><br>Possible reasons: Overloaded drive, ambient temperature too high<br><br>Help: Check ambient temperature, use enclosure cooling if necessary; reduce PWM switching frequency ([#0.41] or [#5.18]), use larger drive rating. |
| EEF | 10 | EEPROM fault<br><br>Possible reasons: Possible parameter loss or corruption caused by severe electrical noise.<br><br>Help: Load default values (via parameter 0(i.e. #x.00), see section 5.2.3), then enter application values, store new parameters, power off and power back on. If EEF trip still present consult supplier. |
| th | 11 | Motor thermistor overtemperature ([#A.16] = 1 momentarily)<br><br>Possible reasons: Overloaded motor, faulty PTC motor thermistors or wire, PTC thermistor input open at drive terminals<br><br>Help: Check PTC motor thermistor input at drive terminal block, check PTC motor thermistors and wire for break, reduce load. |
| Er1 | 12 | Load current offset too great at power up (should be 0)<br><br>Possible reasons: Faulty drive, or severe electrical noise at power up.<br><br>Help: Power off and power back on again. If Er1 trip is still present consult supplier. |
| Er2 | 13 | Microprocessor oscillator faulty<br><br>Possible reasons: Faulty drive.<br><br>Help: Power off and power back on again. If Er2 trip is still present consult supplier. |
| Er3 | 14 | Microprocessor software not functioning correctly<br><br>Possible reasons: Faulty drive, or severe electrical noise at power up..<br><br>Help: Power off and power back on again. If Er3 trip is still present consult supplier. |
| Er4 | 15 | Keypad button depressed at power up<br><br>Possible reasons: One of keypad buttons stuck down.<br><br>Help: Release stuck button. Power off and power back on again. If Er4 trip is still present consult supplier. |
| t16<br>to<br>t99 | 16<br>to<br>99 | User trips where the number is the trip number ([#A.38] = trip number momentarily) |

# 11.0 Serial Communications

## 11.1 Introduction

A serial communications link enables one or more drives to be used in systems controlled by a host unit such as a PLC (Programmable Logic Controller) or computer. The communications link for the drive uses the EIA RS485 standard for the hardware interface.

The Dinverter drive has a standard 2-wire RS485 half-duplex interface that enables all drive set-up, operation and monitoring to be accomplished if required. Therefore, it is possible to control the drive entirely by the RS485 interface without the need for other control cabling.

The host controller can operate up to thirty-two EIA RS485 devices with the use of one line buffer. Further buffers will increase this number if necessary. Each transmitter/receiver within a drive (with the internal termination and external pull-up and pull-down resistors disconnected) loads the RS485 lines by 1 unit load. This means that up to 32 drives can be connected in a single group to one line buffer. However, with the serial addresses available, it is convenient to only have up to 9 drives in a single group.

When additional line buffers are used, up to 81 drives can be operated by the host controller. In this case the drives are organised in a maximum of 9 groups of 9 drives each. A particular drive or group of drives can be given commands without affecting other drives or groups of drives respectively.

The serial communications port of the drive is situated at terminals C4 and C5. The EIA RS485 2-wire port is isolated from the power stage but not isolated from the other control terminals. The EIA RS422 hardware interface is also supported.

**Note:-**

The EIA RS232 hardware interface cannot be used with a 2-wire EIA RS485 interface. Therefore a suitable adapter for connection to a computer RS232 interface port is essential. This adapter must have the hardware and software support to tri-state (i.e. disable) the transmit buffer following message transmission. Otherwise the Dinverter RS485 transmitter will not be successful in transmitting a reply as the host transmitter will cause contention of the 2-wire interface.

## 11.2 Initial Electrical and Mechanical Set-Up

Prior to powering the drive up for the first time, ensure that Sections 4 & 5 of this manual have been studied and the necessary recommended actions have been taken. For initial operation using serial communications, it is assumed that the relevant connections are as shown in Fig 11.1 and 11.2.

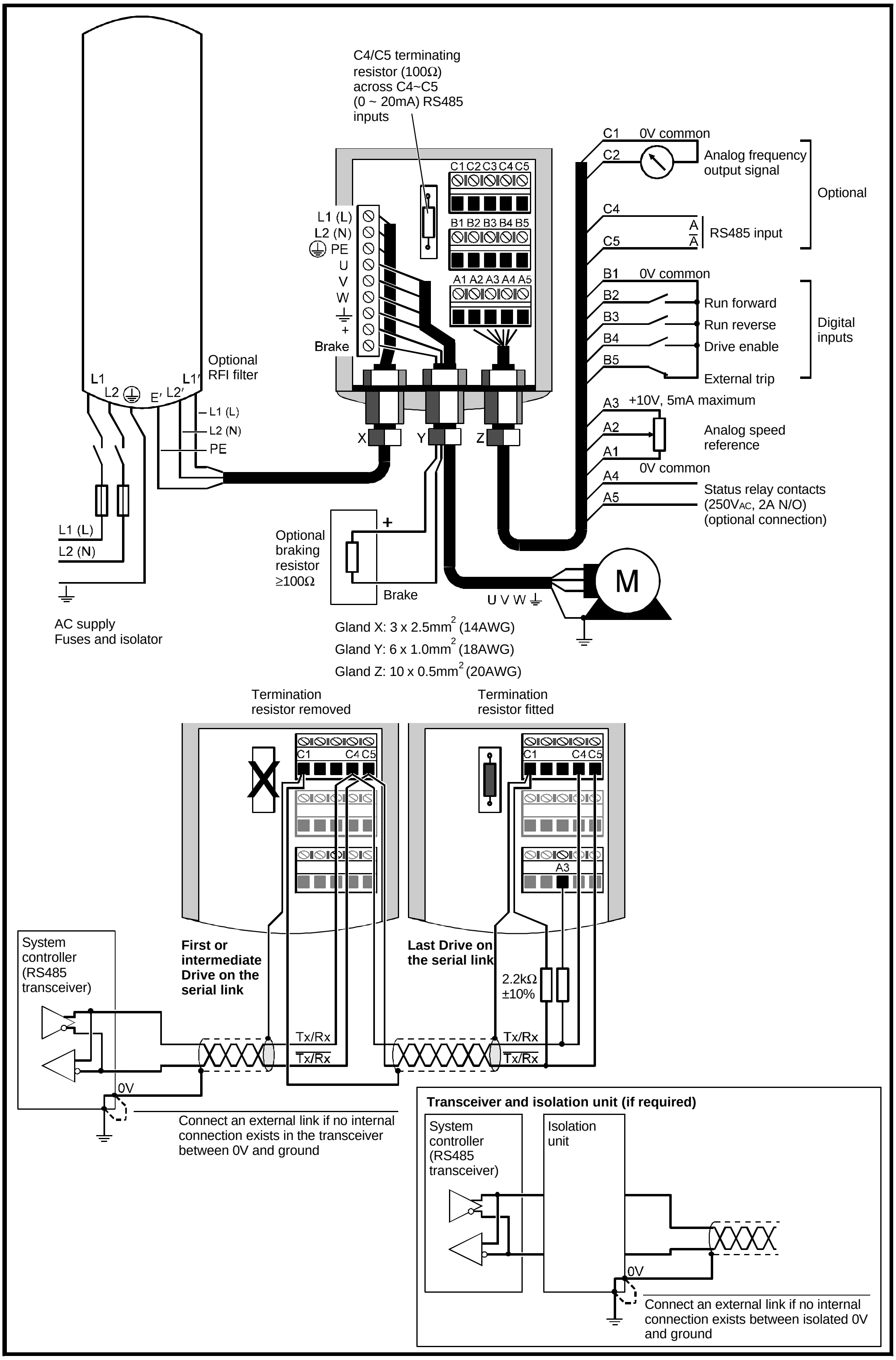



Fig. 11.1 Electrical connections for initial serial communications operation

## Serial communications requirements

> **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.**

If more than one Drive is to be connected to a serial link, make connections as shown in Figure 11.1. If only one Drive is to be connected, make the connections shown for the last Drive.

1 A 100Ω termination resistor **must** be fitted in the last (or only) Drive on the serial link. Use wire-cutters to remove the termination resistor from all Drives except the last Drive on the serial link.

2 Connect two 2.2kΩ ±10% resistors as shown in Figure 4–11 to the last (or only) Drive, on the serial link. Adding these resistors improves noise immunity.

3 The serial communications cable must be shielded. The shield(s) must be connected as shown in Figure 4–11.

In particular:

- Check that the wiring is correct,
- Check that the motor installation is correct and safe,
- Check that the motor shaft is not exposed,
- Check that the signal connections B2 and B3 are not connected to 0V Common (i.e. the switches/contacts are open), and, B4 and B5 are connected to 0V Common (i.e. the switches/contacts are closed). This ensures that the motor will not turn when AC power is applied to the drive.
- Check that the Set Speed Potentiometer (connected to A1, A2, and A3) is set to minimum (wiper is effectively connected to 0V Common wiper).

Notes

- A data communications cable should not run parallel to any power cables, especially ones that connect drives to motors. If parallel runs are unavoidable, ensure a minimum spacing of 300mm (12 in.) between the communications cable and the power cable.
- Cables crossing one another at right-angles are unlikely to give trouble. The maximum cable run length for a EIA RS485 link is 1,200 metres (4,000 feet).
- Care must be taken to ensure that other drives in the system do not have the termination resistor fitted. Excessive signal loss will occur if resistors are connected on drives other than the last one in the group.

Before switching on the power to the drive, it is important to understand the drive operating controls and their operation. If in doubt, DO NOT ADJUST this drive. Damage may occur, or lives may be put at risk. Please read the following sections carefully.

With the drive wired up as described above, apply power to the input of the drive. The drive should power up with ‘rdy’ on the display.

With the drive parameters set to default, the terminals C4 and C5 are ready for RS485 communication. The drive will have a serial address of 1.1, (group 1, unit 1), at baud rate of 4800, and a protocol set by the ANSI standard as defined in Section 11.4 below.

If more than one drive is connected to the host computer, please adjust the serial address of each drive to ensure that each drive has a unique address.

Therefore with the drive in the above condition, all commissioning and operation if need be can be done using the RS485 communication link.

## 11.3 Relevant Parameters

This section gives a full explanation of all the relevant parameters affecting serial communications.

### #7.11 Analogue input 2 (C4/C5) mode selector

Parameter type: RW, U, T, P

Adjustment range: ANS (0), 0.20 (1), 20.0 (2), 4.20 (3), 20.4 (4), or th (5)

Units: -

Default value: ANS (0)

Analogue input 2 (C4/C5) can be configured for different input signal types (including serial communications). The setting of this parameter configures the terminals for the required mode of operation as follows:

| #7.11 Setting (Display) | Setting via Serial comms | Description |
|---|---|---|
| ANS | 0 | RS485 ANSI serial comms port active |
| 0.20 | 1 | Current input 0 to 20mA (20mA full scale) |
| 20.0 | 2 | Current input 20 to 0mA (0mA full scale) |
| 4.20 | 3 | Current input 4 to 20mA (20mA full scale) |

| | | |
|---|---|---|
| 20.4 | 4 | Current input 20 to 4mA (4mA full scale) |
| th | 5 | Motor thermistor input, see Fig. 9.17 in Section 9.8.2 for further details. |

For a complete description of this parameter see the parameter description for #7.11 in Section 9.8.2.

**#b.23 Serial interface address**

Parameter type: RW, U, P

Adjustment range: 0.0 to 9.9

Units: grp.unit (i.e. [group number].[unit number])

Default value: 1.1

Used when terminals C4/C5 are configured in default (i.e. [#7.11] = ANS (0) Analogue input 2 mode selector) to enable the serial interface. Parameter #b.23 defines the serial address of the drive. The address has the following format: [drive group. drive unit]. There are 9 addressable groups for each of 9 possible drive units. If address [0.0] is used, all drives are addressed simultaneously. If [x.0] is used, where x is any number from 1 to 9, all drives in group x are addressed.

Note that for this drive, the only baud rate available is 4800.

**#b.26 Serial transmit delay time**

Parameter type: RW, U

Adjustment range: 0 to 250

Units: ms

Default value: 20 (milliseconds)

The serial transmit delay time defines the minimum time before the drive will enable its RS485 transmit buffer and transmit data in response to a message from the host. (Prior to this time the Dinverter RS485 transmit buffer is disabled to enable the host to transmit a message to the drive receive buffer.) This delay provides the host software with sufficient time to disable its own transmit buffer after transmitting data to the drive. If the host does not disable the transmit buffer within the delay provided, the message transmitted from the drive to the host will be lost because of the contention with both the host and drive transmit buffers enabled.

Note also that the drive holds its transmit buffers enabled for up to 4 milliseconds after it has transmitted the last character of the response.  Therefore, the host must not start transmitting a new message until this 4ms period has elapsed.

These delays are essential for successful operation of the 2-wire half duplex protocol where the transmit and receive data is sent via the same differential pair of wires.

## 11.4 ANSI Protocol Description

Data is transmitted at a fixed speed or baud rate in the form of a character.  A character is comprised of seven bits, and the baud rate represents the data transmission rate in bits/second.

In order for a data receiver to recognise valid data, a frame is placed around each character. This frame contains a start bit, a stop bit, and a parity bit.  Without this frame, the receiver would be unable to synchronise itself with the transmitted data, as the data is asynchronous.

A frame is shown here:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ASCII 7-bit character (Low ASCII set) | | | | | | | | |
| | Least significant Hexadecimal digit | | | | Most significant Hexadecimal digit (3 bits only) | | | | |
| Start bit | Seven data bits | | | | | | | Even Parity bit | Stop bit |
| 0 | bit 0 (lsb) | bit 1 | bit 2 | bit 3 | bit 4 | bit 5 | bit 6 (msb) | (0 or 1) | 1 |
| 1st bit | 2nd bit | 3rd bit | 4th bit | 5th bit | 6th bit | 7th bit | 8th bit | 9th bit | 10th bit |

The frame above consists of 10 bits:

1 start bit, followed by

7 data bits  (starting with the least significant bit (i.e. lsb - bit 0) and ending with the most significant bit (i.e. msb - bit 6), followed by

1 even parity bit, followed by

1 stop bit

The parity bit is used by the data receiver to check the integrity of the 7 data bits it has received.

The 7 data bits are called a character and comprise the low ASCII set. The ASCII character set comprises 128 characters decimally numbered from 0 to 127. The first 32 (0 to 31) characters in the ASCII set (hexadecimal $00_H$ to $01F_H$) are used to represent special control codes. Each control code has a particular meaning (e.g. ASCII character $02_H$ is called ‘STX’ the ‘start of text’).

A message consists of a group of frames or characters. These characters consist of the following types which are used to construct the different types of messages:

Control characters

Address characters

Parameter characters

Data characters

Block Checksum character

These character types are described below.

**Control characters**

Commands and requests are sent to the drive in the form of a set of characters, including control characters as a message packet. Each message is started with a special control character, and may contain further control characters. A list of all the relevant control characters in the ANSI protocol used when sending a message, and receiving is as follows:

| Character | Meaning | ASCII code (2-digit Hexadecimal) | Control Character on Computer Keyboard |
|---|---|---|---|
| EOT | End of Transmission -<br>Reset - prepare for new message | 04 | Control-D |
| ENQ | Enquiry - interrogating a ‘drive’ | 05 | Control-E |
| STX | Start of Text (or data) | 02 | Control-B |
| ETX | End of Text (or data) | 03 | Control-C |
| ACK | Acknowledge (message accepted) | 06 | Control-F |
| NAK | Negative acknowledge (message not accepted) | 15 | Control-U |

| | | | |
|---|---|---|---|
| BS | Backspace | 08 | Control-H |

### Address characters

Each drive on a ANSI communications serial link must be given a unique identity or address so that only one target drive will respond to a transmitted message.  This serial address comprises two parts:

The Group Address which is the first digit of the 2 digit address, and

The Unit Address which is the second digit.

Both the group address and unit address have a range of 1 to 9.  A group or unit address of 0 is not allowed  (i.e. addresses 01, 10, 20, etc. are invalid).  The reason for this is that drives can be grouped together (up to 9 units per group), and a particular message with an address containing 0 can be sent  to all units of the particular group.     To address a particular group, the unit address of zero (0) is used, for example, to address all units of group 6 the full address is 60.

An additional feature of the ANSI protocol is that a message can be sent to all units of all groups simultaneously using the address 00.   For example, the address 00 can be used to send a frequency/speed command to all the drives which are mechanically coupled together driving a conveyor.   All the  drives will then change frequency/speed simultaneously.

**Note**

It is important to realise that when using group addressing (e.g. addresses 00, 10, 20 etc.), the drives within the group addressed will not acknowledge the message sent.  (If several drives try to respond at the same time, they would all be transmitting simultaneously which is not possible when the serial link can only work with one transmitter active at any one time.)

For security, the format of the transmitted address requires that each digit of the two-digit address is repeated, i.e. the address of drive 23 is sent as four characters, e.g. ‘2   2   3   3’.

The serial address immediately follows after the first control character of the message (usually ‘EOT’).

### Parameter characters

For transmission, all parameters are identified by four digits representing the menu and the parameter number, but without the decimal point. Examples:

To send a message to menu 4, parameter 16, (i.e. parameter #4.16), send ‘**0416’** (the leading zero **must** be included)

To send to menu E, parameter 3, (i.e. parameter #E.03) send  ‘**1503’** where 15 is the decimal equivalent of E (in hexadecimal).

**Data characters**

Data to be sent follows the characters immediately after the parameter number. The minimum length of the data field within a message structure is one characters. The data is normally expressed as a decimal numeric value.

**Block Checksum Character (BCC)**

In order to ensure that the messages from or to the drive are not corrupted during transmission, the data responses are concluded with a block checksum character (BCC). (This BCC enables the drive or host to confirm whether the data has been corrupted or not.) See below for calculation of the BCC value depending on the data to be sent.

From all the above character types it is possible to group the correct characters together to produce valid messages. The only two types of message are reading data and writing data. The protocol to perform these two tasks is described below.

11.4.1 Reading Data

To read a parameter value (i.e. host reading data from a drive), the message format from the host is as follows:

| CC | Address | | | | CC | Parameter | | | | CC |
|---|---|---|---|---|---|---|---|---|---|---|
| EOT | GA | GA | UA | UA | STX | M1 | M2 | P1 | P2 | ENQ |

Where:

CC = Control Character

GA = Group Address

UA = Unit Address

[M1][M2] = Menu number

[P1][P2] = Parameter number

Note:- No BCC character is sent in this message.

The drive will reply with the following message structure if the ‘read’ message is understood:

| CC | Parameter | | | | Data | | | | CC | BCC |
|---|---|---|---|---|---|---|---|---|---|---|
| STX | M1 | M2 | P1 | P2 | D1 | D2 | .... | Dn | ETX | BCC |

Where:

CC = Control Character

[M1][M2] = Menu number

[P1][P2] = Parameter number

[D1][D2] ...[Dn] = Data characters including decimal point where necessary, and where:
First character:

+ (43 decimal or $2B_H$) for positive values, or

– (45 decimal or $2D_H$) for negative values.

BCC = Block checksum (calculated as described below)

The data field has either 6 or 7 characters depending on whether a decimal point is transmitted.

Following a ‘read’ message, if the requested parameter is invalid or does not exist, the drive will reply as follows:

| CC |
|---|
| EOT |

An example of a host reading the value of parameter #1.17 on the drive that is addressed as unit 2 of group 1, the host message is:

| CC | Address | | | | CC | Parameter | | | | CC |
|---|---|---|---|---|---|---|---|---|---|---|
| EOT | 1 | 1 | 2 | 2 | STX | 0 | 1 | 1 | 7 | ENQ |

The drive replies with, where [#1.17] = -47.6Hz:

| CC | Parameter | | | | Data | | | | | | | CC | BCC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STX | 0 | 1 | 1 | 7 | - | 0 | 0 | 4 | 7 | . | 6 | ETX | 2 |

The BCC in this example is calculated by the drive as follows:

**Calculating the block checksum (BCC)**

The block checksum is calculated by applying an exclusive 'or' function (XOR) to all of the characters of a message after the 'STX' control character.

**XOR truth table**

| **A** | **B** | **Out** |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

For the 'read' response example above:

The first character of the BCC calculation is **0** (0011 0000 in binary), the value of which is taken as a starting or result value. The next character is **1** (0011 0001 in binary), which now has the exclusive 'or' (XOR) operator act upon it. With the previous result value, a new result occurs of (0000 0001) in binary.

The complete calculation is show in the table below:

| Character | Binary Value | XOR result |
|---|---|---|
| 0 | 0011 0000 | 0011 0000 |
| 1 | 0011 0001 | 0000 0001 |
| 1 | 0011 0001 | 0011 0000 |
| 7 | 0011 0111 | 0000 0111 |
| – | 0010 1101 | 0010 1010 |
| 0 | 0011 0000 | 0001 1010 |
| 0 | 0011 0000 | 0010 1010 |
| 4 | 0011 0100 | 0001 1110 |
| 7 | 0011 0111 | 0010 1001 |
| . | 0010 1110 | 0000 0111 |
| 6 | 0011 0110 | 0011 0001 |
| ETX | 0000 0011 | **0011 0010 = BCC** |

The final value is the BCC, provided that its equivalent decimal value exceeds 31 (or $1F_H$) (ASCII characters from 0 to 31 are used as control codes).

When the final XOR result produces a decimal value less than 32, then 32 is added. In this example, 0011 0010 is 50 decimal, so this is the final BCC value. 50 decimal is the ASCII character ‘2’.

**Re-reading data**

Once a ‘read’ message has been sent from the host and the drive has responded with a valid response, another request for further data can be requested without the need for a full ‘read’ message from the host. The host can request::

- to receive the same parameter data/value again,
- to request the next parameter data/value, or
- to request the previous parameter data/value.

The request from the host consists of a single control character, as follows:

| Control Character | Function | Control Character on Computer Keyboard |
|---|---|---|
| NAK | Return the value of the same parameter | Control-U |
| ACK | Return the value of the next parameter | Control-F |
| BS | Return the value of the previous parameter | Control-H |

This facility can be used to save time when monitoring a parameter value over a period of time.

If the message is lost following data corruption, it will be necessary to recommence the 'read' communication by starting with a complete message sequence and then reverting to the 're-read' rapid sequence described above.

### 11.4.2 Writing Data

To write data (i.e. a value) to a drive parameter (i.e. host writing data to a drive), the message format from the host is as follows:

| CC | Address | | | | CC | Parameter | | | | Data | | | | CC | BCC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EOT | GA | GA | UA | UA | STX | M1 | M2 | P1 | P2 | D1 | D2 | .... | Dn | ETX | BCC |

Where:

CC = Control Character

GA = Group address

GU = Unit address

[M1][ M2] = Menu number

[P1] [P2] = Parameter number

[D1][D2] ...[Dn] = Data characters including decimal point and sign where necessary.

BCC = Block checksum (calculated as described below)

The data field can be of a variable length with a maximum length of 7 characters.

Following the ‘write’ message, the drive will respond with a single control character, as follows:

| Control Character | Meaning | Control Character on Computer Keyboard ASCII Character |
|---|---|---|
| NAK | Message invalid.<br><br>Data is too long or out of range, parameter is invalid, parameter is read-only, or the BCC is incorrect. | Control-U |
| ACK | Acknowledge — Message is valid and has been understood and implemented. | Control-F |

An example of a host writing a value of +76.4 to parameter #1.25 of a drive that is addressed as unit 6 of group 2, the host message is:

| CC | Address | | | | CC | Parameter | | | | Data | | | | | CC | BCC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EOT | 2 | 2 | 6 | 6 | STX | 0 | 1 | 2 | 5 | + | 7 | 6 | . | 4 | ETX | 5 |

The BCC in this example is calculated by the host as follows:

### Calculating the block checksum (BCC)

The block checksum is calculated by applying an exclusive ‘or’ function (XOR) to all of the characters of a message after the ‘STX’ control character.

**XOR truth table**

| A | B | Out |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

For the ‘write’ message example above:

The first character of the BCC calculation is **0** (0011 0000 in binary), the value of which is taken as a starting or result value. The next character is **1** (0011 0001 in binary), which now has the exclusive 'or' (XOR) operator act upon it. With the previous result value, a new result occurs of (0000 0001) in binary.

The complete calculation is show in the table below:

| **Character** | **Binary Value** | **XOR result** |
|---|---|---|
| 0 | 0011 0000 | 0011 0000 |
| 1 | 0011 0001 | 0000 0001 |
| 2 | 0011 0010 | 0011 0011 |
| 5 | 0011 0101 | 0000 0110 |
| + | 0010 1011 | 0010 1101 |
| 7 | 0011 0111 | 0001 1010 |
| 6 | 0011 0110 | 0010 1100 |
| . | 0010 1110 | 0000 0010 |
| 4 | 0011 0100 | 0011 0110 |
| ETX | 0000 0011 | **0011 0101 = BCC** |

The final value is the BCC, provided that its equivalent decimal value exceeds 31 (or $1F_H$) (ASCII characters from 0 to 31 are used as control codes).

When the final XOR result produces a decimal value less than 32, then 32 is added. In this example, 0011 0101 is 53 decimal, so this is the final BCC value. 53 decimal is the ASCII character '5'.

The drive should reply with ACK control character if the message was received correctly, and the BCC agrees with the drive calculation.

**Re-writing data**

Once a complete ‘write’ message has been sent to a drive, and the drive has responded with either a ‘ACK’ or ‘NAK’ character, subsequent ‘write’ messages to that particular drive can use a re-write message structure. The address does not need to be re-transmitted. The ‘re-write’ message structure is as follows:

| CC | Parameter | | | | Data | | | | CC | BCC |
|---|---|---|---|---|---|---|---|---|---|---|
| STX | M1 | M2 | P1 | P2 | D1 | D2 | .... | Dn | ETX | BCC |

When a different drive needs to be addressed, or an ACK or NAK response is not received from the current drive addressed, the ‘re-write’ facility can no longer be used. The particular drive can only be addressed by using the full ‘write’ message with the correct address, etc.