Nidec

All for dreams

*Control User Guide*

# *Commander C200/ C300*

Variable Speed AC drive for induction motors

Part Number: 0478-0535-02
Issue: 2

## Original Instructions

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

## Documentation

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

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

## Warranty and Liability

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

## Environmental policy

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

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

## Restriction of Hazardous Substances (RoHS)

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

## Disposal and Recycling (WEEE)

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

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

## REACH legislation

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

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

## Registered Office

**Nidec Control Techniques Ltd**
**The Gro**
**Newtown**
**Powys**
**SY16 3BE**
**UK**
Registered in England and Wales. Company Reg. No. 01236886.

## Copyright

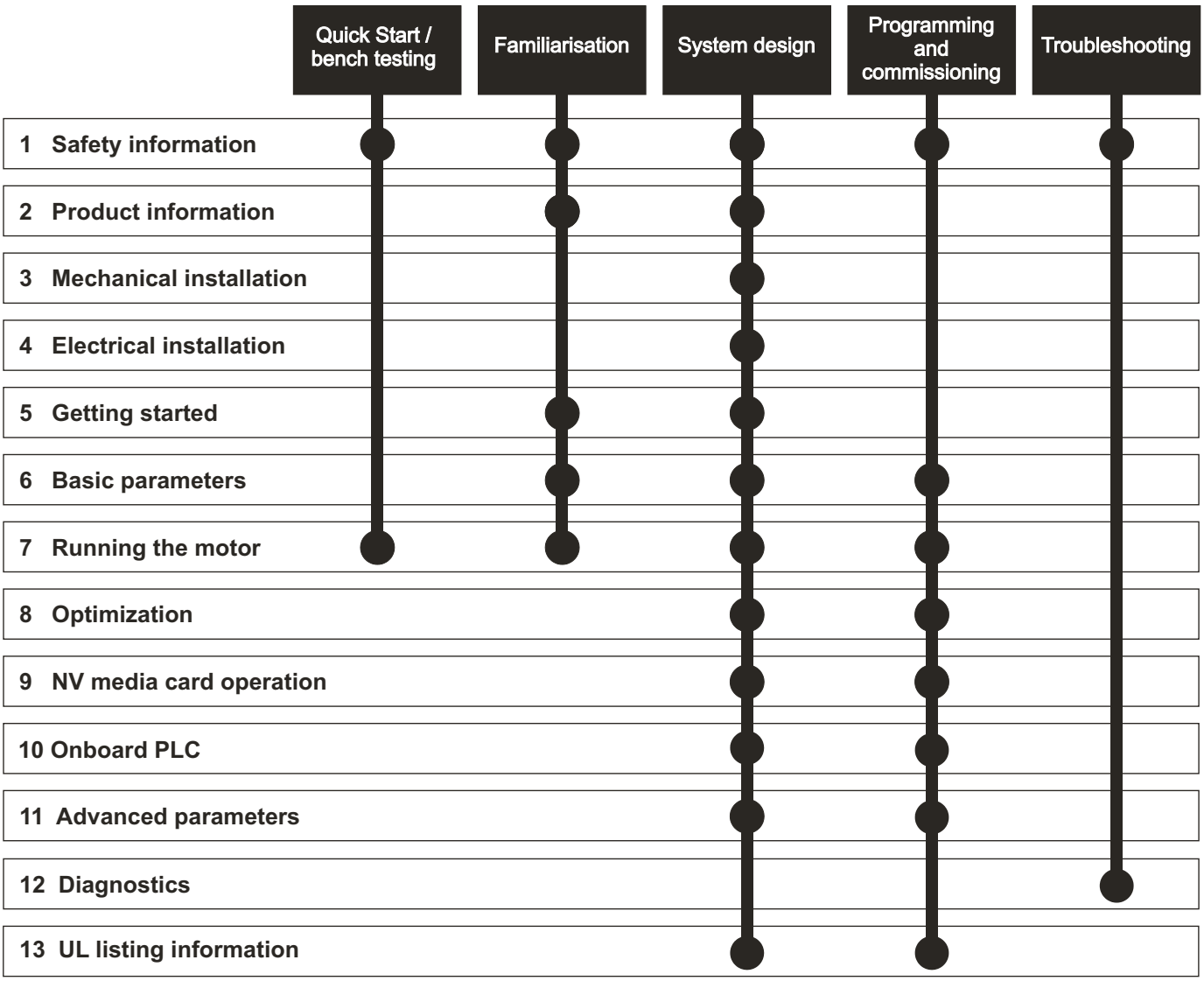
# How to use this guide

This guide is intended to be used in conjunction with the appropriate Power Installation Guide. The Power Installation Guide gives information necessary to physically install the drive. This guide gives information on drive configuration, operation and optimization.

**NOTE**

There are specific safety warnings throughout this guide, located in the relevant sections. In addition, Chapter 1 *Safety information* on page 8 contains general safety information. It is essential that the warnings are observed and the information considered when working with or designing a system using the drive.

This map of the user guide helps to find the right sections for the task you wish to complete, but for specific information, refer to *Contents* on page 4:



# Contents

# EU Declaration of Conformity

**Nidec Control Techniques Ltd,**
**The Gro,**
**Newtown,**
**Powys,**
**UK.**
**SY16 3BE.**

This declaration is issued under the sole responsibility of the manufacturer. The object of the declaration is in conformity with the relevant European Union harmonisation legislation. The declaration applies to the variable speed drive products shown below:

| Model number | Interpretation | Nomenclature aaaa - bbc ddddde |
|---|---|---|
| aaaa | Basic series | C200, C300 |
| bb | Frame size | 01, 02, 03, 04, 05, 06, 07, 08, 09 |
| c | Voltage rating | 1 = 100 V, 2 = 200 V, 4 = 400 V, 5 = 575 V |
| ddddd | Current rating | Example 01000 = 100 A |
| e | Drive format | A = 6P Rectifier + Inverter with internal choke, E = 6P Rectifier + Inverter (external choke) |

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

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

| | |
|---|---|
| EN 61800-5-1:2007 | Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy |
| EN 61800-3: 2004+A1:2012 | Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods |
| EN 61000-6-2:2005 | Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments |
| EN 61000-6-4: 2007+ A1:2011 | Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments |
| EN 61000-3-2:2014 | Electromagnetic compatibility (EMC) - Part 3-2: Limits for harmonic current emissions (equipment input current ≤ 16 A per phase) |
| EN 61000-3-3:2013 | Electromagnetic compatibility (EMC) - Part 3-3: Limitation of voltage changes, voltage fluctuations and flicker in public, low voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection |

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

These products comply with the Restriction of Hazardous Substances Directive (2011/65/EU), the Low Voltage Directive (2014/35/EU) and the Electromagnetic Compatibility Directive (2014/30/EU).

**Jonathan Holman-White**

**Director of Research and Development**

**Date: 9th October 2018.**

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

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

# EU Declaration of Conformity (Machinery Directive)

**Nidec Control Techniques Ltd**
**The Gro**
**Newtown**
**Powys**
**SY16 3BE**
**UK**

This declaration is issued under the sole responsibility of the manufacturer. The object of the declaration is in conformity with the relevant European Union harmonisation legislation. The declaration applies to the variable speed drive products shown below:

| Model No. | Interpretation | Nomenclature aaaa - bbc ddddde |
|---|---|---|
| aaaa | Basic series | C300 |
| bb | Frame size | 01, 02, 03, 04, 05, 06, 07, 08, 09 |
| c | Voltage rating | 1 = 100 V, 2 = 200 V, 4 = 400 V, 5 = 575 V |
| ddddd | Current rating | Example 01000 = 100 A |
| e | Drive format | A = 6P Rectifier + Inverter with internal choke, E = 6P Rectifier + Inverter (external choke) |

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

**This declaration relates to these products when used as a safety component of a machine. Only the Safe Torque Off function may be used for a safety function of a machine. None of the other functions of the drive may be used to carry out a safety function.**

These products fulfil all the relevant provisions of the Machinery Directive (2006/42/EC) and the Electromagnetic Compatibility Directive (2014/30/EU).

EC type examination has been carried out by the following notified body:

TUV Rheinland Industrie Service GmbH
Am Grauen Stein
D-51105 Köln
Germany

EC type-examination certificate numbers:

Frame sizes 1 to 4: 01/205/5383.03/18 dated 2018-08-16
Frame sizes 5 to 9: 01/205/5387.02/18 dated 2018-08-16

Notified body identification number: 0035

The harmonized standards used are shown below:

| | |
|---|---|
| EN 61800-5-2:2007 | Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional |
| EN 61800-5-1:2007 (in extracts) | Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy |
| EN 61800-3: 2004+A1:2012 | Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods |
| EN ISO 13849-1:2008 + AC:2009 | Safety of Machinery, Safety-related parts of control systems, General principles for design |
| EN 62061:2005 + AC:2010 + A1:2013 | Safety of machinery, Functional safety of safety related electrical, electronic and programmable electronic control systems |
| IEC 61508 Parts 1 - 7:2010 | Functional safety of electrical/ electronic/programmable electronic safety-related systems |

Person authorised to complete the technical file: P. Knight
Conformity Engineer

DoC authorised by: **Jon Holman-White**
**Director of Research and Development**

Date: **9th October 2018**

Place: **Newtown, Powys, UK**

**IMPORTANT NOTICE**

**These electronic drive products are intended to be used with appropriate motors, controllers, electrical protection components and other equipment to form complete end products or systems. It is the responsibility of the installer to ensure that the design of the complete machine, including its safety-related control system, is carried out in accordance with the requirements of the Machinery Directive and any other relevant legislation. The use of a safety-related drive in itself does not ensure the safety of the machine. Compliance with safety and EMC regulations depends upon installing and configuring drives correctly, including using the specified input filters. The drive must be installed only by professional installers who are familiar with requirements for safety and EMC. The assembler is responsible for ensuring that the end product or system complies with all relevant laws in the country where it is to be used. For more information regarding Safe Torque Off, refer to the Product Documentation.**

# 1 Safety information

## 1.1 Warnings, Cautions and Notes

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

**WARNING**

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

**CAUTION**

**NOTE**

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

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

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

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

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

## 1.3 Responsibility

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

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

## 1.4 Compliance with regulations

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

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

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

2006/42/EC Safety of machinery.

2014/30/EU: Electromagnetic Compatibility.

## 1.5 Electrical hazards

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

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

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

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

The STOP and Safe Torque Off functions of the drive do not isolate dangerous voltages from the output of the drive or from any external option unit.

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

## 1.6 Stored electrical charge

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

## 1.7 Mechanical hazards

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

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

The Safe Torque Off function may be used in a safety-related application. The system designer is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards.

The design of safety-related control systems must only be done by personnel with the required training and experience. The Safe Torque Off function will only ensure the safety of a machine if it is correctly incorporated into a complete safety system. The system must be subject to a risk assessment to confirm that the residual risk of an unsafe event is at an acceptable level for the application.

## 1.8 Access to equipment

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

## 1.9 Environmental limits

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

## 1.10 Hazardous environments

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

## 1.11 Motor

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

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

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

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

## 1.12 Mechanical brake control

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

## 1.13 Adjusting parameters

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

## 1.14 Electromagnetic compatibility (EMC)

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

# 2 Product information

## 2.1 Introduction

**Open loop AC drive**

Commander C200/C300 delivers maximum machine performance with open loop vector and sensorless induction motor control, for dynamic and efficient machine operation.

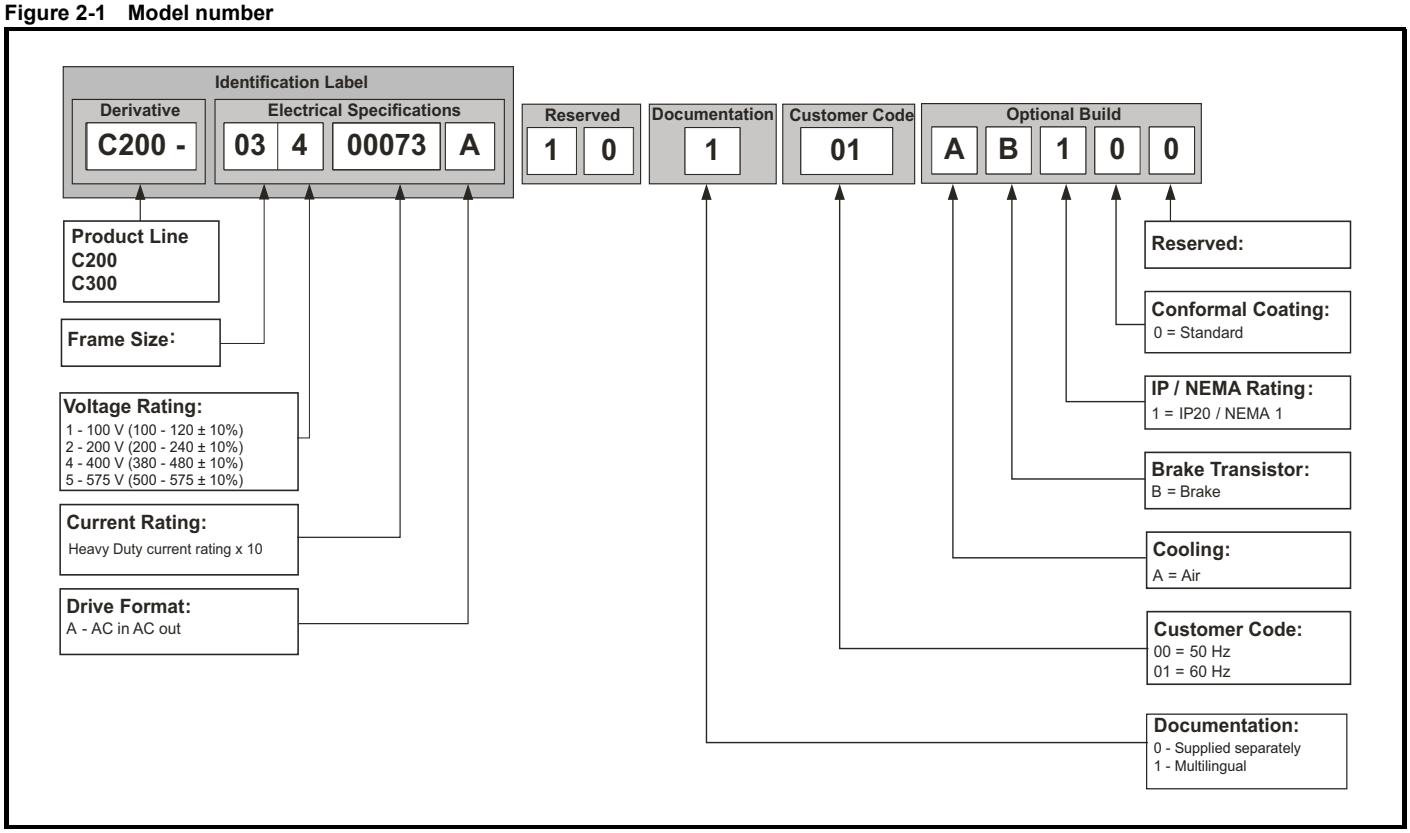
**Features**

- Enhance throughput with Machine Safety (C300 only)
- NV Media Card for parameter copying and data storage
- 24 Vdc backup supply (optional)
- EIA 485 serial communications interface (optional)
- Dual channel Safe Torque Off (STO) input (C300 only)
- Flexible machine integration through communications.

## 2.2 Model number

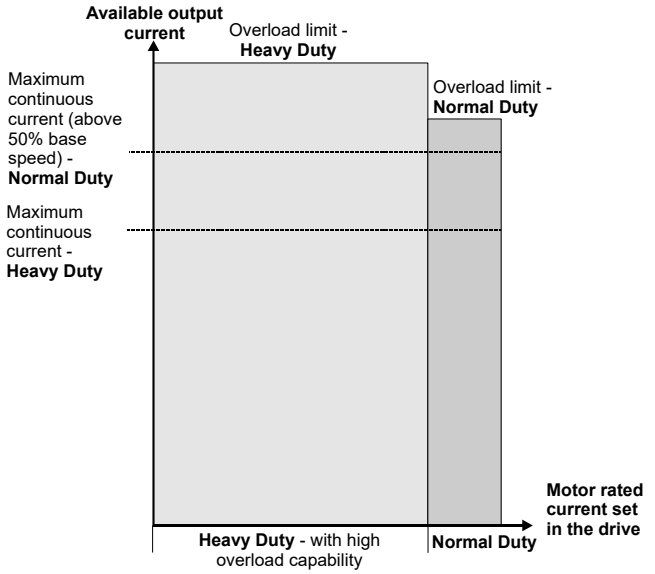
The way in which the model numbers for the Commander range are formed is illustrated below:

**Figure 2-1 Model number**



## 2.3 Ratings

The size 1 to 4 drive is Heavy Duty rated only.
The size 5 to 9 drive is dual rated.
The setting of the motor rated current determines which rating applies - Heavy Duty or Normal Duty.
The two ratings are compatible with motors designed to IEC60034.
The graph aside illustrates the difference between Normal Duty and Heavy Duty with respect to continuous current rating and short term overload limits.




### Normal Duty

For applications which use Self ventilated (TENV/TEFC) induction motors and require a low overload capability, and full torque at low speeds is not required (e.g. fans, pumps).
Self ventilated (TENV/TEFC) induction motors require increased protection against overload due to the reduced cooling effect of the fan at low speed. To provide the correct level of protection the I²t software operates at a level which is speed dependent. This is illustrated in the graph below.

**NOTE**

The speed at which the low speed protection takes effect can be changed by the setting of *Low Speed Thermal Protection Mode* (04.025). The protection starts when the motor speed is below 15 % of base speed when Pr **04.025** = 0 (default) and below 50 % when Pr **04.025** = 1.

### Heavy Duty (default)

For constant torque applications or applications which require a high overload capability, or full torque is required at low speeds (e.g. winders, hoists).
The thermal protection is set to protect force ventilated induction motors by default.

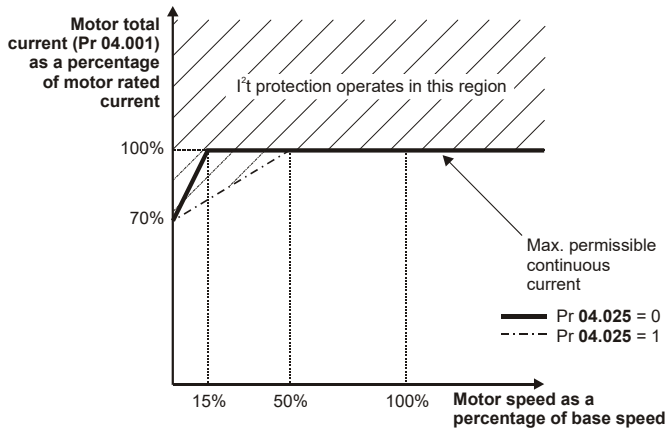
**NOTE**

If the application uses a self ventilated (TENV/TEFC) induction motor and increased thermal protection is required for speeds below 50 % base speed, then this can be enabled by setting *Low Speed Thermal Protection Mode* (04.025) = 1.

### *Operation of motor $I^2t$ protection*

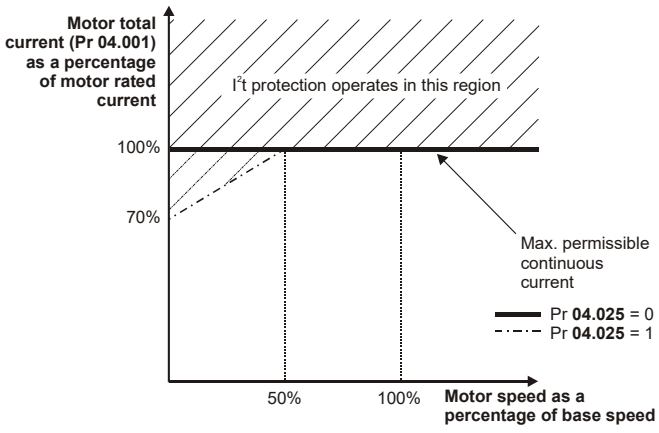
Motor I²t protection is fixed as shown below and is compatible with:

- Self ventilated (TENV/TEFC) induction motors




Motor I²t protection defaults to be compatible with:

- Forced ventilation induction motors



## 2.4 Operating modes

The drive is designed to operate in any of the following modes:

1. Open loop mode
   - Open loop vector mode
   - Fixed V/F mode (V/Hz)
   - Square V/F mode (V/Hz)
2. RFC - A
   - Without position feedback sensor

### 2.4.1 Open loop mode

The drive applies power to the motor at frequencies varied by the user. The motor speed is a result of the output frequency of the drive and slip due to the mechanical load. The drive can improve the speed control of the motor by applying slip compensation. The performance at low speed depends on whether V/F mode or open loop vector mode is selected.

**Open loop vector mode**

The voltage applied to the motor is directly proportional to the frequency except at low speed where the drive uses motor parameters to apply the correct voltage to keep the flux constant under varying load conditions.

Typically 100 % torque is available down to 1 Hz for a 50 Hz motor.

**Fixed V/F mode**

The voltage applied to the motor is directly proportional to the frequency except at low speed where a voltage boost is provided which is set by the user. This mode can be used for multi-motor applications.

Typically 100 % torque is available down to 4 Hz for a 50 Hz motor.

**Square V/F mode**

The voltage applied to the motor is directly proportional to the square of the frequency except at low speed where a voltage boost is provided which is set by the user. This mode can be used for running fan or pump applications with quadratic load characteristics or for multi-motor applications. This mode is not suitable for applications requiring a high starting torque.

### 2.4.2 RFC-A mode

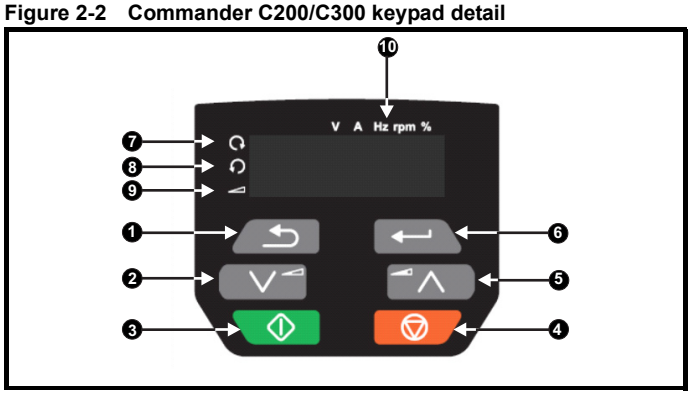
**R**otor **F**lux **C**ontrol for Asynchronous (induction) motors (RFC-A) encompasses closed loop vector control without a position feedback device

Rotor flux control provides closed loop control without the need for position feedback by using current, voltages and key motor parameters to estimate the motor speed. It can eliminate instability traditionally associated with open loop control for example when operating large motors with light loads at low frequencies.

## 2.5 Keypad and display

The keypad and display provide information to the user regarding the operating status of the drive and trip codes, and provide the means for changing parameters, stopping and starting the drive, and the ability to perform a drive reset.

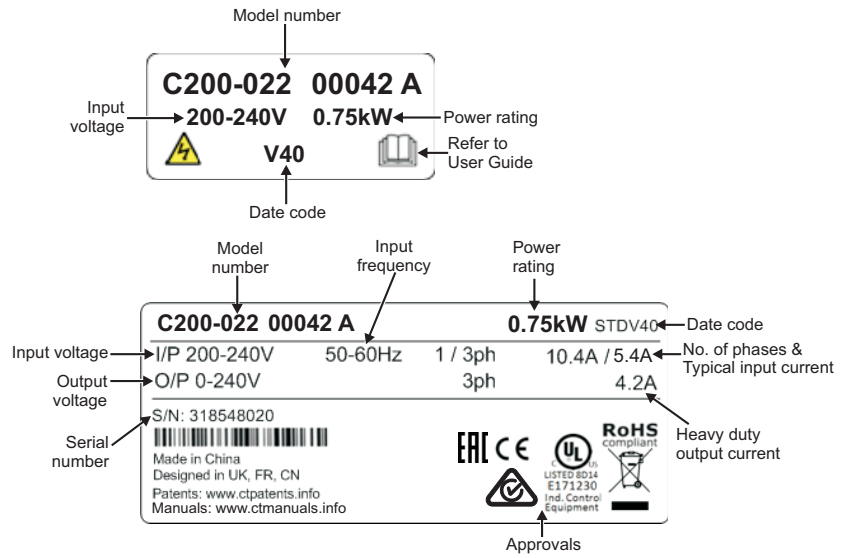
**Figure 2-2 Commander C200/C300 keypad detail**




1. Escape button
2. Down button
3. Start button (green)
4. Stop / Reset button (red)
5. Up button
6. Enter button
7. Run forward indicator
8. Run reverse indicator
9. Keypad reference indicator
10. Unit indicators

## 2.6 Nameplate description

**Figure 2-3 Typical drive rating labels size 2 (C200 shown)**




| Key to approvals | | |
|---|---|---|
| CE | CE approval | Europe |
| | C Tick approval | Australia |
| c UL us | UL / cUL approval | USA & Canada |
| | RoHS compliant | China |
| FUNCTIONAL SAFETY c UL us LISTED | Functional safety | USA & Canada |
| EAC | EurAsian Conformity | EurAsia |

Refer to Figure 2-1 *Model number* on page 10 for further information relating to the labels.

**NOTE**

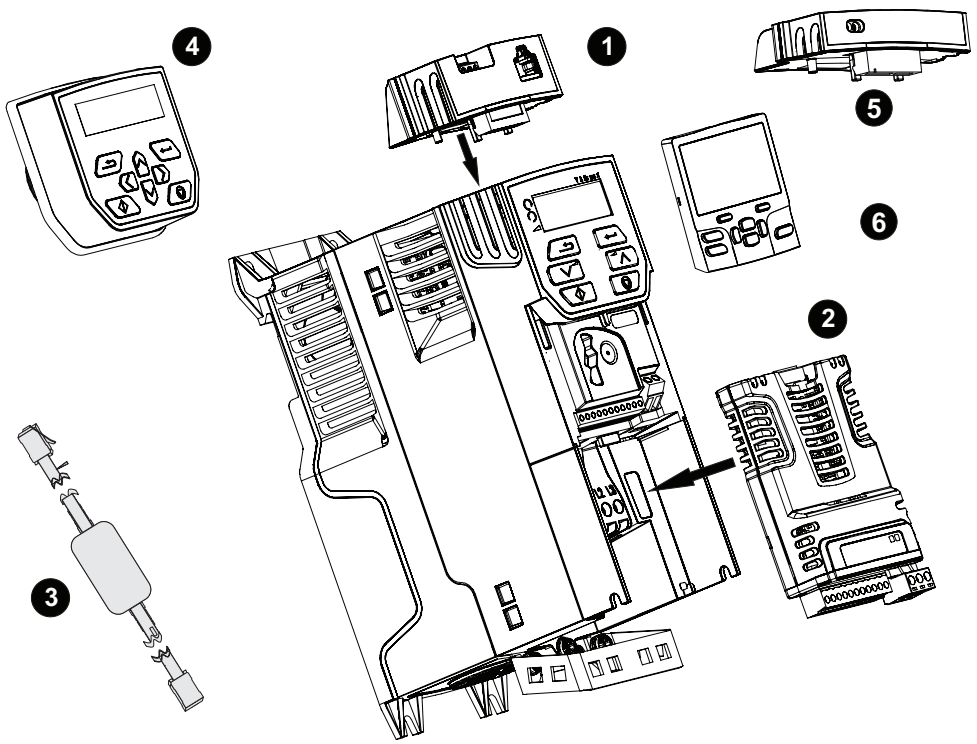
**Date code format**

The date code is four numbers. The first two numbers indicate the year and the remaining numbers indicate the week of the year in which the drive was built. This new format started in 2017.

**Example:**
A date code of **1710** would correspond to week 10 of year 2017.

## 2.7 Options

**Figure 2-4 Options available with the drive**




1. AI 485 Adaptor
2. Option module (SI)
3. CT USB Comms cable
4. Remote mountable LCD keypad
5. AI-Backup adaptor module
6. Remote-Keypad RTC

**Table 2-1 System Integration (SI) option module identification**

| Type | Option module | Color | Name | Further details |
|---|---|---|---|---|
| Fieldbus |  | Purple | SI-PROFIBUS | **Profibus option**<br>PROFIBUS adaptor for communications with the drive |
| |  | Medium Grey | SI-DeviceNet | **DeviceNet option**<br>DeviceNet adaptor for communications with the drive |
| |  | Light Grey | SI-CANopen | **CANopen option**<br>CANopen adaptor for communications with the drive |
| |  | Yellow Green | SI-PROFINET V2 | **PROFINET V2 option**<br>PROFINET V2 adapter for communications with the drive |
| |  | Beige | SI-Ethernet | **Ethernet option**<br>External Ethernet module that supports EtherNet/IP, Modbus TCP/IP and RTMoE. The module can be used to provide global connectivity and integration with IT network technologies, such as wireless networking |
| |  | Brown Red | SI-EtherCAT | **EtherCAT option**<br>EtherCAT adapter for communications with the drive |
| Automation (I/O expansion) |  | Orange | SI-I/O | **Extended I/O**<br>Increases the I/O capability by adding the following combinations:<br>• Digital I/O<br>• Digital Inputs<br>• Analog Inputs (differential or single ended)<br>• Relays |

**Table 2-2 Adaptor Interface (AI) option module identification**

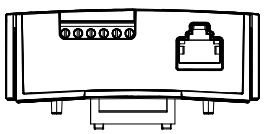
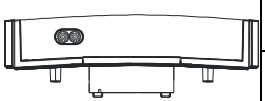
| Type | Option module | Name | Further details |
|---|---|---|---|
| Communications |  | AI-485 adaptor | **EIA 485 serial communications option**<br>Provides a EIA 485 serial communications interface via an RJ45 connector or alternative screw terminals. |
| | | AI-485 24V adaptor | **EIA 485 serial communications option**<br>Provides a EIA 485 serial communications interface via an RJ45 connector or alternative screw terminals. It also provides a 24 V Backup supply input. |
| Backup |  | AI-Backup adaptor | **+24 V Backup and SD card interface**<br>Provides a +24 V Backup supply input and SD card interface |
| | | AI-Smart adaptor | **+24 V Backup and SD card interface**<br>Supplied with 4 GB SD card for parameter copying and an input for 24 V Backup |

**Table 2-3 Keypad identification**

| Type | Keypad | Name | Further Details |
|---|---|---|---|
| Keypad |  | Remote-Keypad | **Remote LCD keypad option**<br>Remote Keypad with a LCD display |
| |  | Remote-Keypad RTC | **Remote LCD keypad option**<br>Remote Keypad with a LCD display and real time clock |

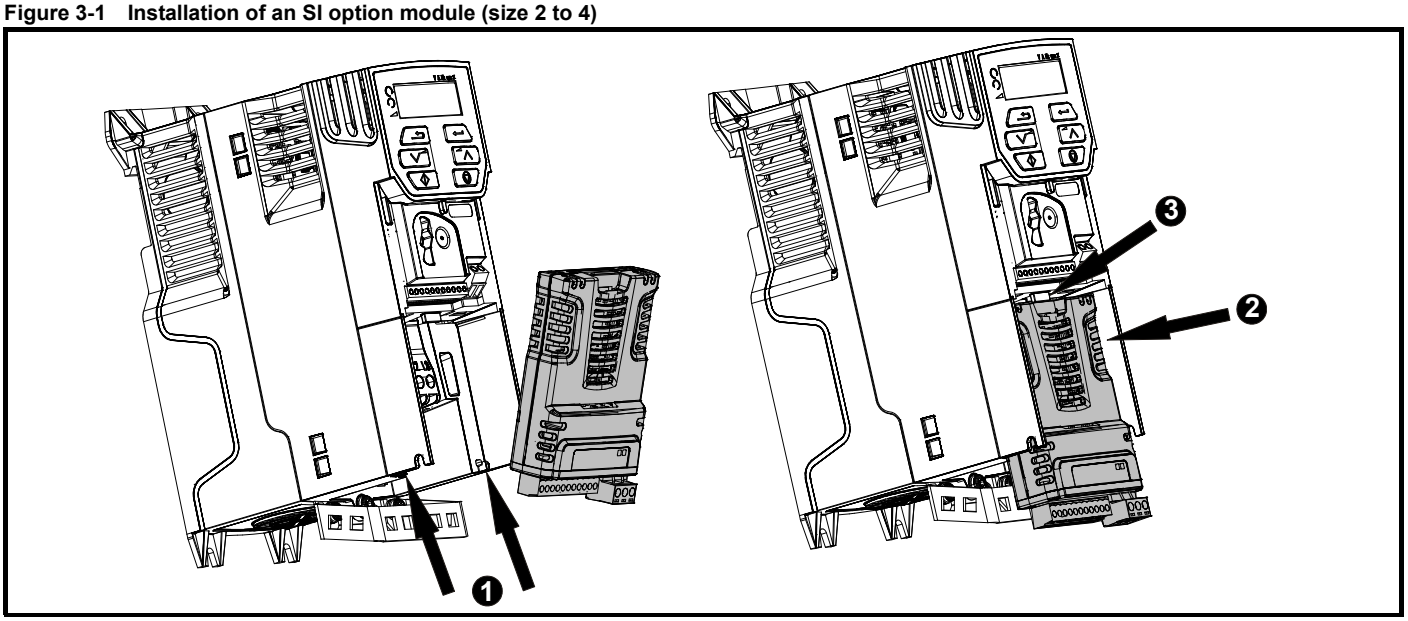
# 3 Mechanical installation

## 3.1 Installing / removing options

**CAUTION**

Power down the drive before installing / removing the SI option module. Failure to do so may result in damage to the product.

**Figure 3-1 Installation of an SI option module (size 2 to 4)**

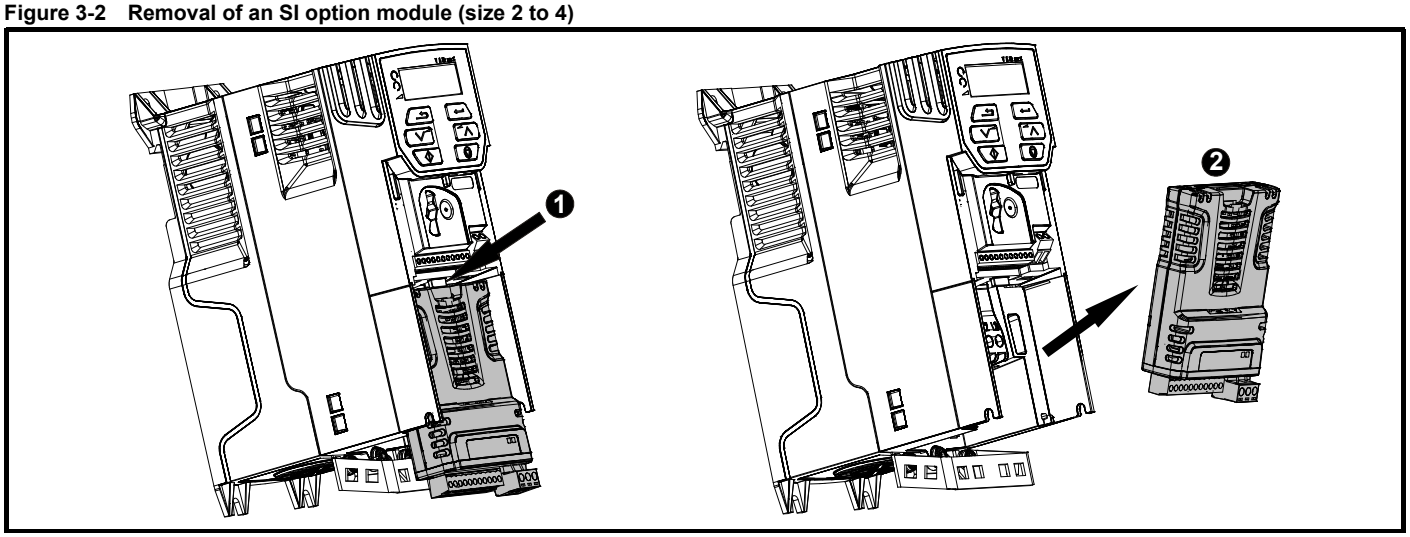



- With the option module tilted slightly backwards, align and locate the two holes in the rear of the option module onto the two tabs (1) on the drive.
- Press the option module onto the drive as shown in (2) until the connector mates with the drive, ensuring that the tab (3) retains the option module in place.

**NOTE**

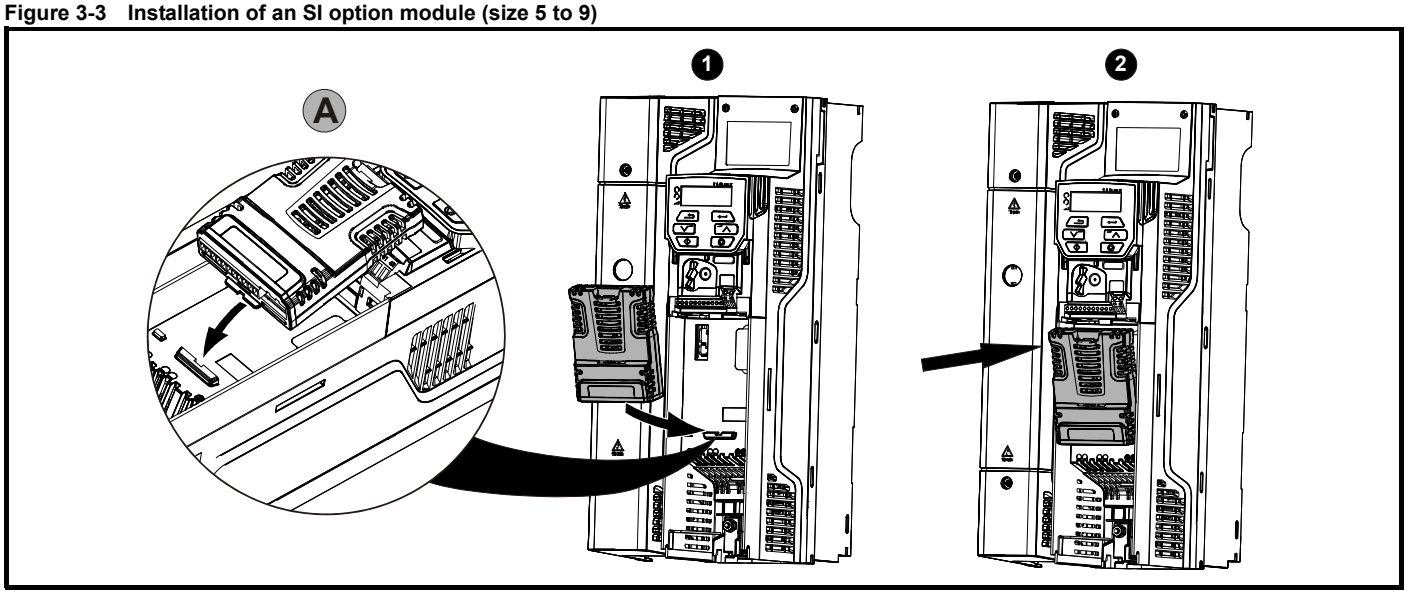
Check that the option module is securely located on the drive. Always ensure that the terminal cover is always replaced before use as this ensures that the option module is firmly secured.

**Figure 3-2 Removal of an SI option module (size 2 to 4)**



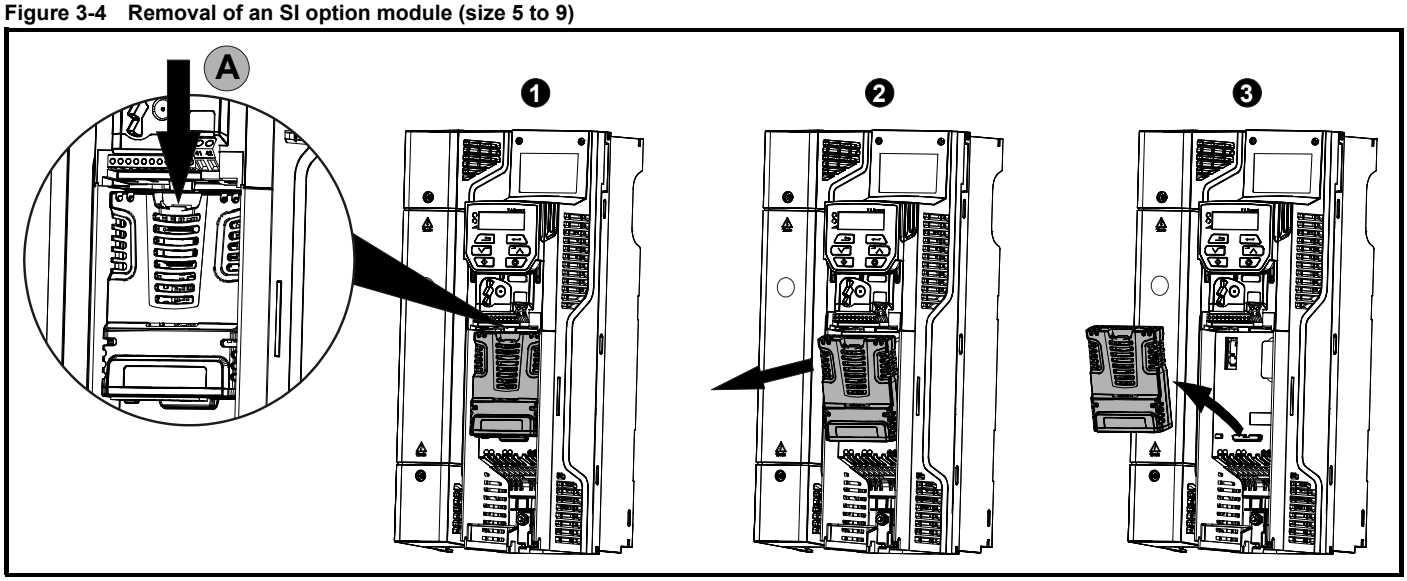

- Press down on the tab (1) to release the option module from the drive housing as shown.
- Tilt the option module slightly towards you and pull away from the drive housing (2).

**Figure 3-3 Installation of an SI option module (size 5 to 9)**



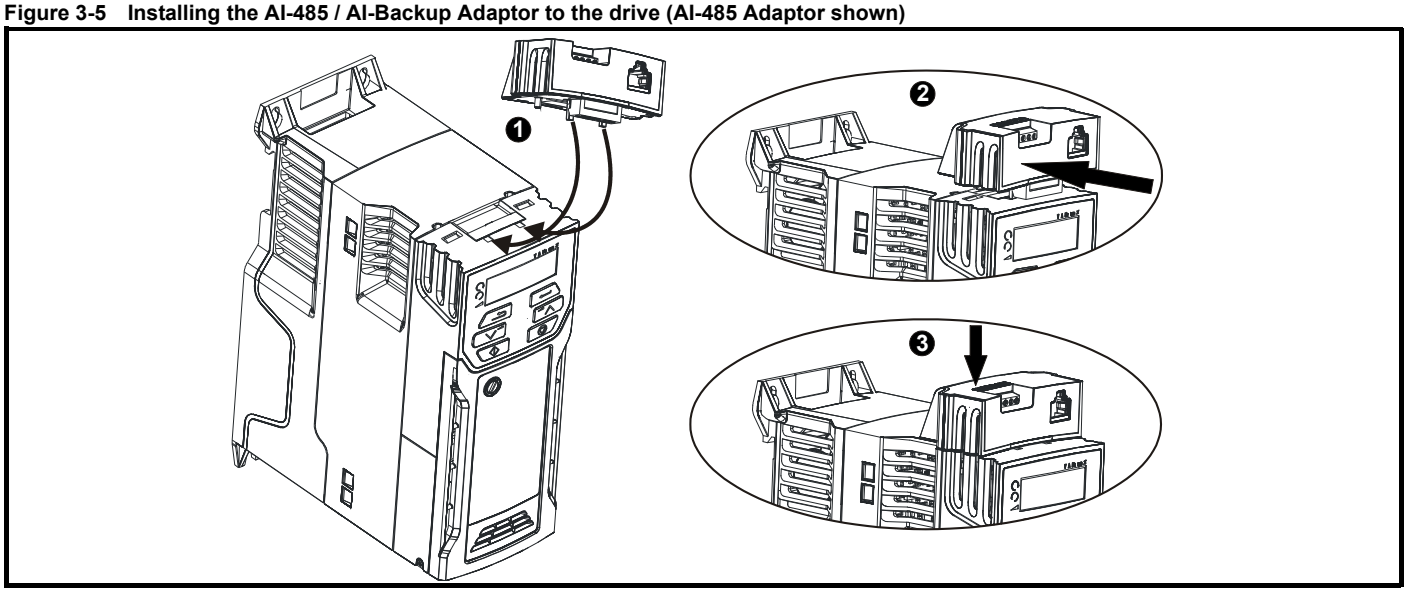

- Move the option module in the direction shown (1).
- Align and insert the option module tab into the slot provided (2), This is shown in the detailed view (A).
- Press down on the option module until it clicks in place.

**Figure 3-4 Removal of an SI option module (size 5 to 9)**



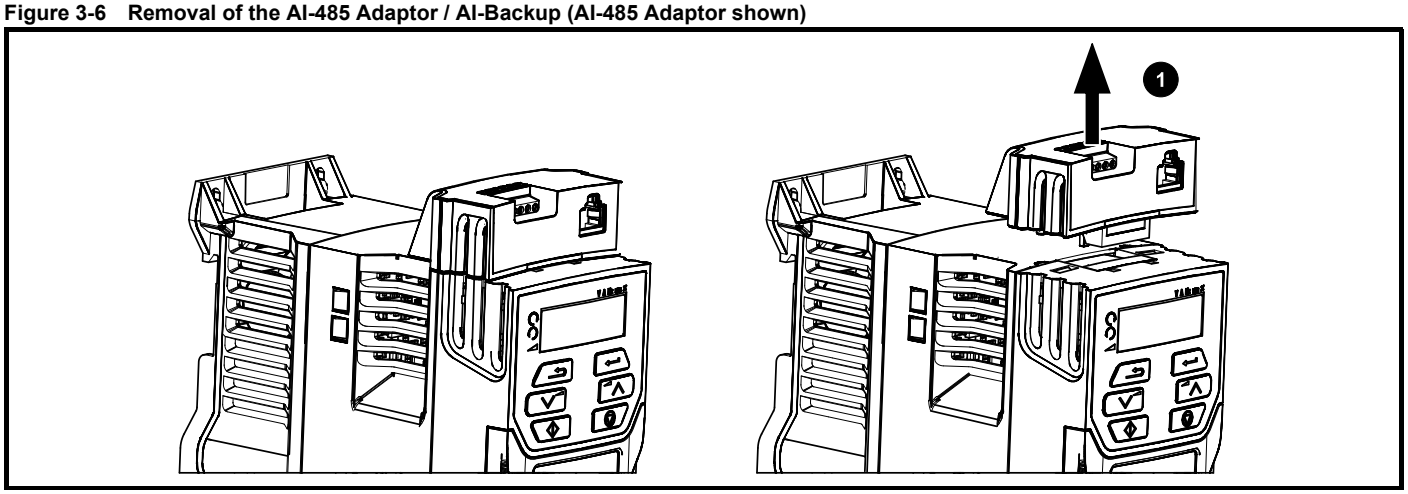

- To release the option module from the drive housing, press down on the tab (1) as shown in detailed view (A).
- Tilt the option module towards you as shown in (2).
- Remove the option module by lifting away from the drive as shown in (3).

**Figure 3-5 Installing the AI-485 / AI-Backup Adaptor to the drive (AI-485 Adaptor shown)**




- Identify the two plastic fingers on the underside of the AI-485 / AI-Backup Adaptor (1) - then insert the two fingers into the corresponding slots in the spring loaded sliding cover on the top of the drive.
- Hold the adaptor firmly and push the spring loaded protective cover towards the back of the drive to expose the connector block (2) below.
- Press the adaptor downwards (3) until the adaptor connector locates into the drive connection below.

**Figure 3-6 Removal of the AI-485 Adaptor / AI-Backup (AI-485 Adaptor shown)**




- To remove the AI-485 / AI-Backup adaptor, pull it up and away from the drive in the direction shown (1)

## 3.2 Real time clock battery replacement

Those keypads which have the real time clock feature contain a battery to ensure the clock works when the drive is powered down. The battery has a long life time but if the battery needs to be replaced or removed, follow the instructions below.

Low battery voltage is indicated by low battery symbol on the keypad display.

**Figure 3-7 Remote Keypad RTC (rear view)**

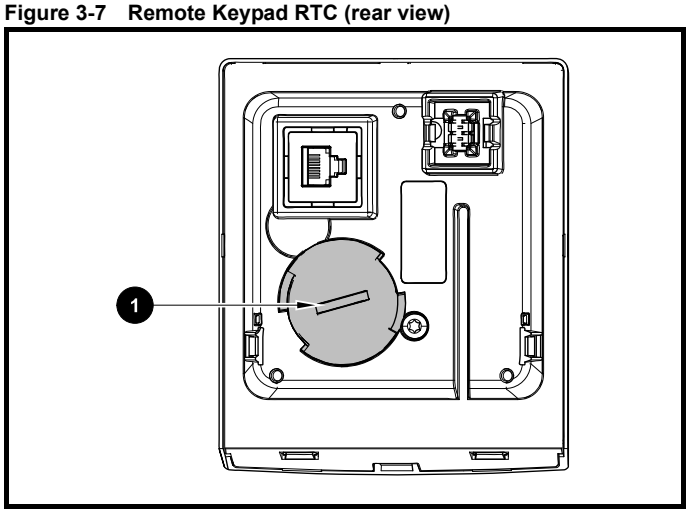



Figure 3-7 above illustrates the rear view of the Remote Keypad RTC.

1. To remove the battery cover insert a flat head screwdriver into the slot as shown (1), push and turn anti-clockwise until the battery cover is released.
2. Replace the battery (the battery type is: CR2032).
3. Reverse point 1 above to replace battery cover.

**NOTE**

Ensure the battery is disposed of correctly.

# 4 Electrical installation

## 4.1 24 Vdc supply

The 24 Vdc supply connected to the +24 V supply terminals on the AI-Backup adaptor provides the following functions:

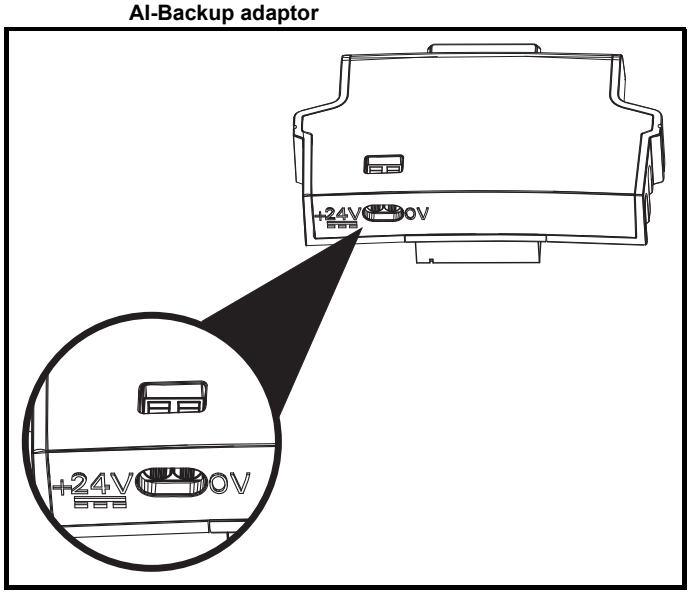
- It can be used as a back-up power supply to keep the control circuits of the drive powered up when the line power supply is removed. This allows any fieldbus modules or serial communications to continue to operate. If the line power supply is re-applied, then the normal operation can carry on after the drive automatically re-initializes the power board parameters.
- It can be used to clone or load parameters in order to pre-configure drives when the line power supply is not available. The keypad can be used to setup parameters if required. However, the drive will be in the Under Voltage state unless the line power supply is enabled, therefore diagnostics may not be possible. (Power down save parameters are not saved when using the 24 V back-up power supply input).

The working voltage range of the 24 V back-up power supply is as follows:

| | |
|---|---|
| **0V** | **0V (connected internally to 0V common - Control terminal 1)** |
| **+ 24 V** | **+ 24 V Backup supply input** |
| Nominal operating voltage | 24.0 Vdc |
| Minimum continuous operating voltage | 19.2 V |
| Maximum continuous operating voltage | 30.0 V |
| Minimum start up voltage | 12.0 V |
| Minimum power supply requirement at 24 V | 20 W |
| Maximum power supply continuous current | 3 A |
| Recommended fuse | 1 A, 50 Vdc |

Minimum and maximum voltage values include ripple and noise. Ripple and noise values must not exceed 5 %.

**Figure 4-1 Location of the 24 Vdc power supply connection on the AI-Backup adaptor**



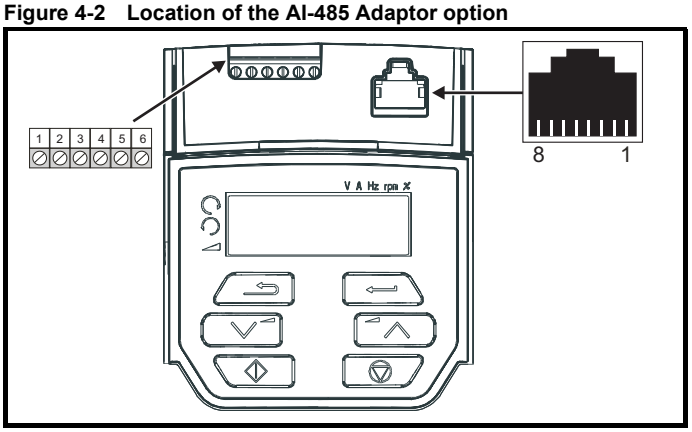

**NOTE**

The 24 Vdc Backup supply can be used on all frame sizes.

## 4.2 Communication connections

Installing an AI-485 Adaptor provides the drive with a 2 wire EIA 485 serial communications interface. This enables the drive set-up, operation and monitoring to be carried out with a PC or controller as required.

**Figure 4-2 Location of the AI-485 Adaptor option**




### 4.2.1 EIA 485 serial communications

The drive only supports Modbus RTU protocol. See Table 4-1 for the connection details.

**NOTE**

Standard Ethernet cables **must not be used** when connecting drives on a EIA 485 network as they do not have the correct twisted pairs for the pinout of the serial comms port.

**Table 4-1 Serial communication port pin-outs (RJ45)**

| Pin | Function |
|---|---|
| 1 | 120 Ω Termination resistor |
| 2 | RX TX |
| 3 | 0V |
| 4 | +24 V (100 mA) output |
| 5 | Not connected |
| 6 | TX enable |
| 7 | RX\ TX\ |
| 8 | RX\ TX\ (if termination resistors are required, link to pin 1) |

Minimum number of connections are 2, 3, 7 and shield.

**Table 4-2 Serial communication port pin-outs (screw terminal block)**

| Pin | Function |
|---|---|
| 1 | 0V |
| 2 | RX\ TX\ (if termination resistor required, link to pin 4) |
| 3 | RX TX |
| 4 | 120 Ω Termination resistor |
| 5 | TX Enable |
| 6 | +24 V (100 mA) output |

**NOTE**

The connections on the RJ45 connector and terminal block are in parallel.

### 4.2.2 Isolation of the EIA 485 serial communication port

The serial communication port is single insulated and meets the requirements for ELV.

**WARNING**

When using the communications port with a personal computer or centralised controller e.g. PLC, an isolation device must be included with a rated voltage at least equal to the drive supply voltage. Ensure that the correct fuses are installed at the drive input, and that the drive is connected to the correct supply voltage.
If a serial communications converter other than the CT Comms cable is used to connect to other circuits classified as Safety Extra Low Voltage (SELV) (e.g. to a personal computer), then a safety isolating barrier must be included to maintain the SELV classification.

An isolated serial communications lead has been designed to connect the drive to IT equipment (such as laptop computers), and is available from the supplier of the drive. See below for details:

**Table 4-3 Isolated serial comms lead details**

| Part number | Description |
|---|---|
| 4500-0096 | CT USB Comms cable |

The “isolated serial communications” lead has reinforced insulation as defined in IEC60950 for altitudes up to 3,000 m.

## 4.3 Control connections

### 4.3.1 General

**Table 4-4 The control connections consist of:**

| Function | Qty | Control parameters available | Terminal number |
|---|---|---|---|
| Single ended analog input | 2 | Mode, offset, invert, scaling, destination | 2, 5 |
| Analog output | 1 | Source, mode, scaling, | 7 |
| Digital input | 5 | Destination, invert | 5, 11, 12, 13, 14 |
| Digital input / output | 1 | Input / output mode select, destination / source, invert | 10 |
| Frequency input | 1 | Maximum reference, input limit, scaling, destination | 14 |
| PWM or frequency output | 1 | Source, scaling, maximum output frequency, mode | 10 |
| Motor thermistor input | 1 | Mode, type, trip threshold, reset threshold | 14 |
| Relay | 1 | Source, invert | 41 |
| Drive enable (Safe Torque Off) | 2 | | 31 (STO 2 input), 34 (STO 1 input) [frame 1- 4] 31 (STO 1 input), 35 (STO 2 input) [frame 5 - 9] |
| +10 V User output | 1 | | 4 |
| +24 V User output | 1 | | 9 |
| 0V common | 1 | | 1 |
| 0V Safe Torque Off | 2 | | 32 (0 V STO 2), 33 (0 V STO 1) [frame 1- 4] 32 (0 V STO 1), 36 (0 V STO 2) [frame 5 - 9] |

**NOTE**

The 0V terminals on the Safe Torque Off are isolated from each other and the 0V common (size 1 to 4). The 0V terminals of the Safe Torque Off function on size 5 to 9 are common with the user 0V terminals.

**Key:**

| | |
|---|---|
| Destination parameter: | Indicates the parameter which is being controlled by the terminal / function |
| Source parameter: | Indicates the parameter being output by the terminal |
| Mode parameter: | Analog - indicates the mode of operation of the terminal, i.e. voltage 0-10 V, current 4-20 mA etc. Digital - indicates the mode of operation of the terminal, (the Drive Enable terminal is fixed in positive logic). |

All analog terminal functions can be programmed in menu 7.

All digital terminal functions (including the relay) can be programmed in menu 8.

**WARNING**

The control circuits are isolated from the power circuits in the drive by basic insulation (single insulation) only. The installer must ensure that the external control circuits are insulated from human contact by at least one layer of insulation (supplementary insulation) rated for use at the AC supply voltage.

**WARNING**

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

**CAUTION**

If any of the digital inputs (including the drive enable input) are connected in parallel with an inductive load (i.e. contactor or motor brake) then suitable suppression (i.e. diode or varistor) should be used on the coil of the load. If no suppression is used then over voltage spikes can cause damage to the digital inputs and outputs on the drive.

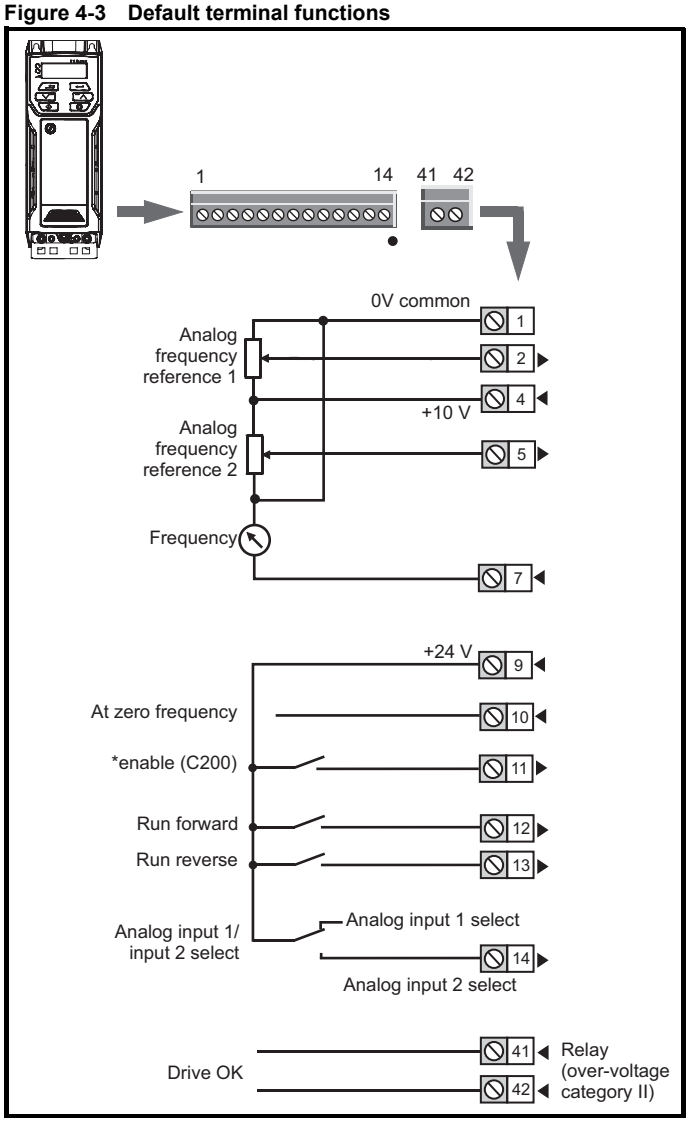
**NOTE**

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

**NOTE**

The Safe Torque Off drive enable terminals are positive logic input only (see Figure 4-4 on page 21).

**Figure 4-3 Default terminal functions**




*C300 uses 'Safe Torque Off' so terminal 11 is unassigned on the Commander C300.

**Figure 4-4 Safe Torque Off inputs (size 1 to 4) C300 only**

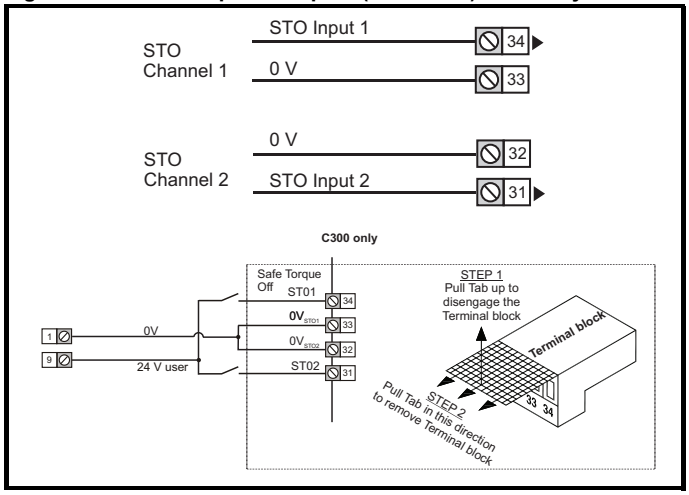
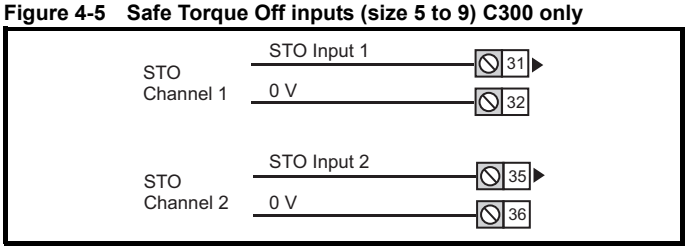



**Figure 4-5 Safe Torque Off inputs (size 5 to 9) C300 only**




## 4.3.2 Control terminal specification

| 1 | 0V common |
|---|---|
| **Function** | **Common connection for all external devices** |

| 2 | Analog input 1 |
|---|---|
| **Default function** | **Frequency reference** |
| Type of input | Unipolar single-ended analog voltage or unipolar current |
| Mode controlled by… | Pr **07.007** |
| **Operating in voltage mode (default)** | |
| Full scale voltage range | 0V to +10 V ±3 % |
| Maximum offset | ±30 mV |
| Absolute maximum voltage range | -18 V to +30 V relative to 0V |
| Input resistance | 100k Ω |
| **Operating in current mode** | |
| Current ranges | 0 to 20 mA ±5 %, 20 to 0 mA ±5 %, 4 to 20 mA ±5 %, 20 to 4 mA ±5 % |
| Maximum offset | 250 µA |
| Absolute maximum voltage (reverse bias) | -18 V to +30 V relative to 0V |
| Absolute maximum current | 25 mA |
| Equivalent input resistance | 165 Ω |
| **Common to all modes** | |
| Resolution | 11 bits |
| Sample rate | 4 ms |

| 4 | +10 V user output |
|---|---|
| **Default function** | **Supply for external analog devices** |
| Nominal voltage | 10.2 V |
| Voltage tolerance | ±3 % |
| Maximum output current | 5 mA |

| 5 | Analog input 2 |
|---|---|
| **Default function** | **Frequency reference** |
| Type of input | Unipolar single-ended analog voltage or positive logic only digital input |
| Mode controlled by.... | Pr **07.011** |
| **Operating in voltage mode (default)** | |
| Full scale voltage range | 0V to +10 V ±3 % |
| Maximum offset | ±30 mV |
| Absolute maximum voltage range | -18 V to +30 V relative to 0V |
| Input resistance | 100 k Ω |
| Resolution | 11 bits |
| Sample rate | 4 ms |
| **Operating in digital mode** | |
| Absolute maximum voltage range | -18 V to +30 V relative to 0V |
| Impedance | 6.8 k Ω |
| Input threshold | 10 V ±0.8 V (IEC 61131-2) |
| Sample rate | 1 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 4 ms. |

| 7 | Analog output 1 |
|---|---|
| **Default function** | **Frequency output** |
| Type of output | Unipolar single-ended analog voltage |
| Voltage range | +10 V |
| Maximum offset | 15 mV |
| Load resistance | ≥ 2k Ω |
| Protection | Short circuit relative to 0V |
| Resolution | 0.1 % |
| Sample rate | 4 ms |

| 9 | +24 V user output |
|---|---|
| **Default function** | **Supply for external digital devices** |
| Voltage tolerance | ±20 % |
| Maximum output current | 100 mA |
| Protection | Current limit and trip |

| 10 | Digital I/O 1 |
|---|---|
| **Default function** | **AT ZERO FREQUENCY output** |
| Type | Positive logic digital input, positive logic voltage source output.<br>PWM or frequency output modes can be selected. |
| Input / output mode controlled by … | Pr **08.031** |
| **Operating as in input** | |
| Absolute maximum applied voltage range | -8 V to +30 V relative to 0V |
| Impedance | 6.8 kΩ |
| Input threshold | 10 V ±0.8 V (IEC 61131-2) |
| **Operating as an output** | |
| Nominal maximum output current | 50 mA |
| Maximum output current | 100 mA (total including +24 Vout) |
| **Common to all modes** | |
| Voltage range | 0V to +24 V |
| Sample rate | 1 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 4 ms |

| 11 | Digital Input 2 |
|---|---|
| 12 | Digital Input 3 |
| 13 | Digital Input 4 |
| **Terminal 11 default function** | **C200: Enable**<br>**C300: Unassigned** |
| **Terminal 12 default function** | **RUN FORWARD input** |
| **Terminal 13 default function** | **RUN REVERSE input** |
| Type | Positive logic only digital inputs |
| Voltage range | 0V to +24 V |
| Absolute maximum applied voltage range | -18 V to +30 V relative to 0V |
| Impedance | 6.8 kΩ |
| Input threshold | 10 V ±0.8 V (IEC 61131-2) |
| Sample rate | 1 ms when routed to destinations Pr 06.035 or Pr 06.036, otherwise 4 ms. |

| 14 | Digital Input 5 |
|---|---|
| **Terminal 14 default function** | **Analog INPUT 1 / INPUT 2 select** |
| Type | Positive logic only digital input. Frequency input or motor thermistor input (bias for DIN44081 ptc, KTY84, PT1000, PT2000 and other types) mode can be selected |
| Voltage range | 0V to +24 V |
| Absolute maximum applied voltage range | -18 V to +30 V relative to 0V |
| Impedance | 6.8 kΩ |
| Input threshold | 10 V ±0.8 V (IEC 61131-2) |
| Sample rate | 1 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 4 ms. |

| 31<br>34 | Safe Torque Off function (drive enable) (Frame 1 to 4) |
|---|---|
| Type | Positive logic only digital input |
| Voltage range | 0 to +24 V |
| Absolute maximum applied voltage | 30 V |
| Logic Threshold | 10 V ±5 V |
| Low state maximum voltage for disable to SIL3 and PL e | 5 V |
| Impedance | >4 mA @ 15 V, <15 mA @30 V (IEC 61131-2, type 1) |
| Low state maximum current for disable to SIL3 and PL e | 0.5 mA |
| Response time | Nominal: 12 ms<br>Maximum: 20 ms |

The Safe Torque Off function may be used in a safety-related application in preventing the drive from generating torque in the motor to a high level of integrity. The system designer is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards. If the Safe Torque Off function is not required, these terminal are used for enabling the drive.

| 41<br>42 | Relay contacts |
|---|---|
| **Default function** | **Drive OK indicator** |
| Contact voltage rating | 240 Vac, Installation over-voltage category II |
| Contact maximum current rating | 2 A AC 240 V<br>4 A DC 30 V resistive load<br>0.5 A DC 30 V inductive load (L/R = 40 ms) |
| Contact minimum recommended rating | 12 V 100 mA |
| Contact type | Normally open |
| Default contact condition | Closed when power applied and drive OK |
| Update rate | 1 ms |

| 32 | 0V STO2 (Frame 1 to 4) C300 only |
|---|---|
| **Function** | Common connection for STO2 |

| 33 | 0V STO1 (Frame 1 to 4) C300 only |
|---|---|
| **Function** | Common connection for STO1 |

| 31<br>35 | **Safe Torque Off function (drive enable) C300 only (Frame 5 to 9)** |
|---|---|
| Type | Positive logic only digital input |
| Voltage range | 0 to +24 V |
| Absolute maximum applied voltage | 30 V |
| Logic Threshold | 10 V ±5 V |
| Low state maximum voltage for disable to SIL3 and PL e | 5 V |
| Impedance | >4 mA @ 15 V (IEC 61131-2, type 1, 3.3 kΩ) |
| Low state maximum current for disable to SIL3 and PL e | 0.5 mA |
| Response time | Nominal: 6 ms<br>Maximum: 20 ms |
| The Safe Torque Off function may be used in a safety-related application in preventing the drive from generating torque in the motor to a high level of integrity. The system designer is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards. If the Safe Torque Off function is not required, these terminal are used for enabling the drive. | |

| 32 | **0V STO1 (Frame 5 to 9) C300 only** |
|---|---|
| **Function** | Common connection for STO1 |

| 36 | **0V STO2 (Frame 5 to 9) C300 only** |
|---|---|
| **Function** | Common connection for STO2 |

**WARNING**

To prevent the risk of a fire hazard in the event of a fault, a fuse or other over-current protection must be installed in the relay circuit.

## 4.4 Safe Torque Off (STO) (C300 only)

The Safe Torque Off function provides a means for preventing the drive from generating torque in the motor, with a very high level of integrity. It is suitable for incorporation into a safety system for a machine. It is also suitable for use as a conventional drive enable input.

The safety function is active when the STO input is in the logic-low state as specified in the control terminal specification. The function is defined according to EN 61800-5-2 and IEC 61800-5-2 as follows. (In these standards a drive offering safety-related functions is referred to as a PDS(SR)):

'Power that can cause rotation (or motion in the case of a linear motor) is not applied to the motor. The PDS(SR) will not provide energy to the motor which can generate torque (or force in the case of a linear motor)'

This safety function corresponds to an uncontrolled stop in accordance with stop category 0 of IEC 60204-1.

The Safe Torque Off function makes use of the special property of an inverter drive with an induction motor, which is that torque cannot be generated without the continuous correct active behaviour of the inverter circuit. All credible faults in the inverter power circuit cause a loss of torque generation.

The Safe Torque Off function is fail-safe, so when the Safe Torque Off input is disconnected the drive will not operate the motor, even if a combination of components within the drive has failed. Most component failures are revealed by the drive failing to operate. Safe Torque Off is also independent of the drive firmware. This meets the requirements of the following standards, for the prevention of operation of the motor.

**Machinery Applications**

The Safe Torque Off function has been independently assessed by Notified Body, TüV Rheinland for use as a safety component of a machine:

*Prevention of unintended motor operation: The safety function "Safe Torque Off" can be used in applications up to Cat 4. PL e according to EN ISO 13849-1, SIL 3 according to EN 61800-5-2/ EN 62061/ IEC 61508 and in lift applications according to EN 81-1 and EN81-2.*

| Type examination certificate number | Date of issue | Models | Frame sizes |
|---|---|---|---|
| 01/205/5387.02/18 | 2018-08-16 | C300 | 5 to 9 |
| 01/205/5383.03/18 | 2018-08-16 | C300 | 1 to 4 |

This certificate is available for download from the TüV Rheinland website at: http://www.tuv.com

**Safety Parameters as verified by TüV Rheinland:**

According to IEC 61508-1 to 07 / EN 61800-5-2 / EN 62061

| Type | Value | Percentage of SIL 3 allowance | Frame sizes |
|---|---|---|---|
| Proof test interval | 20 years | | All |
| High demand or a continuous mode of operation | | | |
| PFH (1/h) | $9.61 \times 10^{-11}$ 1/h | < 1 % | 1 to 4 |
| PFH (1/h) | $4.16 \times 10^{-11}$ 1/h | < 1 % | 5 to 9 |
| Low demand mode of operation (not EN61800-5-2) | | | |
| PFDavg | $8.4 \times 10^{-6}$ | < 1 % | 1 to 4 |
| PFDavg | $3.64 \times 10^{-6}$ | < 1 % | 5 to 9 |

According to EN ISO 13849-1

| Type | Value | Classification |
|---|---|---|
| Category | 4 | |
| Performance Level (PL) | e | |
| $MTTF_D$ (STO1) | >2500 years | High |
| $MTTF_D$ (STO2) | >2500 years | High |
| $MTTF_D$ (Single channel STO) | >2500 years | High |
| $DC_{avg}$ | ≥99 % | High |
| Mission time | 20 years | |

**NOTE**

Logic levels comply with IEC 61131-2:2007 for type 1 digital inputs rated at 24 V. Maximum level for logic low to achieve SIL3 and PL e 5 V and 0.5 mA.

**Lift (Elevator) Applications**

The Safe Torque function has been independently assessed for use as a safety component in lift (elevator) applications by Notified Body, TüV Nord:

*The drives Commander series with safe torque off (STO) function if applied according to the "Conditions of application" fulfil the safety requirements of the standards EN81-1, EN81-2, EN 81-50 and EN60664-1and are in conformity with all relevant requirements of the Directive 95/16/EC.*

| Certificate of Conformity number | Date of issue | Models |
|---|---|---|
| 44 799 13196202 | 2015-04-08 | C300 |

The Safe Torque Off function can be used to eliminate electro-mechanical contactors, including special safety contactors, which would otherwise be required for safety applications.

For further information contact the supplier of the drive.

**UL Approval**

The Safe Torque Off function has been independently assessed by Underwriters Laboratories (UL). The on-line certification (yellow card) reference is: FSPC.E171230.

**Safety Parameters as verified by UL:**

According to IEC 61508-1 to 7

| Type | Value |
|---|---|
| Safety Rating | SIL 3 |
| SFF | > 99% |
| PFH (1/h) | $4.43 \times 10^{-10}$ 1/h (< 1% of SIL 3 allowance) |
| HFT | 1 |
| Beta Factor | 2 % |
| CCF | Not applicable |

According to EN ISO 13849-1

| Type | Value |
|---|---|
| Category | 4 |
| Performance Level (PL) | e |
| $MTTF_D$ | 2574 years |
| Diagnostic coverage | High |
| CCF | 65 |

**Two-channel Safe Torque Off**

The Commander C300 models have dual channel STO.

The dual channel STO has two fully independent channels.

Each input meets the requirements of the standards as defined above.

If either or both inputs are set at a logic low state, there are no single faults in the drive which can permit the motor to be driven.

It is not necessary to use both channels to meet the requirements of the standards. The purpose of the two channels is to allow connection to machine safety systems where two channels are required, and to facilitate protection against wiring faults.

For example, if each channel is connected to a safety-related digital output of a safety related controller, computer or PLC, then on detection of a fault in one output the drive can still be disabled safely through the other output.

Under these conditions, there are no single wiring faults which can cause a loss of the safety function, i.e. inadvertent enabling of the drive.

In the event that the two-channel operation is not required, the two inputs can be connected together to form a single Safe Torque Off input.

In this case it is important to note that a single short-circuit from the Safe Torque Off input to a DC supply > 5 V could cause the drive to be enabled.

This might occur through a fault in the wiring. This can be excluded according to EN ISO 13849-2 by the use of protected wiring. The wiring can be protected by either of the following methods:

- By placing the wiring in a segregated cable duct or other enclosure.

**or**

- By providing the wiring with a grounded shield in a positive-logic grounded control circuit. The shield is provided to avoid a hazard from an electrical fault. It may be grounded by any convenient method; no special EMC precautions are required.

**Note on response time of Safe Torque Off, and use with safety controllers with self-testing outputs:**

Safe Torque Off has been designed to have a response time of greater than 1 ms so that it is compatible with safety controllers whose outputs are subject to a dynamic test with a pulse width not exceeding 1 ms.


The design of safety-related control systems must only be done by personnel with the required training and experience. The Safe Torque Off function will only ensure the safety of a machine if it is correctly incorporated into a complete safety system. The system must be subject to a risk assessment to confirm that the residual risk of an unsafe event is at an acceptable level for the application


Safe Torque Off does not provide electrical isolation. The supply to the drive must be disconnected by an approved isolation device before gaining access to power connections.


Safe Torque Off inhibits the operation of the drive, this includes inhibiting braking. If the drive is required to provide both braking and Safe Torque Off in the same operation (e.g. for emergency stop) then a safety timer relay or similar device must be used to ensure that the drive is disabled a suitable time after braking. The braking function in the drive is provided by an electronic circuit which is not fail-safe. If braking is a safety requirement, it must be supplemented by an independent fail-safe braking mechanism.


It is essential to observe the maximum permitted voltage of 5 V for a safe low (disabled) state of Safe Torque Off. The connections to the drive must be arranged so that voltage drops in the 0V wiring cannot exceed this value under any loading condition. It is strongly recommended that the Safe Torque Off circuits be provided with a dedicated 0V conductors which should be connected to terminals 32 and 33 (sizes 1 to 4) and terminals 32 and 36 (sizes 5 to 9) at the drive.

**Safe Torque Off over-ride**

The drive does not provide any facility to over-ride the Safe Torque Off function, for example for maintenance purposes.

# 5 Getting started

This chapter introduces the user interfaces, menu structure and security levels of the drive.

## 5.1 Understanding the display

### 5.1.1 Keypad

The keypad display consists of a 6 digit LED display. The display shows the drive status or the menu and parameter number currently being edited.

The option module menu (S.mm.ppp) is only displayed if the option module is installed. Where S signifies the option module slot number and the mm.ppp signifies the menu and parameter number of the option module's internal menus and parameter.

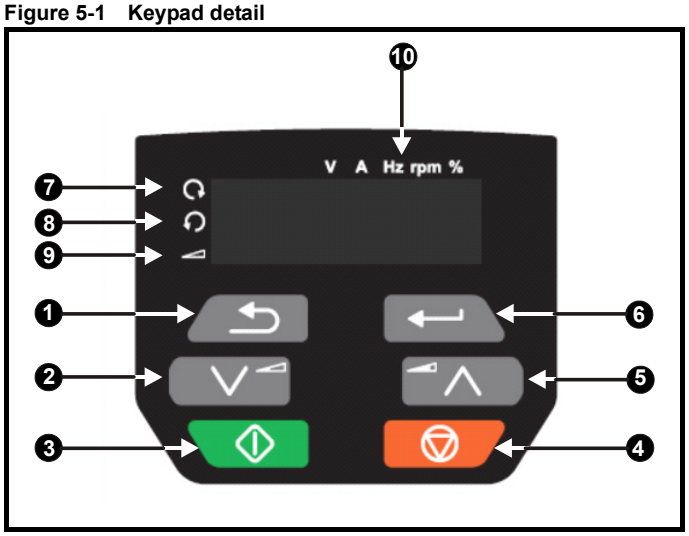
The display also includes LED indicators showing units and status as shown in Figure 5-1.

When the drive is powered up, the display will show the power up parameter defined by *Parameter Displayed At Power-Up* (11.022).

**NOTE**

The values in the *Status Mode Parameters* (Pr **22** and Pr **23**) shown on the display when the drive is running, can be toggled by using the escape button.

**Figure 5-1 Keypad detail**




1. Escape button
2. Down button
3. Start button (green)
4. Stop / Reset button (red)
5. Up button
6. Enter button
7. Run forward indicator
8. Run reverse indicator
9. Keypad reference indicator
10. Unit indicators

**NOTE**

The red stop button is also used to reset the drive.

The parameter value is correctly displayed on the keypad display as shown in Table 5-1.

**Table 5-1 Keypad display formats**

| Display formats | Value |
|---|---|
| Standard | 100.99 |
| Date | 31.12.11 or 12.31.11 |
| Time | 12.34.56 |
| Character | ABCDEF |
| Binary | 5 |
| IP Address | 192.168 88.1* |
| MAC Address | 01.02.03 04.05.06* |
| Version number | 01.23.45 |

*Alternate display

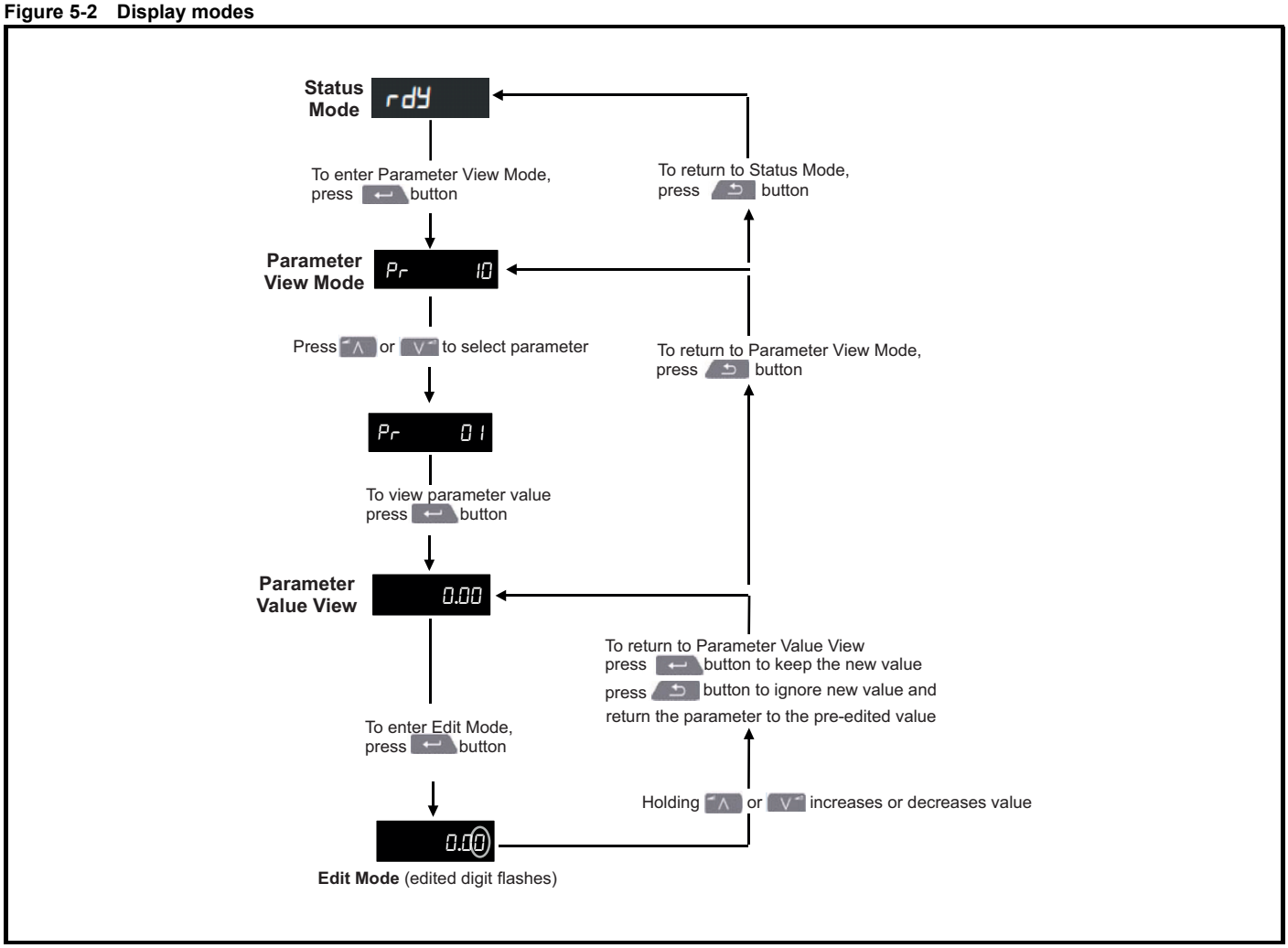
## 5.2 Keypad operation

### 5.2.1 Control buttons

The keypad consists of:

- Up and down button - Used to navigate the parameter structure and change parameter values.
- Enter button - Used to change between parameter edit and view mode, as well as entering data. This button can also be used to select between slot menu and parameter display.
- Escape button - Used to exit from parameter edit or view mode. In parameter edit mode, if parameter values are edited and the escape button pressed, the parameter value will be restored to the value it had on entry to edit mode.
- Start button - Used to provide a 'Run' command if keypad mode is selected.
- Stop / Reset button - Used to reset the drive. In keypad mode can be used for 'Stop'.

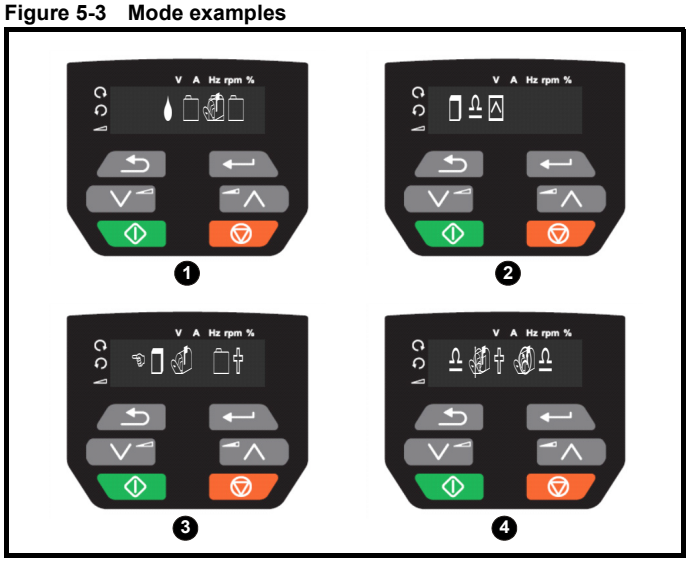
**Figure 5-2 Display modes**




**NOTE**

The up and down buttons can only be used to move between menus if Pr **10** has been set to show 'ALL'. Refer to section 5.9 *Parameter access level and security* on page 29.

**Figure 5-3 Mode examples**




**1** Parameter view mode: Read write or Read only

**2** Status mode: Drive OK status

If the drive is ok and the parameters are not being edited or viewed, the display will show one of the following:

inh', 'rdy' or status mode parameter value.

**3** Status mode: Trip status

When the drive is in trip condition, the display will indicate that the drive has tripped and the display will show the trip code. For further information regarding trip codes, refer to section 12.4 *Trips, Sub-trip numbers* on page 149.

**4** Status mode: Alarm status

During an 'alarm' condition the display flashes between the drive status parameter value and the alarm.

**WARNING**

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

**NOTE**

When changing the values of parameters, make a note of the new values in case they need to be entered again.

**NOTE**

New parameter values must be saved to ensure that the new values apply after the drive has been power cycled. Refer to section 5.7 *Saving parameters* on page 28.

## 5.3 Menu structure

The drive parameter structure consists of menus and parameters.

The drive initially powers up so that only Menu 0 can be viewed. The up and down arrow buttons are used to navigate between parameters and once Pr **10** has been set to 'All' the up and down buttons are used to navigate between menus.

For further information refer to section 5.9 *Parameter access level and security* on page 29.

The menus and parameters rollover in both directions i.e. if the last parameter is displayed, a further press will cause the display to rollover and show the first parameter.

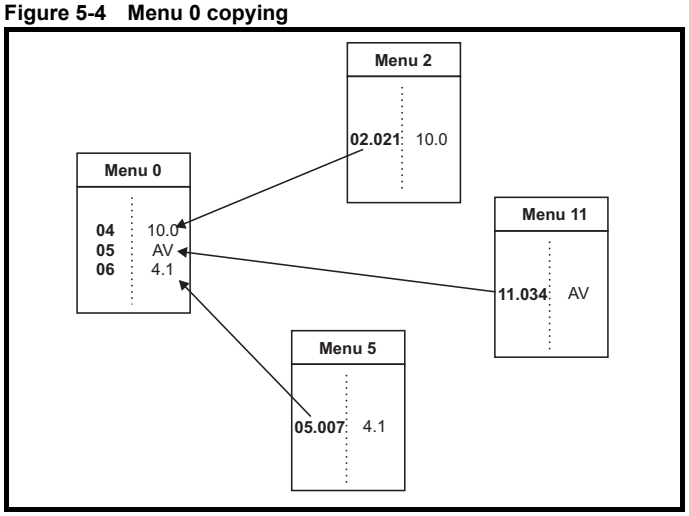
When changing between menus, the drive remembers which parameter was last viewed in a particular menu and thus displays that parameter.

## 5.4 Menu 0

Menu 0 is used to bring together various commonly used parameters for basic easy set up of the drive. The parameters displayed in Menu 0 can be configured in Menu 22.

Appropriate parameters are copied from the advanced menus into Menu 0 and thus exist in both locations.
For further information, refer to Chapter 6 *Basic parameters* on page 31.

**Figure 5-4 Menu 0 copying**




## 5.5 Advanced menus

The advanced menus consist of groups or parameters appropriate to a specific function or feature of the drive. Menus 0 to 24 can be viewed on the Keypad.

The option module menu (1.mm.ppp) is only displayed if the option module is installed. Where 1 signifies the option module slot number and the mm.ppp signifies the menu and parameter number of the option module's internal menus and parameters.

**Table 5-2 Advanced menu descriptions**

| Menu | Description |
|---|---|
| 0 | Commonly used basic set up parameters for quick / easy programming |
| 1 | Frequency reference |
| 2 | Ramps |
| 3 | Frequency control |
| 4 | Torque and current control |
| 5 | Motor control |
| 6 | Sequencer and clock |
| 7 | Analog I/O |
| 8 | Digital I/O |
| 9 | Programmable logic, motorized pot, binary sum, timers |
| 10 | Status and trips |
| 11 | Drive set-up and identification, serial communications |
| 12 | Threshold detectors and variable selectors |
| 14 | User PID controller |
| 15 | Option module slot 1 set-up menu |
| 18 | General option module application menu 1 |
| 20 | General option module application menu 2 |
| 21 | Second motor parameters |
| 22 | Menu 0 set-up |
| 24 | Option module slot 1 application menu |
| Slot 1 | Slot 1 option menus* |

* Only displayed when the option module is installed.

### 5.5.1 Display messages

The following tables indicate the various possible mnemonics which can be displayed by the drive and their meaning.

**Table 5-3 Status indications**

| String | Description | Drive output stage |
|---|---|---|
| **inh** | The drive is inhibited and cannot be run. The Safe Torque Off signal is not applied to Safe Torque Off terminals or Pr **06.015** is set to 0. The other conditions that can prevent the drive from enabling are shown as bits in *Enable Conditions* (06.010) | Disabled |
| **rdy** | The drive is ready to run. The drive enable is active, but the drive inverter is not active because the final drive run is not active | Disabled |
| **Stop** | The drive is stopped / holding zero speed. | Enabled |
| **S.Loss** | Supply loss condition has been detected | Enabled |
| **dc inj** | The drive is applying dc injection braking | Enabled |
| **Er** | The drive has tripped and no longer controlling the motor. The trip code appears on the display. | Disabled |
| **UV** | The drive is in the under voltage state either in low voltage or high voltage mode. | Disabled |
| **HEAt** | The motor pre-heat function is active | Enabled |

### 5.5.2 Alarm indications

An alarm is an indication given on the display by alternating the alarm string with the drive status string on the display. Alarms strings are not displayed when a parameter is being edited.

**Table 5-4 Alarm indications**

| Alarm string | Description |
|---|---|
| **br.res** | Brake resistor overload. *Braking Resistor Thermal Accumulator* (10.039) in the drive has reached 75.0 % of the value at which the drive will trip. |
| **OV.Ld** | *Motor Protection Accumulator* (04.019) in the drive has reached 75.0 % of the value at which the drive will trip and the load on the drive is >100 %. |
| **d.OV.Ld** | Drive over temperature. *Percentage Of Drive Thermal Trip Level* (07.036) in the drive is greater than 90 %. |
| **tuning** | The autotune procedure has been initialized and an autotune in progress. |
| **LS** | Limit switch active. Indicates that a limit switch is active and that is causing the motor to be stopped. |
| **Opt.Al** | Option slot alarm. |
| **Lo.AC** | Low voltage mode. See *Low AC Alarm* (10.107). |
| **I.AC.Lt** | Current limit active. See *Current Limit Active* (10.009). |
| **24.LoSt** | 24V Backup not present. See *24V Alarm Loss Enable* (11.098) |

## 5.6 Changing the operating mode

**Procedure**

Use the following procedure only if a different operating mode is required:

1. Ensure the drive is not enabled, i.e. drive is in inhibit or under voltage state.
2. Change the setting of Pr **79** as follows:

| Pr 79 setting | | Operating mode |
|---|---|---|
|  | 1 | Open-loop |
|  | 2 | RFC-A |

The figures in the second column apply when serial communications are used.

**NOTE**

When the operating mode is changed, a parameter save is carried out.

3. Either:

- Press the red  reset button
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100.

## 5.7 Saving parameters

When changing a parameter in Menu 0, the new value is saved when pressing the Enter button  to return to parameter view mode from parameter edit mode.

If parameters have been changed in the advanced menus, then the change will not be saved automatically. A save function must be carried out.

**Procedure**

1. Select 'Save' in Pr **00** or Pr **mm.000** (alternatively enter a value of 1001 in Pr **00** or Pr **mm.000**)
2. Either:

- Press the red  reset button
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100

## 5.8 Restoring parameter defaults

Restoring parameter defaults by this method saves the default values in the drives memory. *User security status* (Pr **10**) and *User security code* (Pr **25**) are not affected by this procedure).

**Procedure**

1. Ensure the drive is not enabled, i.e. drive is in inhibit or under voltage state.
2. Select 'Def.50' or 'Def.60' in Pr **00** or Pr **mm.000**. (alternatively, enter 1233 (50 Hz settings) or 1244 (60 Hz settings) in Pr **00** or Pr **mm.000**).
3. Either:

- Press the red  reset button
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100

## 5.9 Parameter access level and security

The parameter access level determines whether the user has access to Menu 0 only or to all the advanced menus (Menus 1 to 24) in addition to Menu 0.

The User Security determines whether the access to the user is read only or read write.

Both the User Security and Parameter Access Level can operate independently of each other as shown in Table 5-5.

**Table 5-5 Parameter access level and security**

| User security status (Pr 10) | Access level | Menu 0 status | Advanced menu status |
|---|---|---|---|
| 0 | LEVEL.1 | RW | Not visible |
| 1 | LEVEL.2 | RW | Not visible |
| 2 | ALL | RW | RW |
| 3 | StAtUS | RW | Not visible |
| 4 | no.Acc | RW | Not visible |

The default settings of the drive are Parameter Access Level: LEVEL.1 and user Security Open i.e. read / write access to Menu 0 with the advanced menus not visible.

### 5.9.1 User Security Level / Access Level

The drive provides a number of different levels of security that can be set by the user via *User Security Status* (Pr **10**); these are shown in the table below.

| User Security Status (Pr 10) | Description |
|---|---|
| LEVEL.1 (0) | Access to first 10 parameters in Menu 0 only. |
| LEVEL.2 (1) | Access to all parameters in Menu 0. |
| ALL (2) | Access to all menus. |
| StAtUS (3) | The keypad remains in status mode and only first 10 parameters in Menu 0 can be viewed or edited. |
| no.Acc (4) | The keypad remains in status mode and only first 10 parameters in Menu 0 can be viewed or edited. Drive parameters cannot be accessed via a comms interface. |

### 5.9.2 Changing the User Security Level /Access Level

The security level is determined by the setting of Pr **10** or Pr **11.044**. The Security Level can be changed through the keypad even if the User Security Code has been set.

### 5.9.3 User Security Code

The User Security Code, when set, prevents write access to any of the parameters in any menu.

#### Setting User Security Code

Enter a value between 1 and 9999 in Pr **25** and press the  button; the security code has now been set to this value. In order to activate the security, the Security level must be set to desired level in Pr **10**. When the drive is reset, the security code will have been activated and the drive returns to LEVEL.1. The value of Pr **25** will return to 0 in order to hide the security code.

#### Unlocking User Security Code

Select a parameter that need to be edited and press the  button, the display will now show ‘Co’. Use the arrow buttons to set the security code and press the  button. With the correct security code entered, the display will revert to the parameter selected in edit mode.

If an incorrect security code is entered, the following message ‘Co.Err’ is displayed, and the display will revert to parameter view mode.

#### Disabling User Security

Unlock the previously set security code as detailed above. Set Pr **25** to 0 and press the  button. The User Security has now been disabled, and will not have to be unlocked each time the drive is powered up to allow read / write access to the parameters.

## 5.10 Displaying parameters with non-default values only

By selecting 'diff.d' in Pr **00** (Alternatively, enter 12000 in Pr **00**), the only parameters that will be visible to the user will be those containing a non-default value. This function does not require a drive reset to become active. In order to deactivate this function, return to Pr **00** and select 'none' (alternatively enter a value of 0). Please note that this function can be affected by the access level enabled, refer to section 5.9 *Parameter access level and security* on page 29 for further information regarding access level.

## 5.11 Displaying destination parameters only

By selecting 'dest' in Pr **00** (Alternatively enter 12001 in Pr **00**), the only parameters that will be visible to the user will be destination parameters. This function does not require a drive reset to become active. In order to deactivate this function, return to Pr **00** and select 'none' (alternatively enter a value of 0).

Please note that this function can be affected by the access level enabled, refer to section 5.9 *Parameter access level and security* on page 29 for further information regarding access level.

## 5.12 Communications

Installing an AI-485 Adaptor provides the drive with a 2 wire EIA 485 serial communications interface. This enables the drive set-up, operation and monitoring to be carried out with a PC or controller as required.

### 5.12.1 EIA 485 Serial communications

Communication is via the RJ45 connector or screw terminals (parallel connection). The drive only supports Modbus RTU protocol.

The communications port applies a 1.25 unit load to the communications network.

**USB to EIA485 Communications**

An external USB hardware interface such as a PC cannot be used directly with the 2-wire EIA485 interface of the drive. Therefore a suitable converter is required.

A suitable USB to EIA485 isolated converter is available from Control Techniques as follows:

- CT USB Comms cable (CT Part No. 4500-0096)

When using the above converter or any other suitable converter with the drive, it is recommended that no terminating resistors be connected on the network. It may be necessary to 'link out' the terminating resistor within the converter depending on which type is used. The information on how to link out the terminating resistor will normally be contained in the user information supplied with the converter.

**Serial communications set-up parameters**

The following parameters need to be set according to the system requirements.

| Serial communications set-up parameters | | |
|---|---|---|
| *Serial Mode* (11.024) | 8 2 NP (0),<br>8 1 NP (1),<br>8 1 EP (2),<br>8 1 OP (3),<br>8 2 NP M (4),<br>8 1 NP M (5),<br>8 1 EP M (6),<br>8 1 OP M (7),<br>7 1 EP (8),<br>7 1 OP (9),<br>7 1 EP M (10),<br>7 1 OP M (11) | The drive only supports the Modbus RTU protocol and is always a slave. This parameter defines the supported data formats used by the EIA 485 comms port (if installed) on the drive. This parameter can be changed via the drive keypad, via a option module or via the comms interface itself. |
| *Serial Baud Rate* (Pr **43**) | 600 (1),<br>1200 (2),<br>2400 (3),<br>4800 (4),<br>9600 (5),<br>19200 (6),<br>38400 (7),<br>57600(8),<br>76800(9),<br>115200 (10) | This parameter can be changed via the drive keypad, via a option module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original baud rate. The master should wait at least 20 ms before sending a new message using the new baud rate. |
| *Serial Address* (Pr **44**) | 1 to 247 | This parameter defines the serial address and an addresses between 1 and 247 are permitted. |
| *Reset Serial Communications* (Pr **45**) | Off (0) or On (1) | When the above parameters are modified the changes do not have an immediate effect on the serial communication system. The new values are used after the next power up or if Reset Serial Communications is set to 1. |

# 6 Basic parameters

Menu 0 is used to bring together various commonly used parameters for basic easy set up of the drive. All the parameters in Menu 0 appear in other menus in the drive (denoted by {…}). Menu 22 can be used to configure the parameters in Menu 0.

## 6.1 Parameter ranges and Variable minimum/maximums:

Some parameters in the drive have a variable range with a variable minimum and a variable maximum value which is dependent on one of the following:

- The settings of other parameters
- The drive rating
- The drive mode
- Combination of any of the above

For more information please see section 11.1 *Parameter ranges and Variable minimum/maximums:* on page 87.

## 6.2 Menu 0: Basic parameters

| Parameter | | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | OL | RFC-A | OL | RFC-A | | | | | | |
| **01** | Minimum Speed | **{01.007}** | 0.00 to Pr **02** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **02** | Maximum Speed | **{01.006}** | 0.00 to 550.00 Hz | | 50Hz default: 50.00 Hz<br>60Hz default: 60.00 Hz | | RW | Num | | | | US |
| **03** | Acceleration Rate 1 | **{02.011}** | 0.0 to 32000.0 s/Maximum Frequency | | 5.0 s/Maximum Frequency | | RW | Num | | | | US |
| **04** | Deceleration Rate 1 | **{02.021}** | 0.0 to 32000.0 s/Maximum Frequency | | 10.0 s/Maximum Frequency | | RW | Num | | | | US |
| **05** | Drive Configuration | **{11.034}** | AV (0), AI (1), AV.Pr (2), AI.Pr (3), PrESEt (4), PAd (5), PAd.rEF (6), E.Pot (7), torquE (8), Pid (9) | | AV (0) | | RW | Txt | | | PT | US |
| **06** | Motor Rated Current | **{05.007}** | 0.00 to Drive Rating A | | Maximum Heavy Duty Rating A | | RW | Num | | RA | | US |
| **07** | Motor Rated Speed* | **{05.008}** | 0.0 to 33000.0 rpm | | 50Hz default: 1500.0 rpm<br>60Hz default: 1800.0 rpm | 50Hz default: 1450.0 rpm<br>60Hz default: 1750.0 rpm | RW | Num | | | | US |
| **08** | Motor Rated Voltage | **{05.009}** | 0 to 765 V | | 110V drive: 230 V<br>200V drive: 230 V<br>400V drive 50 Hz: 400 V<br>400V drive 60 Hz: 460 V<br>575V drive: 575 V | | RW | Num | | RA | | US |
| **09** | Motor Rated Power Factor** | **{05.010}** | 0.00 to 1.00 | | 0.85 | | RW | Num | | RA | | US |
| **10** | User Security Status | **{11.044}** | LEVEL.1 (0), LEVEL.2 (1), ALL (2), StAtUS (3), no.Acc (4) | | LEVEL.1 (0) | | RW | Num | ND | | PT | |
| **11** | Start/Stop Logic Select | **{06.004}** | 0 to 6 | | 5 | | RW | Num | | | | US |
| **15** | Jog Reference | **{01.005}** | 0.00 to 300.00 Hz | | 1.50 Hz | | RW | Num | | | | US |
| **16** | Analog Input 1 Mode | **{07.007}** | 4-20.S (-6), 20-4.S (-5), 4-20.L (-4), 20-4.L (-3), 4-20.H (-2), 20-4.H (-1), 0-20 (0), 20-0 (1), 4-20.tr (2), 20-4.tr (3), 4-20 (4), 20-4 (5), Volt (6) | | Volt (6) | | RW | Txt | | | | US |
| **17** | Bipolar Reference Enable | **{01.010}** | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **18** | Preset Reference 1 | **{01.021}** | 0.00 to Pr **02** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **19** | Preset Reference 2 | **{01.022}** | 0.00 to Pr **02** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **20** | Preset Reference 3 | **{01.023}** | 0.00 to Pr **02** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **21** | Preset Reference 4 | **{01.024}** | 0.00 to Pr **02** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **22** | Status Mode Parameter 2 | **{11.019}** | 0.000 to 30.999 | | 4.020 | | RW | Num | | | PT | US |
| **23** | Status Mode Parameter 1 | **{11.018}** | 0.000 to 30.999 | | 2.001 | | RW | Num | | | PT | US |
| **24** | Customer Defined Scaling | **{11.021}** | 0.000 to 10.000 | | 1.000 | | RW | Num | | | | US |
| **25** | User Security Code | **{11.030}** | 0 to 9999 | | 0 | | RW | Num | ND | | PT | US |
| **27** | Power-up Keypad Control Mode Reference | **{01.051}** | Reset (0), Last (1), Preset (2) | | Reset (0) | | RW | Txt | | | | US |
| **28** | Ramp Mode Select | **{02.004}** | Fast (0), Std (1), Std.bst (2), Fst.bst (3) | | Std (1) | | RW | Txt | | | | US |
| **29** | Ramp Enable | **{02.002}** | | Off (0) or On (1) | | On (1) | RW | Bit | | | | US |
| **30** | Parameter Cloning | **{11.042}** | NonE (0), rEAd (1), Prog (2), Auto (3), boot (4) | | NonE (0) | | RW | Txt | | NC | | US |
| **31** | Stop Mode | **{06.001}** | Coast (0), rp (1), rp.dc I (2), dc I (3), td.dc I (4), dis (5) | Coast (0), rp (1), rp.dc I (2), dc I (3), td.dc I (4), dis (5), No.rp (6) | rp (1) | | RW | Txt | | | | US |
| **32** | Dynamic V to F Select | **{05.013}** | 0 to 1 | | 0 | | RW | Num | | | | US |
| | Flux Optimisation Select | **{05.013}** | | 0 to 1 | | 0 | RW | Num | | | | US |
| **33** | Catch A Spinning Motor | **{06.009}** | dis (0), Enable (1), Fr.Only (2), Rv.Only (3) | | dis (0) | | RW | Txt | | | | US |
| **34** | Digital Input 5 Select | **{08.035}** | Input (0), th.Sct (1), th (2), th.Notr (3), Fr (4) | | Input (0) | | RW | Txt | | | | US |
| **35** | Digital Output 1 Control | **{08.091}** | 0 to 21 | | 0 | | RW | Num | | | | US |
| **36** | Analog Output 1 Control | **{07.055}** | 0 to 15 | | 0 | | RW | Txt | | | | US |
| **37** | Maximum Switching Frequency | **{05.018}** | 0.667 (0), 1 (1), 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz | 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz | 3 (3) kHz | | RW | Txt | | | | US |
| **38** | Autotune | **{05.012}** | 0 to 2 | 0 to 3 | 0 | | RW | Num | | NC | | US |
| **39** | Motor Rated Frequency | **{05.006}** | 0.0 to 550.00 Hz | | 50Hz: 50.00 Hz<br>60Hz: 60.00 Hz | | RW | Num | | RA | | US |
| **40** | Number of Motor Poles*** | **{05.011}** | Auto (0) to 32 (16) | | Auto (0) | | RW | Num | | | | US |

| Parameter | | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | OL | RFC-A | OL | RFC-A | | | | | | |
| 41 | Control Mode | {05.014} | Ur.S (0), Ur (1), Fd (2), Ur.Auto (3), Ur.I (4), SrE (5), Fd.tAP (6) | | Fd (2) | | RW | Txt | | | | US |
| 42 | Low Frequency Voltage Boost | {05.015} | 0.0 to 25.0 % | | 3.0 % | | RW | Num | | | | US |
| 43 | Serial Baud Rate | {11.025} | 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 76800 (9), 115200 (10) | | 19200 (6) | | RW | Txt | | | | US |
| 44 | Serial Address | {11.023} | 1 to 247 | | 1 | | RW | Num | | | | US |
| 45 | Reset Serial Communications | {11.020} | Off (0) or On (1) | | Off (0) | | RW | | ND | NC | | |
| 46 | BC Upper Current Threshold | {12.042} | 0 to 200 % | | 50 % | | RW | Num | | | | US |
| 47 | BC Lower Current Threshold | {12.043} | 0 to 200 % | | 10 % | | RW | | | | | US |
| 48 | BC Brake Release Frequency | {12.044} | 0.00 to 20.00 Hz | | 1.00 Hz | | RW | Num | | | | US |
| 49 | BC Brake Apply Frequency | {12.045} | 0.00 to 20.00 Hz | | 2.00 Hz | | RW | Num | | | | US |
| 50 | BC Brake Delay | {12.046} | 0.0 to 25.0 s | | 1.0 s | | RW | Num | | | | US |
| 51 | BC Post-brake Release Delay | {12.047} | 0.0 to 25.0 s | | 1.0 s | | RW | Num | | | | US |
| 53 | BC Initial Direction | {12.050} | Ref (0), For (1), Rev (2) | | Ref (0) | | RW | Txt | | | | US |
| 54 | BC Brake Apply Through Zero Threshold | {12.051} | 0.00 to 25.00 Hz | | 1.00 Hz | | RW | Num | | | | US |
| 55 | BC Enable | {12.041} | dis (0), Relay (1), dig IO (2), User (3) | | dis (0) | | RW | Txt | | | | US |
| 56 | Trip 0 | {10.020} | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| 57 | Trip 1 | {10.021} | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| 58 | Trip 2 | {10.022} | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| 59 | OUP Enable | {11.047} | Stop (0) or Run (1) | | Run (1) | | RW | Txt | | | | US |
| 60 | OUP Status | {11.048} | -2147483648 to 2147483647 | | | | RO | Num | ND | NC | PT | |
| 64 | Ramp Rate Units | {02.039} | 0: (s/100Hz), 1: (s/Maximum Frequency), 2: (s/1000Hz) | | 1 (s/Maximum Frequency) | | RW | Num | | | | US |
| 65 | Frequency Controller Proportional Gain Kp1 | {03.010} | | 0.000 to 200.000 s/rad | | 0.100 s/rad | RW | Num | | | | US |
| 66 | Frequency Controller Integral Gain Ki1 | {03.011} | | 0.00 to 655.35 s²/rad | | 0.10 s²/rad | RW | Num | | | | US |
| 67 | Sensorless Mode Filter | {03.079} | | 4 (0), 5 (1), 6 (2), 8 (3), 12 (4), 20 (5) ms | | 4 (0) ms | RW | Txt | | | | US |
| 69 | Spin Start Boost | {05.040} | 0.0 to 10.0 | | 1.0 | | RW | Num | | | | US |
| 70 | PID1 Output | {14.001} | ± 100.00 % | | | | RO | Num | ND | NC | PT | |
| 71 | PID1 Proportional Gain | {14.010} | 0.000 to 4.000 | | 1.000 | | RW | Num | | | | US |
| 72 | PID1 Integral Gain | {14.011} | 0.000 to 4.000 | | 0.500 | | RW | Num | | | | US |
| 73 | PID1 Feedback Invert | {14.006} | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| 74 | PID1 Output Upper Limit | {14.013} | 0.00 to 100.00 % | | 100.00 % | | RW | Num | | | | US |
| 75 | PID1 Output Lower Limit | {14.014} | ± 100.00 % | | -100.00 % | | RW | Num | | | | US |
| 76 | Action on Trip Detection | {10.037} | 0 to 31 | | 0 | | RW | Num | | | | US |
| 77 | Maximum Heavy Duty Current Rating | {11.032} | 0.00 to Drive HD Current Rating A | | | | RO | Num | ND | NC | PT | |
| 78 | Software Version | {11.029} | 0 to 99.99.99 | | | | RO | Num | ND | NC | PT | |
| 79 | User Drive Mode | {11.031} | OPEn.LP (1), RFC-A (2) | | OPEn.LP (1) | RFC-A (2) | RW | Txt | ND | NC | PT | US |
| 81 | Reference Selected | {01.001} | -Pr **02** to Pr **02** or Pr **01** to Pr **02** Hz | | | | RO | Num | ND | NC | PT | |
| 82 | Pre-ramp Reference | {01.003} | -Pr **02** to Pr **02** or Pr **01** to Pr **02** Hz | | | | RO | Num | ND | NC | PT | |
| 83 | Final Demand Reference | {03.001} | -Pr **02** to Pr **02** or Pr **01** to Pr **02** Hz | | | | RO | Num | ND | NC | PT | FI |
| 84 | D.C. Bus Voltage | {05.005} | 0 to 1190 V | | | | RO | Num | ND | NC | PT | FI |
| 85 | Output Frequency | {05.001} | ± 550.00 Hz | | | | RO | Num | ND | NC | PT | FI |
| 86 | Output Voltage | {05.002} | 0 to 930 V | | | | RO | Num | ND | NC | PT | FI |
| 87 | Motor Rpm | {05.004} | ± 33000.0 rpm | | | | RO | Num | ND | NC | PT | FI |
| 88 | Current Magnitude | {04.001} | 0 to Drive Maximum Current A | | | | RO | Num | ND | NC | PT | FI |
| 89 | Torque Producing Current | {04.002} | ± Drive Maximum Current A | | | | RO | Num | ND | NC | PT | FI |
| 90 | Digital I/O Read Word | {08.020} | 0 to 2047 | | | | RO | Bin | ND | NC | PT | |
| 91 | Reference On | {01.011} | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| 92 | Reverse Select | {01.012} | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| 93 | Jog Select | {01.013} | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| 94 | Analog Input 1 | {07.001} | ± 100.00 % | | | | RO | Num | ND | NC | PT | FI |
| 95 | Analog Input 2 | {07.002} | ± 100.00 % | | | | RO | Num | ND | NC | PT | FI |

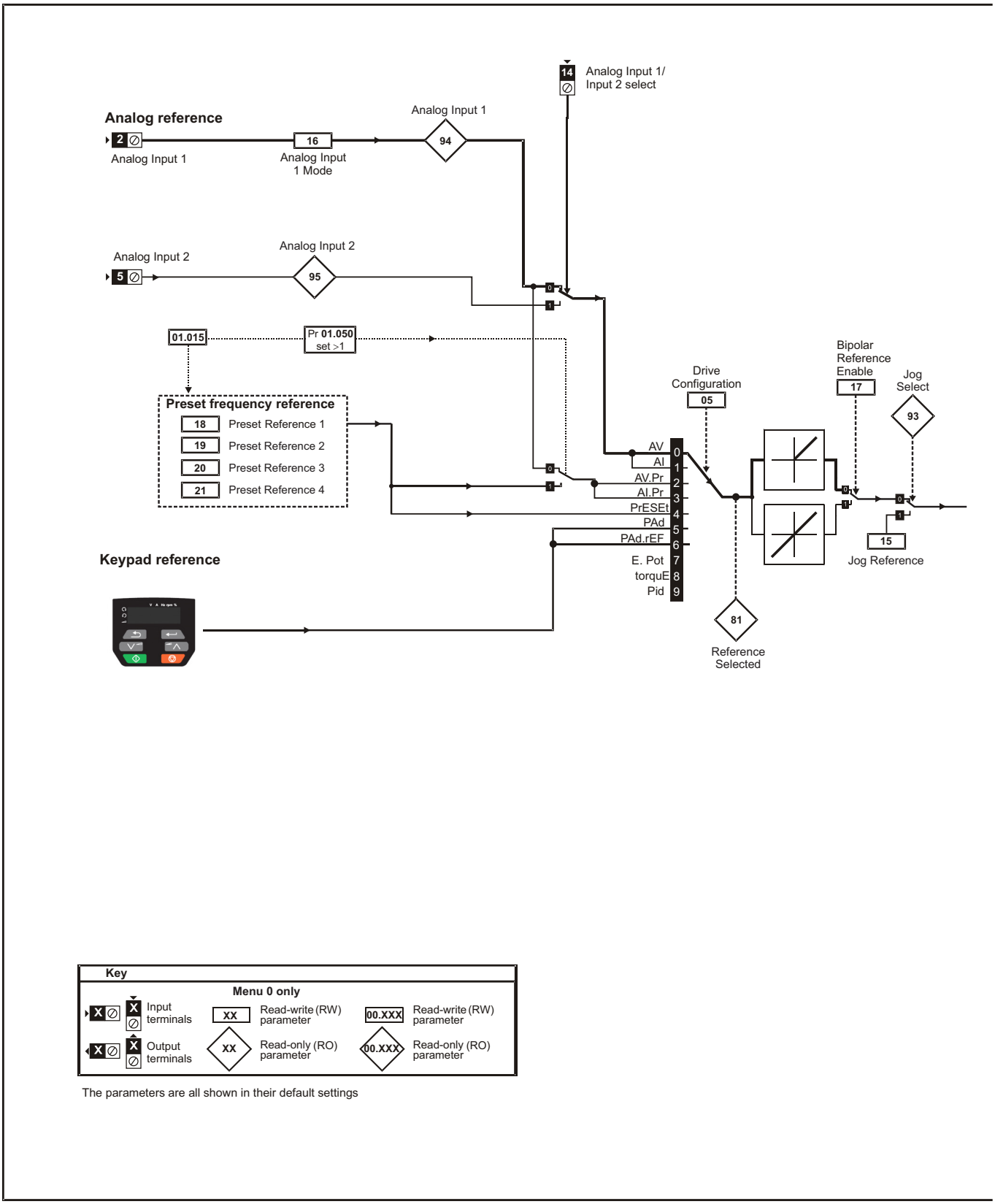
* Setting Pr **07** to 0.0 will disable slip compensation.

** Following a rotating autotune Pr **09** {05.010} is continuously written by the drive, calculated from the value of *Stator Inductance* (Pr **05.025**). To manually enter a value into Pr **09** {05.010}, Pr **05.025** will need to be set to 0. Refer to the description of Pr **05.010** in the *Parameter Reference Guide* for further details.

*** If this parameter is read via serial communications, it will show pole pairs.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |
| IP | IP address | Mac | Mac address | Date | Date parameter | Time | Time parameter | | | | | | |

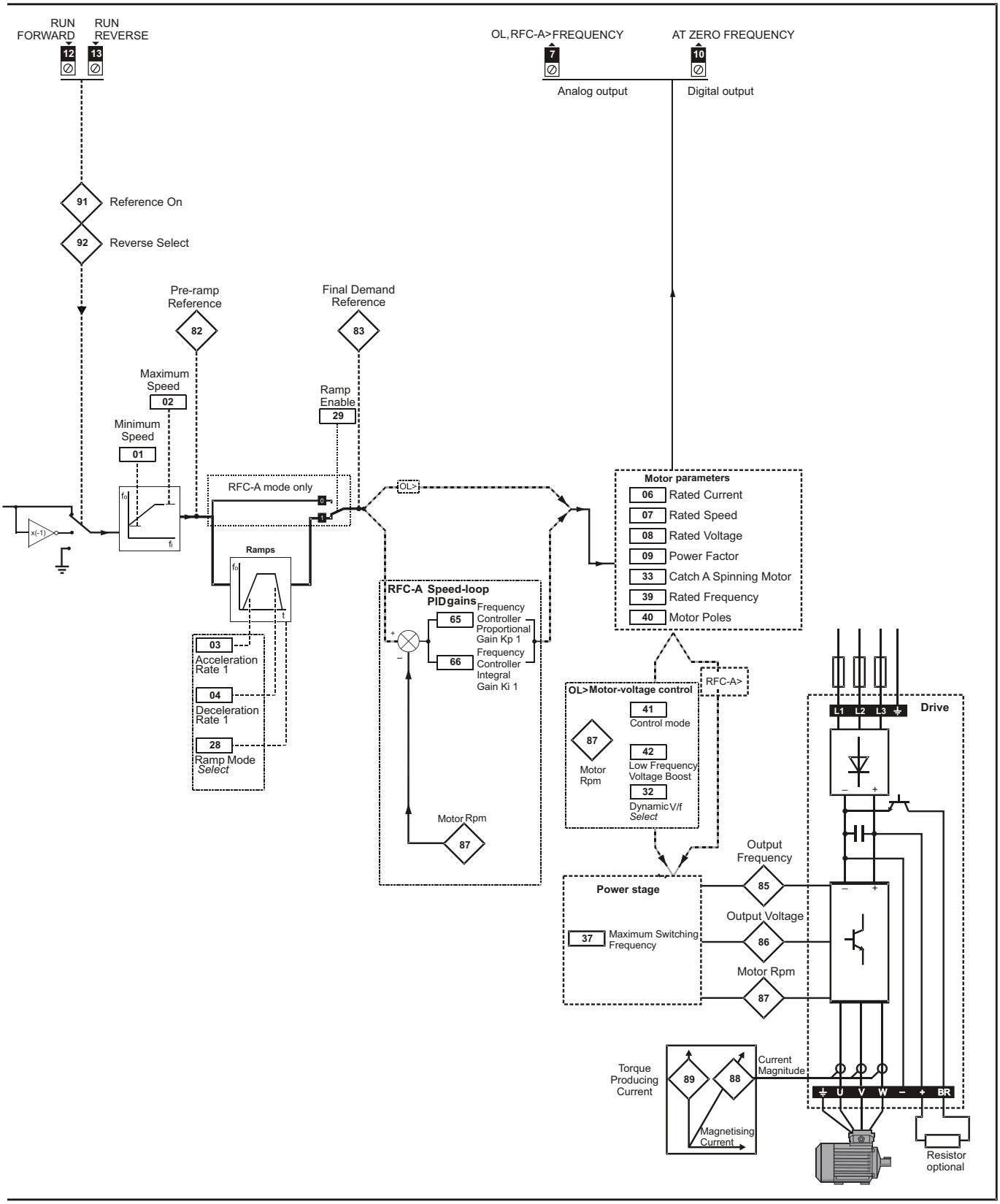
**Figure 6-1 Menu 0 logic diagram**







The parameters are all shown in their default settings


RUN FORWARD
RUN REVERSE
12
13
OL, RFC-A> FREQUENCY
AT ZERO FREQUENCY
7
10
Analog output
Digital output
91 Reference On
92 Reverse Select
Pre-ramp Reference
82
Final Demand Reference
83
Maximum Speed
02
Minimum Speed
01
Ramp Enable
29
RFC-A mode only
OL>
Ramps
03 Acceleration Rate 1
04 Deceleration Rate 1
28 Ramp Mode Select
RFC-A Speed-loop PIDgains
65 Frequency Controller Proportional Gain Kp 1
66 Frequency Controller Integral Gain Ki 1
Motor Rpm
87
Motor parameters
06 Rated Current
07 Rated Speed
08 Rated Voltage
09 Power Factor
33 Catch A Spinning Motor
39 Rated Frequency
40 Motor Poles
OL>Motor-voltage control
RFC-A>
41 Control mode
42 Low Frequency Voltage Boost
32 Dynamic V/f Select
Power stage
37 Maximum Switching Frequency
Output Frequency
85
Output Voltage
86
Motor Rpm
87
Drive
L1 L2 L3
U V W – + BR
Torque Producing Current
89
88
Current Magnitude
Magnetising Current
Resistor optional

## 6.3 Parameter descriptions

### 6.3.1 Pr 00

Pr **00** is available in all menus, commonly used functions are provided as text strings in Pr **00** shown in Table 6-1. The functions in Table 6-1 can also be selected by entering the appropriate numeric values (as shown in Table 6-2) in Pr **00**. For example, enter 4001 in Pr **00** to store drive parameters on an NV media card.

**Table 6-1 Commonly used functions in Pr 00**

| Value | Equivalent value | String | Action |
|---|---|---|---|
| 0 | 0 | **None** | No action |
| 1001 | 1 | **SAVE** | Save drive parameters to non-volatile memory |
| 6001 | 2 | **LOAd.1** | Load the data from file 1 on a non-volatile media card into the drive provided it is a parameter file |
| 4001 | 3 | **SAVE.1** | Store the drive parameters in file 1 on a non-volatile media card |
| 6002 | 4 | **LOAd.2** | Load the data from file 2 on a non-volatile media card into the drive provided it is a parameter file |
| 4002 | 5 | **SAVE.2** | Store the drive parameters in file 2 on a non-volatile media card |
| 6003 | 6 | **LOAd.3** | Load the data from file 3 on a non-volatile media card into the drive provided it is a parameter file |
| 4003 | 7 | **SAVE.3** | Store the drive parameters in file 3 on a non-volatile media card |
| 12000 | 8 | **diff.d** | Only display parameters that are different from their default value |
| 12001 | 9 | **dest** | Only display parameters that are used to set-up destinations |
| 1233 | 10 | **def.50** | Load 50 Hz defaults |
| 1244 | 11 | **def.60** | Load 60 Hz defaults |
| 1070 | 12 | **rst.opt** | Reset option module |

**Table 6-2 Functions in Pr 00**

| Value | Action |
|---|---|
| 1000 | Save parameters when *Under Voltage Active* (Pr **10.016**) is not active. |
| 1001 | Save parameters under all conditions |
| 1070 | Reset option module |
| 1233 | Load standard (50 Hz) defaults |
| 1234 | Load standard (50 Hz) defaults to all menus except option module menu 15 |
| 1244 | Load US (60 Hz) defaults |
| 1245 | Load US (60 Hz) defaults to all menus except option module menu 15 |
| 1299 | Reset {St.HF} trip. |
| 2001* | Create a boot file on a non-volatile media card based on the present drive parameters including all Menu 20 parameters |
| 4yyy* | NV media card: Transfer the drive parameters to parameter file yyy |
| 5yyy | NV media card: Transfer the onboard user program to onboard user program file yyy |
| 59999*** | Delete onboard user program |
| 6yyy* | NV media card: Load the drive parameters from parameter file yyy |
| 7yyy* | NV media card: Erase file yyy |
| 8yyy* | NV Media card: Compare the data in the drive with file yyy |
| 9555* | NV media card: Clear the warning suppression flag |
| 9666* | NV media card: Set the warning suppression flag |
| 9777* | NV media card: Clear the read-only flag |
| 9888* | NV media card: Set the read-only flag |
| 12000** | Only display parameters that are different from their default value. This action does not require a drive reset. |
| 12001** | Only display parameters that are used to set-up destinations (i.e. DE format bit is 1). This action does not require a drive reset. |

* See Chapter 9 *NV Media Card* on page 77 for more information on these functions.

** These functions do not require a drive reset to become active.
All other functions require a drive reset to initiate the function. Equivalent values and strings are also provided in the table above.

*** Program cannot be deleted if the drive is active or if the user program is running.

Set Pr **01** at the required minimum output frequency of the drive for both directions of rotation. The drive speed reference is scaled between Pr **01** and Pr **02**. Pr **01** is a nominal value; slip compensation may cause the actual frequency to be higher. When the drive is jogging, Pr **01** has no effect.

| 02 | | Maximum Speed | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.00 to 550.00 Hz | | | ⇨ | Def.50: 50.00 Hz<br>Def.60: 60.00 Hz | | | | |

Set Pr **02** at the required maximum output frequency for both directions of rotation. The drive speed reference is scaled between Pr **01** and Pr **02**. Pr **02** is a nominal value; slip compensation may cause the actual frequency to be higher. The drive has additional over-speed protection.

| 03 | | Acceleration Rate 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.0 to 32000.0 s/100 Hz | | | ⇨ | 5.0 s/100 Hz | | | | |

Set Pr **03** at the required rate of acceleration. Note that larger values produce lower acceleration. The rate applies in both directions of rotation.

| 04 | | Deceleration Rate 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.0 to 32000.0 s/100 Hz | | | ⇨ | 10.0 s/100 Hz | | | | |

Set Pr **04** at the required rate of deceleration. Note that larger values produce lower deceleration. The rate applies in both directions of rotation.

| 05 | | Drive Configuration | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | PT | US | |
| OL / RFC-A | ⇳ | AV (0), AI (1), AV.Pr (2), AI.Pr (3), PrESEt (4), PAd (5), PAd.rEF (6), E.Pot (7), torquE (8), Pid (9) | | | ⇨ | AV (0) | | | | |

**Table 6-3 Parameter changes when drive configuration is changed**

| Parameter number | Description | Drive Configuration | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **AV** | **AI** | **AV.Pr** | **AI.Pr** | **PrESEt** | **PAd** | **PAd.rEF** | **E.Pot** | **torquE** | **Pid** |
| **01.014** | Reference select | 0 | 0 | 1 | 1 | 3 | 4 | 6 | 3 | 0 | 1 |
| **06.004** | Start/stop logic | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **07.007** | Analog input 1 mode | 6 | 4 | 6 | 4 | 6 | 6 | 6 | 6 | 4 | 4 |
| **07.010** | Analog input 1 destination | 01.036 | 01.036 | 01.036 | 01.036 | 01.036 | 01.036 | 01.036 | 01.036 | 01.036 | 0.000 |
| **07.011** | Analog input 2 mode | 6 | 6 | 7 | 7 | 7 | 6 | 6 | 7 | 6 | 6 |
| **07.014** | Analog input 2 destination | 01.037 | 01.037 | 01.046 | 01.046 | 01.046 | 01.037 | 01.037 | 09.027 | 04.008 | 0.000 |
| **07.051** | Analog input 1 control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **07.052** | Analog input 2 control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **08.022** | Digital input 2 destination | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **08.025** | Digital input 5 destination | 01.041 | 01.041 | 01.045 | 01.045 | 01.045 | 01.041 | 01.041 | 09.026 | 04.011 | 14.008 |
| **08.085** | DI 5 Control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **09.025** | Motorized pot destination | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 01.021 | 0.000 | 0.000 |
| **14.003** | PID 1 reference source | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 07.002 |
| **14.004** | PID 1 feedback source | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 07.001 |
| **14.016** | PID 1 destination | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 01.036 |

The setting of Pr **05** automatically sets the drive configuration.

| Value | Text | Description |
|---|---|---|
| 0 | AV | Analog input 1 (voltage) or Analog input 2 (voltage) selected by terminal (Local/Remote) |
| 1 | AI | Analog input 1 (current) or Analog input 2 (voltage) selected by terminal (Local/Remote) |
| 2 | AV.Pr | Analog input 1 (voltage) or 3 presets selected by terminal |
| 3 | AI.Pr | Analog input 1 (current) or 3 presets selected by terminal |
| 4 | PrESEt | Four presets selected by terminal |
| 5 | PAd | Keypad reference |
| 6 | PAd.rEF | Keypad reference with terminal control |
| 7 | E.Pot | Electronic Potentiometer |
| 8 | torquE | Torque mode, Analog input 1 (current frequency reference) or Analog input 2 (voltage torque reference) selected by terminal |
| 9 | Pid | PID mode, Analog input 1 (current feedback source) and Analog input 2 (voltage reference source) |

Action will only occur if the drive is inactive and no User Actions are running. Otherwise, the parameter will return to its pre altered value on exit from edit mode. All parameters are saved if this parameter changes.

**Figure 6-2 Pr 05 = AV**

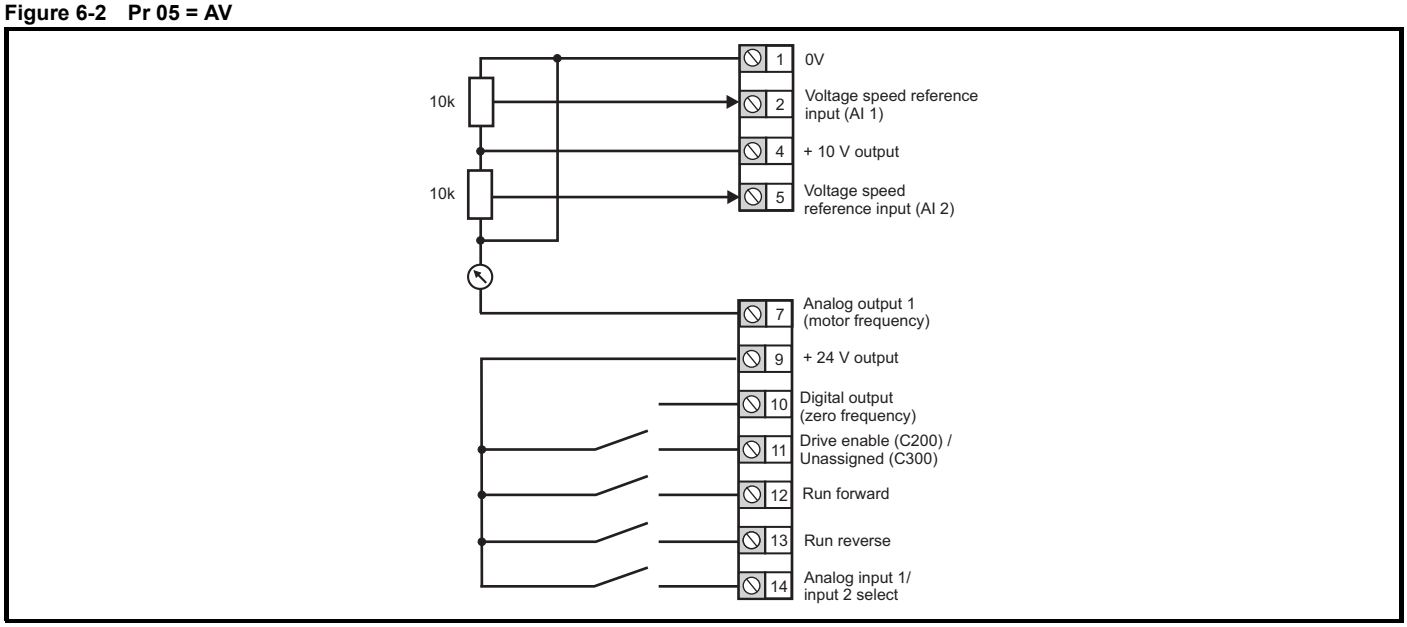



**Figure 6-3 Pr 05 = AI**

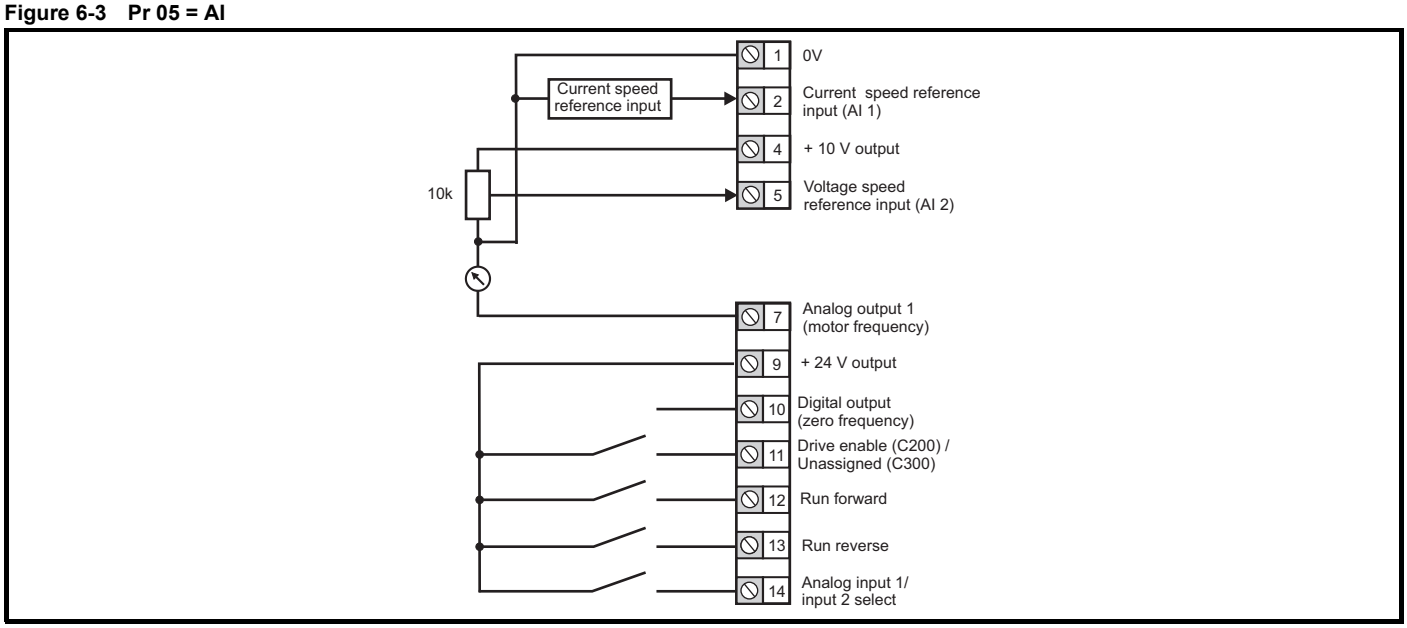
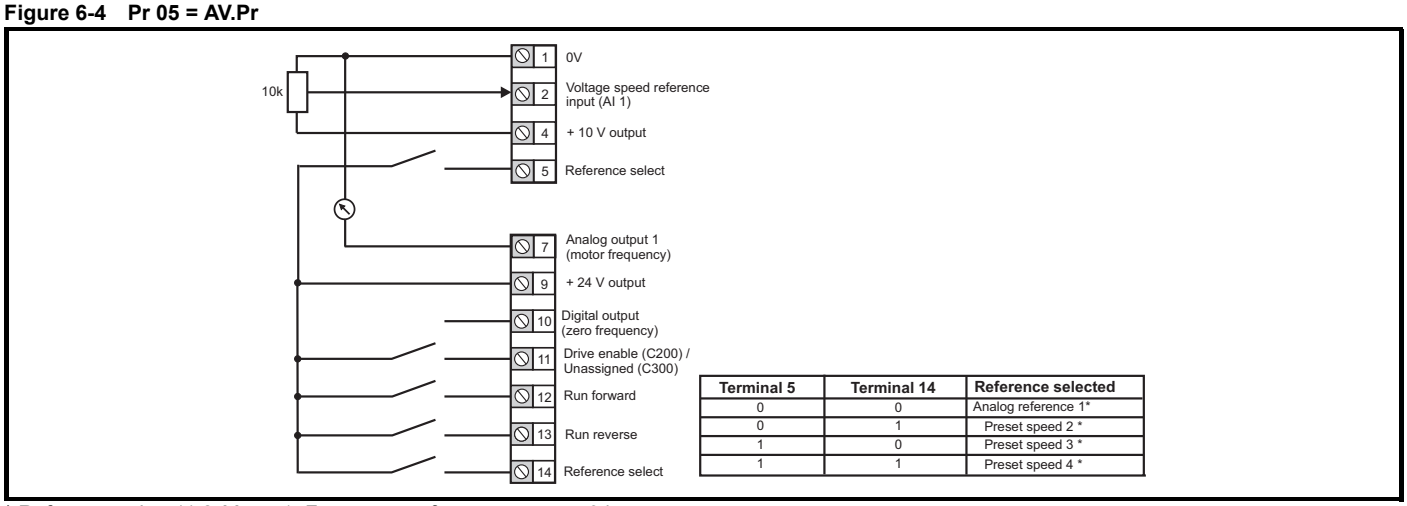


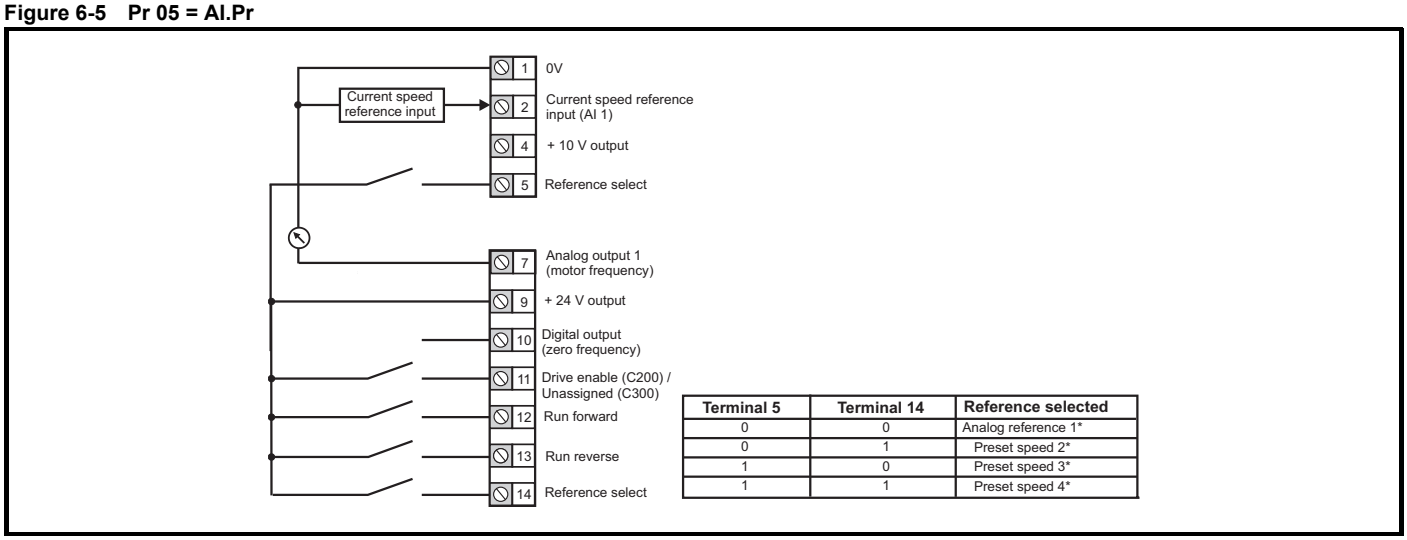
**Figure 6-4 Pr 05 = AV.Pr**




| Terminal 5 | Terminal 14 | Reference selected |
|---|---|---|
| 0 | 0 | Analog reference 1* |
| 0 | 1 | Preset speed 2 * |
| 1 | 0 | Preset speed 3 * |
| 1 | 1 | Preset speed 4 * |

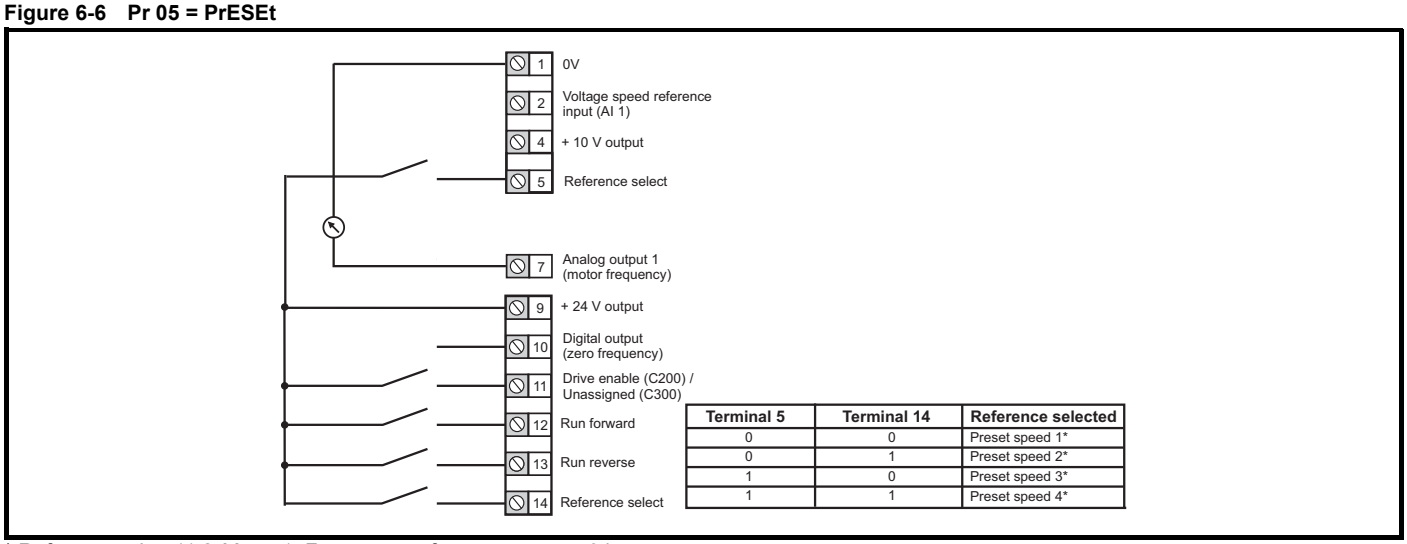
* Refer to section 11.2 *Menu 1: Frequency reference* on page 94.

**Figure 6-5 Pr 05 = AI.Pr**




| Terminal 5 | Terminal 14 | Reference selected |
|---|---|---|
| 0 | 0 | Analog reference 1* |
| 0 | 1 | Preset speed 2* |
| 1 | 0 | Preset speed 3* |
| 1 | 1 | Preset speed 4* |

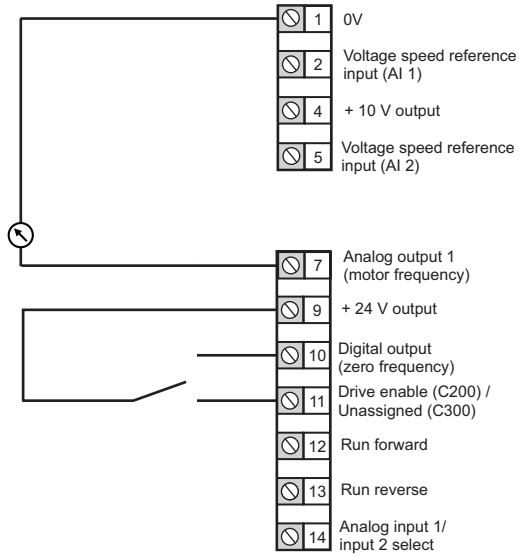
**Figure 6-6 Pr 05 = PrESEt**




| Terminal 5 | Terminal 14 | Reference selected |
|---|---|---|
| 0 | 0 | Preset speed 1* |
| 0 | 1 | Preset speed 2* |
| 1 | 0 | Preset speed 3* |
| 1 | 1 | Preset speed 4* |

* Refer to section 11.2 *Menu 1: Frequency reference* on page 94.

**Figure 6-7 Pr 05 = PAd**




When Pr **05** is set to PAd, to run in reverse:

- Set Pr **17** to On

The Keypad reference can now be set to a negative frequency to run the motor in the reverse direction.

**Figure 6-8 Pr 05 = PAd.rEF**

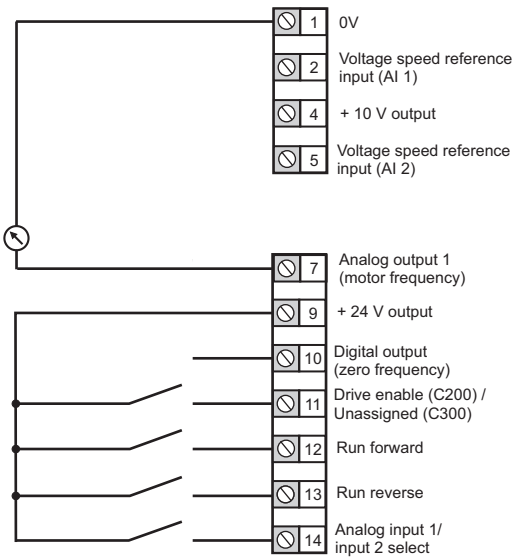
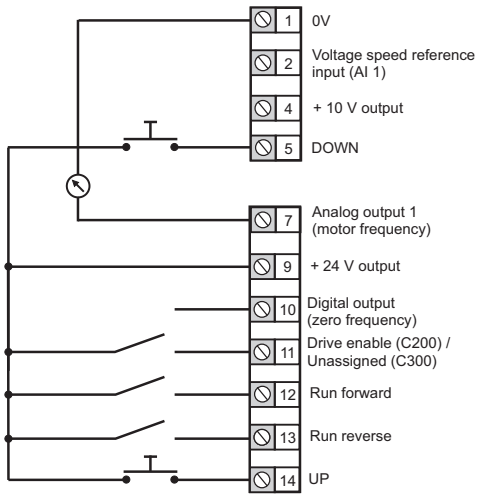


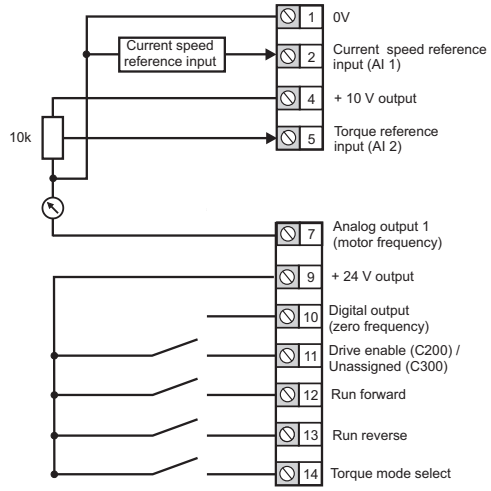

**Figure 6-9 Pr 05 = E.Pot**




When Pr **05** is set to E.Pot, the following parameters may need to be adjusted:

- Pr **09.023**: Motorized pot up/down rate (s/100 %)
- Pr **09.022**: Motorized pot bipolar select (0 = unipolar, 1 = bipolar)
- Pr **09.021**: Motorized pot mode: 0 = zero at power-up, 1 = last value at power-up, 2 = zero at power-up and only change when drive is running, 3 = last value at power-up and only change when drive is running, 4 = zero at power-up and drive disabled, only change when drive is running.

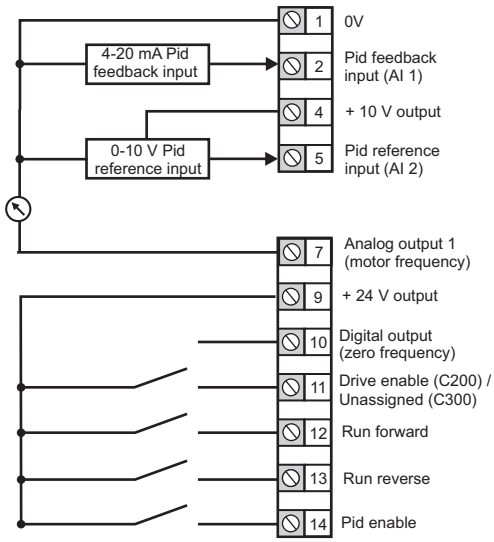
**Figure 6-10 Pr 05 = torquE**




**WARNING**

When torque mode is selected and the drive is connected to an unloaded motor, the motor speed may increase rapidly to the maximum speed (Pr **02** +10 %).

**Figure 6-11 Pr 05 = Pid**




When Pr **05** is set to Pid, the following parameters may need to be adjusted:

- PID proportional gain*
- PID integral gain*
- PID feedback invert*
- PID output upper limit (%)*
- PID output lower limit (%)*

* Refer to section 11.14 *Menu 14: User PID controller* on page 138.

| **06** | | **Motor Rated Current** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | US | |
| **OL** | ⇳ | 0.00 to Drive Rating A | | | ⇨ | Maximum Heavy Duty Rating A | | | |
| **RFC-A** | | | | | | | | | |

The rated current parameter must be set to the maximum continuous current of the motor (taken from the name plate). The motor rated current is used in the following:

- Current limits
- Motor thermal overload protection
- Vector mode voltage control
- Slip compensation
- Dynamic V/F control

| 07 | | Motor Rated Speed | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL | ⇳ | 0.0 to 33000.0 rpm* | | | | | ⇨ | Def.50: 1500.0 rpm<br>Def.60: 1800.0 rpm | | |
| RFC-A | | | | | | | | Def.50: 1450.0 rpm<br>Def.60: 1750.0rpm | | |

Set to the rated speed of the motor (taken from the motor name plate). The motor rated speed is used to calculate the correct slip speed for the motor.

| 08 | | Motor Rated Voltage | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | RA | | US |
| OL<br>RFC-A | ⇳ | 0 to 240 V or 0 to 480 V | | | | | ⇨ | 110 V drive: 230 V<br>200 V drive: 230 V<br>400 V drive 50 Hz: 400 V<br>400 V drive 60 Hz: 460 V<br>575 V drive: 575 V | | |

The Rated Voltage (Pr **08**) and the Rated Frequency (Pr **39**) are used to define the voltage to frequency characteristic applied to the motor. The Rated Frequency (Pr **39**) is also used in conjunction with the Motor Rated Speed (Pr **07**) to calculate the rated slip for slip compensation.

| 09 | | Motor Rated Power Factor | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | RA | | US |
| OL<br>RFC-A | ⇳ | 0.00 to 1.00 | | | | | ⇨ | 0.85 | | |

Enter the motor rated power factor cos φ (taken from the motor name plate).

The drive can measure the motor rated power factor by performing a rotating autotune (see Autotune (Pr **38**).

| 10 | | User Security Status | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | ND | | PT | US | |
| OL<br>RFC-A | ⇳ | LEVEL.1 (0), LEVEL.2 (1),<br>ALL (2), StAtUS (3), no.Acc (4) | | | | | ⇨ | LEVEL.1 (0) | | |

This parameter controls access via the drive keypad as follows:

| Value | Text | Function |
|---|---|---|
| 0 | LEVEL.1 | Access to first 10 parameters in Menu 0 only. |
| 1 | LEVEL.2 | Access to all parameters in Menu 0. |
| 2 | ALL | Access to all menus. |
| 3 | StAtUS | The keypad remains in status mode and no parameters can be viewed or edited. |
| 4 | no.Acc | The keypad remains in status mode and no parameters can be viewed or edited. Drive parameters cannot be accessed via a comms interface. |

| 11 | | Start/Stop Logic Select | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL<br>RFC-A | ⇳ | 0 to 6 | | | | | ⇨ | 5 | | |

This parameter changes the functions of the input terminals which are normally associated with the enabling, starting and stopping the drive.

| Pr 11 | Terminal 11 | Terminal 12 | Terminal 13 | Latching |
|---|---|---|---|---|
| 0 | User programmable | Run Forward | Run Reverse | No |
| 1 | /Stop | Run Forward | Run Reverse | Yes |
| 2 | User programmable | Run | Forward/Reverse | No |
| 3 | /Stop | Run | Forward/Reverse | Yes |
| 4 | /Stop | Run | Jog Forward | Yes |
| 5 | User programmable | Run Forward | Run Reverse | No |
| 6 | User programmable | User programmable | User programmable | User programmable |

Action will only occur if the drive is inactive. If the drive is active, the parameter will return to its pre-altered value on exit from edit mode.

| 15 | | Jog Reference | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.00 to 300.00 Hz | | | ⇨ | 1.50 Hz | | | | |

Defines the reference when jog is enabled.

| 16 | | Analog Input 1 Mode | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | | US | |
| OL | ⇳ | 4-20.S (-6), 20-4.S (-5), 4-20.L (-4), 20-4.L (-3), 4-20.H (-2), 20-4.H (-1), 0-20 (0), 20-0 (1), 4-20.tr (2), 20-4.tr (3), 4-20 (4), 20-4 (5), Volt (6) | | | ⇨ | Volt (6) | | | | |

Defines the mode of analog input 1.

The table below gives all the possible analog input modes.

| Value | Text | Function |
|---|---|---|
| -6 | 4-20.S | Stop on loss |
| -5 | 20-4.S | Stop on loss |
| -4 | 4-20.L | 4-20 mA switching to equivalent of 4 mA input current on loss |
| -3 | 20-4.L | 20-4 mA switching to equivalent of 20 mA input current on loss |
| -2 | 4-20.H | 4-20 mA hold at level before loss on loss |
| -1 | 20-4.H | 20-4 mA hold at level before loss on loss |
| 0 | 0-20 | 0-20 mA |
| 1 | 20-0 | 20-0 mA |
| 2 | 4-20.tr | 4-20 mA trip on loss |
| 3 | 20-4.tr | 20-4 mA trip on loss |
| 4 | 4-20 | 4-20 mA no action on loss |
| 5 | 20-4 | 20-4 mA no action on loss |
| 6 | Volt | Voltage |

**NOTE** In 4-20 mA and 20-4 mA modes loss of input is detected if the current falls below 3 mA.

**NOTE** If both analog inputs (A1 and A2) are to be set-up as voltage inputs, and if the potentiometers are supplied from the drive's +10 V rail (terminal T4), they must have a resistance > 4 kΩ each.

| 17 | | Bipolar Reference Enable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Bit | | | | | | | US | |
| OL / RFC-A | ⇳ | Off (0) or On (1) | | | ⇨ | Off (0) | | | | |

Pr **17** determines whether the reference is uni-polar or bi-polar.

See *Minimum Speed* (Pr **01**). Allows negative speed reference in keypad mode.

| 18 to 21 | | Preset Reference 1 to 4 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.00 to Pr **02** Hz | | | ⇨ | 0.00 Hz | | | | |

If the preset reference has been selected (see Pr **05**), the speed at which the motor runs is determined by these parameters.

See *Drive Configuration* (Pr **05**).

| 22 | | Status Mode Parameter 2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | PT | US | |
| OL / RFC-A | ⇳ | 0.000 to 30.999 | | | ⇨ | 4.020 | | | | |

This parameter and *Status Mode Parameter 1* (Pr **23**) define which parameters are displayed in Status mode. The values can be alternated by

pressing the Escape key, if the drive is running.

| 23 | | Status Mode Parameter 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | PT | US | |
| OL / RFC-A | ⇳ | 0.000 to 30.999 | | | ⇨ | 2.001 | | | | |

See *Status Mode Parameter 2* (Pr **22**).

| 24 | | Customer Defined Scaling | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.000 to 10.000 | | | ⇨ | 1.000 | | | | |

This parameter defines the scaling applied to *Status Mode Parameter 1* (Pr **23**). The scaling is only applied in the Status mode.

| 25 | | User Security Code | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | ND | | PT | US | |
| OL / RFC-A | ⇳ | 0-9999 | | | ⇨ | 0 | | | | |

If any number other than 0 is programmed into this parameter, user security can be applied so that no parameters except Pr **10** can be adjusted with the keypad. When this parameter is read via a keypad it appears as zero. Refer to the *Control User Guide* for further information.

| 27 | | Power-up Keypad Control Mode Reference | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | ND | NC | PT | US | |
| OL / RFC-A | ⇳ | rESEt (0), LASt (1), PrESEt (2) | | | ⇨ | rESEt (0) | | | | |

Defines which value of keypad control mode reference is displayed at power-up.

| Value | Text | Description |
|---|---|---|
| 0 | rESEt | Keypad reference is zero |
| 1 | LASt | Keypad reference is the last used value |
| 2 | PrESEt | Keypad reference is copied from *Preset Reference 1* (Pr **18**) |

| 28 | | Ramp Mode Select | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | | US | |
| OL / RFC-A | ⇳ | Fast (0), Std (1), Std.bst (2), Fst.bst (3) | | | ⇨ | Std (1) | | | | |

Defines the mode used by the ramp system.

**0:** Fast ramp

**1:** Standard ramp

**2:** Standard ramp with motor voltage boost

**3:** Fast ramp with motor voltage boost

Fast ramp is linear deceleration at programmed rate, normally used when a braking resistor is installed.

Standard ramp is controlled deceleration to prevent DC bus over-voltage trips, normally used when there is no braking resistor installed.

If a high motor voltage mode is selected, deceleration rates can be faster for a given inertia but motor temperatures will be higher.

| 29 | | Ramp Enable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Bit | | | | | | | US | |
| OL / RFC-A | ⇳ | Off (0) or On (1) | | | ⇨ | On (1) | | | | |

Setting Pr **29** to 0 allows the user to disable the ramps. This is generally used when the drive is required to closely follow a speed reference which already contains acceleration and deceleration ramps.

| 30 | | Parameter Cloning | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | NC | | US* | |
| OL / RFC-A | ⇳ | NonE (0), rEAd (1), Prog (2), Auto (3), boot (4) | | | | ⇨ | NonE (0) | | | |

* Only a value of 3 or 4 in this parameter is saved.

If Pr **30** is equal to 1 or 2, this value is not transferred to the EEPROM or the drive. If Pr **30** is set to a 3 or 4 the value is transferred.

| Parameter string | Parameter value | Comment |
|---|---|---|
| NonE | 0 | Inactive |
| rEAd | 1 | Read parameter set from the NV Media Card |
| Prog | 2 | Programming a parameter set to the NV Media Card |
| Auto | 3 | Auto save |
| boot | 4 | Boot mode |

For further information, please refer to Chapter 9 *NV Media Card* on page 77.

| 31 | | Stop Mode | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | | US | |
| OL | ⇳ | CoASt (0), rP (1), rP.dc I (2), dc I (3), td.dc I (4), dis (5) | | | | ⇨ | rP (1) | | | |
| RFC-A | ⇳ | CoASt (0), rP (1), rP.dc I (2), dc I (3), td.dc I (4), dis (5), No.rP (6) | | | | ⇨ | rP (1) | | | |

Defines how the motor is controlled when the run signal is removed from the drive.

| Value | Text | Description |
|---|---|---|
| 0 | CoASt | Coast stop |
| 1 | rP | Ramp stop |
| 2 | rP.dc I | Ramp stop + 1 second dc injection |
| 3 | dc I | Injection braking stop with detection of zero speed |
| 4 | td.dc I | Timed injection braking stop |
| 5 | dis | Disable |
| 6 | No.rP | No ramp (RFC-A mode only) |

See the *Control User Guide* for further information.

| 32 | | Dynamic V To F Select / Flux Optimization Select | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0 to 1 | | | | ⇨ | 0 | | | |

**Open-loop:**

Set to 1 to enable Dynamic V to F mode in open-loop mode only.

**0:** Fixed linear voltage to frequency ratio (constant torque - standard load)

**1:** Voltage to frequency ratio dependant on load current. This gives a higher motor efficiency.

**RFC-A:**

If this parameter is set to 1, the flux is reduced so that the magnetizing current is equal to the torque producing current, to optimize copper losses and reduce iron losses in the motor under low load conditions.

| 33 | | Catch a Spinning Motor | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | | US | |
| OL / RFC-A | ⇳ | dis (0), Enable (1), Fr.Only (2), Rv.Only (3) | | | | ⇨ | dis (0) | | | |

If the drive is to be configured in fixed boost mode (Pr **41** = Fd or SrE) with catch a spinning motor software enabled, an autotune (see Pr **38** on page 48) must be carried out to measure the motor's stator resistance beforehand. If a stator resistance is not measured, the drive may trip on OV or OI.AC while trying to catch a spinning motor.

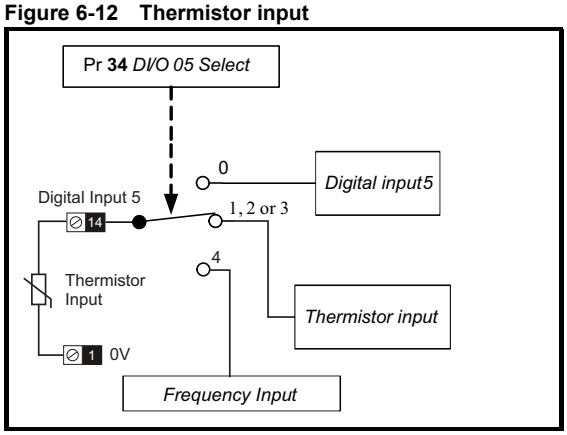
| Pr 33 | Text | Function |
|---|---|---|
| 0 | dis | Disabled |
| 1 | Enable | Detect all frequencies |
| 2 | Fr.Only | Detect positive frequencies only |
| 3 | Rv.Only | Detect negative frequencies only |

| 34 | | Digital Input 5 Select | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | | US | |
| OL / RFC-A | ⇳ | Input (0), th.Sct (1), th (2), th.Notr (3), Fr (4) | | | | ⇨ | Input (0) | | | |

This parameter selects the function of Digital Input 5 (terminal 14).

| Value | Text | Function |
|---|---|---|
| 0 | Input | Digital input |
| 1 | th.Sct | Temperature measurement input with short circuit detection (Resistance <50 Ω) |
| 2 | th | Temperature measurement input without short circuit detection but with *th* trip |
| 3 | th.Notr | Temperature measurement input with no trips |
| 4 | Fr | Frequency input |

**Figure 6-12 Thermistor input**




| 35 | | Digital Output 1 Control | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0-21 | | | | ⇨ | 0 | | | |

Defines the behaviour of digital output 1 (terminal 10).

| Value | Description |
|---|---|
| 0 | User defined by Digital IO1 Source/Destination A |
| 1 | Drive running signal |
| 2 | Frequency arrived signal |
| 3 | Frequency level detection signal |
| 4 | Frequency level detection signal |
| 5 | Overload detection signal |

| | |
|---|---|
| 6 | Power off state |
| 7 | External fault stop |
| 8 | Frequency upper limit |
| 9 | Frequency lower limit |
| 10 | Drive running at zero frequency |
| 14 | Drive ready |
| 15 | Drive OK |
| 18 | Brake release |
| 19 | Torque limiting (Valid while the torque is limited by torque limiting value 1/2) |
| 20 | Forward or reverse |
| 21 | Motor 1 or 2 |

| **36** | | **Analog Output 1 Control** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Txt | | | | | | | US | |
| **OL** | ⇳ | 0 to 14 | ⇨ | 0 | | | | | |
| **RFC-A** | | | | | | | | | |

Defines the functionality of Analog Output 1 (terminal 7).

| Value | Description |
|---|---|
| 0 | User defined by Analog Output 1 Source A |
| 1 | Frequency output |
| 2 | Frequency reference |
| 3 | Motor speed |
| 4 | Current Magnitude |
| 6 | Torque output |
| 7 | Torque current output |
| 8 | Voltage output |
| 9 | DC bus voltage (0~800 V) |
| 10 | Analog Input 1 |
| 11 | Analog Input 2 |
| 12 | Power output (0~2 x Pe) |
| 13 | Torque limitation |
| 14 | Torque reference (0~300 %) |

| **37** | | **Maximum Switching Frequency** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Txt | | | | | | | US | |
| **OL** | ⇳ | 0.667 (0), 1 (1), 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz | ⇨ | 3 (3) kHz | | | | | |
| **RFC-A** | | 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz | | | | | | | |

Defines the maximum switching frequency that can be used by the drive.

| Pr 37 | Text | Description |
|---|---|---|
| 0 | 0.667 | 667 Hz switching frequency |
| 1 | 1 | 1 kHz switching frequency |
| 2 | 2 | 2 kHz switching frequency |
| 3 | 3 | 3 kHz switching frequency |
| 4 | 4 | 4 kHz switching frequency |
| 5 | 6 | 6 kHz switching frequency |
| 6 | 8 | 8 kHz switching frequency |
| 7 | 12 | 12 kHz switching frequency |
| 8 | 16 | 16 kHz switching frequency |

See the *Power Installation Guide* for drive derating data.

| 38 | | Autotune | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | NC | | US | |
| OL | ⇳ | 0 to 2 | | | | ⇨ | 0 | | | |
| RFC-A | | 0 to 3 | | | | | | | | |

Defines the auto-tune test to be performed.

There are two autotune tests available in open loop mode, a stationary and a rotating test. A rotating autotune should be used whenever possible so the measured value of power factor of the motor is used by the drive.

**Open Loop and RFC-A:**

1. A stationary autotune can be used when the motor is loaded and it is not possible to remove the load from the motor shaft. To perform a Stationary autotune, set Pr **38** to 1,
2. A rotating autotune should only be used if the motor is unloaded. A rotating autotune first performs a stationary autotune, as above, then a rotating test is performed in which the motor is accelerated with currently selected ramps up to a frequency of *Rated Frequency* (Pr **39**) x 2/3, and the frequency is maintained at that level for 4 seconds. To perform a Rotating autotune, set Pr **38** to 2.

**RFC-A only:**

3. This test measures the total inertia of the load and the motor. A series of progressively larger torque levels are applied to the motor to accelerate the motor up to 3/4 x *Motor Rated Speed* (Pr **07**) to determine the inertia from the acceleration/deceleration time.

Following the completion of an autotune test the drive will go into the inhibit state. The drive must be placed into a controlled disable condition before the drive can be made to run at the required reference. The drive can be put in to a controlled disable condition by removing the Safe Torque Off signal from terminals 31 & 34.


A rotating autotune will cause the motor to accelerate up to 2/3 base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The Safe Torque Off signals must be removed before the drive can be made to run at the required reference.The drive can be stopped at any time by removing the run signal or removing the drive enable.

| 39 | | Motor Rated Frequency | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | RA | | US | |
| OL | ⇳ | 0.00 to 550.00 Hz* | | | | ⇨ | Def.50: 50.00 Hz<br>Def.60: 60.00 Hz | | | |
| RFC-A | | | | | | | | | | |

Enter the value from the rating plate of the motor. Defines the voltage to frequency ratio applied to the motor.

| 40 | | Number Of Motor Poles | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL | ⇳ | Auto (0) to 32 (16) | | | | ⇨ | Auto (0) | | | |
| RFC-A | | | | | | | | | | |

Set to the number of poles of the motor. The auto mode calculates the number of motor poles from the settings of Pr **07** and Pr **39**.

| 41 | | Control Mode | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | | US | |
| OL | ⇳ | Ur.S (0), Ur (1), Fd (2), Ur.Auto (3), Ur.I (4), SrE (5), Fd.tap (6) | | | | ⇨ | Fd (2) | | | |
| RFC-A | | | | | | | | | | |

Defines the drive output mode, which can either be a voltage mode or a current mode.

| Value | Text | Description |
|---|---|---|
| 0 | Ur.S | Stator resistance and voltage offset measured at each start |
| 1 | Ur | No measurements |
| 2 | Fd | Fixed boost mode. |
| 3 | Ur.Auto | Stator resistance and voltage offset measured at first drive enable |
| 4 | Ur.I | Stator resistance and voltage offset measured at each power-up |
| 5 | SrE | Square law characteristic |
| 6 | Fd.tap (6) | Fixed boost with taper |

| 42 | | Low Frequency Voltage Boost | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.0 to 25.0 % | | | ⇨ | 3.0 % | | | |

Determines the boost level when Pr **41** is set to Fd, SrE or Fd.tap modes.

| 43 | | Serial Baud Rate | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Txt | | | | | | | US | |
| OL / RFC-A | ⇳ | 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 76800 (9), 115200 (10) | | | ⇨ | 19200 (6) | | | |

Defines the serial baud rate of the drive

Changing the parameters does not immediately change the serial communications settings. See *Reset Serial Communications* (Pr **45**) for more details.

| 44 | | Serial Address | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 1 to 247 | | | ⇨ | 1 | | | |

Used to define the unique address for the drive for the serial interface. The drive is always a slave address 0 is used to globally address all slaves, and so this address should not be set in this parameter.

Changing the parameters does not immediately change the serial communications settings. See *Reset Serial Communications* (Pr **45**) for more details.

| 45 | | Reset Serial Communications | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Bit | | | | ND | NC | | US | |
| OL / RFC-A | ⇳ | Off (0) or On (1) | | | ⇨ | Off (0) | | | |

Set to On (1) to update communications set-up.

**NOTE** The display will briefly display On and return to Off on reset.

| 46 | | Brake Controller Upper Current Threshold | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0 to 200 % | | | ⇨ | 50 % | | | |

Defines the upper current threshold for the brake. See Brake Controller Brake Release in *Parameter Reference Guide*.

| 47 | | Brake Controller Lower Current Threshold | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0 to 200 % | | | ⇨ | 10 % | | | |

Defines the lower current limit for the brake. See Brake Controller Brake Release in *Parameter Reference Guide*.

| 48 | | Brake Controller Brake Release Frequency | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.00 to 20.00 Hz | | | ⇨ | 1.00 Hz | | | |

Defines the Brake Release Frequency. See Brake Controller Brake Release in *Parameter Reference Guide.*

| 49 | | Brake Controller Brake Apply Frequency | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.00 to 20.00 Hz | | | | ⇨ | 2.00 Hz | | | |

Defines the Brake Apply Frequency. See Brake Controller Brake Release in *Parameter Reference Guide*.

| 50 | | Brake Controller Brake Delay | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.0 to 25.0 s | | | | ⇨ | 1.0 s | | | |

Defines the pre-brake release delay. See Brake Controller Brake Release in *Parameter Reference Guide*.

| 51 | | Brake Controller Post-brake Release Delay | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.0 to 25.0 s | | | | ⇨ | 1.0 s | | | |

Defines the post-brake release delay.

| 53 | | Brake Controller Initial Direction | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | | US | |
| OL / RFC-A | ⇳ | rEF (0), For (1), rEv (2) | | | | ⇨ | rEF (0) | | | |

Defines the initial direction of the brake.

| Value | Text |
|---|---|
| 0 | rEF |
| 1 | For |
| 2 | rEv |

See Brake Controller Brake Release in *Parameter Reference Guide*.

| 54 | | Brake Controller Brake Apply Through Zero Threshold | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0.00 to 25.00 Hz | | | | ⇨ | 1.00 Hz | | | |

Defines if the brake is applied through zero threshold. See Brake Controller Brake Release in *Parameter Reference Guide*.

| 55 | | Brake Controller Enable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | | US | |
| OL / RFC-A | ⇳ | diS (0), rELAy (1), dig IO (2), USEr (3) | | | | ⇨ | diS (0) | | | |

| Value | Text |
|---|---|
| 0 | diS |
| 1 | rELAy |
| 2 | dig IO |
| 3 | USEr |

If *Brake Controller Enable* (Pr **55**) = diS, the brake controller is disabled.

If *Brake Controller Enable* (Pr **55**) = rELAy, the brake controller is enabled with I/O set up to control the brake via the relay output. Drive ok is re-routed to digital I/O.

If *Brake Controller Enable* (Pr **55**) = dig IO, the brake controller is enabled with I/O set up to control the brake via digital I/O. Drive ok is routed to the relay output.

If *Brake Controller Enable* (Pr **55**) = USEr, the brake controller is enabled, but no parameters are set up to select the brake output.

| 56 to 58 | | Trip 0 to 2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RO | | Txt | | | | ND | NC | PT | PS | |
| OL / RFC-A | ⇳ | 0 to 255 | | | | ⇨ | | | | |

These parameters show the last 3 trips.

| 59 | | OUP Enable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | | US | |
| OL / RFC-A | ⇳ | Stop (0) or Run (1) | | | | ⇨ | Run (1) | | | |

Enables the onboard user program.

Onboard user programming provides a background task that loops continuously and a timed task that is executed each time at a defined rate. For further information, refer to the *Parameter Reference Guide.*

| 60 | | OUP Status | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RO | | Num | | | | ND | NC | PT | | |
| OL / RFC-A | ⇳ | -2147483648 to 2147483647 | | | | ⇨ | | | | |

This parameter indicates the status of the user program in the drive. For further information, refer to the *Parameter Reference Guide.*

| 64 | | Ramp Rate Units | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | 0 to 2 | | | | ⇨ | 1 | | | |

The ramp rate parameters (*Acceleration Rate 1* (02.011) - *Acceleration Rate 8* (02.018), *Jog Acceleration Rate* (02.019), *Deceleration Rate 1* (02.021) - *Deceleration Rate 8* (02.028) and *Jog Deceleration Rate* (02.029)) are specified in *s / Ramp Rate Frequency*. Ramp rate frequency is selected with *Ramp Rate Units* (02.039) as defined in the table below.

| ***Ramp Rate Units* (02.039)** | **Ramp rate frequency** |
|---|---|
| 0 | Seconds per 100 Hz |
| 1 | Seconds per Maximum Frequency |
| 2 | Seconds per 1000 Hz |

Maximum frequency is defined by *Maximum Speed* (01.006) if *Select Motor 2 Parameters* (11.045) = 0 or *M2 Maximum Speed* (21.001) if *Select Motor 2 Parameters* (11.045) = 1.

| 65 | | Frequency Controller Proportional Gain Kp1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL | ⇳ | | | | | ⇨ | | | | |
| RFC-A | | 0.000 to 200.000 s/rad | | | | | 0.100 s/rad | | | |

Defines the proportional gain for frequency controller 1.

**RFC modes only.**

The controller includes a feed forward proportional gain (Kp), a feed forward integral gain (Ki), and a differential feedback gain (Kd).

**Proportional gain (Kp)**

If Kp is non-zero and Ki is zero the controller will only have a proportional term, and there must be a frequency error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual frequencies.

**Integral gain (Ki)**

The integral gain is provided to prevent frequency regulation. The error is accumulated over a period of time and used to produce the necessary torque reference without any frequency error. Increasing the integral gain reduces the time taken for the frequency to reach the correct level and increases the stiffness of the system, i.e. it reduces the positional displacement produced by applying a load torque to the motor.

| 66 | | Frequency Controller Integral Gain Ki1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL | ⇳ | | | | | ⇨ | | | | |
| RFC-A | | 0.00 to 655.35 s²/rad | | | | | 0.10 s²/rad | | | |

Defines the integral gain for frequency controller 1. See *Frequency Controller Proportional Gain Kp1* (Pr **65**).

| 67 | | Sensorless Mode Filter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Txt | | | | | | | US | |
| OL | ⇳ | | | | | ⇨ | | | | |
| RFC-A | | 4 (0), 5 (1), 6 (2), 8 (3), 12 (4), 20 (5) ms | | | | | 4 (0) ms | | | |

Defines the time constant for the filter applied to the output of the frequency estimator system.

| 69 | | Spin Start Boost | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL | ⇳ | 0.0 to 10.0 | | | | ⇨ | 1.0 | | | |
| RFC-A | | | | | | | | | | |

*Spin Start Boost* (Pr **69**) is used by the algorithm that detects the frequency of a spinning motor when the drive is enabled and *Catch A Spinning Motor* (Pr **33**) ≥ 1. For smaller motors the default value of 1.0 is suitable, but for larger motors *Spin Start Boost* (Pr **69**) may need to be increased.

If *Spin Start Boost* (Pr **69**) is too small the drive will detect zero speed whatever the frequency of the motor, and if *Spin Start Boost* (Pr **69**) is too large the motor may accelerate away from standstill when the drive is enabled.

| 70 | | PID1 Output | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RO | | Num | | | | ND | NC | PT | | |
| OL | ⇳ | ±100.00 % | | | | ⇨ | | | | |
| RFC-A | | | | | | | | | | |

This parameter is the output of the PID controller. For further information, refer to the *Parameter Reference Guide.*

| 71 | | PID1 Proportional Gain | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL | ⇳ | 0.000 to 4.000 | | | | ⇨ | 1.000 | | | |
| RFC-A | | | | | | | | | | |

Proportional gain applied to the PID error. For further information, refer to the *Parameter Reference Guide.*

| 72 | | PID1 Integral Gain | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL | ⇳ | 0.000 to 4.000 | | | | ⇨ | 0.500 | | | |
| RFC-A | | | | | | | | | | |

Integral gain applied to the PID error. For further information, refer to the *Parameter Reference Guide.*

| 73 | | PID1 Feedback Invert | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Bit | | | | | | | US | |
| OL | ⇳ | Off (0) or On (1) | | | | ⇨ | Off (0) | | | |
| RFC-A | | | | | | | | | | |

This parameter allows the PID feedback source to be inverted. For further information, refer to the *Parameter Reference Guide.*

| 74 | | PID1 Output Upper Limit | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RW | | Num | | | | | | | US | |
| OL | ⇳ | 0.00 to 100.00 % | | | | ⇨ | 100.00 % | | | |
| RFC-A | | | | | | | | | | |

This parameter with *PID1 Output Lower Limit* (Pr **75**) allows the output to be limited to a range. For further information, refer to the *Parameter Reference Guide.*

| 75 | | PID1 Output Lower Limit | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Num | | | | | | | US | |
| OL / RFC-A | ⇳ | ±100.00 % | | | ⇨ | -100.00 % | | | |

See *PID1 Output Upper Limit* (Pr **74**).

| 76 | | Action On Trip Detection | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Num | | | | ND | NC | PT | US | |
| OL / RFC-A | ⇳ | 0 - 31 | | | ⇨ | 0 | | | |

**Bit 0:** Stop on defined non-important trips

**Bit 1:** Disable braking resistor overload detection

**Bit 2**: Disable phase loss stop

**Bit 3:** Disable braking resistor temperature monitoring

**Bit 4:** Disable parameter freeze on trip. Refer to *Parameter Reference Guide.*

| 77 | | Maximum Heavy Duty Rating | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | | |
| OL / RFC-A | ⇳ | 0.00 to Drive HD Current Rating A | | | ⇨ | | | | |

Displays the maximum heavy duty current rating of the drive.

| 78 | | Software Version | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | | |
| OL / RFC-A | ⇳ | 0 to 99.99.99 | | | ⇨ | | | | |

Displays the software version in the drive.

| 79 | | User Drive Mode | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RW | Txt | | | | ND | NC | PT | US | |
| OL / RFC-A | ⇳ | OPEn.LP (1), RFC-A (2) | | | ⇨ | OPEn.LP (1) / RFC-A (2) | | | |

Defines the mode of the drive.

| 81 | | Reference Selected | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | | |
| OL / RFC-A | ⇳ | -Pr **02** to Pr **02** or Pr **01** to Pr **02** Hz | | | ⇨ | | | | |

This is the basic reference selected from the available sources.

| 82 | | Pre-ramp Reference | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | | |
| OL / RFC-A | ⇳ | -Pr **02** to Pr **02** or Pr **01** to Pr **02** Hz | | | ⇨ | | | | |

The *Pre-ramp Reference* is the final output from the reference system that is fed into the ramp system.

| 83 | | Final Demand Reference | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | FI | |
| OL / RFC-A | ⇳ | -Pr **02** to Pr **02** or Pr **01** to Pr **02** Hz | | | ⇨ | | | | |

**Open loop mode:**

*Final Demand Reference* shows the fundamental drive output frequency from the *Post Ramp Reference* and the *Hard Frequency Reference*.

**RFC mode:**

*Final Demand Reference* shows the reference at the input to the frequency controller, which is the sum of the *Post Ramp Reference*, if the ramp output is not disabled and the hard frequency reference (if enabled). If the drive is disabled *Final Demand Reference* shows 0.00.

| 84 | D.C. Bus Voltage | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | FI | |
| OL / RFC-A | ⇳ | 0 to 415 V or 0 to 830 V | | | ⇨ | | | | |

Voltage across the internal DC bus of the drive.

| 85 | Output Frequency | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | FI | |
| OL / RFC-A | ⇳ | ± 550.00 Hz | | | ⇨ | | | | |

**Open loop mode:**

The *Output Frequency* is the sum of the *Post Ramp Reference* and the motor slip compensation frequency.

**RFC-A mode:**

The output frequency is not controlled directly, but the *Output Frequency* is a measurement of the frequency applied to the motor.

| 86 | Output Voltage | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | FI | |
| OL / RFC-A | ⇳ | 0 to 325 V or 0 to 650 V | | | ⇨ | | | | |

The *Output Voltage* is the r.m.s line to line voltage at the a.c. terminals of the drive.

| 87 | Motor Rpm | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | FI | |
| OL / RFC-A | ⇳ | ±33000.0 rpm* | | | ⇨ | | | | |

*Motor Rpm* = 60 x Frequency / Pole pairs

where

Pole pairs = the numeric value of *Number Of Motor Poles* (Pr **40**) (i.e. 3 for a 6 pole motor)

The frequency used to derive the *Motor Rpm* is the *Final Demand Reference* (Pr **83**). The maximum and minimum values allow for a 10% over-shoot of the speed.

| 88 | Current Magnitude | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | FI | |
| OL / RFC-A | ⇳ | 0 to Drive Maximum Current A | | | ⇨ | | | | |

*Current Magnitude* is the instantaneous drive output current scaled so that it represents the r.m.s. phase current in Amps under steady state conditions.

| 89 | Torque Producing Current | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | Num | | | | ND | NC | PT | FI | |
| OL / RFC-A | ⇳ | ± Drive Maximum Current A | | | ⇨ | | | | |

*Torque Producing Current* is the instantaneous level of torque producing current scaled so that it represents the r.m.s. level of torque producing current under steady state conditions.

| 90 | | Digital I/O Read Word | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | | Bin | | | | ND | NC | PT | |
| OL / RFC-A | ⇳ | 0 to 2047 | | | ⇨ | | | | |

*Digital I/O Read Word* reflects the state of digital inputs/outputs 1 to 5 and the relay.

| 91 | | Reference On | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | | Bit | | | | ND | NC | PT | |
| OL / RFC-A | ⇳ | Off (0) or On (1) | | | ⇨ | | | | |

*Reference On*, which is controlled by the drive sequencer, indicates that the reference from the reference system is active.

| 92 | | Reverse Select | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | | Bit | | | | ND | NC | PT | |
| OL / RFC-A | ⇳ | Off (0) or On (1) | | | ⇨ | | | | |

*Reverse Select,* which is controlled by the drive sequencer, is used to invert *Reference Selected* (Pr **81**) or the *Jog Reference* (Pr **15**).

| 93 | | Jog Select | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | | Bit | | | | ND | NC | PT | |
| OL / RFC-A | ⇳ | Off (0) or On (1) | | | ⇨ | | | | |

*Jog Select*, which is controlled by the drive sequencer, is used to select the *Jog Reference* (Pr **15**).

| 94 | | Analog Input 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | | Num | | | | ND | NC | PT | FI |
| OL / RFC-A | ⇳ | ±100.00 % | | | ⇨ | | | | |

This parameter displays the level of the analog signal present at analog input 1 (terminal 2).

| 95 | | Analog Input 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RO | | Num | | | | ND | NC | PT | FI |
| OL / RFC-A | ⇳ | ±100.00 % | | | ⇨ | | | | |

This parameter displays the level of the analog signal present at analog input 2 (terminal 5).

# 7 Running the motor

This chapter takes the new user through all the essential steps to running a motor for the first time, in each of the possible operating modes.

For information on tuning the drive for the best performance, see Chapter 8 *Optimization* on page 63.

**WARNING**

Ensure that no damage or safety hazard could arise from the motor starting unexpectedly.

**CAUTION**

The values of the motor parameters affect the protection of the motor.
The default values in the drive should not be relied upon.
It is essential that the correct value is entered in Pr **06** *Motor Rated Current*. This affects the thermal protection of the motor.

**CAUTION**

If the drive is started using the keypad it will run to the speed defined by the keypad reference (Pr **01.017**). This may not be acceptable depending on the application. The user must check in Pr **01.017** and ensure that the keypad reference has been set to 0.

**WARNING**

If the intended maximum speed affects the safety of the machinery, additional independent over-speed protection must be used.

## 7.1 Quick start connections

### 7.1.1 Basic requirements

This section shows the basic connections which must be made for the drive to run in the required mode. For minimal parameter settings to run in each mode please see the relevant part of section 7.3 *Quick start commissioning / start-up* on page 61.

**Table 7-1 Minimum control connection requirements for each control mode**

| Drive control method | Requirements |
|---|---|
| Terminal mode | Drive enable<br>Speed / Torque reference<br>Run forward / Run reverse |
| Keypad mode | Drive enable |
| Serial communications | Drive enable<br>Serial communications link |

## 7.2 Changing the operating mode

**Procedure**

Use the following procedure only if a different operating mode is required:

1. Ensure that the drive is not enabled, i.e. drive is in inhibit or under voltage state.
2. Change the setting of Pr **79** as follows:

| Pr 79 setting | | Operating mode |
|---|---|---|
| OPEnLP | 1 | Open-loop |
| rFC-A | 2 | RFC-A |

The figures in the second column apply when serial communications are used.

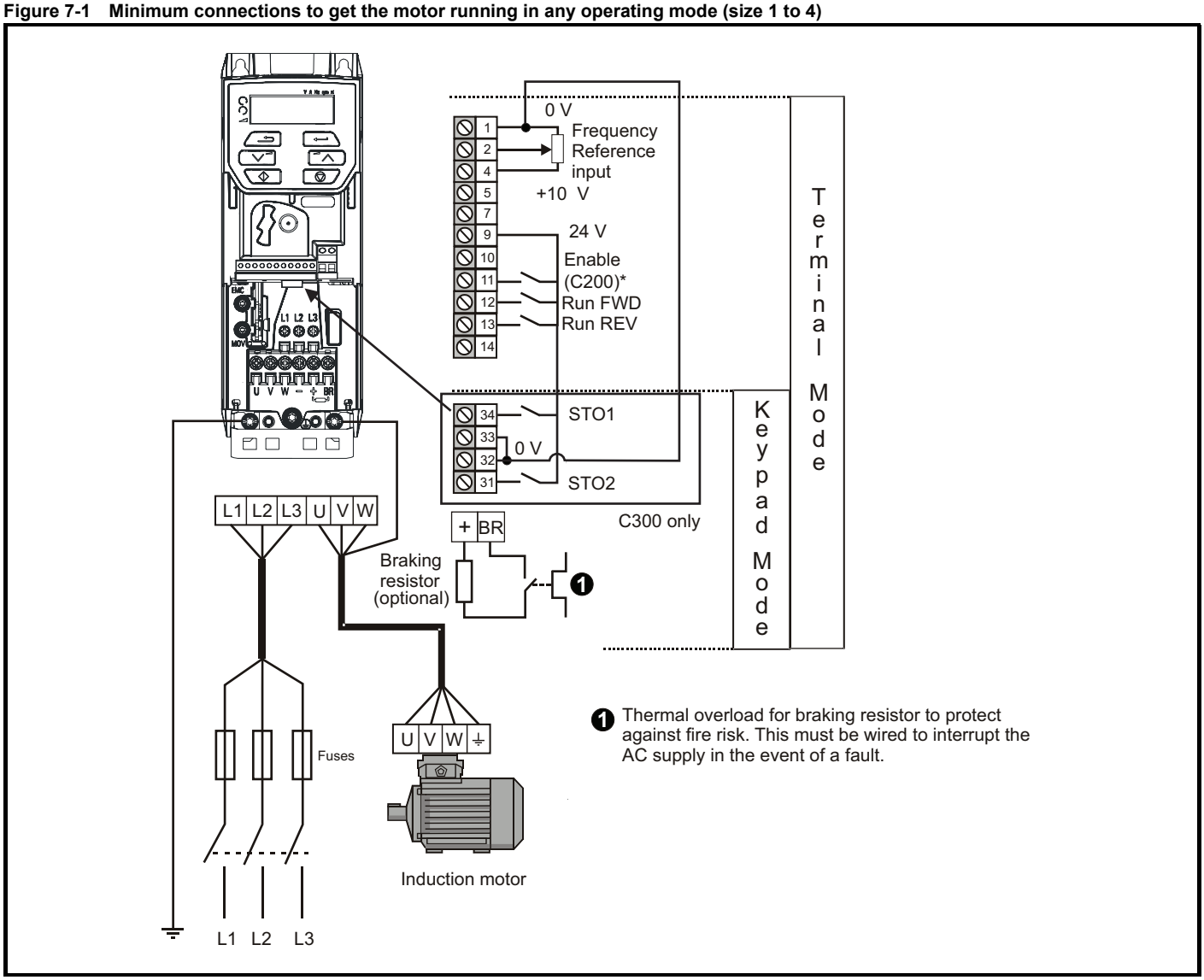
3. Either:

- Press the red reset button
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100.

**NOTE**

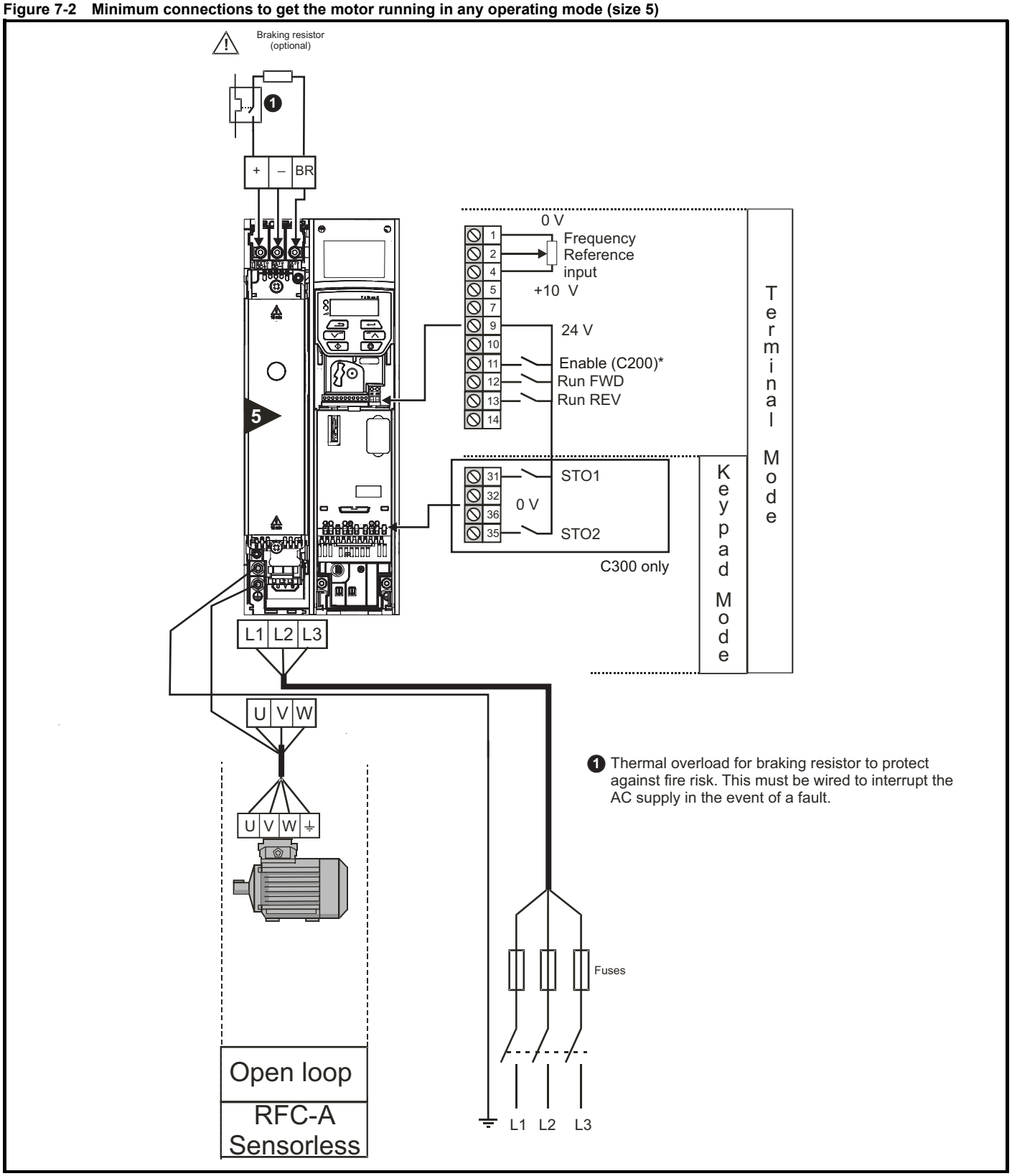
When the operating mode is changed, a parameter save is carried out.

**Figure 7-1 Minimum connections to get the motor running in any operating mode (size 1 to 4)**



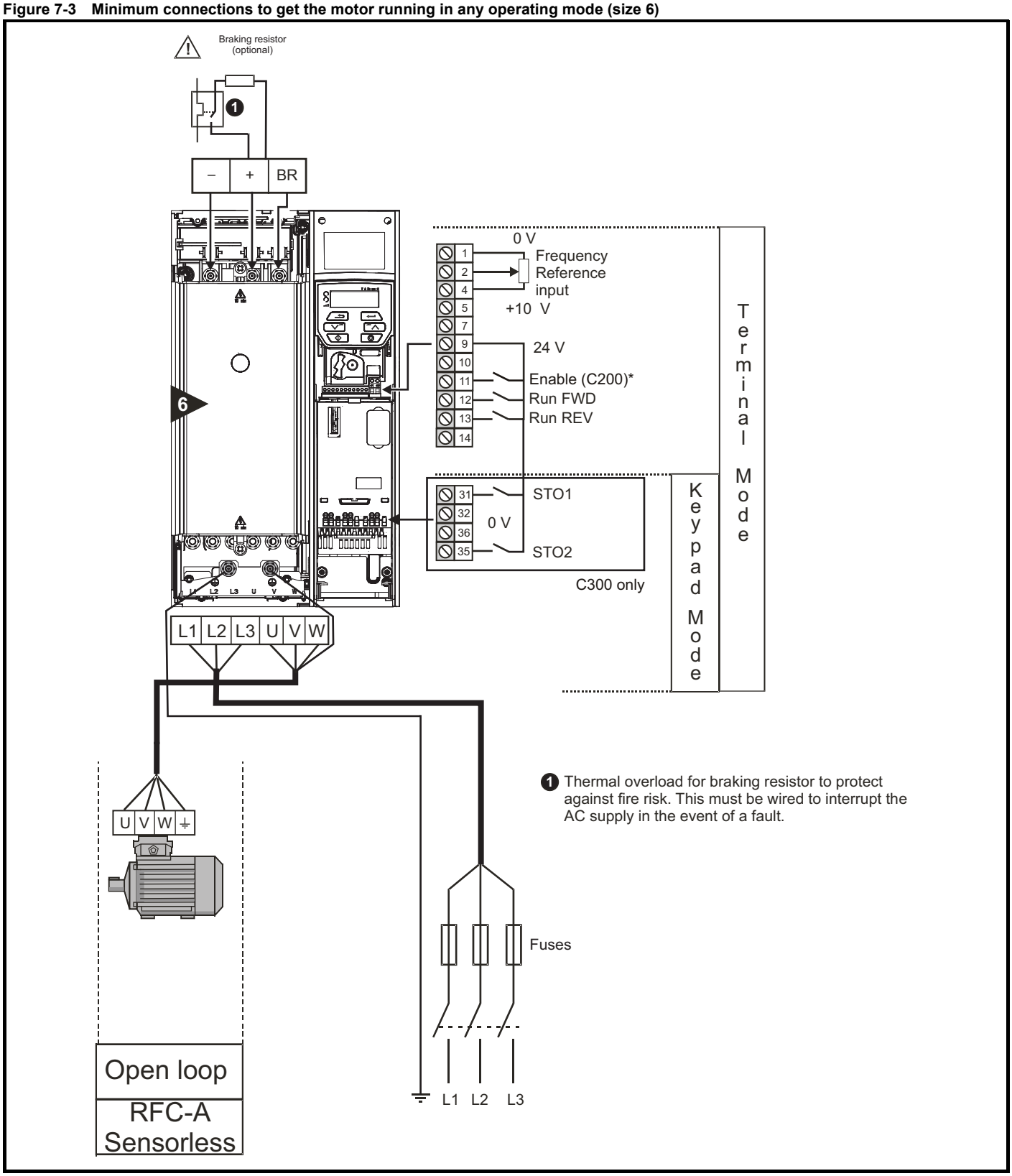

* Terminal 11 unassigned on Commander C300

**Figure 7-2 Minimum connections to get the motor running in any operating mode (size 5)**



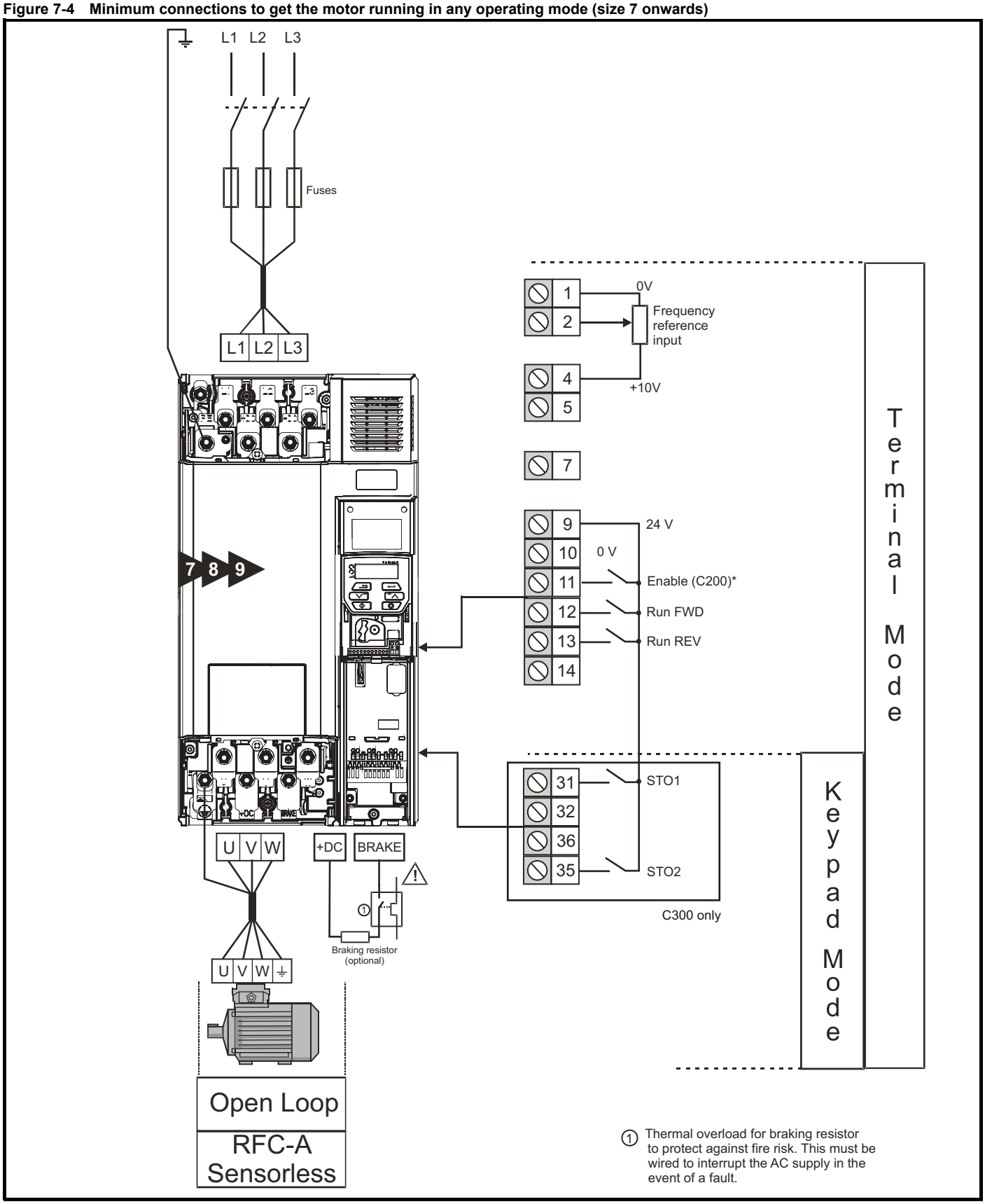

* Terminal 11 unassigned on Commander C300

**Figure 7-3 Minimum connections to get the motor running in any operating mode (size 6)**




* Terminal 11 unassigned on Commander C300

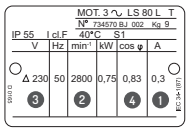
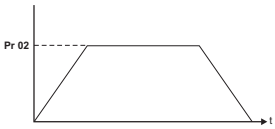
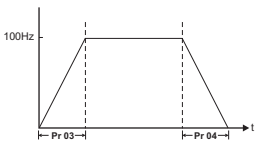
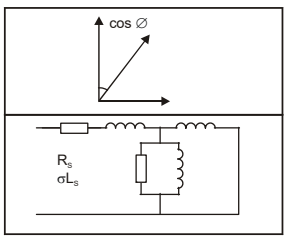
**Figure 7-4 Minimum connections to get the motor running in any operating mode (size 7 onwards)**



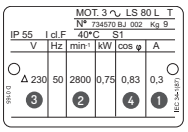
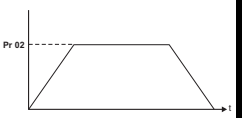
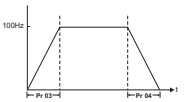
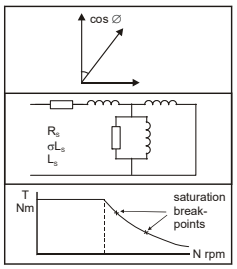
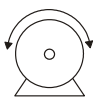

* Terminal 11 unassigned on Commander C300

# 7.3 Quick start commissioning / start-up

## 7.3.1 Open loop

| Action | Detail | |
|---|---|---|
| Before power-up | Ensure:<br>• The drive enable signal is not given (terminals 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9 is open)<br>• Run signal is not given, terminal 12/13 is open.<br>• Motor is connected to the drive.<br>• The motor connection is correct for the drive ⅄ or Δ connection.<br>• The correct supply voltage is connected to the drive. |  |
| Power-up the drive | Verify that open loop mode is displayed as the drive powers up.<br>If the mode is incorrect see section 5.6 *Changing the operating mode* on page 28.<br>Ensure:<br>• Drive displays 'inh' (enable terminals are open).<br>If the drive trips, see Chapter 12 *Diagnostics* on page 147. |  |
| Enter motor nameplate details | ❶ Motor rated current in Pr **06** (Amps)<br>❷ Motor rated speed in Pr **07** (rpm / min$^{-1}$)<br>❸ Motor rated voltage in Pr **08** (Volts)<br>❹ Motor rated power factor (cos ϕ) in Pr **09** |  |
| Set maximum speed | Enter:<br>• Maximum speed in Pr **02** (Hz) |  |
| Set acceleration / deceleration rates | Enter:<br>• Acceleration rate in Pr **03** (s/Maximum Frequency)<br>• Deceleration rate in Pr **04** (s/Maximum Frequency) (If braking resistor is installed, set Pr **28** = FAST. Also ensure Pr **10.030** and Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'It.br' trips may be seen). |  |
| Autotune | The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A rotating autotune should be used whenever possible so the measured value of power factor of the motor is used by the drive.<br>**WARNING** A rotating autotune will cause the motor to accelerate up to $^{2}/_{3}$ base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable.<br>• A stationary autotune can be used when the motor is loaded and it is not possible to uncouple the load from the motor shaft. A stationary autotune measures the stator resistance of the motor and the dead time compensation for the drive. These are required for good performance in vector control modes. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **09**.<br>• A rotating autotune should only be used if the motor is uncoupled. A rotating autotune first performs a stationary autotune before rotating the motor at $^{2}/_{3}$ base speed in the direction selected. The rotating autotune measures the power factor of the motor.<br>To perform an autotune:<br>• Set Pr **38** = 1 for a stationary autotune or set Pr **38** = 2 for a rotating autotune<br>• Close the drive enable signal (apply 24V to terminal 11 on C200 or terminal 31 and 34 on C300 size 1 to 4 or terminal 31 and 35 on C300 size 5 to 9). The drive will display 'rdy'.<br>• Give a run command (apply +24 V to terminal 12 - Run forward or terminal 13 - Run reverse). The display will flash 'tuning' while the drive is performing the autotune.<br>• Wait for the drive to display 'inh' and for the motor to come to a standstill.<br>If the drive trips, see Chapter 12 *Diagnostics* on page 147.<br>• Remove the drive enable and run signal from the drive. |  |
| Save parameters | Select 'Save' in Pr **00** or Pr **mm.000** (alternatively enter a value of 1001) and press the red reset button. | |
| Run | Drive is now ready to run |  |

### 7.3.2 RFC - A mode

| Action | Detail | |
|---|---|---|
| Before power-up | Ensure:<br>• The drive enable signal is not given (terminal 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9 is open)<br>• Run signal is not given, terminal 12/13 is open.<br>• Motor is connected to the drive.<br>• The motor connection is correct for the drive ⅄ or Δ connection.<br>• The correct supply voltage is connected to the drive. |  |
| Power-up the drive | Verify that RFC-A mode is displayed as the drive powers up.<br>If the mode is incorrect see section 5.6 *Changing the operating mode* on page 28.<br>Ensure:<br>• Drive displays 'inh' (enable terminals are open).<br>If the drive trips, see Chapter 12 *Diagnostics* on page 147. |  |
| Enter motor nameplate details | ❶ Motor rated current in Pr **06** (Amps)<br>❷ Motor rated speed in Pr **07** (rpm / min$^{-1}$)*<br>❸ Motor rated voltage in Pr **08** (Volts)<br>❹ Motor rated power factor (cos ϕ) in Pr **09** |  |
| Set maximum speed | Enter:<br>• Maximum speed in Pr **02** (Hz) |  |
| Set acceleration / deceleration rates | Enter:<br>• Acceleration rate in Pr **03** (s/Maximum Frequency)<br>• Deceleration rate in Pr **04** (s/Maximum Frequency) (If braking resistor is installed, set Pr **28** = FAST. Also ensure Pr **10.030**, Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'It.br' trips may be seen). |  |
| Autotune | The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive.<br>**WARNING** A rotating autotune will cause the motor to accelerate up to $^2/_3$ base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable.<br>• A stationary autotune can be used when the motor is loaded and it is not possible to uncouple the load from the motor shaft. The stationary autotune measures the stator resistance and transient inductance of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **04.013** and Pr **04.014** are updated. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **09**.<br>• A rotating autotune should only be used if the motor is uncoupled. A rotating autotune first performs a stationary autotune before rotating the motor at $^2/_3$ base speed in the direction selected. The rotating autotune measures the stator inductance of the motor and calculates the power factor.<br>To perform an autotune:<br>• Set Pr **38** = 1 for a stationary autotune or set Pr **38** = 2 for a rotating autotune<br>• Close the drive enable signal (apply 24V to terminal 11 on C200 or terminal 31 and 34 on C300 size 1 to 4 or terminal 31 and 35 on C300 size 5 to 9). The drive will display 'rdy'.<br>• Give a run command (apply +24 V to terminal 12 - Run forward or terminal 13 - Run reverse). The display will flash 'tuning' while the drive is performing the autotune.<br>• Wait for the drive to display 'inh' and for the motor to come to a standstill.<br>If the drive trips, see Chapter 12 *Diagnostics* on page 147.<br>• Remove the drive enable and run signal from the drive. |  |
| Save parameters | Select 'Save' in Pr **00** or Pr **mm.000** (alternatively enter a value of 1001) and press red reset button. | |
| Run | The drive is now ready to run |  |

* Slip is required for RFC-A mode.

# 8 Optimization

This chapter takes the user through methods of optimizing the drive set-up and maximize the performance. The auto-tuning features of the drive simplify the optimization tasks.

## 8.1 Motor map parameters

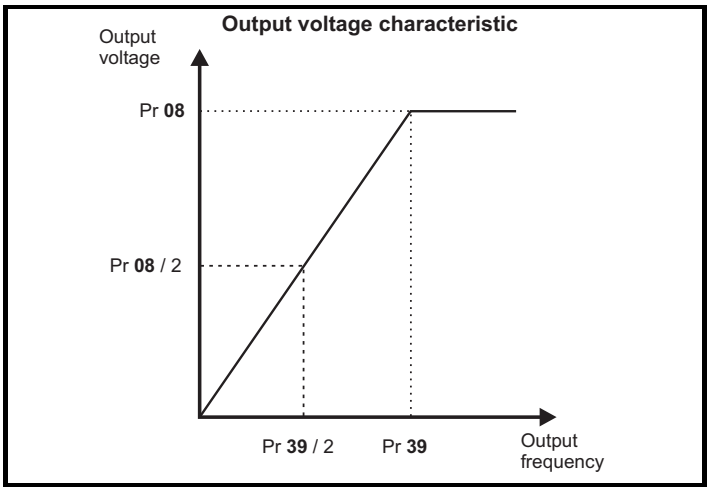
### 8.1.1 Open loop motor control

| **Pr 06 {05.007} *Motor Rated Current*** | **Defines the maximum continuous motor current** |
|---|---|

- The rated current parameter must be set to the maximum continuous current of the motor. The motor rated current is used in the following:
- Current limits (see section section 8.3 *Current limits* on page 70, for more information)
- Motor thermal overload protection (see section section 8.4 *Motor thermal protection* on page 70, for more information)
- Vector mode voltage control (see *Control Mode* later in this table)
- Slip compensation (see *Enable Slip Compensation* (05.027), later in this table)
- Dynamic V/F control

| **Pr 08 {05.009} *Motor Rated Voltage*** | **Defines the voltage applied to the motor at rated frequency** |
|---|---|
| **Pr 39 {05.006} *Motor Rated Frequency*** | **Defines the frequency at which rated voltage is applied** |

The *Motor Rated Voltage* (Pr **08**) and the *Motor Rated Frequency* (Pr **39**) are used to define the voltage to frequency characteristic applied to the motor (see *Control Mode*, later in this table). The *Motor Rated Frequency* is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see *Motor Rated Speed*, later in this table).



| **Pr 07 {05.008}** ***Motor Rated Speed*** | **Defines the full load rated speed of the motor** |
|---|---|
| **Pr 40 {05.011}** ***Number of Motor Poles*** | **Defines the number of motor poles** |

The motor rated speed and the number of poles are used with the motor rated frequency to calculate the rated slip of induction machines in Hz.

Rated slip (Hz) = Motor rated frequency - (Number of pole pairs x [Motor rated speed / 60]) = $\mathbf{Pr39} = \left(\frac{\mathbf{Pr40}}{\mathbf{2}} \times \frac{\mathbf{Pr07}}{\mathbf{60}}\right)$

If Pr **07** is set to 0 or to synchronous speed, slip compensation is disabled. If slip compensation is required this parameter should be set to the nameplate value, which should give the correct rpm for a hot machine. Sometimes it will be necessary to adjust this when the drive is commissioned because the nameplate value may be inaccurate. Slip compensation will operate correctly both below base speed and within the field-weakening region. Slip compensation is normally used to correct for the motor speed to prevent speed variation with load. The rated load rpm can be set higher than synchronous speed to deliberately introduce speed droop. This can be useful to aid load sharing with mechanically coupled motors.

Pr **40** is also used in the calculation of the motor speed display by the drive for a given output frequency. When Pr **40** is set to 'Auto', the number of motor poles is automatically calculated from the rated frequency Pr **39**, and the motor rated speed Pr **07**.

Number of poles = 120 x (*Rated Frequency* (Pr **39**) / *Rated Speed* (Pr **07**)) rounded to the nearest even number.

| **Pr 43 {05.010}** ***Motor Rated Power Factor*** | **Defines the angle between the motor voltage and current** |
|---|---|

The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current. The power factor is used in conjunction with the *Motor Rated Current* (Pr **06**), to calculate the rated active current and magnetising current of the motor. The rated active current is used extensively to control the drive, and the magnetising current is used in vector mode stator resistance compensation. It is important that this parameter is set up correctly. The drive can measure the motor rated power factor by performing a rotating autotune (see *Autotune* (Pr **38**), overleaf).

| **Pr 38 {05.012}** ***Auto-tune*** | |
|---|---|

There are two autotune tests available in open loop mode, a stationary and a rotating test. A rotating autotune should be used whenever possible so the measured value of power factor of the motor is used by the drive.

- A stationary autotune can be used when the motor is loaded and it is not possible to remove the load from the motor shaft. The stationary test measures the *Stator Resistance* (05.017), *Transient Inductance* (05.024), *Maximum Deadtime Compensation* (05.059) and *Current At Maximum Deadtime Compensation* (05.060) which are required for good performance in vector control modes (see *Control Mode* later in this table). The stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **09**. To perform a Stationary autotune, set Pr **38** to 1, and provide the drive with both an enable signal (on terminals 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9) and a run signal (on terminals 12 or 13).

- A rotating autotune should only be used if the motor is unloaded. A rotating autotune first performs a stationary autotune, as above, then a rotating test is performed in which the motor is accelerated with currently selected ramps up to a frequency of *Motor Rated Frequency* (Pr **39**) x 2/3, and the frequency is maintained at that level for 4 seconds. *Stator Inductance* (05.025) is measured and this value is used in conjunction with other motor parameters to calculate *Motor Rated Power Factor* (Pr **09**). To perform a Rotating autotune, set Pr **38** to 2, and provide the drive with both an enable signal (on terminals 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9) and a run signal (on terminals 12 or 13).

Following the completion of an autotune test the drive will go into the inhibit state. The drive must be placed into a controlled disable condition before the drive can be made to run at the required reference. The drive can be put in to a controlled disable condition by removing the Safe Torque Off signal from terminals 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9, setting the *Drive Enable* (06.015) to OFF (0) or disabling the drive via the *Control Word* (06.042) and *Control Word Enable* (06.043).

**Pr 41 {05.014} *Control Mode***

There are several voltage modes available which fall into two categories, vector control and fixed boost.

**Vector control**

Vector control mode provides the motor with a linear voltage characteristic from 0 Hz to *Motor Rated Frequency*, and then a constant voltage above motor rated frequency. When the drive operates between motor rated frequency/50 and motor rated frequency/4, full vector based stator resistance compensation is applied. When the drive operates between motor rated frequency/4 and motor rated frequency/2 the stator resistance compensation is gradually reduced to zero as the frequency increases. For the vector modes to operate correctly the *Motor Rated Power Factor* (Pr **09**), *Stator Resistance* (05.017), *Maximum Deadtime Compensation* (05.059) and current at *Maximum Deadtime Compensation* (05.060) are all required to be set up accurately. The drive can be made to measure these by performing an autotune (see Pr **38** *Autotune*). The drive can also be made to measure the stator resistance automatically every time the drive is enabled or the first time the drive is enabled after it is powered up, by selecting one of the vector control voltage modes.

(0) **Ur.S** = The stator resistance is measured and the parameters for the selected motor map are over-written each time the drive is made to run. This test can only be done with a stationary motor where the flux has decayed to zero. Therefore this mode should only be used if the motor is guaranteed to be stationary each time the drive is made to run. To prevent the test from being done before the flux has decayed there is a period of 1 second after the drive has been in the ready state during which the test is not done if the drive is made to run again. In this case, previously measured values are used. Ur S mode ensures that the drive compensates for any change in motor parameters due to changes in temperature. The new value of stator resistance is not automatically saved to the drive's EEPROM.

(4) **Ur.I** = The stator resistance is measured when the drive is first made to run after each power-up. This test can only be done with a stationary motor. Therefore this mode should only be used if the motor is guaranteed to be stationary the first time the drive is made to run after each power-up. The new value of stator resistance is not automatically saved to the drive's EEPROM.

(1) **Ur** = The stator resistance and voltage offset are not measured. The user can enter the motor and cabling resistance into the *Stator Resistance* (05.017). However this will not include resistance effects within the drive inverter. Therefore if this mode is to be used, it is best to use an autotune test initially to measure the stator resistance.

(3) **Ur.Auto** = The stator resistance is measured once, the first time the drive is made to run. After the test has been completed successfully the *Control Mode* (Pr **41**) is changed to Ur mode. The *Stator Resistance* (05.017) parameter is written to, and along with the *Control Mode* (Pr **41**), are saved in the drive's EEPROM. If the test fails, the voltage mode will stay set to Ur Auto and the test will be repeated next time the drive is made to run.

**Fixed boost**

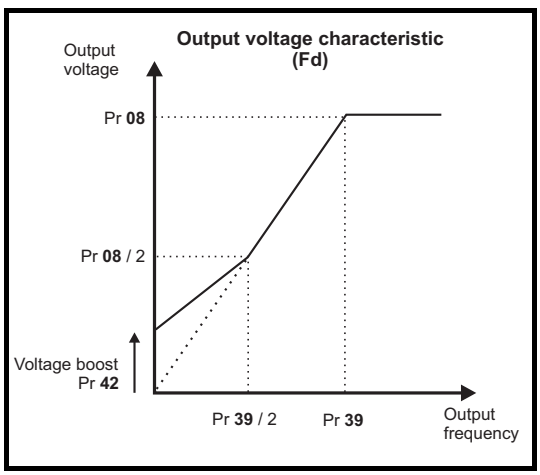
The stator resistance is not used in the control of the motor, instead a fixed characteristic with low frequency voltage boost as defined by Pr **42**, is used. Fixed boost mode should be used when the drive is controlling multiple motors. There are three settings of fixed boost available:

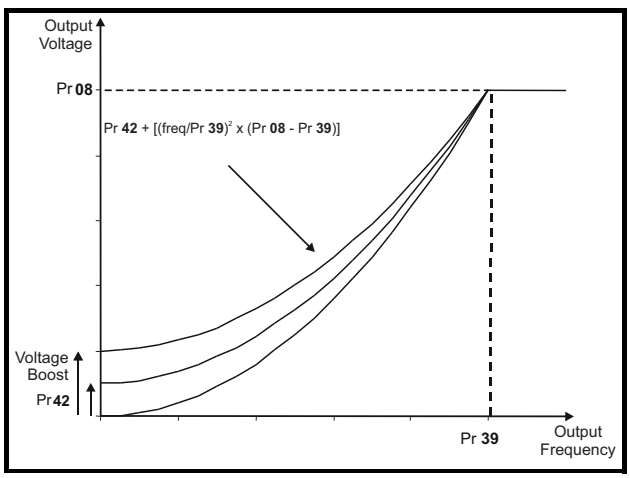
(2) **Fixed (Fd)** = This mode provides the motor with a linear voltage characteristic from 0 Hz to *Motor Rated Frequency* (Pr **39**), and then a constant voltage above rated frequency.

(5) **Square (SrE)** = This mode provides the motor with a square law voltage characteristic from 0 Hz to *Motor Rated Frequency* (Pr **39**), and then a constant voltage above rated frequency. This mode is suitable for variable torque applications like fans and pumps where the load is proportional to the square of the speed of the motor shaft. This mode should not be used if a high starting torque is required.

(6) **Fixed Tapered (Fd.tap)** = This mode provides the motor with a linear voltage characteristic with a tapered slip limit.

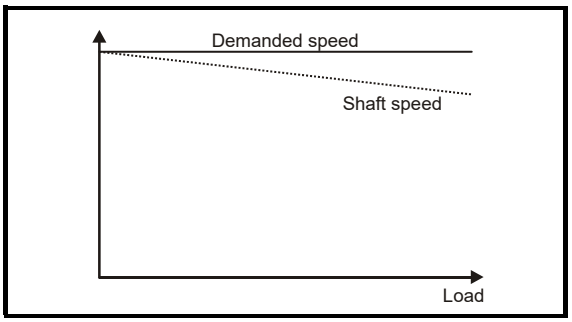
For mode 2 and 5, at low frequencies (from 0 Hz to ½ x Pr **39**) a voltage boost is applied as defined by Pr **42** as shown below:



**Pr 05.027** ***Enable Slip Compensation***

When a motor, being controlled in open loop mode, has load applied a characteristic of the motor is that the output speed droops in proportion to the load applied as shown:




In order to prevent the speed droop shown above slip compensation should be enabled. To enable slip compensation Pr **05.027** must be set to 100 % (this is the default setting), and the motor rated speed must be entered in Pr **07** (Pr **05.008**).

The motor rated speed parameter should be set to the synchronous speed of the motor minus the slip speed. This is normally displayed on the motor nameplate, i.e. for a typical 18.5 kW, 50 Hz, 4 pole motor, the motor rated speed would be approximately 1465 rpm. The synchronous speed for a 50 Hz, 4 pole motor is 1500 rpm, so therefore the slip speed would be 35 rpm. If the synchronous speed is entered in Pr **07**, slip compensation will be disabled. If too small a value is entered in Pr **07**, the motor will run faster than the demanded frequency. The synchronous speeds for 50 Hz motors with different numbers of poles are as follows:

2 pole = 3000 rpm, 4 pole = 1500 rpm, 6 pole =1000 rpm, 8 pole = 750 rpm

### 8.1.2 RFC-A mode

**Pr 06 {05.007} *Motor Rated Current*** — **Defines the maximum motor continuous current**

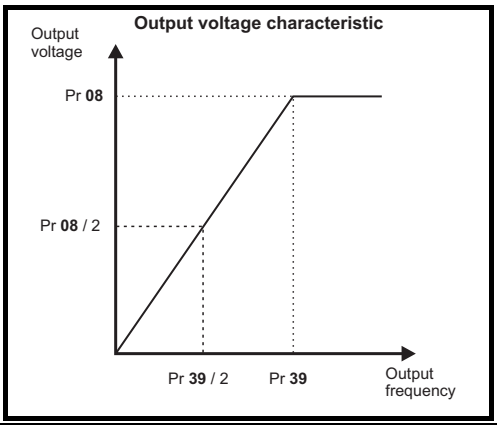
The motor rated current parameter must be set to the maximum continuous current of the motor. The motor rated current is used in the following:

- Current limits (see section 8.3 *Current limits* on page 70, for more information).
- Motor thermal overload protection (see section 8.4 *Motor thermal protection* on page 70, for more information)
- Vector control algorithm

**Pr 08 {05.009} *Motor Rated Voltage*** — **Defines the voltage applied to the motor at rated frequency**

**Pr 39 {05.006} *Motor Rated Frequency*** — **Defines the frequency at which rated voltage is applied**

The *Motor Rated Voltage* (Pr **08**) and the *Motor Rated Frequency* (Pr **39**) are used to define the voltage to frequency characteristic applied to the motor (see *Control Mode* (Pr **41**), later in this table). The motor rated frequency is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see *Motor Rated Speed (*Pr **07**), later in this table).




**Pr 07 {05.008} *Motor Rated Speed*** — **Defines the full load rated speed of the motor and slip**

**Pr 40 {05.011} *Number of Motor Poles*** — **Defines the number of motor poles**

The motor rated speed and motor rated frequency are used to determine the full load slip of the motor which is used by the vector control algorithm.

Incorrect setting of this parameter has the following effects:

- Reduced efficiency of motor operation
- Reduction of maximum torque available from the motor
- Reduced transient performance
- Inaccurate control of absolute torque in torque control modes

The nameplate value is normally the value for a hot motor; however, some adjustment may be required when the drive is commissioned if the nameplate value is inaccurate. A fixed value can be entered in this parameter.

When Pr **40** is set to 'Auto', the number of motor poles is automatically calculated from the *Motor Rated Frequency* (Pr **39**), and the *Motor Rated Speed* (Pr **07**).

Number of poles = 120 x (Motor *Rated Frequency* (Pr **39** / Motor *Rated Speed* (Pr **07**) rounded to the nearest even number.

**Pr 09 {05.010} *Motor Rated Power Factor*** — **Defines the angle between the motor voltage and current**

The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current. If the *Stator Inductance* (05.025) is set to zero then the power factor is used in conjunction with the *Motor Rated Current* (Pr **06**) and other motor parameters to calculate the rated active and magnetising currents of the motor, which are used in the vector control algorithm. If the stator inductance has a non-zero value this parameter is not used by the drive, but is continuously written with a calculated value of power factor. The stator inductance can be measured by the drive by performing a rotating autotune (see *Autotune* (Pr **38**), later in this table).

**Pr 38 {05.012} *Autotune***

There are three autotune tests available in RFC-A mode, a stationary test, a rotating test and a mechanical load measurement test. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive. An inertia measurement test should be performed separately to a stationary or rotating autotune.

**NOTE**

It is highly recommended that a rotating autotune is performed (Pr **38** set to 2).

- A stationary autotune can be used when the motor is loaded and it is not possible to remove the load from the motor shaft. The stationary autotune measures the *Stator Resistance* (05.017) and *Transient Inductance* (05.024) of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **04.013** and Pr **04.014** are updated. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **09**. To perform a Stationary autotune, set Pr **38** to 1, and provide the drive with both an enable signal (on terminal 31 & 34) and a run signal (on terminal 12 or 13).
- A rotating autotune should only be used if the motor is unloaded. A rotating autotune first performs a stationary autotune, a rotating test is then performed which the motor is accelerated with currently selected ramps up to a frequency of *Motor Rated Frequency* (Pr **39**) x 2/3, and the frequency is maintained at the level for up to 40 s. During the rotating autotune the *Stator Inductance* (05.025), and the motor saturation breakpoints (Pr **05.029**, Pr **05.030**, Pr **05.062** and Pr **05.063**) are modified by the drive. The power factor is also modified for user information only, but is not used after this point as the stator inductance is used in the vector control algorithm instead. To perform a Rotating autotune, set Pr **38** to 2, and provide the drive with both an enable signal (on terminal 31 & 34) and a run signal (on terminal 12 or 13).
- The mechanical load test can measure the total inertia of the load and the motor. A series of progressively larger torque levels are applied to the motor (20 %, 40 % … 100 % of rated torque) to accelerate the motor up to ¾ x Motor Rated Speed (Pr **07**) to determine the inertia from the acceleration/deceleration time. The test attempts to reach the required speed within 5s, but if this fails, the next torque level is used. When 100 % torque is used, the test allows 60 s for the required speed to be reached, but if this is unsuccessful, a tun.1 trip is initiated. To reduce the time taken for the test, it is possible to define the level of torque to be used for the test by setting Mechanical Load Test Level (05.021) to a non-zero value. When the test level is defined, the test is only carried out at the defined test level and 60 s is allowed for the motor to reach the required speed. It should be noted that if the maximum speed allows for flux weakening then it may not be possible to achieve the required torque level to accelerate the motor fast enough. If this is the case, the maximum speed reference should be reduced.
  1. The motor must be stationary at the start of the test.
  2. The motor is accelerated in the required direction up to ¾ of the maximum speed reference and then decelerated to zero speed.
  3. The test is repeated with progressively higher torque until the required speed is reached.

  To perform a mechanical load measurement autotune, set Pr **38** to 3, and provide the drive with both an enable signal (on terminal 31 & 34) and a run signal (on terminal 12 or 13). Following the completion of an autotune test the drive will go into the inhibit state. The drive must be placed into a controlled disable condition before the drive can be made to run at the required reference. The drive can be put in to a controlled disable condition by removing the Safe Torque Off signal from terminal 31 & 34, setting the *Drive Enable* (06.015) to OFF (0) or disabling the drive via the control word (Pr **06.042** & Pr **06.043**).

**{04.013} / {04.014} *Current Loop Gains***

The current loop gains proportional (Kp) and integral (Ki) gains control the response of the current loop to a change in current (torque) demand. The default values give satisfactory operation with most motors. However, for optimal performance in dynamic applications it may be necessary to change the gains to improve the performance. The *Current Controller Kp Gain* (04.013) is the most critical value in controlling the performance. The values for the current loop gains can be calculated by performing a stationary or rotating autotune (see *Autotune* Pr **38**, earlier in this table) the drive measures the *Stator Resistance* (05.017) and *Transient Inductance* (05.024) of the motor and calculates the current loop gains.

This will give a step response with minimum overshoot after a step change of current reference. The proportional gain can be increased by a factor of 1.5 giving a similar increase in bandwidth; however, this gives a step response with approximately 12.5 % overshoot. The equation for the integral gain gives a conservative value. In some applications where it is necessary for the reference frame used by the drive to dynamically follow the flux very closely (i.e. high speed Sensorless RFC-A induction motor applications) the integral gain may need to have a significantly higher value.

### *Frequency Loop Gains* (00.065 {03.010}, Pr 00.066 {03.011}

The frequency loop gains control the response of the frequency controller to a change in frequency demand. The frequency controller includes proportional (Kp) and integral (Ki) feed forward terms, and a differential (Kd) feedback term. The drive holds two sets of these gains and either set may be selected for use by the frequency controller with Pr **03.016**. If Pr **03.016** = 0, gains Kp1, Ki1 and Kd1 (Pr **03.010** to Pr **03.012**) are used, and if Pr **03.016** = 1, gains Kp2, Ki2 and Kd2 (Pr **03.013** to Pr **03.015**) are used. **Pr 03.016** may be changed when the drive is enabled or disabled.

Frequency Controller Proportional Gain (Kp), Pr **65** {03.010} and **Pr 03.013**

If the proportional gain has a value and the integral gain is set to zero the controller will only have a proportional term, and there must be a frequency error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual frequencies. This effect, called regulation, depends on the level of the proportional gain, the higher the gain the smaller the frequency error for a given load. If the proportional gain is too high either the acoustic noise produced by numerical quantization becomes unacceptable, or the stability limit is reached.

Frequency Controller Integral Gain (Ki), Pr **66** {03.011} and Pr **03.014**

The integral gain is provided to prevent frequency regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any frequency error. Increasing the integral gain reduces the time taken for the frequency to reach the correct level and increases the stiffness of the system, i.e. it reduces the positional displacement produced by applying a load torque to the motor. Unfortunately increasing the integral gain also reduces the system damping giving overshoot after a transient. For a given integral gain, the damping can be improved by increasing the proportional gain. A compromise must be reached where the system response, stiffness and damping are all adequate for the application. For RFC-A Sensorless mode, it is unlikely that the integral gain can be increased much above 0.50.

Differential Gain (Kd), Pr **03.012** and Pr **03.015**

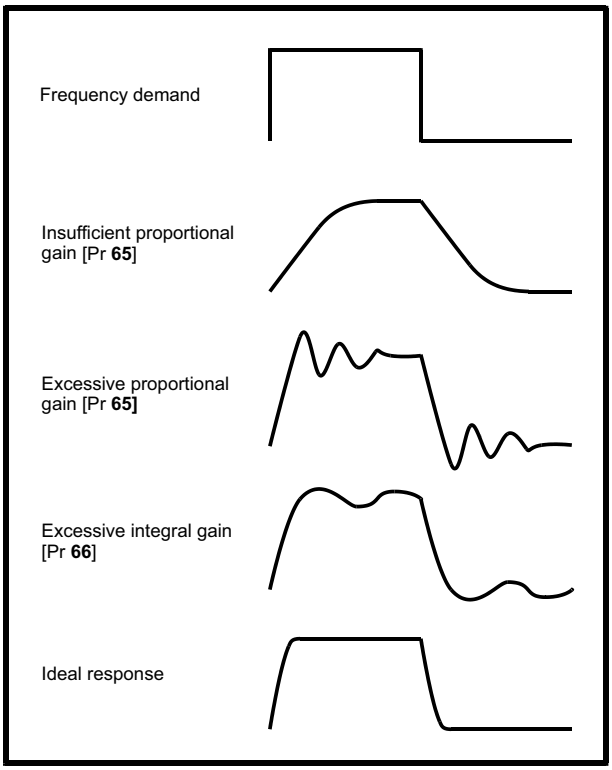
The differential gain is provided in the feedback of the frequency controller to give additional damping. The differential term is implemented in a way that does not introduce excessive noise normally associated with this type of function. Increasing the differential term reduces the overshoot produced by under-damping, however, for most applications the proportional and integral gains alone are sufficient.

Gain Change Threshold, Pr **03.017**

If the Frequency Controller Gain Select (03.016) = 2, gains Kp1, Ki1 and Kd1 (Pr **03.010** to Pr **03.012**) are used while the modulus of the frequency demand is less than the value held by Gain Change Threshold (03.017), else gains Kp2, Ki2 and Kd2 (Pr **03.013** to Pr **03.015**) will be used.

Tuning the frequency loop gains:

This involves the connecting of an oscilloscope to analog output 1 to monitor the frequency feedback.
Give the drive a step change in frequency reference and monitor the response of the drive on the oscilloscope.
The proportional gain (Kp) should be set up initially. The value should be increased up to the point where the frequency overshoots and then reduced slightly.
The integral gain (Ki) should then be increased up to the point where the frequency becomes unstable and then reduced slightly.
It may now be possible to increase the proportional gain to a higher value and the process should be repeated until the system response approaches the ideal response as shown.
The diagram shows the effect of incorrect P and I gain settings as well as the ideal response.



## 8.2 Maximum motor rated current

**Size 1 to 4:**

The maximum motor rated current is the *Maximum Heavy Duty Current Rating* (Pr **77**).

The values for the Heavy Duty rating can be found in the *Power Installation Guide*.

**Size 5 onwards:**

The maximum motor rated current allowed by the drive is greater than the *Maximum Heavy Duty Current Rating* (Pr **77**). The ratio between the Normal Duty rating and the *Maximum Heavy Duty Current Rating* (Pr **77**) varies between drive sizes. The values for the Normal and Heavy Duty rating can be found in the *Power Installation Guide*. If the *Motor Rated Current* (Pr **06**) is set above the *Maximum Heavy Duty Current Rating* (Pr **77**), the current limits and the motor thermal protection scheme are modified (see section 8.3 *Current limits*and section 8.4 *Motor thermal protection*below for further information).

## 8.3 Current limits

The default setting for the current limit parameters is:

- 165 % x motor rated torque producing current for open loop mode.
- 175 % x motor rated torque producing current for RFC-A mode.

There are three parameters which control the current limits:

- Motoring current limit: power flowing from the drive to the motor
- Regen current limit: power flowing from the motor to the drive
- Symmetrical current limit: current limit for both motoring and regen operation

The lowest of either the motoring and regen current limit, or the symmetrical current limit applies.

The maximum setting of these parameters depends on the values of motor rated current, drive rated current and the power factor.

With size 5 upwards, increasing the motor rated current (Pr **06** / Pr **05.007**) above the Heavy Duty rating (default value), will automatically reduce the current limits in Pr **04.005** to Pr **04.007**. If the motor rated current is then set to or below the Heavy Duty rating, the current limits will be left at their reduced values.

The drive can be oversized to permit a higher current limit setting to provide higher accelerating torque as required up to a maximum of 1000 %.

## 8.4 Motor thermal protection

A time constant thermal model is provided to estimate the motor temperature as a percentage of its maximum allowed temperature.

The motor thermal protection is modelled using losses in the motor. The losses in the motor are calculated as a percentage value, so that under these conditions the *Motor Protection Accumulator* (04.019) would eventually reach 100 %.

Percentage losses = 100 % x [Load related losses]

Where:

Load related losses = $[I / (K_1 \times I_{Rated})]^2$

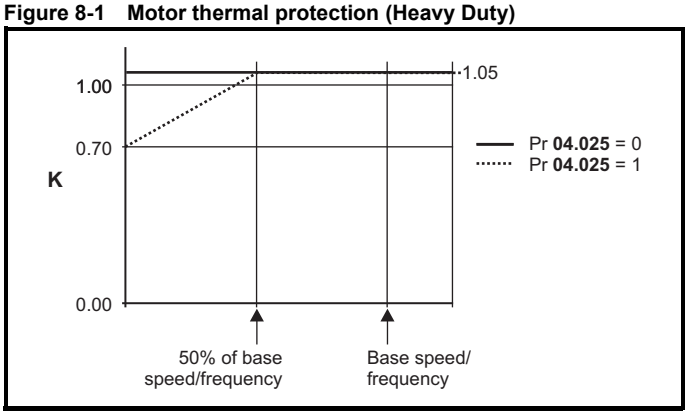
Where:

I = *Current Magnitude* (Pr **88**)

$I_{Rated}$ = *Motor Rated Current* (Pr **06**)

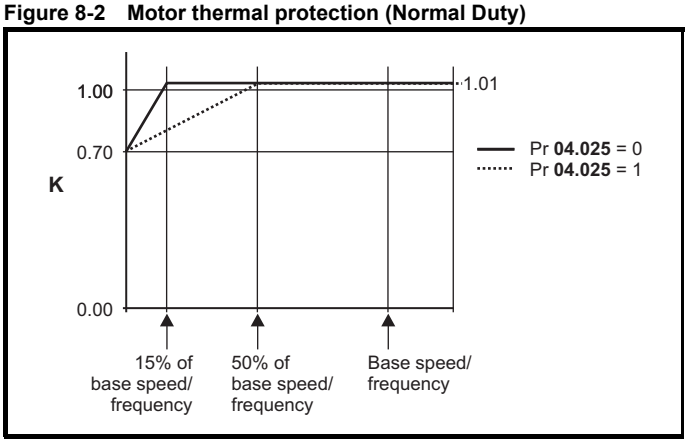
If *Motor Rated Current* (Pr **06**) ≤ *Maximum Heavy Duty Current* (Pr **77**)

**Figure 8-1 Motor thermal protection (Heavy Duty)**




If Pr **04.025** is 0 the characteristic is for a motor which can operate at rated current over the whole speed range. Induction motors with this type of characteristic normally have forced cooling. If Pr **04.025** is 1 the characteristic is intended for motors where the cooling effect of motor fan reduces with reduced motor speed below 50 % of base speed/ frequency. The maximum value for K1 is 1.05, so that above the knee of the characteristics the motor can operate continuously up to 105 % current.

**Figure 8-2 Motor thermal protection (Normal Duty)**




Both settings of Pr **04.025** are intended for motors where the cooling effect of the motor fan reduces with reduced motor speed, but with different speeds below which the cooling effect is reduced. If Pr **04.025** is 0 the characteristic is intended for motors where the cooling effect reduces with motor speed below 15 % of base speed/frequency. If Pr **04.025** is 1 the characteristic is intended for motors where the cooling effect reduces with motor speed below 50 % of base speed/frequency. The maximum value for K1 is 1.01, so that above the knee of the characteristics the motor can operate continuously up to 101 % current.

When the estimated temperature in Pr **04.019** reaches 100 % the drive takes some action depending on the setting of Pr **04.016**. If Pr **04.016** is 0, the drive trips when Pr **04.019** reaches 100 %. If Pr **04.016** is 1, the current limit is reduced to (K - 0.05) x 100 % when Pr **04.019** reaches 100 %.

The current limit is set back to the user defined level when Pr **04.019** falls below 95 %. The thermal model temperature accumulator accumulates the temperature of the motor while the drive remains powered-up. By default, the accumulator is set to the power down value at power up. If the rated current defined by Pr **06** is altered, the accumulator is reset to zero.

The default setting of the thermal time constant (Pr **04.015**) is 179 s which is equivalent to an overload of 150 % for 120 s from cold.

## 8.5 Switching frequency

The default switching frequency is 3 kHz, however this can be increased up to a maximum of 16 kHz by Pr **37**.

If switching frequency is increased from 3 kHz the following apply:

1. Increased heat loss in the drive, which means that derating to the output current must be applied.
   See the derating tables for switching frequency and ambient temperature in the *Power Installation Guide*.
2. Reduced heating of the motor - due to improved output waveform quality.
3. Reduced acoustic noise generated by the motor.
4. Increased sample rate on the speed and current controllers. A trade off must be made between motor heating, drive heating and the demands of the application with respect to the sample time required.

**NOTE**

Lowest switching frequency in RFC-A mode is 2 kHz.

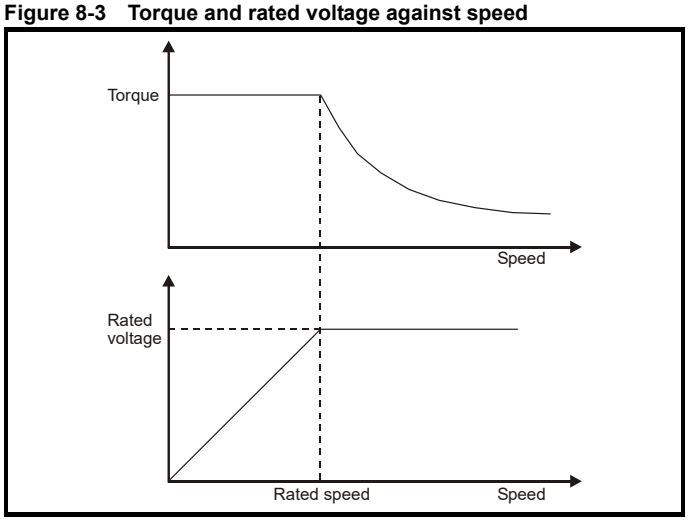
**Table 8-1 Sample rates for various control tasks at each switching frequency**

| | 0.667 1 kHz | 3, 6, 12 kHz | 2, 4, 8, 16 kHz | Open loop | RFC-A |
|---|---|---|---|---|---|
| Level 1 | 250 µs | 167 µs | 2 kHz = 250 µs<br>4 kHz = 125 µs<br>8 kHz = 125 µs<br>16 kHz = 125 µs | Peak limit | Current controllers |
| Level 2 | 250 µs | | | Current limit and ramps | Speed controller and ramps |
| Level 3 | 1 ms | | | Voltage controller | |
| Level 4 | 4 ms | | | Time critical user interface | |
| Background | | | | Non-time critical user interface | |

### 8.5.1 Field weakening (constant power) operation

The drive can be used to run an induction machine above synchronous speed into the constant power region. The speed continues to increase and the available shaft torque reduces. The characteristics below show the torque and output voltage characteristics as the speed is increased above the rated value.

**Figure 8-3 Torque and rated voltage against speed**




Care must be taken to ensure the torque available above base speed is sufficient for the application to run satisfactorily.

The saturation breakpoint parameters (Pr **05.029**, Pr **05. 030**, Pr **05.062** and Pr **05.063**) found during the autotune in RFC-A mode ensure the magnetizing current is reduced in the correct proportion for the specific motor. (In open loop mode the magnetizing current is not actively controlled).

### 8.5.2 Maximum frequency

In all operating modes the maximum output frequency is limited to 550 Hz.

### 8.5.3 Over-modulation (open-loop only)

The maximum output voltage level of the drive is normally limited to an equivalent of the drive input voltage minus voltage drops within the drive (the drive will also retain a few percent of the voltage in order to maintain current control). If the motor rated voltage is set at the same level as the supply voltage, some pulse deletion will occur as the drive output voltage approaches the rated voltage level. If Pr **05.020** (Over-modulation enable) is set to 1 the modulator will allow over modulation, so that as the output frequency increases beyond the rated frequency the voltage continues to increase above the rated voltage.

This can be used for example:

- To obtain high output frequencies with a low switching frequency which would not be possible with space vector modulation limited to unity modulation depth,

or

- In order to maintain a higher output voltage with a low supply voltage.

The disadvantage is that the machine current will be distorted as the modulation depth increases above unity, and will contain a significant amount of low order odd harmonics of the fundamental output frequency. The additional low order harmonics cause increased losses and heating in the motor.

### 8.5.4 Switching frequency/Output frequency ratio

With a default switching frequency of 3 kHz, the maximum output frequency should be limited to 250 Hz. Ideally, a minimum ratio of 12:1 should be maintained between the switching frequency and the output frequency. This ensures the number of switchings per cycle is sufficient to ensure the output waveform quality is maintained at a minimum level.

## 8.6 CT Modbus RTU specification

This section describes the adaptation of the MODBUS RTU protocol offered on Control Techniques' products. The portable software class which implements this protocol is also defined.

MODBUS RTU is a master slave system with half-duplex message exchange. The Control Techniques (CT) implementation supports the core function codes to read and write registers. A scheme to map between MODBUS registers and CT parameters is defined. The CT implementation also defines a 32 bit extension to the standard 16 bit register data format.

### 8.6.1 MODBUS RTU

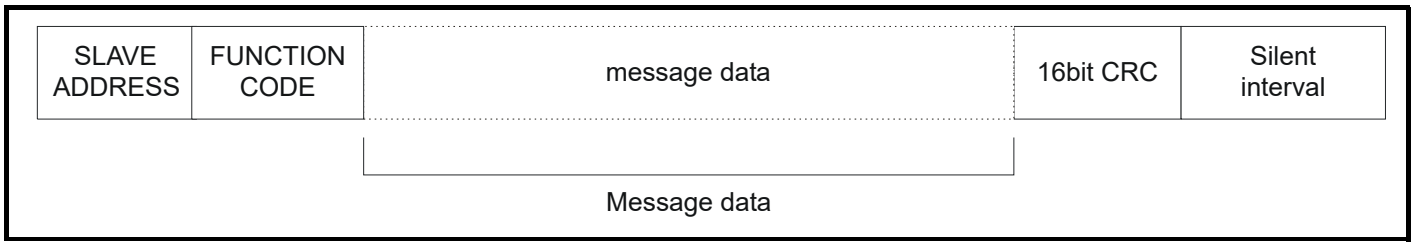
**Physical layer**

| Attribute | Description |
|---|---|
| Normal physical layer for multi-drop operation | EIA485 2 wire |
| Bit stream | Standard UART asynchronous symbols with Non Return to Zero (NRZ) |
| Symbol | Each symbol consists of:-<br>1 start bit<br>8 data bits (transmitted least significant bit first)<br>2 stop bits* |
| Baud rates | 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200 |

* The drive will accept a packet with 1 or 2 stop bits but will always transmit 2 stop bits

**RTU framing**

The frame has the following basic format

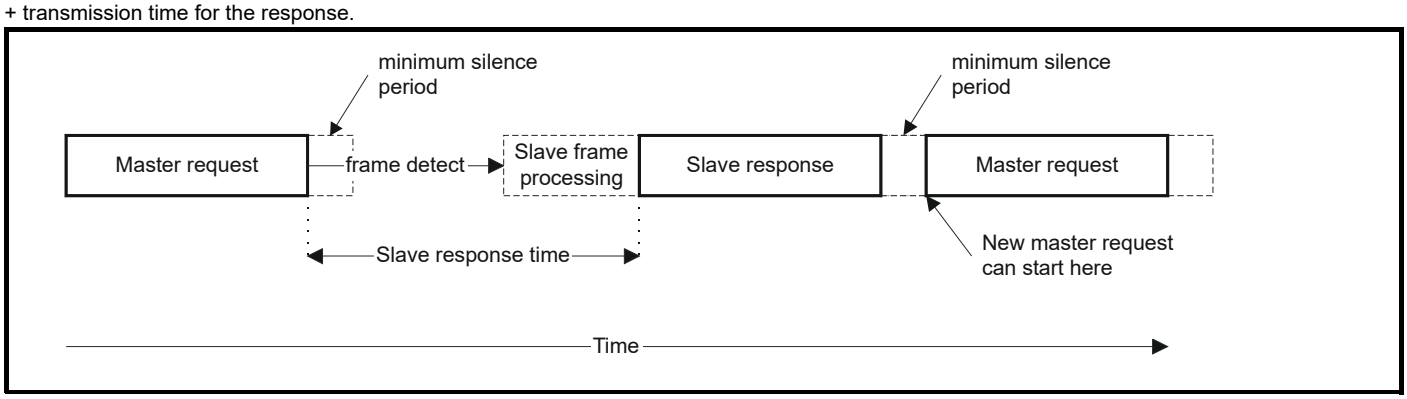



The frame is terminated with a minimum silent period of 3.5 character times (for example, at 19200 baud the minimum silent period is 2 ms). Nodes use the terminating silence period to detect the end of frame and begin frame processing. All frames must therefore be transmitted as a continuous stream without any gaps greater or equal to the silence period. If an erroneous gap is inserted then receiving nodes may start frame processing early in which case the CRC will fail and the frame will be discarded.

MODBUS RTU is a master slave system. All master requests, except broadcast requests, will lead to a response from an individual slave. The slave will respond (i.e. start transmitting the response) within the quoted maximum slave response time (this time is quoted in the data sheet for all Control Techniques products). The minimum slave response time is also quoted but will never be less that the minimum silent period defined by 3.5 character times.

If the master request was a broadcast request then the master may transmit a new request once the maximum slave response time has expired.

The master must implement a message time out to handle transmission errors. This time out period must be set to the maximum slave response time + transmission time for the response.




### 8.6.2 Slave address

The first byte of the frame is the slave node address. Valid slave node addresses are 1 through 247 decimal. In the master request this byte indicates the target slave node; in the slave response this byte indicates the address of the slave sending the response.

**Global addressing**

Address zero addresses all slave nodes on the network. Slave nodes suppress the response messages for broadcast requests.

### 8.6.3 MODBUS registers

The MODBUS register address range is 16 bit (65536 registers) which at the protocol level is represented by indexes 0 through 65535.

#### PLC registers

Modicon PLCs typically define 4 register 'files' each containing 65536 registers. Traditionally, the registers are referenced 1 through 65536 rather than 0 through 65535. The register address is therefore decremented on the master device before passing to the protocol.

| File type | Description |
|---|---|
| 1 | Read only bits ("coil") |
| 2 | Read / write bits ("coil") |
| 3 | Read only 16bit register |
| 4 | Read / write 16bit register |

The register file type code is NOT transmitted by MODBUS and all register files can be considered to map onto a single register address space. However, specific function codes are defined in MODBUS to support access to the "coil" registers.

All standard CT drive parameters are mapped to register file '4' and the coil function codes are not required.

#### CT parameter mapping

The Modbus register address is 16 bits in size, of which the upper two bits are used for data type selection leaving 14 bits to represent the parameter address, taking into account the slave increments the address value by 1, this results in a theoretical maximum parameter address of 163.84 (limited to 162.99 in software) when the default standard addressing mode (see *Serial Mode* (11.024)) is used.

To access a parameter number above 99 in any drive menu then the modified addressing mode must be used (see *Serial Mode* (11.024)), this will allow access to parameter numbers up to 255 but also limit the maximum menu number to 63.

The Modbus slave device increments the register address by 1 before processing the command, this effectively prevents access to parameter Pr 00.000 in the drive or option module.

The table below shows how the start register address is calculated for both addressing modes.

| Parameter | Addressing mode | Protocol register | | | |
|---|---|---|---|---|---|
| 0.mm.ppp | Standard | mm x 100 + ppp - 1 | | | |
| | Modified | mm x 256 + ppp - 1 | | | |
| **Examples** | | | | | |
| | | **16-bit** | | **32-bit** | |
| | | **Decimal** | **Hex (0x)** | **Decimal** | **Hex (0x)** |
| 0.01.021 | Standard | 120 | 00 78 | 16504 | 40 78 |
| | Modified | 276 | 01 14 | 16660 | 41 14 |
| 0.01.000 | Standard | 99 | 00 63 | 16483 | 40 63 |
| | Modified | 255 | 00 FF | 16639 | 40 FF |
| 0.03.161 | Standard | N/A | N/A | N/A | N/A |
| | Modified | 928 | 03 A0 | 17312 | 43 A0 |

#### Data types

The MODBUS protocol specification defines registers as 16 bit signed integers. All CT devices support this data size.

Refer to the section 8.6.7 *Extended data types* on page 75 for detail on accessing 32 bit register data.

### 8.6.4 Data consistency

All CT devices support a minimum data consistency of one parameter (16 bit or 32 bit data). Some devices support consistency for a complete multiple register transaction.

### 8.6.5 Data encoding

MODBUS RTU uses a 'big-endian' representation for addresses and data items (except the CRC, which is 'little-endian'). This means that when a numerical quantity larger than a single byte is transmitted, the MOST significant byte is sent first. So for example

| | | | | | | |
|---|---|---|---|---|---|---|
| 16 - bits | 0x1234 | would be | 0x12 | 0x34 | | |
| 32 - bits | 0x12345678 | would be | 0x12 | 0x34 | 0x56 | 0x78 |

### 8.6.6 Function codes

The function code determines the context and format of the message data. Bit 7 of the function code is used in the slave response to indicate an exception.

The following function codes are supported:

| Code | Description |
|---|---|
| 3 | Read multiple 16 bit registers |
| 6 | Write single register |
| 16 | Write multiple 16 bit registers |
| 23 | Read and write multiple 16 bit registers |

#### FC03 Read multiple

Read a contiguous array of registers. The slave imposes an upper limit on the number of registers, which can be read. If this is exceeded the slave will issue an exception code 2.

**Table 8-2 Master request**

| Byte | Description |
|---|---|
| 0 | Slave destination node address 1 through 247, 0 is global |
| 1 | Function code 0x03 |
| 2 | Start register address MSB |
| 3 | Start register address LSB |
| 4 | Number of 16 bit registers MSB |
| 5 | Number of 16 bit registers LSB |
| 6 | CRC LSB |
| 7 | CRC MSB |

**Table 8-3 Slave response**

| Byte | Description |
|---|---|
| 0 | Slave source node address |
| 1 | Function code 0x03 |
| 2 | Length of register data in read block (in bytes) |
| 3 | Register data 0 MSB |
| 4 | Register data 0 LSB |
| 3+byte count | CRC LSB |
| 4+byte count | CRC MSB |

### FC06 Write single register

Writes a value to a single 16 bit register. The normal response is an echo of the request, returned after the register contents have been written. The register address can correspond to a 32 bit parameter but only 16 bits of data can be sent.

**Table 8-4 Master request**

| Byte | Description |
|---|---|
| 0 | Slave node address 1 through 247, 0 is global |
| 1 | Function code 0x06 |
| 2 | Register address MSB |
| 3 | Register address LSB |
| 4 | Register data MSB |
| 5 | Register data LSB |
| 6 | CRC LSB |
| 7 | CRC MSB |

**Table 8-5 Slave response**

| Byte | Description |
|---|---|
| 0 | Slave source node address |
| 1 | Function code 0x06 |
| 2 | Register address MSB |
| 3 | Register address LSB |
| 4 | Register data MSB |
| 5 | Register data LSB |
| 6 | CRC LSB |
| 7 | CRC MSB |

### FC16 Write multiple

Writes a contiguous array of registers. The slave imposes an upper limit on the number of registers which can be written. If this is exceeded the slave will discard the request and the master will time out.

**Table 8-6 Master request**

| Byte | Description |
|---|---|
| 0 | Slave node address 1 through 247, 0 is global |
| 1 | Function code 0x10 |
| 2 | Start register address MSB |
| 3 | Start register address LSB |
| 4 | Number of 16 bit registers MSB |
| 5 | Number of 16 bit registers LSB |
| 6 | Length of register data to write (in bytes) |
| 7 | Register data 0 MSB |
| 8 | Register data 0 LSB |
| 7+byte count | CRC LSB |
| 8+byte count | CRC MSB |

**Table 8-7 Slave response**

| Byte | Description |
|---|---|
| 0 | Slave source node address |
| 1 | Function code 0x10 |
| 2 | Start register address MSB |
| 3 | Start register address LSB |
| 4 | Number of 16 bit registers written MSB |
| 5 | Number of 16 bit registers written LSB |
| 6 | CRC LSB |
| 7 | CRC MSB |

### FC23 Read/Write multiple

Writes and reads two contiguous arrays of registers. The slave imposes an upper limit on the number of registers which can be written. If this is exceeded the slave will discard the request and the master will time out.

**Table 8-8 Master request**

| Byte | Description |
|---|---|
| 0 | Slave node address 1 through 247, 0 is global |
| 1 | Function code 0x17 |
| 2 | Start register address to read MSB |
| 3 | Start register address to read LSB |
| 4 | Number of 16 bit registers to read MSB |
| 5 | Number of 16 bit registers to read LSB |
| 6 | Start register address to write MSB |
| 7 | Start register address to write LSB |
| 8 | Number of 16 bit registers to write MSB |
| 9 | Number of 16 bit registers to write LSB |
| 10 | Length of register data to write (in bytes) |
| 11 | Register data 0 MSB |
| 12 | Register data 0 LSB |
| 11+byte count | CRC LSB |
| 12+byte count | CRC MSB |

**Table 8-9 Slave response**

| Byte | Description |
|---|---|
| 0 | Slave source node address |
| 1 | Function code 0x17 |
| 2 | Length of register data in read block (in bytes) |
| 3 | Register data 0 MSB |
| 4 | Register data 0 LSB |
| 3+byte count | CRC LSB |
| 4+byte count | CRC MSB |

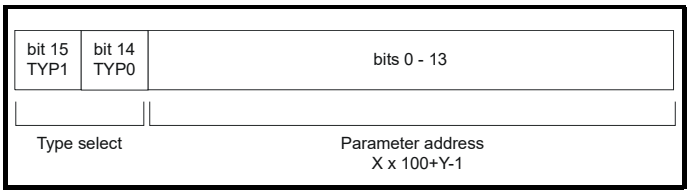
### 8.6.7 Extended data types

Standard MODBUS registers are 16bit and the standard mapping maps a single #X.Y parameter to a single MODBUS register. To support 32 bit data types (integer and float) the MODBUS multiple read and write services are used to transfer a contiguous array of 16bit registers.

Slave devices typically contain a mixed set of 16 bit and 32 bit registers. To permit the master to select the desired 16 bit or 32 bit access the top two bits of the register address are used to indicate the selected data type.

**NOTE**

The selection is applied for the whole block access.




The 2bit type field selects the data type according to the table below:

| Type field bits 15-14 | Selected data type | Comments |
|---|---|---|
| 00 | INT16 | backward compatible |
| 01 | INT32 | |
| 10 | Float32 | IEEE754 standard<br>Not supported on all slaves |
| 11 | Reserved | |

If a 32 bit data type is selected then the slave uses two consecutive 16 bit MODBUS registers (in 'big endian'). The master must also set the correct 'number of 16 bit registers'.

Example, read Pr **20.021** through Pr **20.024** as 32 bit parameters using FC03 from node 8:

**Table 8-10 Master request**

| Byte | Value | Description |
|---|---|---|
| 0 | 0x08 | Slave destination node address |
| 1 | 0x03 | FC03 multiple read |
| 2 | 0x47 | Start register address Pr **20.021**<br>(16384 + 2021 - 1) = 18404 = 0x47E4 |
| 3 | 0xE4 | |
| 4 | 0x00 | Number of 16bit registers to read<br>Pr **20.021** through Pr **20.024** is 4x32 bit registers = 8x16 bit registers |
| 5 | 0x08 | |
| 6 | CRC LSB | |
| 7 | CRC MSB | |

**Table 8-11 Slave response**

| Byte | Value | Description |
|---|---|---|
| 0 | 0x08 | Slave destination node address |
| 1 | 0x03 | FC03 multiple read |
| 2 | 0x10 | Length of data (bytes) = 4x32 bit registers = 16 bytes |
| 3-6 | | Pr **20.021** data |
| 7-10 | | Pr **20.022** data |
| 11-14 | | Pr **20.023** data |
| 15-18 | | Pr **20.024** data |
| 19 | CRC LSB | |
| 20 | CRC MSB | |

#### Reads when actual parameter type is different from selected

The slave will send the least significant word of a 32 bit parameter if that parameter is read as part of a 16 bit access.

The slave will sign extend the least significant word if a 16 bit parameter is accessed as a 32 bit parameter. The number of 16 bit registers must be even during a 32 bit access.

Example, If Pr **01.028** is a 32 bit parameter with a value of 0x12345678, Pr **01.029** is a signed 16 bit parameter with a value of 0xABCD, and Pr **01.030** is a signed 16 bit parameter with a value of 0x0123.

| Read | Start register address | Number of 16 bit registers | Response | Comments |
|---|---|---|---|---|
| Pr **01.028** | 127 | 1 | 0x5678 | Standard 16 bit access to a 32 bit register will return low 16 bit word of truncated data |
| Pr **01.028** | 16511* | 2 | 0x12345678 | Full 32 bit access |
| Pr **01.028** | 16511* | 1 | Exception 2 | Number of words must be even for 32 bit access |
| Pr **01.029** | 128 | 1 | 0xABCD | Standard 16 bit access to a 32 bit register will return low 16 bit word of data |
| Pr **01.029** | 16512* | 2 | 0xFFFFABCD | 32 bit access to a 16 bit register will return 32 bit sign extended data |
| Pr **01.030** | 16513* | 2 | 0x00000123 | 32 bit access to a 16 bit register will return 32 bit sign extended data |
| Pr **01.028** to Pr **01.029** | 127 | 2 | 0x5678, 0xABCD | Standard 16 bit access to a 32 bit register will return low 16 bit word of truncated data |
| Pr **01.028** to Pr **01.029** | 16511* | 4 | 0x12345678, 0xFFFFABCD | Full 32 bit access |

* Bit 14 is set to allow 32 bit access.

#### Writes when actual parameter type is different from selected

The slave will allow writing a 32 bit value to a 16 bit parameter as long as the 32 bit value is within the normal range of the 16 bit parameter.

The slave will allow a 16 bit write to a 32 bit parameter. The slave will sign extend the written value, therefore the effective range of this type of write will be -32768 to +32767.

Examples, if Pr **01.028** has a range of ±100000, and Pr **01.029** has a range of ±10000.

| Write | Start register address | Number of 16 bit registers | Data | Comments |
|---|---|---|---|---|
| Pr **01.028** | 127 | 1 | 0x1234 | Standard 16 bit write to a 32bit register. Value written = 0x00001234 |
| Pr **01.028** | 127 | 1 | 0xABCD | Standard 16 bit write to a 32 bit register. Value written = 0xFFFFABCD |
| Pr **01.028** | 16511 | 2 | 0x00001234 | Value written = 0x00001234 |
| Pr **01.029** | 128 | 1 | 0x0123 | Value written = 0x0123 |
| Pr **01.029** | 16512 | 2 | 0x00000123 | Value written = 0x00000123 |

* Bit 14 is set to allow 32 bit access

### 8.6.8 Exceptions

The slave will respond with an exception response if an error is detected in the master request. If a message is corrupted and the frame is not received or the CRC fails then the slave will not issue an exception. In this case the master device will time out. If a write multiple (FC16 or FC23) request exceeds the slave maximum buffer size then the slave will discard the message. No exception will be transmitted in this case and the master will time out.

#### Exception message format

The slave exception message has the following format.

| Byte | Description |
|---|---|
| 0 | Slave source node address |
| 1 | Original function code with bit 7 set |
| 2 | Exception code |
| 3 | CRC LSB |
| 4 | CRC MSB |

#### Exception codes

The following exception codes are supported.

| Code | Description |
|---|---|
| 1 | Function code not supported |
| 2 | Register address out of range, or request to read too many registers |

#### Parameter over range during block write FC16

The slave processes the write block in the order the data is received. If a write fails due to an out of range value then the write block is terminated. However, the slave does not raise an exception response, rather the error condition is signalled to the master by the number of successful writes field in the response.

#### Parameter over range during block read/write FC23

There will be no indication that there has been a value out of range during a FC23 access.

### 8.6.9 CRC

The CRC is a 16bit cyclic redundancy check using the standard CRC-16 polynomial x16 + x15 + x2 + 1. The 16 bit CRC is appended to the message and transmitted LSB first.

The CRC is calculated on ALL the bytes in the frame.

### 8.6.10 Device compatibility parameters

All devices have the following compatibility parameters defined:

| Parameter | Description |
|---|---|
| Device ID | Unique device identification code |
| Minimum slave response time | The minimum delay between the end of a message from the master and the time at which the master is ready to receive a response from the slave. Refer to para 11-26 |
| Maximum slave response time | When global addressing, the master must wait for this time before issuing a new message. In a network of devices, the slowest time must be used |
| Maximum baud rate | |
| 32 bit float data type supported | If this data type is not supported then an over range error will be raised if this data type is used |
| Maximum buffer size | Determines the maximum block size. |

# 9 NV Media Card

## 9.1 Introduction

The Non-Volatile Media Card feature enables simple configuration of parameters, parameter back-up and drive cloning using an SD card.

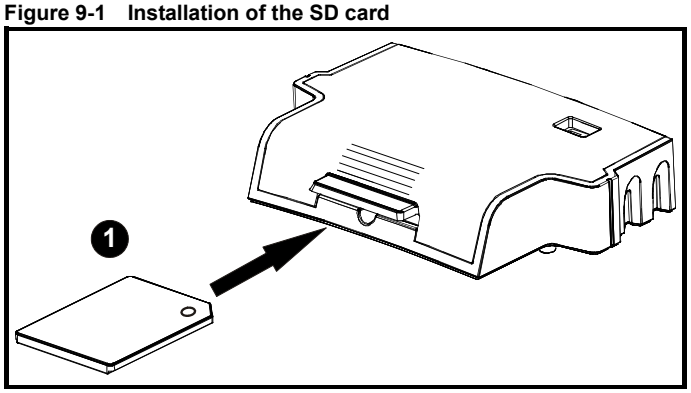
The SD card can be used for:

- Parameter copying between drives
- Saving drive parameter sets

The NV Media Card (SD card) is located in the AI-Backup adaptor.

The card is not hot swappable, but the AI-Backup adaptor is “hot swapped” only when the five unit LEDs on the display are not flashing. The unit LEDs flash during the data transfer.

**Figure 9-1 Installation of the SD card**




1. Installing the SD card

**NOTE**

A flat bladed screwdriver or similar tool is required in order to insert / remove the SD card fully into the AI-Backup adaptor.

Before inserting / removing the SD card into / from the AI-Backup adaptor, the AI-Backup adaptor must be removed from the drive.

**NOTE**

The drive supports SD cards formatted with the FAT32 file system only.

## 9.2 SD card support

An SD memory card can be inserted in the AI-Backup adaptor in order to transfer data to the drive, however the following limitations should be noted:

If a parameter from the source drive does not exist in the target drive then no data is transferred for that parameter.

If the data for the parameter in the target drive is out of range then the data is limited to the range of the target parameter.

If the target drive has a different rating to the source drive then the normal rules for this type of transfer apply as described later.

No checking is possible to determine if the source and target product types are the same, and so no warning is given if they are different.

If an SD card is used then the drive will recognise the following file types through the drive parameter interface.

| File Type | Description |
|---|---|
| Parameter file | A file that contains all copied user save parameters from the drive menus (1 to 30) in difference from default format |
| Macro file | The same as a parameter file, but defaults are not loaded before the data is transferred from the card |

These files can be created on a card by the drive and then transferred to any other drive including derivatives. If the Drive Derivative (11.028) is different between the source and target drives then the data is transferred but a {C.Pr} trip is initiated.

It is possible for other data to be stored on the card, but this should not be stored in the <MCDF> folder and it will not be visible via the drive parameter interface.

### 9.2.1 Changing the drive mode

If the source drive mode is different from the target drive mode then the mode will be changed to the source drive mode before the parameters are transferred. If the required drive mode is outside the allowed range for the target then a {C.typ} trip is initiated and no data is transferred.

### 9.2.2 Different voltage ratings

If the voltage rating of the source and target drives is different then all parameters except those that are rating dependent (i.e. attribute RA=1) are transferred to the target drive. The rating dependent parameters are left at their default values. After the parameters have been transferred and saved to non-volatile memory a {C.rtg} trip is given as a warning. The table below gives a list of the rating dependent parameters.

| Parameters |
|---|
| *Standard Ramp Voltage* (02.008) |
| *Motoring Current Limit* (04.005) |
| *M2 Motoring Current Limit* (21.027) |
| *Regenerating Current Limit* (04.006) |
| *M2 Regenerating Current Limit* (21.028) |
| *Symmetrical Current Limit* (04.007) |
| *M2 Symmetrical Current Limit* (21.029) |
| *User Current Maximum Scaling* (04.024) |
| *Motor Rated Current* (05.007) |
| *M2 Motor Rated Current* (21.007) |
| *Motor Rated Voltage* (05.009) |
| *M2 Motor Rated Voltage* (21.009) |
| *Motor Rated Power Factor* (05.010) |
| *M2 Motor Rated Power Factor* (21.010) |
| *Stator Resistance* (05.017) |
| *M2 Stator Resistance* (21.012) |
| *Maximum Switching Frequency* (05.018) |
| *Transient Inductance /Ld* (05.024) |
| *M2 Transient Inductance /Ld* (21.014) |
| *Stator Inductance* (05.025) |
| *M2 Stator Inductance* (21.024) |
| *Injection Braking Level* (06.006) |
| *Supply Loss Detection Level* (06.048) |

### 9.2.3 Different option modules installed

If the option module ID code (15.001) is different for any option module installed to the source drive compared to the destination drive, then the parameters for the set-up for that option module are not transferred, but and are instead set to their default values. After the parameters have been transferred and saved to non-volatile memory, a {C.OPt} trip is given as a warning.

### 9.2.4 Different current ratings

If any of the current rating parameters (Maximum Heavy Duty Rating (Pr **77**), Maximum Rated Current (11.060) or Full Scale Current Kc (11.061)) are different between the source and target then all parameters are still written to the target drive, but some may be limited by their allowed range. To give similar performance in the target compared to the source drive the frequency and current controller gains are modified as shown below. Note that this does not apply if the file identification number is larger than 500.

| Gains | Multiplier |
|---|---|
| *Frequency Controller Proportional Gain Kp1 (03.010)* | [Source Full Scale Current Kc (11.061)] / |
| *Frequency Controller Integral Gain Ki1 (03.011)* | [Target Full Scale Current Kc (11.061)] |
| *Frequency Controller Proportional Gain Kp2 (03.013)* | |
| *Frequency Controller Integral Gain Ki2 (03.014)* | |
| *M2 Frequency Controller Proportional Gain Kp (21.017)* | |
| *M2 Frequency Controller Integral Gain Ki (21.018)* | |
| *Current Controller Kp Gain (04.013)* | |
| *Current Controller Ki Gain (04.014)* | |
| *M2 Current Controller Kp Gain (21.022)* | |
| *M2 Current Controller Ki Gain (21.023)* | |

### 9.2.5 Different variable maximums

It should be noted that if ratings of the source and target drives are different, it is possible that some parameters with variable maximums may be limited and not have the same values as in the source drive.

### 9.2.6 Macro files

Macro files are created in the same way as parameter files except that *NV Media Card Create Special File* (11.072) must be set to 1 before the file is created on the NV media card. *NV Media Card Create Special File* (11.072) is set to zero after the file has been created or the transfer fails. When a macro file is transferred to a drive the drive mode is not changed even if the actual mode is different to that in the file and defaults are not loaded before the parameters are copied from the file to the drive.

The table below gives a summary of the values used in Pr **00** for NV media card operations. The yyy represents the file identification number.

**Table 9-1 Functions in Pr 00**

| Value | Action |
|---|---|
| 2001 | Transfer the drive parameters to parameter file 001 and sets the block as bootable.<br>This will include the parameters from any attached option module. |
| 4yyy | Transfer the drive parameters to parameter file yyy. This will include the parameters from any attached option module. |
| 5yyy | Transfer the onboard user program to onboard user program file yyy. |
| 6yyy | Load the drive parameters from parameter file yyy. |
| 7yyy | Erase file yyy. |
| 8yyy | Compare the data in the drive with the file yyy. The data in the drive is compared to the data in the file yyy. If the files are the same then Pr **00** is simply reset to 0 when the compare is complete. If the files are different a {Card Compare} trip is initiated. All other NV media card trips also apply. |
| 9555 | Clear the warning suppression flag. |
| 9666 | Set the warning suppression flag. |
| 9777 | Clear the read-only flag. |
| 9888 | Set the read-only flag. |
| 59999* | Delete onboard user program. |

* Program cannot be deleted if the drive is active or if the user program is running.

### 9.2.7 Writing to the NV Media Card

**4yyy - Writes defaults differences to the NV Media Card**

The data block only contains the parameter differences from the last time default settings were loaded.

All parameters except those with the NC (Not copied) coding bit set are transferred to the NV Media Card. In addition to these parameters all menu 20 parameters (except Pr **20.000**), can be transferred to the NV Media Card.

**Writing a parameter set to the NV Media Card (Pr 30 = Prog (2))**

Setting Pr **30** to Prog (2) and resetting the drive will save the parameters to the NV Media Card, i.e. this is equivalent to writing 4001 to Pr **00**. All NV Media Card trips apply. If the data block already exists it is automatically overwritten. When the action is complete this parameter is automatically reset to NonE (0).

### 9.2.8 Reading from the NV Media Card

**6yyy - Reading from NV Media Card**

When the data is transferred back to the drive, using 6yyy in Pr **00**, it is transferred to the drive RAM and the EEPROM. A parameter save is not required to retain the data after-power down. Set up data for any option module installed stored on the card are transferred to the drive. If the option module installed is different between source and destination drives, the menu for the option module slot where the option module category is different is not updated from the card and will contain its default values after the copying action. The drive will produce a 'C.OPt' trip if the option module installed to the source and the destination drives are different. If the data is being transferred to the drive with different voltage or current rating a 'C.rtg' trip will occur.

The following drive rating dependant parameters (RA coding bit set) will not be transferred to the destination drive by a NV Media Card when the voltage rating of the destination drive is different from the source drive and the file is a parameter file.

However, drive rating dependent parameters will be transferred if only the current rating is different. If drive rating dependant parameters are not transferred to the destination drive they will contain their default values.

Pr **02.008** Standard Ramp Voltage

Pr **04.005** to Pr **04.007** and Pr **21.027** to Pr **21.029** Motoring Current Limits

Pr **04.024**, User Current Maximum Scaling

Pr **04.041** User Over Current Trip Level

Pr **05.007**, Pr **21.007** Rated Current

Pr **05.009**, Pr **21.009** Rated Voltage

Pr **05.010**, Pr **21.010** Rated Power Factor

Pr **05.017**, Pr **21.012** Stator Resistance

Pr **05.018** Maximum Switching Frequency

Pr **05.024**, Pr **21.014** Transient Inductance

Pr **05.025**, Pr **21.024** Stator Inductance

Pr **06.006** Injection Braking Level

Pr **06.048** Supply Loss Detection Level

Pr **06.073** Braking IGBT Lower Threshold

Pr **06.074** Braking IGBT Upper Threshold

Pr **06.075** Low Voltage Braking IGBT Threshold

**Reading a parameter set from the NV Media Card (Pr 30 = rEAd (1))**

Setting Pr **30** to rEAd (1) and resetting the drive will transfer the parameters from the card into the drive parameter set and the drive EEPROM, i.e. this is equivalent to writing 6001 to Pr **00**.

All NV Media Card trips apply. Once the parameters are successfully copied this parameter is automatically reset to NonE (0). Parameters are saved to the drive EEPROM after this action is complete.

### 9.2.9 Auto saving parameter changes (Pr 30 = Auto (3))

This setting causes the drive to automatically save any changes made to menu 0 parameters on the drive to the NV Media Card. The latest menu 0 parameter set in the drive is therefore always backed up on the NV Media Card. Changing Pr **30** to Auto (3) and resetting the drive will immediately save the complete parameter set from the drive to the card, i.e. all parameters except parameters with the NC coding bit set. Once the whole parameter set is stored only the individual modified menu 0 parameter setting is updated.

Advanced parameter changes are only saved to the NV Media Card when Pr **00** is set to 'SAVE' or a 1001 and the drive reset.

All NV Media Card trips apply. If the data block already contains information it is automatically overwritten.

If the card is removed when Pr **30** is set to 3, Pr **30** is then automatically set to NonE (0).

When a new NV Media Card is installed Pr **30** must be set back to Auto (3) by the user and the drive reset so the complete parameter set is rewritten to the new NV Media Card if auto mode is still required.

When Pr **30** is set to Auto (3) and the parameters in the drive are saved, the NV Media Card is also updated, and therefore the NV Media Card becomes a copy of the drives stored configuration.

At power up, if Pr **30** is set to Auto (3), the drive will save the complete parameter set to the NV Media Card. The 5 unit LEDs will flash during this operation. This is done to ensure that if a user puts a new NV Media Card in during power down the new NV Media Card will have the correct data.

**NOTE**

When Pr **30** is set to Auto (3) the setting of Pr **30** itself is saved to the drive EEPROM but not the NV Media Card.

### 9.2.10 Booting up from the NV Media Card on every power up (Pr 30 = boot (4))

When Pr **30** is set to boot (4) the drive operates the same as Auto mode except when the drive is powered-up. The parameters on the NV Media Card will be automatically transferred to the drive at power up if the following are true:

- A card is inserted in the drive
- Parameter data block 1 exists on the card
- The data in block 1 is type 1 to 4 (as defined in Pr **11.038**)
- Pr **30** on the card set to boot (4)

The 5 unit LEDs will flash during this operation. If the drive mode is different from that on the card, the drive gives a 'C.tyP' trip and the data is not transferred.

If 'boot' mode is stored on the copying NV Media Card this makes the copying NV Media Card the master device. This provides a very fast and efficient way of re-programming a number of drives.

'boot' mode is saved to the card, but when the card is read, the value of Pr **30** is not transferred to the drive.

### 9.2.11 Booting up from the NV Media Card on every power up (Pr 00 = 2001)

It is possible to create a bootable parameter data block by setting Pr **00** to 2001 and initiating a drive reset. This data block is created in one operation and is not updated when further parameter changes are made.

Setting Pr **00** to 2001 will overwrite the data block 1 on the card if it already exists.

### 9.2.12 8yyy - Comparing the drive full parameter set with the NV Media Card values

Setting 8yyy in Pr **00**, will compare the NV Media Card file with the data in the drive. If the compare is successful Pr **00** is simply set to 0. If the compare fails a 'C.cPr' trip is initiated.

### 9.2.13 7yyy - Erasing data from the NV Media Card values

Data can be erased from the NV Media Card either one block at a time or all blocks in one go.

- Setting 7yyy in Pr **00** will erase NV Media Card data block yyy

### 9.2.14 9666 / 9555 - Setting and clearing the NV Media Card warning suppression flag

If the option module installed to the source and destination drive are different the drive will produce a 'C.OPt' trip.

If the data is being transferred to a drive of a different voltage or current rating a 'C.rtg' trip will occur. It is possible to suppress these trips by setting the warning suppression flag. If this flag is set the drive will not trip if the option module or drive ratings are different between the source and destination drives. The option module or rating dependent parameters will not be transferred.

- Setting 9666 in Pr **00** will set the warning suppression flag
- Setting 9555 in Pr **00** will clear the warning suppression flag

### 9.2.15 9888 / 9777 - Setting and clearing the NV Media Card read only flag

The NV Media Card may be protected from writing or erasing by setting the read only flag. If an attempt is made to write or erase a data block when the read only flag is set, a 'C.rdo' trip is initiated. When the read only flag is set only codes 6yyy or 9777 are effective.

- Setting 9888 in Pr **00** will set the read only flag
- Setting 9777 in Pr **00** will clear the read only flag

## 9.3 NV Media Card parameters

**Table 9-2 Key to parameter table coding**

| | | | |
|---|---|---|---|
| RW | Read / Write | ND | No default value |
| RO | Read only | NC | Not copied |
| Num | Number parameter | PT | Protected parameter |
| Bit | Bit parameter | RA | Rating dependant |
| Txt | Text string | US | User save |
| Bin | Binary parameter | PS | Power-down save |
| FI | Filtered | DE | Destination |

| **11.036** | **NV Media Card File Previously Loaded** | | | | | |
|---|---|---|---|---|---|---|
| RO | Num | | NC | PT | | |
| ⇳ | 0 to 999 | | | ⇨ | 0 | |

This parameter shows the number of the data block last transferred from an SD card to the drive. If defaults are subsequently reloaded this parameter is set to 0.

| **11.037** | **NV Media Card File Number** | | | | | |
|---|---|---|---|---|---|---|
| RW | Num | | | | | |
| ⇳ | 0 to 999 | | | ⇨ | 0 | |

This parameter should have the data block number which the user would like the information displayed in Pr **11.038**, Pr **11.039**.

| **11.038** | **NV Media Card File Type** | | | | | |
|---|---|---|---|---|---|---|
| RO | Txt | ND | NC | PT | | |
| ⇳ | 0 to 2 | | | ⇨ | 0 | |

Displays the type of data block selected with Pr **11.037**.

| **Pr 11.038** | **String** | **Type / mode** |
|---|---|---|
| 0 | None | No file selected |
| 1 | Open-loop | Open loop mode parameter file |
| 2 | RFC-A | RFC-A mode parameter file |

| **11.039** | **NV Media Card File Version** | | | | | |
|---|---|---|---|---|---|---|
| RO | Num | ND | NC | PT | | |
| ⇳ | 0 to 9999 | | | ⇨ | 0 | |

Displays the version number of the file selected in Pr **11.037**.

| **11.042 {30}** | **Parameter Cloning** | | | | | |
|---|---|---|---|---|---|---|
| RW | Txt | | NC | | | US |
| ⇳ | NonE (0), rEAd (1), Prog (2), Auto (3), boot (4) | | | ⇨ | 0 | |

## 9.4 NV Media Card trips

After an attempt to read, write or erase data from a NV Media Card a trip is initiated if there has been a problem with the command.

See Chapter 12 *Diagnostics* on page 147 for more information on NV Media Card trips.

## 9.5 Data block header information

Each data block stored on a NV Media Card has header information detailing the following:

- *NV Media Card File Number* (11.037)
- *NV Media Card File Type* (11.038)
- *NV Media Card File Version* (11.039)

The header information for each data block which has been used can be viewed in Pr **11.038** to Pr **11.039** by increasing or decreasing the data block number set in Pr **11.037**. If there is no data on the card Pr **11.037** can only have a value of 0.

# 10 Onboard PLC

## 10.1 Onboard PLC and Machine Control Studio

The drive has the ability to store and execute a 30 kB (less 4 kB of proxy) Onboard PLC user program without the need for additional hardware in the form of an option module.

Machine Control Studio is an IEC61131-3 development environment designed for use with Commander and compatible application modules. Machine Control Studio is based on CODESYS from 3S-Smart Software Solutions.

All of the programming languages defined in the IEC standard IEC 61131-3 are supported in the Machine Control Studio development environment.

- ST (Structured text)
- LD (Ladder diagram)
- FBD (Function block diagram)
- IL (Instruction list)
- SFC (Sequential function chart)
- CFC (Continuous Function Chart). CFC is an extension to the standard IEC programming languages

Machine Control Studio provides a complete environment for the development of user programs. Programs can be created, compiled and downloaded to a Commander for execution, via the communications port on the front of the drive. The run-time operation of the compiled program on the target can also be monitored using Machine Control Studio and facilities are provided to interact with the program on the target by setting new values for target variables and parameters.

The Onboard PLC and Machine Control Studio form the first level of functionality in a range of programmable options for Commander.

Machine Control Studio can be downloaded from www.controltechniques.com.

See the Machine Control Studio help file for more information regarding using Machine Control Studio, creating user programs and downloading user programs to the drive.

## 10.2 Benefits

The combination of the Onboard PLC and Machine Control Studio, means that the drive can replace nano and some micro PLCs in many applications

Machine Control Studio benefits from access to the standard CODESYS function and function block libraries as well as those from third parties. Functions and function blocks available as standard in Machine Control Studio include, but not limited to, the following:

- Arithmetic blocks
- Comparison blocks
- Timers
- Counters
- Multiplexers
- Latches
- Bit manipulation

Typical applications for the Onboard PLC include:

- Ancillary pumps
- Fans and control valves
- Interlocking logic
- Sequence routines
- Custom control words.

## 10.3 Features

The Commander Onboard PLC user program has the following features:

### 10.3.1 Tasks

The Onboard PLC allows use of two tasks.

- Clock: A high priority real time task. The clock task interval can be set from 16 ms to 262 s in multiples of 16 ms. The parameter *Onboard User Program: Clock Task Time Used* (11.051) shows the percentage of the available time used by clock task. A read or write of a drive parameter by the user program takes a finite period of time. It is possible to select up to 10 parameters as fast access parameter which reduced the amount of time it takes for the user program to read from or write to a drive parameter. This is useful when using a clock task with a fast update rate as selecting a parameter for fast access reduces the amount of the clock task resource required to access parameters.
- Freewheeling: A non-real time background task. The freewheeling task is scheduled for a short period once every 256 ms. The time for which the task is scheduled will vary depending on the loading of the drive's processor. When scheduled, several scans of the user program may be performed. Some scans may execute in microseconds. However, when the main drive functions are scheduled there will be a pause in the execution of the program causing some scans to take many milliseconds. The parameter *Onboard User Program: Freewheeling Tasks Per Second* (11.050) shows the number of times the freewheeling task has started per second.

### 10.3.2 Variables

The Onboard PLC supports the use of variables with the data types of Boolean, integer (8 bit, 16 bit and 32 bit, signed and unsigned), floating point (64 bit only), strings and time.

### 10.3.3 Custom menu

Machine Control Studio can construct a custom drive menu to reside in menu 30 on the drive. The following properties of each parameter can be defined using Machine Control Studio:

- Parameter name
- Number of decimal places
- The units for the parameter to be display on the keypad.
- The minimum, maximum and default values
- Memory handling (i.e. power down save, user save or volatile)
- Data type. The drive provides a limited set of 1 bit, 8 bit, 16 bit and 32 bit integer parameters to create the customer menu.

Parameters in this customer menu can be accessed by the user program and will appear on the keypad.

### 10.3.4 Limitations

The Onboard PLC user program has the following limitations:

- The flash memory allocated to the Onboard PLC is 30 kB which includes the user program and its header which results in a maximum user program size of about 12 kB
- The Onboard PLC is provided with 2 kB of RAM.
- The drive is rated for 100 program downloads. This limitation is imposed by the flash memory used to store the program within the drive.
- There is only one real-time task with a minimum period of 16 ms.
- The freewheeling background task runs at a low priority. The drive is prioritized to perform the clock task and its major functions first, e.g. motor control, and will use any remaining processing time to execute the freewheeling task as a background activity. As the drive's processor becomes more heavily loaded, less time is spent executing the freewheeling task.
- Breakpoints, single stepping and online program changes are not possible.
- The Graphing tool is not supported.
- The variable data types REAL (32 bit floating point), LWORD (64 bit integer) and WSTRING (Unicode string), and retained variables are not supported.

## 10.4 Onboard PLC parameters

The following parameters are associated with the Onboard PLC user program.

| 11.047 | Onboard User Program: Enable | | | | | |
|---|---|---|---|---|---|---|
| RW | Txt | | | | US | |
| ⇳ | Stop (0) or Run (1) | | | ⇨ | Run (1) | |

This parameter stops and starts the user program.

**0 - Stop the User Program**

The onboard user program is stopped.

**1 - Run the User Program**

The user program will execute. Background task starts from the beginning.

| 11.048 | Onboard User Program: Status | | | | | |
|---|---|---|---|---|---|---|
| RO | Txt | | NC | PT | | |
| ⇳ | -2147483648 to 2147483647 | | | ⇨ | | |

This parameter is read-only and indicates the status of the user program in the drive. The user program writes the value to this parameter.

0: Stopped

1: Running

2: Exception

3: No user program present

| 11.049 | Onboard User Program: Programming Events | | | | | |
|---|---|---|---|---|---|---|
| RO | Uni | | NC | PT | PS | |
| ⇳ | 0 to 65535 | | | ⇨ | | |

This parameter holds the number of times an Onboard PLC user program download has taken place and is 0 on dispatch from the factory. The drive is rated for one hundred program downloads. This parameter is not altered when defaults are loaded.

| 11.050 | Onboard User Program: Freewheeling Tasks Per Second | | | | | |
|---|---|---|---|---|---|---|
| RO | Uni | | NC | PT | | |
| ⇳ | 0 to 65535 | | | ⇨ | | |

This parameter shows the number of times the freewheeling task has started per second.

| 11.051 | Onboard User Program: Clock Task Time Used | | | | | |
|---|---|---|---|---|---|---|
| RO | | | NC | PT | | |
| ⇳ | 0.0 to 100.0 % | | | ⇨ | | |

This parameter shows the percentage of the available time used by the user program clock task.

| 11.055 | Onboard User Program: Clock Task Scheduled Interval | | | | | |
|---|---|---|---|---|---|---|
| RO | | | NC | PT | | |
| ⇳ | 0 to 262128 ms | | | ⇨ | | |

This parameter shows the interval at which the clock task is scheduled to run at in ms.

## 10.5 Onboard PLC trips

If the drive detects an error in the user program it will initiate a User Program trip. The sub-trip number for the User Program trip details the reason for the error. See Chapter 12 *Diagnostics* on page 147 for more information on the User Program trip.

# 11 Advanced parameters

This is a quick reference to all parameters in the drive showing units, ranges limits etc, with block diagrams to illustrate their function. Full descriptions of the parameters can be found in the *Parameter Reference Guide*.

**WARNING**

**These advanced parameters are listed for reference purposes only. The lists in this chapter do not include sufficient information for adjusting these parameters. Incorrect adjustment can affect the safety of the system, and damage the drive and or external equipment. Before attempting to adjust any of these parameters, refer to the *Parameter reference guide*.**

**Table 11-1 Menu descriptions**

| Menu | Description |
|---|---|
| 0 | Commonly used basic set up parameters for quick / easy programming |
| 1 | Frequency reference |
| 2 | Ramps |
| 3 | Frequency control |
| 4 | Torque and current control |
| 5 | Motor control |
| 6 | Sequencer and clock |
| 7 | Analog I/O |
| 8 | Digital I/O |
| 9 | Programmable logic, motorized pot, binary sum, timers |
| 10 | Status and trips |
| 11 | Drive set-up and identification, serial communications |
| 12 | Threshold detectors and variable selectors |
| 14 | User PID controller |
| 15 | Option module slot 1 set-up menu |
| 18 | General option module application menu 1 |
| 20 | General option module application menu 2 |
| 21 | Second motor parameters |
| 22 | Menu 0 set-up |
| 24 | Option module slot 1 application menu |
| Slot 1 | Slot 1 option menus** |

** Only displayed when the option module is installed.

**Operation mode abbreviations:**

**Open-loop**: Sensorless control for induction motors

**RFC-A**: Asynchronous Rotor Flux Control for induction motors

**Default abbreviations:**

Standard default value (50 Hz AC supply frequency)

USA default value (60 Hz AC supply frequency)

**NOTE**

Parameter numbers shown in brackets {...} are the equivalent Menu 0 parameters. Some Menu 0 parameters appear twice since their function depends on the operating mode.

In some cases, the function or range of a parameter is affected by the setting of another parameter. The information in the lists relates to the default condition of any parameters affected in this way.

**Table 11-2 Key to parameter table coding**

| Coding | Attribute |
|---|---|
| **RW** | Read/Write: can be written by the user |
| **RO** | Read only: can only be read by the user |
| **Bit** | 1 bit parameter. 'On' or 'Off' on the display |
| **Num** | Number: can be uni-polar or bi-polar |
| **Txt** | Text: the parameter uses text strings instead of numbers. |
| **Bin** | Binary parameter |
| **IP** | IP Address parameter |
| **Mac** | Mac Address parameter |
| **Date** | Date parameter |
| **Time** | Time parameter |
| **Chr** | Character parameter |
| **FI** | Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing. |
| **DE** | Destination: This parameter selects the destination of an input or logic function. |
| **RA** | Rating dependent: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will be transferred to the destination drive by non-volatile storage media when the rating of the destination drive is different from the source drive and the file is a parameter file. However, the values will be transferred if only the current rating is different and the file is a difference from default type file. |
| **ND** | No default: The parameter is not modified when defaults are loaded |
| **NC** | Not copied: not transferred to or from non-volatile media during copying. |
| **PT** | Protected: cannot be used as a destination. |
| **US** | User save: parameter saved in drive EEPROM when the user initiates a parameter save. |
| **PS** | Power-down save: parameter automatically saved in drive EEPROM when the under volts (UV) state occurs. |

**Table 11-3 Feature look-up table**

| Features | Related parameters (Pr) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acceleration rates | 02.010 | 02.011 to 02.019 | | 02.032 | 02.033 | 02.034 | 02.002 | | | | | | |
| Analog I/O | Menu 7 | | | | | | | | | | | | |
| Analog input 1 | 07.001 | 07.007 | 07.008 | 07.009 | 07.010 | 07.028 | 07.051 | 07.030 | 07.061 | 07.062 | 07.063 | 07.064 | |
| Analog input 2 | 07.002 | 07.011 | 07.012 | 07.013 | 07.014 | | 07.031 | 07.052 | 07.065 | 07.066 | 07.067 | 07.068 | |
| Analog output 1 | 07.019 | 07.020 | | | 07.055 | 07.099 | | | | | | | |
| Analog reference 1 | 01.036 | 07.010 | 07.001 | 07.007 | 07.008 | 07.009 | 07.028 | 07.051 | 07.030 | 07.061 | 07.062 | 07.063 | 07.064 |
| Analog reference 2 | 01.037 | 07.014 | 01.041 | 07.002 | 07.011 | 07.012 | 07.013 | 07.032 | 07.031 | 07.065 | 07.066 | 07.067 | 07.068 |
| Application menu | Menu 18 | | | | Menu 20 | | | | | | | | |
| At frequency indicator bit | 03.006 | 03.007 | 03.009 | 10.006 | 10.005 | 10.007 | | | | | | | |
| Auto reset | 10.034 | 10.035 | 10.036 | 10.001 | | | | | | | | | |
| Autotune | 05.012 | | 05.017 | 05.021 | 05.024 | 05.025 | 05.010 | 05.029 | 05.030 | 05.062 | 05.063 | 05.059 | 05.060 |
| Binary sum | 09.029 | 09.030 | 09.031 | 09.032 | 09.033 | 09.034 | | | | | | | |
| Bipolar reference | 01.010 | | | | | | | | | | | | |
| Brake control | 12.040 to 12.047 | | | 12.050 | 12.051 | | | | | | | | |
| Braking | 10.011 | 10.010 | 10.030 | 10.031 | 06.001 | 02.004 | 02.002 | 10.012 | 10.039 | 10.040 | | | |
| Catch a spinning motor | 06.009 | 05.040 | | | | | | | | | | | |
| Coast to stop | 06.001 | | | | | | | | | | | | |
| Copying | 11.042 | 11.036 to 11.039 | | | | | | | | | | | |
| Cost - per kWh electricity | 06.016 | 06.017 | 06.024 | 06.025 | 06.026 | | 06.027 | | | | | | |
| Current controller | 04.013 | 04.014 | | | | | | | | | | | |
| Current feedback | 04.001 | 04.002 | 04.017 | 04.004 | | 04.020 | | 04.024 | 04.026 | 10.008 | 10.009 | 10.017 | |
| Current limits | 04.005 | 04.006 | 04.007 | 04.018 | 04.015 | 04.019 | 04.016 | 05.007 | 05.010 | 10.008 | 10.009 | 10.017 | |
| DC bus voltage | 05.005 | 02.008 | | | | | | | | | | | |
| DC injection braking | 06.006 | 06.007 | 06.001 | | | | | | | | | | |
| Deceleration rates | 02.020 | 02.021 to 02.029 | | 02.004 | 02.035 to 02.037 | | 02.002 | 02.008 | 06.001 | 10.030 | 10.031 | 10.039 | 02.009 |
| Defaults | 11.043 | 11.046 | | | | | | | | | | | |
| Digital I/O | Menu 8 | | | | | | | | | | | | |
| Digital I/O read word | 08.020 | | | | | | | | | | | | |
| Digital I/O T10 | 08.001 | 08.011 | 08.021 | 08.031 | 08.081 | 08.091 | 08.121 | | | | | | |
| Digital Input T11 | 08.002 | 08.012 | 08.022 | | 08.082 | 08.122 | | | | | | | |
| Digital Input T12 | 08.003 | 08.013 | 08.023 | | 08.083 | 08.123 | | | | | | | |
| Digital input T13 | 08.004 | 08.014 | 08.024 | 08.084 | 08.124 | | | | | | | | |
| Digital input T14 | 08.005 | 08.015 | 08.025 | | 08.035 | 08.085 | 08.125 | | | | | | |
| Direction | 10.013 | 06.030 | 06.031 | 01.003 | 10.014 | 02.001 | 03.002 | 08.003 | 08.004 | 10.040 | | | |
| Drive active | 10.002 | 10.040 | | | | | | | | | | | |
| Drive derivative | 11.028 | | | | | | | | | | | | |
| Drive OK | 10.001 | 08.028 | 08.008 | 08.018 | 10.036 | 10.040 | | | | | | | |
| Dynamic performance | 05.026 | | | | | | | | | | | | |
| Dynamic V/F | 05.013 | | | | | | | | | | | | |
| Enable | 06.015 | | | | 06.038 | | | | | | | | |
| Estimated frequency | 03.002 | 03.003 | 03.004 | | | | | | | | | | |
| External trip | 10.032 | | | | | | | | | | | | |
| Fan speed | 06.045 | | | | | | | | | | | | |
| Field weakening - induction motor | 05.029 | 05.030 | 01.006 | 05.028 | 05.062 | 05.063 | | | | | | | |
| Filter change | 06.019 | 06.018 | 06.021 | 06.022 | 06.023 | | | | | | | | |
| Firmware version | 11.029 | 11.035 | | | | | | | | | | | |

| Features | Related parameters (Pr) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency controller | 03.010 to 03.017 | | | | | | | | | | | | |
| Frequency reference selection | 01.014 | 01.015 | | | | | | | | | | | |
| Frequency slaving | 03.001 | 03.013 | 03.014 | 03.015 | 03.016 | 03.017 | 03.018 | | | | | | |
| Hard frequency reference | 03.022 | 03.023 | | | | | | | | | | | |
| Heavy duty rating | 05.007 | 11.032 | | | | | | | | | | | |
| High stability space vector modulation | 05.019 | | | | | | | | | | | | |
| I/O sequencer | 06.004 | 06.030 | 06.031 | 06.032 | 06.033 | 06.034 | 06.042 | 06.043 | 06.041 | | | | |
| Inertia compensation | 02.038 | | 04.022 | 03.018 | | | | | | | | | |
| Jog reference | 01.005 | 02.019 | 02.029 | | | | | | | | | | |
| Keypad reference | 01.017 | 01.014 | 01.043 | 01.051 | 06.012 | 06.013 | | | | | | | |
| Limit switches | 06.035 | 06.036 | | | | | | | | | | | |
| Line power supply loss | 06.003 | 10.015 | 10.016 | 05.005 | 06.046 | 06.048 | 06.051 | | | | | | |
| Logic function 1 | 09.001 | 09.004 | 09.005 | 09.006 | 09.007 | 09.008 | 09.009 | 09.010 | | | | | |
| Logic function 2 | 09.002 | 09.014 | 09.015 | 09.016 | 09.017 | 09.018 | 09.019 | 09.020 | | | | | |
| Maximum speed | 01.006 | | | | | | | | | | | | |
| Menu 0 set-up | | | | Menu 22 | | | | | | | | | |
| Minimum speed | 01.007 | 10.004 | | | | | | | | | | | |
| Motor map | 05.006 | 05.007 | 05.008 | 05.009 | 05.010 | 05.011 | | | | | | | |
| Motor map 2 | Menu 21 | | 11.045 | | | | | | | | | | |
| Motorized potentiometer | 09.021 | 09.022 | 09.023 | 09.024 | 09.025 | 09.026 | 09.027 | 09.028 | 09.003 | | | | |
| NV media card | 11.036 to 11.039 | | | 11.042 | | | | | | | | | |
| Offset reference | 01.004 | 01.038 | 01.009 | | | | | | | | | | |
| Open loop vector mode | 05.014 | 05.017 | 05.088 | | | | | | | | | | |
| Operating mode | | 11.031 | | 05.014 | | | | | | | | | |
| Output | 05.001 | 05.002 | 05.003 | 05.004 | | | | | | | | | |
| Over frequency threshold | 03.008 | | | | | | | | | | | | |
| Over modulation enable | 05.020 | | | | | | | | | | | | |
| PID controller | Menu 14 | | | | | | | | | | | | |
| Power up parameter | 11.022 | | | | | | | | | | | | |
| Preset speeds | 01.015 | 01.021 to 01.028 | | | | 01.014 | 01.042 | 01.045 to 01.047 | | | 01.050 | | |
| Programmable logic | Menu 9 | | | | | | | | | | | | |
| Ramp (accel / decel) mode | 02.004 | 02.008 | 06.001 | 02.002 | 02.003 | 10.030 | 10.031 | 10.039 | | | | | |
| Reference selection | 01.014 | 01.015 | 01.049 | 01.050 | 01.001 | | | | | | | | |
| Regenerating | 10.010 | 10.011 | 10.030 | 10.031 | 06.001 | 02.004 | 02.002 | 10.012 | 10.039 | 10.040 | | | |
| Relay output | 08.008 | 08.018 | 08.028 | | | | | | | | | | |
| Reset | 10.001 | | 10.033 | 10.034 | 10.035 | 10.036 | 10.038 | | | | | | |
| RFC mode | | | | 05.040 | | | | | | | | | |
| S ramp | 02.006 | 02.007 | | | | | | | | | | | |
| Sample rates | 05.018 | | | | | | | | | | | | |
| Security code | 11.030 | 11.044 | | | | | | | | | | | |
| Serial comms | 11.023 to 11.027 | | 11.099 | 11.020 | | | | | | | | | |
| Skip references | 01.029 | 01.030 | 01.031 | 01.032 | 01.033 | 01.034 | 01.035 | | | | | | |
| Slip compensation | 05.027 | 05.008 | 05.033 | 05.036 | 05.084 | | | | | | | | |
| Status word | 10.040 | | | | | | | | | | | | |
| Supply | 05.005 | 06.003 | 06.046 | 06.048 | 06.051 | 06.058 | 06.059 | | | | | | |
| Switching frequency | 05.018 | 05.035 | 07.034 | 07.035 | | | | | | | | | |

| Features | Related parameters (Pr) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thermal protection - drive | 05.018 | 05.035 | 07.004 | 07.005 | | | 07.035 | 10.018 | | | | | |
| Thermal protection - motor | 04.015 | 05.007 | 04.019 | 04.016 | 04.025 | | 08.035 | | | | | | |
| Thermistor input | 07.046 | 07.047 | 07.048 | 07.049 | 07.050 | 08.035 | | | | | | | |
| Threshold detector 1 | 12.001 | 12.003 to 12.007 | | | | | | | | | | | |
| Threshold detector 2 | 12.002 | 12.023 to 12.027 | | | | | | | | | | | |
| Time - filter change | 06.019 | 06.018 | 06.021 | 06.022 | 06.023 | | | | | | | | |
| Time - powered up log | 06.020 | | | 06.019 | 06.017 | 06.018 | 06.084 | | | | | | |
| Time - run log | | | | 06.019 | 06.017 | 06.018 | 06.084 | | | | | | |
| Torque | 04.003 | 04.026 | 05.032 | | | | | | | | | | |
| Torque mode | 04.008 | 04.011 | | | | | | | | | | | |
| Trip detection | 10.037 | 10.038 | 10.020 to 10.029 | | | | | | | | | | |
| Trip log | 10.020 to 10.029 | | | 10.041 to 10.060 | | | | 10.070 to 10.079 | | | | | |
| Under voltage | 05.005 | 10.016 | 10.015 | 10.068 | | | | | | | | | |
| V/F mode | 05.015 | 05.014 | | | | | | | | | | | |
| Variable selector 1 | 12.008 to 12.016 | | | | | | | | | | | | |
| Variable selector 2 | 12.028 to 12.036 | | | | | | | | | | | | |
| Voltage controller | 05.031 | | | | | | | | | | | | |
| Voltage mode | 05.014 | 05.017 | | 05.015 | | | | | | | | | |
| Voltage rating | 11.033 | 05.009 | 05.005 | | | | | | | | | | |
| Voltage supply | | 06.046 | 05.005 | | | | | | | | | | |
| Warning | 10.019 | 10.012 | 10.017 | 10.018 | 10.040 | | | | | | | | |
| Zero frequency indicator bit | 03.005 | 10.003 | | | | | | | | | | | |

## 11.1 Parameter ranges and Variable minimum/maximums:

Some parameters in the drive have a variable range with a variable minimum and a variable maximum value which is dependent on one of the following:

- The settings of other parameters
- The drive rating
- The drive mode
- Combination of any of the above

The tables below give the definition of variable minimum/maximum and the maximum range of these.

| VM_AC_VOLTAGE | Range applied to parameters showing AC voltage |
|---|---|
| **Units** | V |
| **Range of [MIN]** | 0 |
| **Range of [MAX]** | 0 to 930 |
| **Definition** | VM_AC_VOLTAGE[MAX] is drive voltage rating dependent. See Table 11-4.<br>VM_AC_VOLTAGE[MIN] = 0 |

| VM_AC_VOLTAGE_SET | Range applied to the AC voltage set-up parameters |
|---|---|
| **Units** | V |
| **Range of [MIN]** | 0 |
| **Range of [MAX]** | 0 to 765 |
| **Definition** | VM_AC_VOLTAGE_SET[MAX] is drive voltage rating dependent. See Table 11-4.<br>VM_AC_VOLTAGE_SET[MIN] = 0 |

| VM_ACCEL_RATE | Maximum applied to the ramp rate parameters |
|---|---|
| **Units** | s / 100 Hz, s/1000 Hz, s/Max Frequency |
| **Range of [MIN]** | Open-loop: 0.0<br>RFC-A: 0.0 |
| **Range of [MAX]** | Open-loop: 0.0 to 32000.0<br>RFC-A: 0.0 to 32000.0 |
| **Definition** | A maximum needs to be applied to the ramp rate parameters because the units are a time for a change of speed from zero to a defined level or to maximum speed. If the change of speed is to the maximum speed then changing the maximum speed changes the actual ramp rate for a given ramp rate parameter value. The variable maximum calculation ensures that longest ramp rate (parameter at its maximum value) is not slower than the rate with the defined level, i.e. 32000.0 s/100 Hz.<br>The maximum frequency is taken from *Maximum Speed* (01.006) if *Select Motor 2 Parameters* (11.045) = 0, or *M2 Maximum Speed* (21.001) if *Select Motor 2 Parameters* (11.045) = 1.<br>VM_ACCEL_RATE[MIN] = 0.0<br>If Ramp Rate Units (02.039) = 0:<br>VM_ACCEL_RATE[MAX] = 32000.0<br>Otherwise:<br>VM_ACCEL_RATE[MAX] = 32000.0 x Maximum frequency / 100.00 |

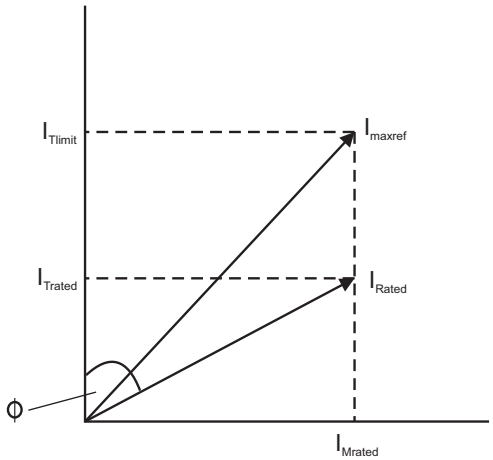
| VM_DC_VOLTAGE | Range applied to DC voltage reference parameters |
|---|---|
| **Units** | V |
| **Range of [MIN]** | 0 |
| **Range of [MAX]** | 0 to 1190 |
| **Definition** | VM_DC_VOLTAGE[MAX] is the full scale DC bus voltage feedback (over voltage trip level) for the drive. This level is drive voltage rating dependent. See Table 11-4.<br>VM_DC_VOLTAGE[MIN] = 0 |

| VM_DC_VOLTAGE_SET | Range applied to DC voltage reference parameters |
|---|---|
| **Units** | V |
| **Range of [MIN]** | 0 |
| **Range of [MAX]** | 0 to 1150 |
| **Definition** | VM_DC_VOLTAGE_SET[MAX] is drive voltage rating dependent. See Table 11-4<br>VM_DC_VOLTAGE_SET[MIN] = 0 |

| VM_DRIVE_CURRENT | Range applied to parameters showing current in A |
|---|---|
| **Units** | A |
| **Range of [MIN]** | -9999.99 to 0.00 |
| **Range of [MAX]** | 0.00 to 9999.99 |
| **Definition** | VM_DRIVE_CURRENT[MAX] is equivalent to the full scale (over current trip level) for the drive and is given by *Full Scale Current Kc* (11.061).<br><br>VM_DRIVE_CURRENT[MIN] = - VM_DRIVE_CURRENT[MAX] |

| VM_FREQ | Range applied to parameters showing frequency |
|---|---|
| **Units** | Hz |
| **Range of [MIN]** | -1100.00 |
| **Range of [MAX]** | 1100.00 |
| **Definition** | This variable minimum/maximum defines the range of speed monitoring parameters. To allow headroom for overshoot the range is set to twice the range of the speed references.<br>VM_FREQ[MIN] = 2 x VM_SPEED_FREQ_REF[MIN]<br>VM_FREQ[MAX] = 2 x VM_SPEED_FREQ_REF[MAX] |

| VM_MAX_SWITCHING_FREQUENCY | Range applied to the maximum switching frequency parameters |
|---|---|
| **Units** | User units |
| **Range of [MIN]** | Open-loop: 0 (0.667 kHz)<br>RFC-A: 2 (2 kHz) |
| **Range of [MAX]** | Open-loop: 8 (16 kHz)<br>RFC-A: 8 (16 kHz) |
| **Definition** | VM_SWITCHING_FREQUENCY[MAX] = Power stage dependent<br>VM_SWITCHING_FREQUENCY[MIN] = 0<br>This variable maximum is used by the *Minimum Switching Frequency* (05.038) to define the minimum frequency limit used if the inverter thermal model is actively reducing the switching frequency due to temperature.<br>Note that parameter *Maximum Switching Frequency* (05.018) takes priority over parameter *Minimum Switching Frequency* (05.038) so is not limited by parameter *Minimum Switching Frequency* (05.038). The actual minimum switching frequency limit used is the lower of *Maximum Switching Frequency* (05.018) and *Minimum Switching Frequency* (05.038). |

| **VM_MOTOR1_CURRENT_LIMIT** | Range applied to current limit parameters (motor 1) |
|---|---|
| **Units** | % |
| **Range of [MIN]** | 0.0 |
| **Range of [MAX]** | 0.0 to 1000.0 |
| **Definition** |  <br>VM_MOTOR1_CURRENT_LIMIT[MAX] is dependent on the drive rating and motor set-up parameters.<br>VM_MOTOR1_CURRENT_LIMIT[MIN] = 0.0<br>**Open-loop**<br>VM_MOTOR1_CURRENT_LIMIT[MAX] = ($I_{Tlimit}$ / $I_{Trated}$) x 100 %<br>Where:<br>$I_{Tlimit} = I_{MaxRef} \times \cos(\sin^{-1}(I_{Mrated} / I_{MaxRef}))$<br>$I_{Mrated}$ = Pr **05.007** sin $\phi$<br>$I_{Trated}$ = Pr **05.007** x cos $\phi$<br>cos $\phi$ = Pr **05.010**<br>$I_{MaxRef}$ is 0.7 x Pr **11.061** when the motor rated current set in Pr **05.007** is less than or equal to Pr **11.032** (i.e. Heavy duty), otherwise it is the lower of 0.7 x Pr **11.061** or 1.1 x Pr **11.060** (i.e. Normal Duty).<br>$$\textbf{MOTOR1\_CURRENT\_LIMIT\_MAX} = \frac{\sqrt{\left[\left[\frac{\textbf{Maximum current}}{\textbf{Motor rated current}}\right]^2 + (\textbf{PF})^2 - \textbf{1}\right]}}{\textbf{PF}} \times \textbf{100\%}$$<br>Where:<br>Motor rated current is given by Pr **05.007**<br>PF is motor rated power factor given by Pr **05.010**<br>(MOTOR2_CURRENT_LIMIT_MAX is calculated from the motor map 2 parameters)<br>The Maximum current is (1.5 x Rated drive current) when the rated current set by Pr **05.007** is less than or equal to the Maximum Heavy Duty current rating specified in Pr **11.032**, otherwise it is (1.1 x Maximum motor rated current).<br>For example, with a motor of the same rating as the drive and a power factor of 0.85, the maximum current limit is 165.2%.<br>The rated active and rated magnetising currents are calculated from the power factor (Pr **05.010**) and motor rated current (Pr **05.007**) as:<br>rated active current = power factor x motor rated current<br>rated magnetising current = $\sqrt{(1 - \text{power factor}^2)}$ x motor rated current<br>**RFC-A**<br>VM_MOTOR1_CURRENT_LIMIT[MAX] = ($I_{Tlimit}$ / $I_{Trated}$) x 100 %<br>Where:<br>$I_{Tlimit} = I_{MaxRef} \times \cos(\sin^{-1}(I_{Mrated} / I_{MaxRef}))$<br>$I_{Mrated}$ = Pr **05.007** x sin $\phi_1$<br>$I_{Trated}$ = Pr **05.007** x cos $\phi_1$<br>$\phi_1 = \cos^{-1}$ (Pr **05.010**) + $\phi_2$. $\phi_1$ is calculated during an autotune. See the variable minimum / maximum calculations in the *Parameter Reference Guide* for more information regarding $\phi_2$.<br>$I_{MaxRef}$ is 0.9 x Pr **11.061** when the motor rated current set in Pr **05.007** is less than or equal to Pr **11.032** (i.e. Heavy duty), otherwise it is the lower of 0.9 x Pr **11.061** or 1.1 x Pr **11.060** (i.e. Normal Duty). |

| VM_MOTOR2_CURRENT_LIMIT | Range applied to current limit parameters (motor 2) |
|---|---|
| **Units** | % |
| **Range of [MIN]** | 0.0 |
| **Range of [MAX]** | 0.0 to 1000.0 |
| **Definition** | VM_MOTOR2_CURRENT_LIMIT[MAX] is dependent on the drive rating and motor set-up parameters.<br>VM_MOTOR2_CURRENT_LIMIT[MIN] = 0.0<br>Refer to VM_MOTOR1_CURRENT_LIMIT for more information. For VM_MOTOR2_CURRENT_LIMIT[MAX] use Pr **21.007** instead of Pr **05.007** and Pr **21.010** instead of Pr **05.010**. |

| VM_NEGATIVE_REF_CLAMP1 | Limits applied to the negative frequency clamp (motor 1) |
|---|---|
| **Units** | Hz |
| **Range of [MIN]** | -550.00 to 0.00 |
| **Range of [MAX]** | 0.00 to 550.00 |
| **Definition** | This variable maximum/minimum defines the range of the negative frequency clamp associated with motor map 1 (*Minimum Speed* (01.007)). The minimum and maximum are affected by the settings of the *Negative Reference Clamp Enable* (01.008), *Bipolar Reference Enable* (01.010) and *Maximum Speed* (01.006) as shown in the table below. |

| ***Negative Reference Clamp Enable* (01.008)** | ***Bipolar Reference Enable* (01.010)** | **VM_NEGATIVE_REF_ CLAMP1[MIN]** | **VM_NEGATIVE_REF_ CLAMP1[MAX]** |
|---|---|---|---|
| 0 | 0 | 0.00 | Pr **01.006** |
| 0 | 1 | 0.00 | 0.00 |
| 1 | X | -VM_POSITIVE_REF_CLAMP[MAX] | 0.00 |

| VM_NEGATIVE_REF_CLAMP2 | Limits applied to the negative frequency clamp (motor 2) |
|---|---|
| **Units** | Hz |
| **Range of [MIN]** | -550.00 to 0.00 |
| **Range of [MAX]** | 0.00 to 550.00 |
| **Definition** | This variable maximum/minimum defines the range of the negative frequency clamp associated with motor map 2 (*M2 Minimum Speed* (21.002)). It is defined in the same way as VM_NEGATIVE_REF_CLAMP1 except that the *M2 Maximum Speed* (21.001) is used instead of *Maximum Speed* (01.006). |

| VM_POSITIVE_REF_CLAMP | Limits applied to the positive frequency reference clamp |
|---|---|
| **Units** | Hz |
| **Range of [MIN]** | 0.00 |
| **Range of [MAX]** | 550.00 |
| **Definition** | VM_POSITIVE_REF_CLAMP[MAX] defines the range of the positive reference clamp, *Maximum Speed* (01.006), which in turn limit the references. |

| VM_POWER | Range applied to parameters that either set or display power |
|---|---|
| **Units** | kW |
| **Range of [MIN]** | -9999.99 to 0.00 |
| **Range of [MAX]** | 0.00 to 9999.99 |
| **Definition** | VM_POWER[MAX] is rating dependent and is chosen to allow for the maximum power that can be output by the drive with maximum AC output voltage, at maximum controlled current and unity power factor.<br>VM_POWER[MAX] = √3 x VM_AC_VOLTAGE[MAX] x VM_DRIVE_CURRENT[MAX] / 1000<br>VM_POWER[MIN] = -VM_POWER[MAX] |

| VM_RATED_CURRENT | Range applied to rated current parameters |
|---|---|
| **Units** | A |
| **Range of [MIN]** | 0.00 |
| **Range of [MAX]** | 0.00 to 9999.99 |
| **Definition** | VM_RATED_CURRENT [MAX] = *Maximum Rated Current* (11.060) and is dependent on the drive rating.<br>VM_RATED_CURRENT [MIN] = 0.00 |

| **VM_SPEED_FREQ_REF** | Range applied to the frequency reference parameters |
|---|---|
| **Units** | Hz |
| **Range of [MIN]** | -550.00 to 0.00 |
| **Range of [MAX]** | 0.00 to 550.00 |
| **Definition** | This variable minimum/maximum is applied throughout the frequency and speed reference system so that the references can vary in the range from the minimum to maximum clamps. |

| ***Negative Reference Clamp Enable* (01.008)** | **VM_SPEED_FREQ_REF[MAX] if *Select Motor 2 Parameters* (11.045) = 0** | **VM_SPEED_FREQ_REF[MAX] if *Select Motor 2 Parameters* (11.045) = 1** |
|---|---|---|
| 0 | *Maximum Speed* (01.006) | *M2 Maximum Speed* (21.001) |
| 1 | *Maximum Speed* (01.006) or \|*Minimum Speed* (01.007)\| whichever the larger | *M2 Maximum Speed* (21.001) or \|M2 *Minimum Speed* (21.002)\| whichever the larger |

VM_SPEED_FREQ_REF[MIN] = -VM_SPEED_FREQ_REF[MAX].

| **VM_SPEED_FREQ_REF_UNIPOLAR** | Unipolar version of VM_SPEED_FREQ_REF |
|---|---|
| **Units** | Hz |
| **Range of [MIN]** | 0.00 |
| **Range of [MAX]** | 0.00 to 550.00 |
| **Definition** | VM_SPEED_FREQ_REF_UNIPOLAR[MAX] = VM_SPEED_FREQ_REF[MAX]<br>VM_SPEED_FREQ_REF_UNIPOLAR[MIN] = 0.00 |

| **VM_SPEED_FREQ_USER_REFS** | Range applied to analog reference parameters |
|---|---|
| **Units** | Hz |
| **Range of [MIN]** | -550.00 to 550.00 |
| **Range of [MAX]** | 0.00 to 550.00 |
| **Definition** | This variable maximum is applied to *Analog Reference 1* (01.036), *Analog Reference 2* (01.037) and *Keypad Reference* (01.017).<br>The maximum applied to these parameters is the same as other frequency reference parameters.<br>VM_SPEED_FREQ_USER_REFS [MAX] = VM_SPEED_FREQ_REF[MAX]<br>However the minimum is dependent on *Negative Reference Clamp Enable* (01.008) and *Bipolar Reference Enable* (01.010). |

| ***Negative Reference Clamp Enable* (01.008)** | ***Bipolar Reference Enable* (01.010)** | **VM_SPEED_FREQ_USER_REFS[MIN]** |
|---|---|---|
| 0 | 0 | If *Select Motor 2 Parameters* (11.045) = 0 *Minimum Speed* (01.007), otherwise *M2 Minimum Speed* (21.002) |
| 0 | 1 | -VM_SPEED_FREQ_REF[MAX] |
| 1 | 0 | 0.00 |
| 1 | 1 | -VM_SPEED_FREQ_REF[MAX] |

| **VM_SUPPLY_LOSS_LEVEL** | Range applied to the supply loss threshold |
|---|---|
| **Units** | V |
| **Range of [MIN]** | 0 to 1150 |
| **Range of [MAX]** | 0 to 1150 |
| **Definition** | VM_SUPPLY_LOSS_LEVEL[MAX] = VM_DC_VOLTAGE_SET[MAX]<br>VM_SUPPLY_LOSS_LEVEL[MIN] is drive voltage rating dependent. See Table 11-4 |

| **VM_TORQUE_CURRENT** | Range applied to torque and torque producing current parameters |
|---|---|
| **Units** | % |
| **Range of [MIN]** | -1000.0 to 0.0 |
| **Range of [MAX]** | 0.0 to 1000.0 |

| ***Select Motor 2 Parameters* (11.045)** | **VM_TORQUE_CURRENT[MAX]** |
|---|---|
| 0 | VM_MOTOR1_CURRENT_LIMIT[MAX] |
| 1 | VM_MOTOR2_CURRENT_LIMIT[MAX] |

**Definition** VM_TORQUE_CURRENT[MIN] = -VM_TORQUE_CURRENT[MAX]

| **VM_TORQUE_CURRENT_UNIPOLAR** | Unipolar version of VM_TORQUE_CURRENT |
|---|---|
| **Units** | % |
| **Range of [MIN]** | 0.0 |
| **Range of [MAX]** | 0.0 to 1000.0 |
| **Definition** | VM_TORQUE_CURRENT_UNIPOLAR[MAX] = VM_TORQUE_CURRENT[MAX]<br>VM_TORQUE_CURRENT_UNIPOLAR[MIN] =0.0<br>*User Current Maximum Scaling* (04.024) defines the variable maximum/minimums VM_USER_CURRENT which is applied to *Percentage Load* (04.020) and *Torque Reference* (04.008). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user. This maximum is subject to a limit of MOTOR1_CURRENT_LIMIT or MOTOR2_CURRENT_LIMIT depending on which motor map is currently active.<br>The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX]) varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting. |

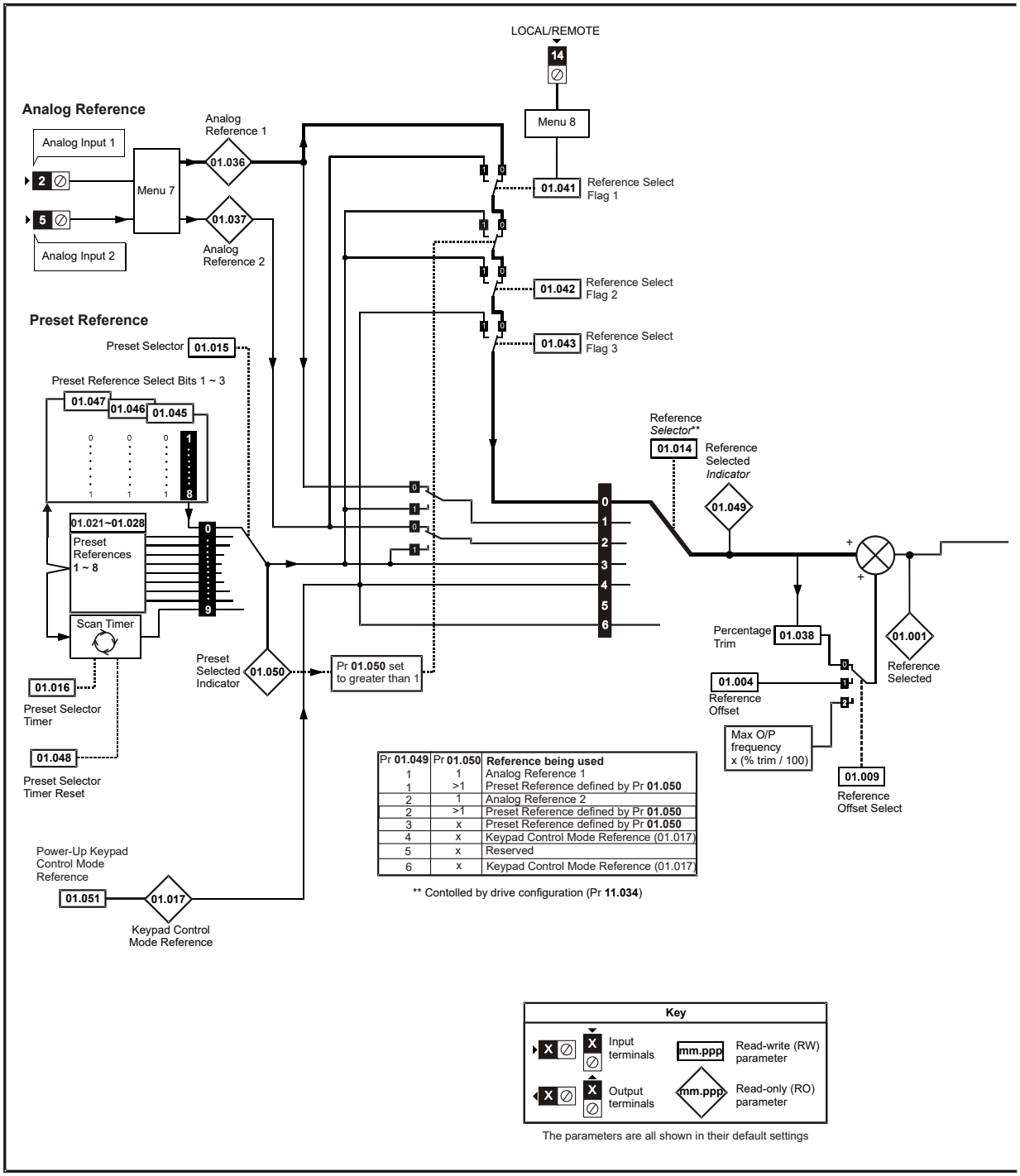
| **VM_USER_CURRENT** | Range applied to torque reference and percentage load parameters with one decimal place |
|---|---|
| **Units** | % |
| **Range of [MIN]** | -1000.0 to 0.0 |
| **Range of [MAX]** | 0.0 to 1000.0 |
| **Definition** | VM_USER_CURRENT[MAX] = *User Current Maximum Scaling* (04.024)<br>VM_USER_CURRENT[MIN] = -VM_USER_CURRENT[MAX]<br>*User Current Maximum Scaling* (04.024) defines the variable maximum/minimums VM_USER_CURRENT which is applied to *Percentage Load* (04.020) and *Torque Reference* (04.008). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user. This maximum is subject to a limit of MOTOR1_CURRENT_LIMIT or MOTOR2_CURRENT_LIMIT depending on which motor map is currently active.<br>The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX]) varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting. |

**Table 11-4 Voltage ratings dependant values**

| **Variable min/max** | **Voltage level** | | | |
|---|---|---|---|---|
| | **100 V** | **200 V** | **400 V** | **575 V** |
| VM_DC_VOLTAGE_SET(MAX] | 400 | | 800 | 955 |
| VM_DC_VOLTAGE(MAX]<br>Frame 1 to 4 | 510 | | 870 | N/A |
| VM_DC_VOLTAGE(MAX]<br>Frame 5 to 9 | 415 | | 830 | 990 |
| VM_AC_VOLTAGE_SET(MAX] Frame 1 to 4 | 240 | | 480 | N/A |
| VM_AC_VOLTAGE_SET(MAX] Frame 5 to 9 | 265 | | 530 | 635 |
| VM_AC_VOLTAGE[MAX] | 325 | | 650 | 780 |
| VM_STD_UNDER_VOLTS[MIN] | 175 | | 330 | 435 |
| VM_SUPPLY_LOSS_LEVEL{MIN] | 205 | | 410 | 540 |

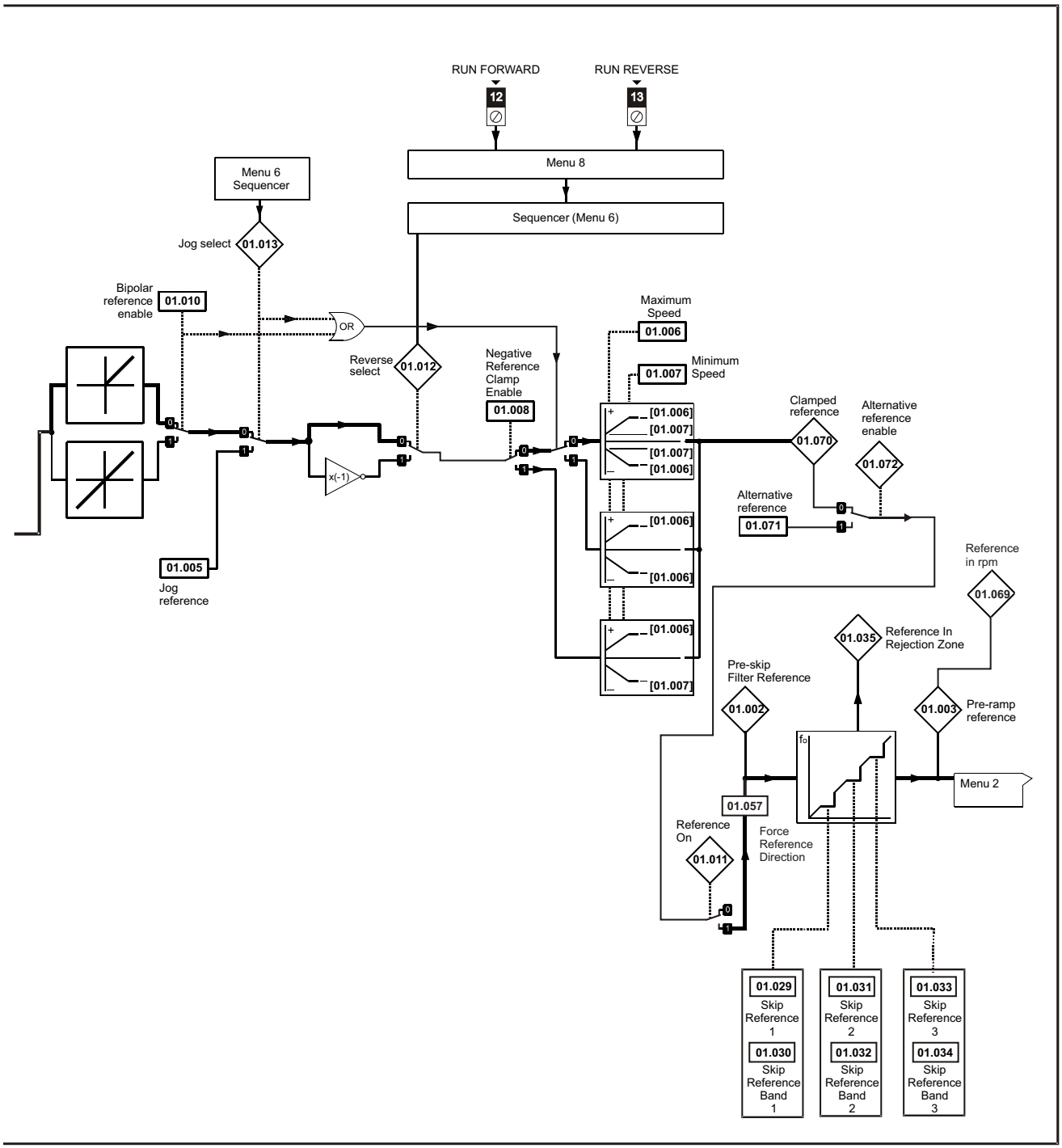
## 11.2 Menu 1: Frequency reference

**Figure 11-1 Menu 1 logic diagram**




| Pr **01.049** | Pr **01.050** | **Reference being used** |
|---|---|---|
| 1 | 1 | Analog Reference 1 |
| 1 | >1 | Preset Reference defined by Pr **01.050** |
| 2 | 1 | Analog Reference 2 |
| 2 | >1 | Preset Reference defined by Pr **01.050** |
| 3 | x | Preset Reference defined by Pr **01.050** |
| 4 | x | Keypad Control Mode Reference (01.017) |
| 5 | x | Reserved |
| 6 | x | Keypad Control Mode Reference (01.017) |

** Contolled by drive configuration (Pr **11.034**)

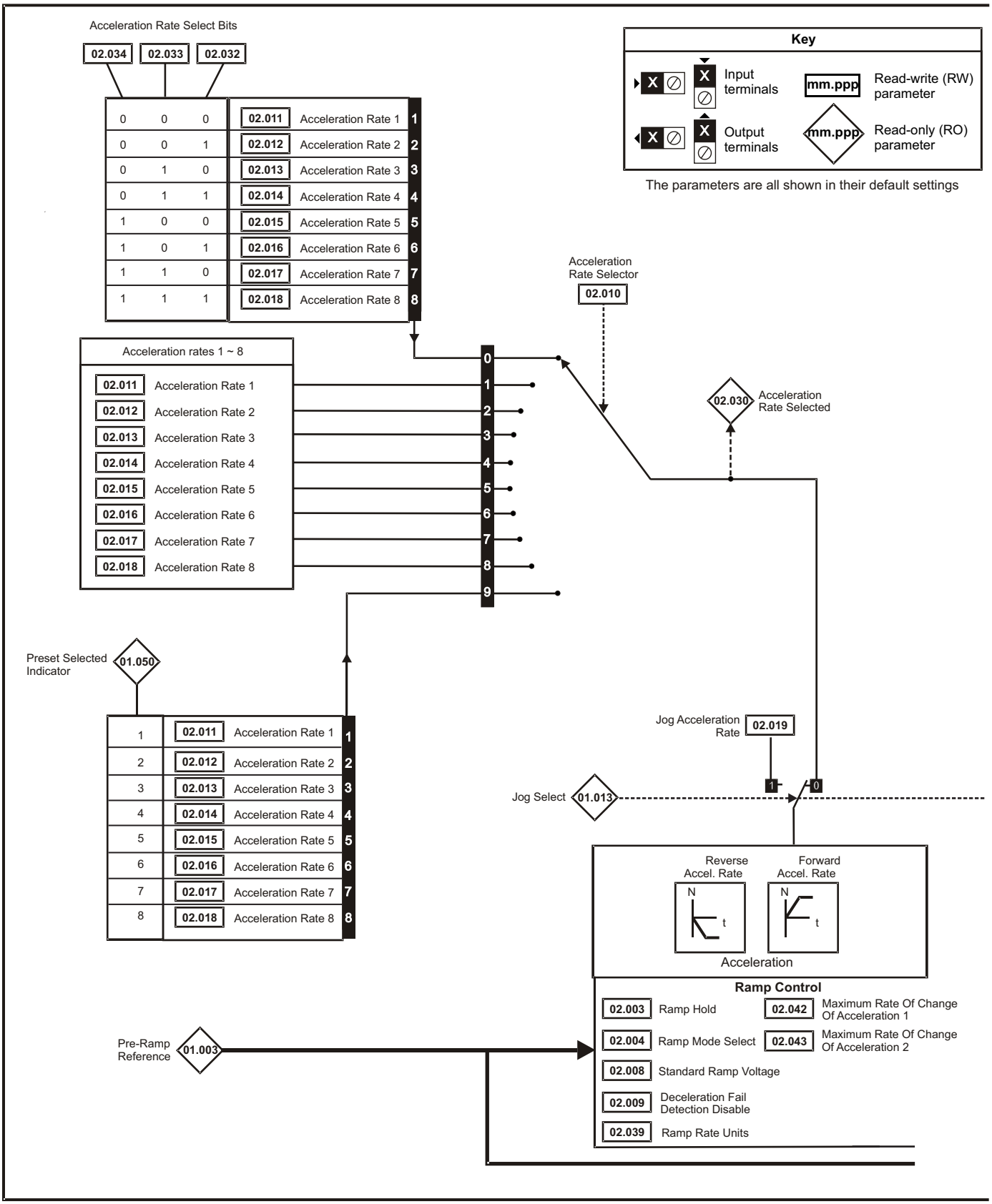

RUN FORWARD
12
RUN REVERSE
13
Menu 8
Sequencer (Menu 6)
Menu 6 Sequencer
Jog select 01.013
Bipolar reference enable 01.010
OR
Reverse select 01.012
Negative Reference Clamp Enable 01.008
Maximum Speed 01.006
Minimum Speed 01.007
[01.006]
[01.007]
[01.007]
[01.006]
[01.006]
[01.006]
[01.006]
[01.007]
x(-1)
Clamped reference 01.070
Alternative reference enable 01.072
Alternative reference 01.071
01.005 Jog reference
Reference in rpm 01.069
01.035 Reference In Rejection Zone
Pre-skip Filter Reference 01.002
01.003 Pre-ramp reference
Menu 2
01.057
Reference On 01.011
Force Reference Direction
01.029 Skip Reference 1
01.030 Skip Reference Band 1
01.031 Skip Reference 2
01.032 Skip Reference Band 2
01.033 Skip Reference 3
01.034 Skip Reference Band 3

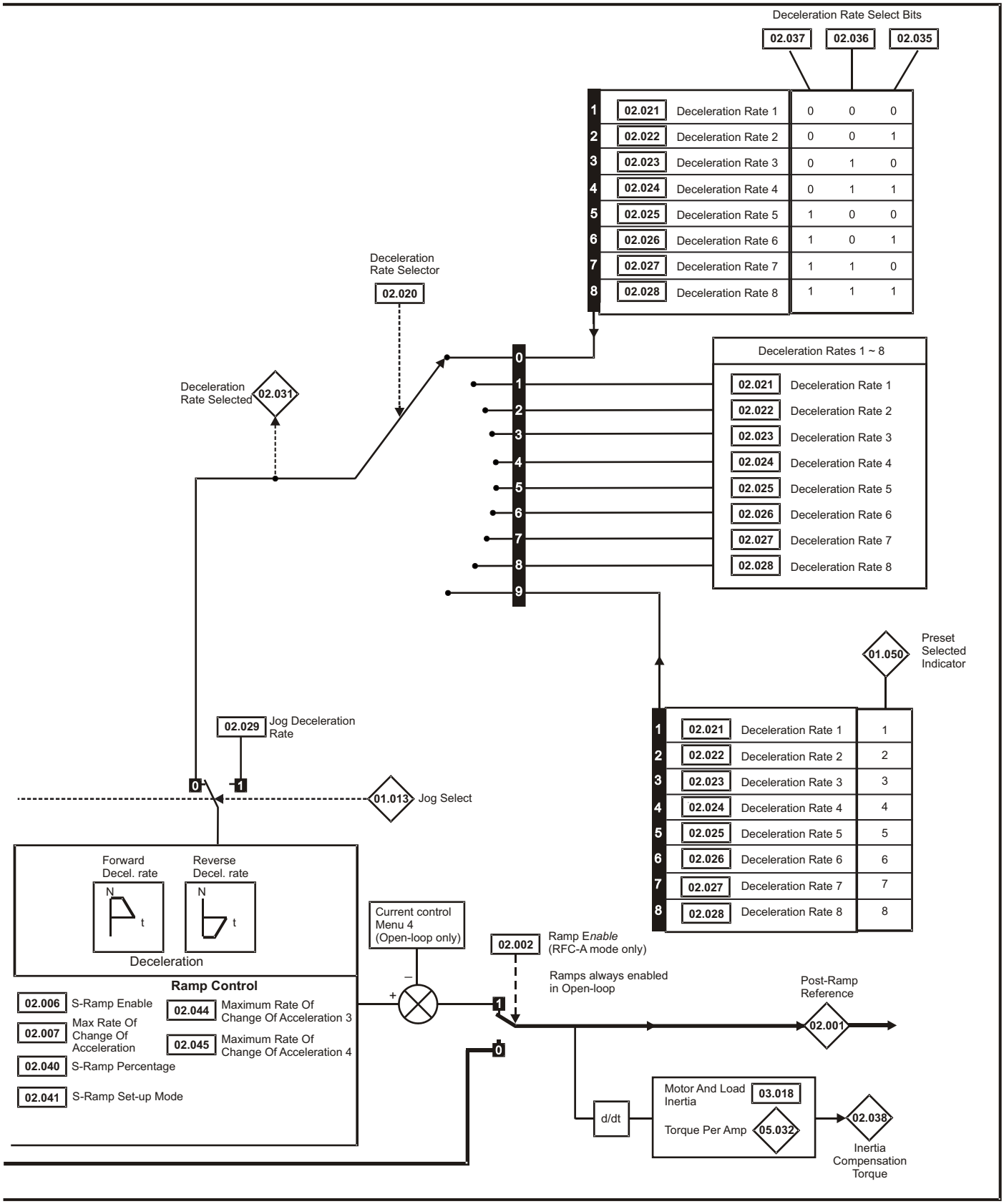
| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **01.001** | Reference Selected | 0.00 to Pr **01.006** Hz | | | | RO | Num | ND | NC | PT | |
| **01.002** | Pre-skip Filter Reference | 0.00 to Pr **01.006** Hz | | | | RO | Num | ND | NC | PT | |
| **01.003** | Pre-ramp Reference | 0.00 to Pr **01.006** Hz | | | | RO | Num | ND | NC | PT | |
| **01.004** | Reference Offset | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.005** | Jog Reference | 0.00 to 300.00 Hz | | 1.50 Hz | | RW | Num | | | | US |
| **01.006** | Maximum Speed | 0.00 to 550.00 Hz | | 50Hz: 50.00 Hz<br>60Hz: 60.00 Hz | | RW | Num | | | | US |
| **01.007** | Minimum Speed | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.008** | Negative Reference Clamp Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **01.009** | Reference Offset Select | 0 to 2 | | 0 | | RW | Num | | | | US |
| **01.010** | Bipolar Reference Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **01.011** | Reference On | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **01.012** | Reverse Select | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **01.013** | Jog Select | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **01.014** | Reference Selector | A1.A2 (0), A1.Pr (1), A2.Pr (2), PrESEt (3), PAd (4), rES (5), PAd.rEF (6) | | A1.A2 (0) | | RW | Txt | | | | US |
| **01.015** | Preset Selector | 0 to 9 | | 0 | | RW | Num | | | | US |
| **01.016** | Preset Selector Timer | 0 to 400.0 s | | 10.0 s | | RW | Num | | | | US |
| **01.017** | Keypad Control Mode Reference | VM_SPEED_FREQ_USER_REFS Hz | | 0.00 Hz | | RO | Num | | NC | PT | PS |
| **01.021** | Preset Reference 1 | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.022** | Preset Reference 2 | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.023** | Preset Reference 3 | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.024** | Preset Reference 4 | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.025** | Preset Reference 5 | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.026** | Preset Reference 6 | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.027** | Preset Reference 7 | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.028** | Preset Reference 8 | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.029** | Skip Reference 1 | 0.00 to 550.00 Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.030** | Skip Reference Band 1 | 0.00 to 25.00 Hz | | 0.50 Hz | | RW | Num | | | | US |
| **01.031** | Skip Reference 2 | 0.00 to 550.00 Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.032** | Skip Reference Band 2 | 0.00 to 25.00 Hz | | 0.50 Hz | | RW | Num | | | | US |
| **01.033** | Skip Reference 3 | 0.00 to 550.00 Hz | | 0.00 Hz | | RW | Num | | | | US |
| **01.034** | Skip Reference Band 3 | 0.00 to 25.00 Hz | | 0.50 Hz | | RW | Num | | | | US |
| **01.035** | Reference In Rejection Zone | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **01.036** | Analog Reference 1 | VM_SPEED_FREQ_USER_REFS Hz | | 0.00 Hz | | RO | Num | | NC | | |
| **01.037** | Analog Reference 2 | VM_SPEED_FREQ_USER_REFS Hz | | 0.00 Hz | | RO | Num | | NC | | |
| **01.038** | Percentage Trim | ± 100.00 % | | 0.00 % | | RW | Num | | NC | | |
| **01.041** | Reference Select Flag 1 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **01.042** | Reference Select Flag 2 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **01.043** | Reference Select Flag 3 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **01.045** | Preset Select Flag 1 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **01.046** | Preset Select Flag 2 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **01.047** | Preset Select Flag 3 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **01.048** | Preset Selector Timer Reset | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **01.049** | Reference Selected Indicator | 1 to 6 | | | | RO | Num | ND | NC | PT | |
| **01.050** | Preset Selected Indicator | 1 to 8 | | | | RO | Num | ND | NC | PT | |
| **01.051** | Power-up Keypad Control Mode Reference | rESEt (0), LASt (1), PrESEt (2) | | rESEt (0) | | RW | Txt | | | | US |
| **01.057** | Force Reference Direction | NonE (0), For (1), rEv (2) | | NonE (0) | | RW | Txt | | | | |
| **01.069** | Reference in rpm | ± 33000.0 rpm | | | | RO | Num | ND | NC | PT | |
| **01.070** | Clamped Reference | 0.00 to Pr **01.006** Hz | | | | RO | Num | ND | NC | PT | |
| **01.071** | Alternative Reference | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | NC | PT | |
| **01.072** | Alternative Reference Enable | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.3 Menu 2: Ramps

**Figure 11-2 Menu 2 logic diagram**




Deceleration Rate Select Bits
02.037
02.036
02.035
1 02.021 Deceleration Rate 1 0 0 0
2 02.022 Deceleration Rate 2 0 0 1
3 02.023 Deceleration Rate 3 0 1 0
4 02.024 Deceleration Rate 4 0 1 1
5 02.025 Deceleration Rate 5 1 0 0
6 02.026 Deceleration Rate 6 1 0 1
7 02.027 Deceleration Rate 7 1 1 0
8 02.028 Deceleration Rate 8 1 1 1
Deceleration Rate Selector
02.020
Deceleration Rate Selected
02.031
0 1 2 3 4 5 6 7 8 9
Deceleration Rates 1 ~ 8
02.021 Deceleration Rate 1
02.022 Deceleration Rate 2
02.023 Deceleration Rate 3
02.024 Deceleration Rate 4
02.025 Deceleration Rate 5
02.026 Deceleration Rate 6
02.027 Deceleration Rate 7
02.028 Deceleration Rate 8
01.050
Preset Selected Indicator
1 02.021 Deceleration Rate 1 1
2 02.022 Deceleration Rate 2 2
3 02.023 Deceleration Rate 3 3
4 02.024 Deceleration Rate 4 4
5 02.025 Deceleration Rate 5 5
6 02.026 Deceleration Rate 6 6
7 02.027 Deceleration Rate 7 7
8 02.028 Deceleration Rate 8 8
02.029 Jog Deceleration Rate
0 1
01.013 Jog Select
Forward Decel. rate
Reverse Decel. rate
N t
Deceleration
Ramp Control
02.006 S-Ramp Enable
02.007 Max Rate Of Change Of Acceleration
02.040 S-Ramp Percentage
02.041 S-Ramp Set-up Mode
02.044 Maximum Rate Of Change Of Acceleration 3
02.045 Maximum Rate Of Change Of Acceleration 4
Current control Menu 4 (Open-loop only)
02.002 Ramp Enable (RFC-A mode only)
Ramps always enabled in Open-loop
Post-Ramp Reference
02.001
d/dt
Motor And Load Inertia 03.018
Torque Per Amp 05.032
02.038
Inertia Compensation Torque

| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **02.001** | Post Ramp Reference | 0.00 to Pr **01.006** Hz | | | | RO | Num | ND | NC | PT | |
| **02.002** | Ramp Enable | | Off (0) or On (1) | | On (1) | RW | Bit | | | | US |
| **02.003** | Ramp Hold | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **02.004** | Ramp Mode Select | FASt (0), Std (1), Std.bSt (2), FSt.bSt (3) | | Std (1) | | RW | Txt | | | | US |
| **02.005** | Disable Ramp Output | | Off (0) or On (1) | | Off (0) | RW | Bit | | | | US |
| **02.006** | S Ramp Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **02.007** | Max Rate Of Change Of Acceleration | 0.0 to 300.0 s²/100Hz | | 3.1 s²/100 Hz | | RW | Num | | | | US |
| **02.008** | Standard Ramp Voltage | 0 to 1150 V | | 110 V drive: 375 V<br>200 V drive: 375 V<br>400 V drive 50 Hz: 750 V<br>400 V drive 60 Hz: 775 V<br>575 V drive: 895 V | | RW | Num | | RA | | US |
| **02.009** | Deceleration Fail Detection Disable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **02.010** | Acceleration Rate Selector | 0 to 9 | | 0 | | RW | Num | | | | US |
| **02.011** | Acceleration Rate 1 | 0.0 to 32000.0 s/Maximum Frequency | | 5.0 s/Maximum Frequency | | RW | Num | | | | US |
| **02.012** | Acceleration Rate 2 | | | | | RW | Num | | | | US |
| **02.013** | Acceleration Rate 3 | | | | | RW | Num | | | | US |
| **02.014** | Acceleration Rate 4 | | | | | RW | Num | | | | US |
| **02.015** | Acceleration Rate 5 | | | | | RW | Num | | | | US |
| **02.016** | Acceleration Rate 6 | | | | | RW | Num | | | | US |
| **02.017** | Acceleration Rate 7 | | | | | RW | Num | | | | US |
| **02.018** | Acceleration Rate 8 | | | | | RW | Num | | | | US |
| **02.019** | Jog Acceleration Rate | 0.0 to 32000.0 s/Maximum Frequency | | 0.2 s/Maximum Frequency | | RW | Num | | | | US |
| **02.020** | Deceleration Rate Selector | 0 to 9 | | 0 | | RW | Num | | | | US |
| **02.021** | Deceleration Rate 1 | 0.0 to 32000.0 s/Maximum Frequency | | 10.0 s/Maximum Frequency | | RW | Num | | | | US |
| **02.022** | Deceleration Rate 2 | | | | | RW | Num | | | | US |
| **02.023** | Deceleration Rate 3 | | | | | RW | Num | | | | US |
| **02.024** | Deceleration Rate 4 | | | | | RW | Num | | | | US |
| **02.025** | Deceleration Rate 5 | | | | | RW | Num | | | | US |
| **02.026** | Deceleration Rate 6 | | | | | RW | Num | | | | US |
| **02.027** | Deceleration Rate 7 | | | | | RW | Num | | | | US |
| **02.028** | Deceleration Rate 8 | | | | | RW | Num | | | | US |
| **02.029** | Jog Deceleration Rate | 0.0 to 32000.0 s/Maximum Frequency | | 0.2 s/Maximum Frequency | | RW | Num | | | | US |
| **02.030** | Acceleration Rate Selected | 0 to 8 | | | | RO | Num | ND | NC | PT | |
| **02.031** | Deceleration Rate Selected | 0 to 8 | | | | RO | Num | ND | NC | PT | |
| **02.032** | Acceleration Rate Select Bit 0 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **02.033** | Acceleration Rate Select Bit 1 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **02.034** | Acceleration Rate Select Bit 2 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **02.035** | Deceleration Rate Select Bit 0 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **02.036** | Deceleration Rate Select Bit 1 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **02.037** | Deceleration Rate Select Bit 2 | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **02.038** | Inertia Compensation Torque | | ±1000.0 % | | | RO | Num | ND | NC | PT | |
| **02.039** | Ramp Rate Units | 0 (s/100 Hz), 1 (s/Maximum Frequency), 2 (s/1000 Hz) | | 1 (s/Maximum Frequency) | | RW | Num | | | | US |
| **02.040** | S Ramp Percentage | 0.0 to 50.0 % | | 0.0 % | | RW | Num | | | | US |
| **02.041** | S Ramp Set-up Mode | 0 to 2 | | 0 | | RW | Num | | | | US |
| **02.042** | Maximum Rate Of Change Of Acceleration 1 | 0.0 to 300.0 s²/100 Hz | | 0.0 s²/100 Hz | | RW | Num | | | | US |
| **02.043** | Maximum Rate Of Change Of Acceleration 2 | 0.0 to 300.0 s²/100 Hz | | 0.0 s²/100 Hz | | RW | Num | | | | US |
| **02.044** | Maximum Rate Of Change Of Acceleration 3 | 0.0 to 300.0 s²/100 Hz | | 0.0 s²/100 Hz | | RW | Num | | | | US |
| **02.045** | Maximum Rate Of Change Of Acceleration 4 | 0.0 to 300.0 s²/100 Hz | | 0.0 s²/100 Hz | | RW | Num | | | | US |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.4 Menu 3: Frequency control

**Figure 11-3 Menu 3 Open-loop logic diagram**

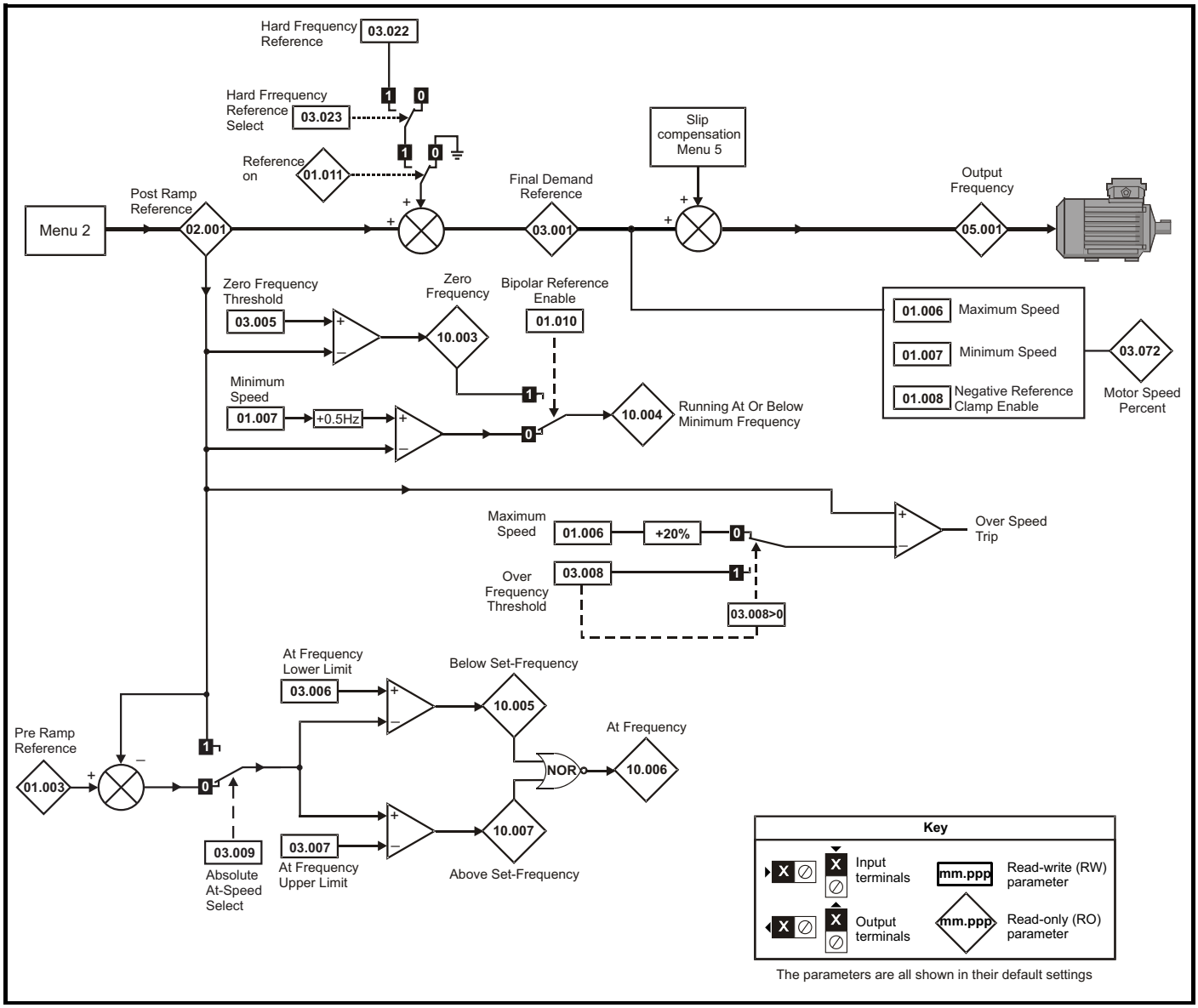
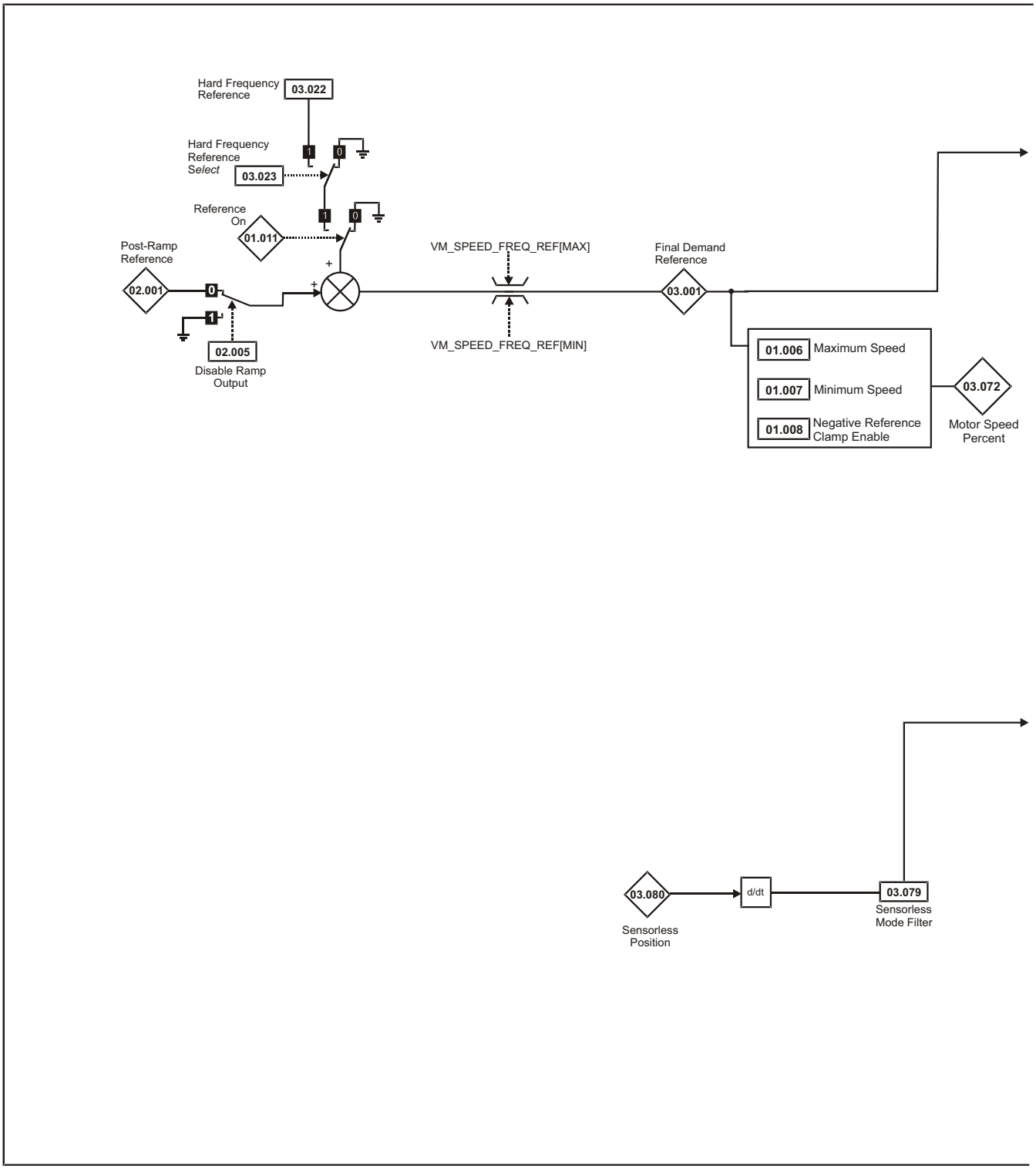


**Figure 11-4 Menu 3 RFC-A logic diagram**



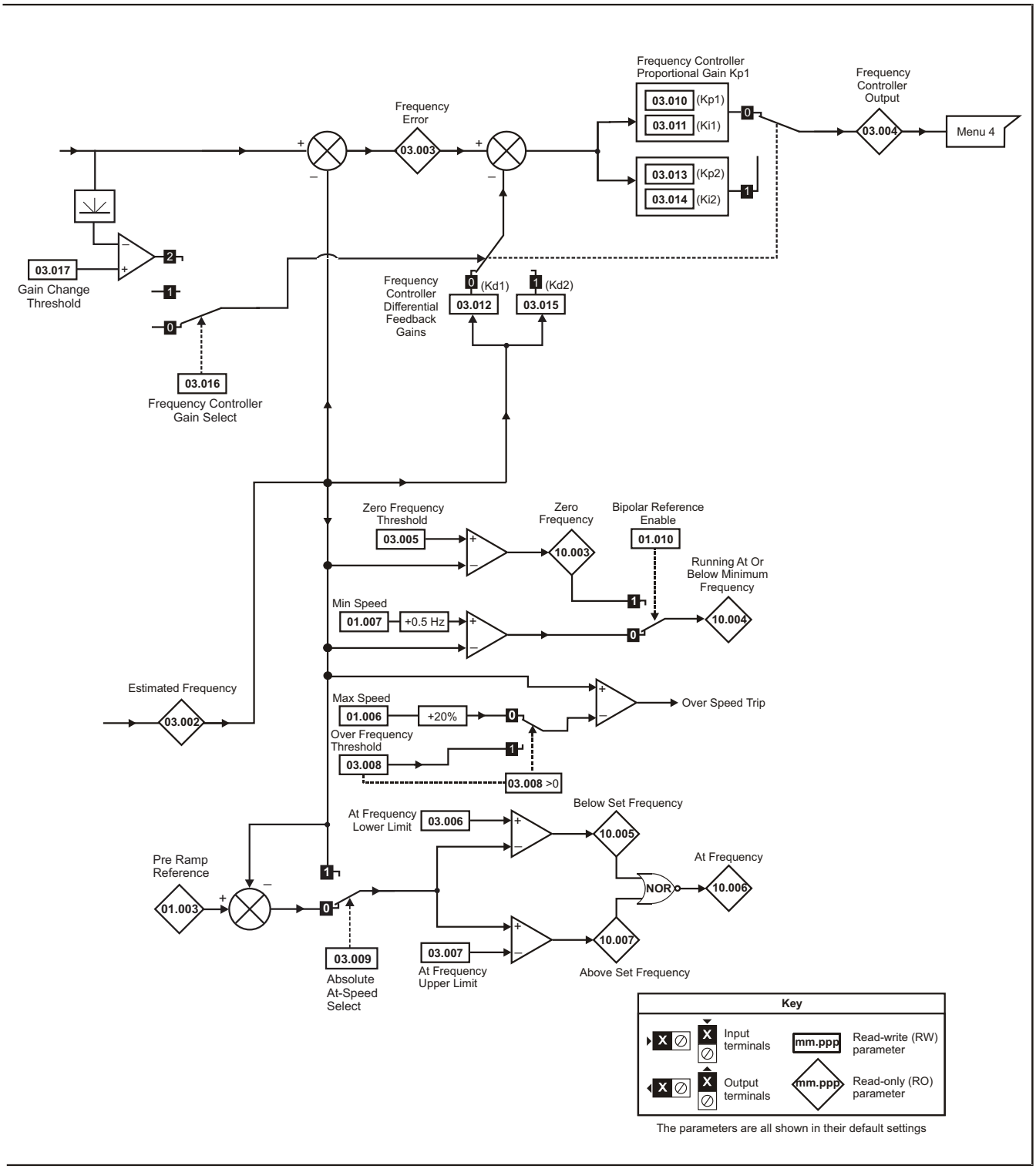
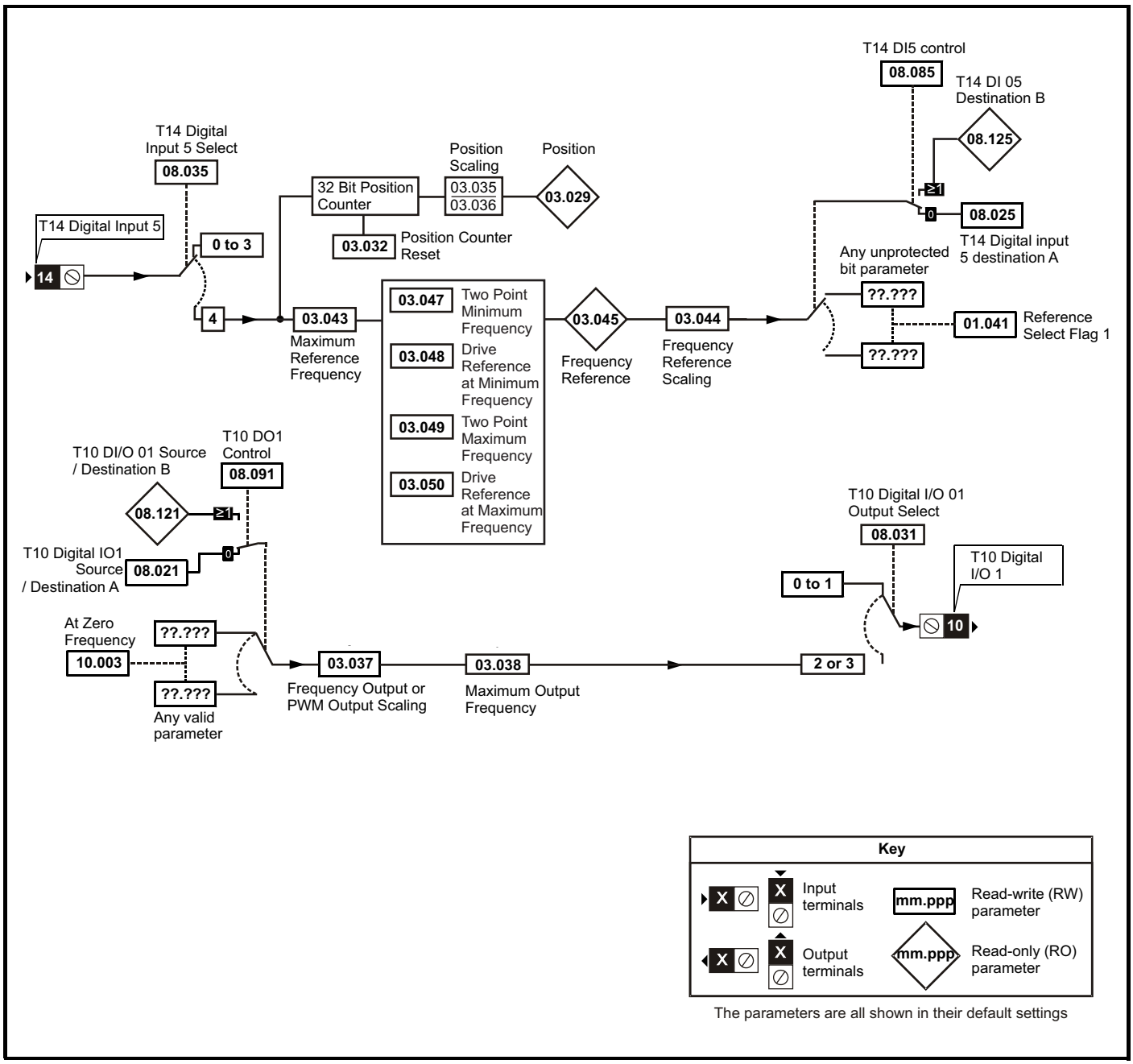

Frequency Controller Proportional Gain Kp1
03.010 (Kp1)
03.011 (Ki1)
03.013 (Kp2)
03.014 (Ki2)
Frequency Controller Output
03.004
Menu 4
Frequency Error
03.003
03.017
Gain Change Threshold
03.016
Frequency Controller Gain Select
Frequency Controller Differential Feedback Gains
03.012 (Kd1)
03.015 (Kd2)
Zero Frequency Threshold
03.005
Zero Frequency
10.003
Bipolar Reference Enable
01.010
Running At Or Below Minimum Frequency
10.004
Min Speed
01.007
+0.5 Hz
Estimated Frequency
03.002
Max Speed
01.006
+20%
Over Speed Trip
Over Frequency Threshold
03.008
03.008 >0
At Frequency Lower Limit
03.006
Below Set Frequency
10.005
Pre Ramp Reference
01.003
NOR
At Frequency
10.006
03.009
Absolute At-Speed Select
03.007
At Frequency Upper Limit
10.007
Above Set Frequency
Key
Input terminals
Output terminals
mm.ppp
Read-write (RW) parameter
Read-only (RO) parameter
The parameters are all shown in their default settings

**Figure 11-5 Menu 3 Logic diagram**



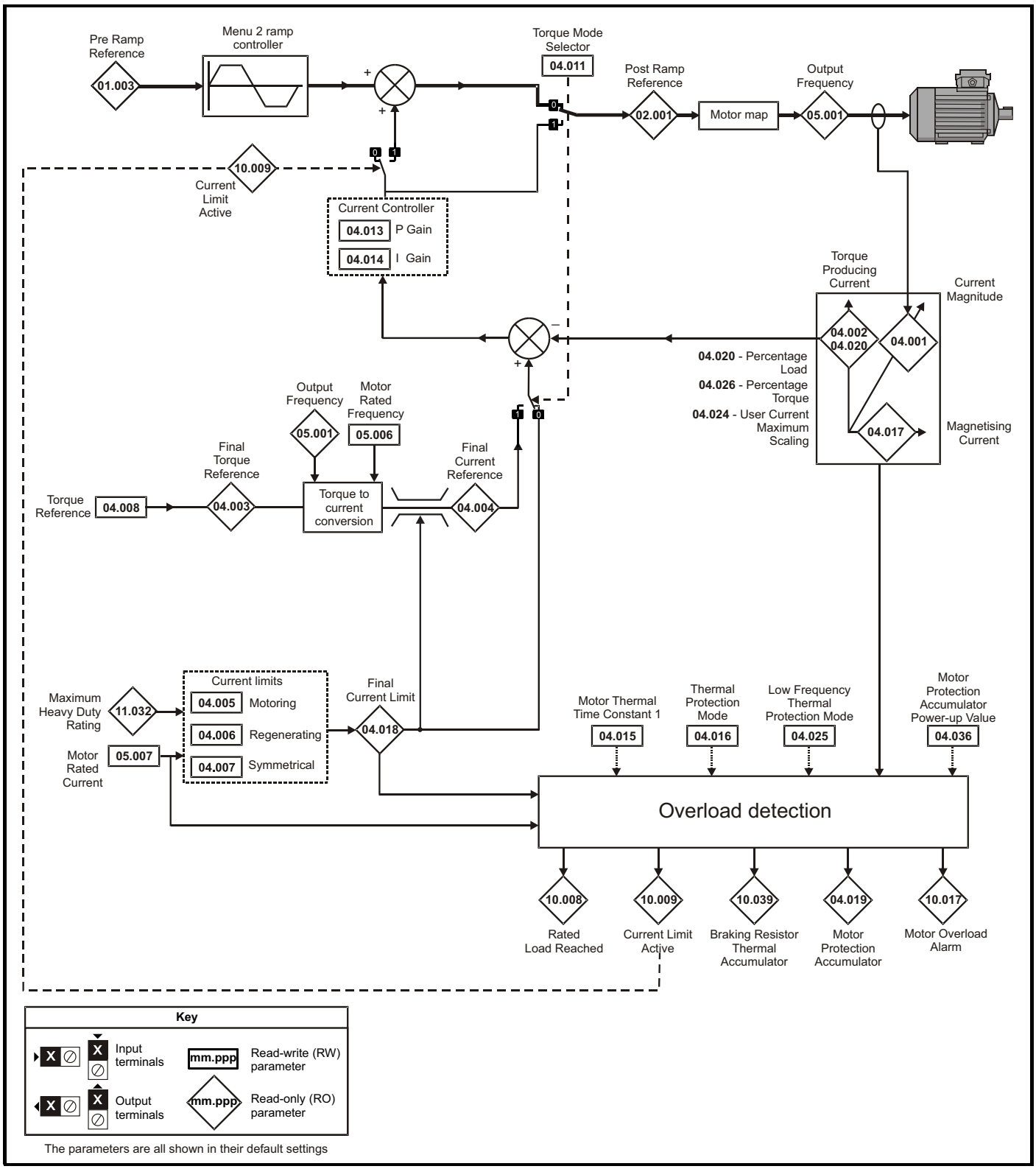

The parameters are all shown in their default settings

| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **03.001** | Final Demand Reference | -Pr **01.006** to Pr **01.006** or Pr **01.007** to Pr **01.006** Hz | | | | RO | Num | ND | NC | PT | FI |
| **03.002** | Estimated Frequency | | -Pr **01.006** to Pr **01.006** or Pr **01.007** to Pr **01.006** Hz | | | RO | Num | ND | NC | PT | FI |
| **03.003** | Frequency Error | | -Pr **01.006** to Pr **01.006** or Pr **01.007** to Pr **01.006** Hz | | | RO | Num | ND | NC | PT | FI |
| **03.004** | Frequency Controller Output | | VM_TORQUE_CURRENT % | | | RO | Num | ND | NC | PT | FI |
| **03.005** | Zero Frequency Threshold | 0.00 to 20.00 Hz | | 2.00 Hz | | RW | Num | | | | US |
| **03.006** | At Frequency Lower Limit | 0.00 to 550.00 Hz | | 1.00 Hz | | RW | Num | | | | US |
| **03.007** | At Frequency Upper Limit | 0.00 to 550.00 Hz | | 1.00 Hz | | RW | Num | | | | US |
| **03.008** | Over Frequency Threshold | 0.00 to 550.00 Hz | | 0.00 Hz | | RW | Num | | | | US |
| **03.009** | Absolute At Frequency Select | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **03.010** | Frequency Controller Proportional Gain Kp1 | | 0.000 to 200.000 s/rad | | 0.100 s/rad | RW | Num | | | | US |
| **03.011** | Frequency Controller Integral Gain Ki1 | | 0.00 to 655.35 s²/rad | | 0.10 s²/rad | RW | Num | | | | US |
| **03.012** | Frequency Controller Differential Feedback Gain Kd1 | | 0.00000 to 0.65535 1/rad | | 0.00000 1/rad | RW | Num | | | | US |
| **03.013** | Frequency Controller Proportional Gain Kp2 | | 0.000 to 200.000 s/rad | | 0.100 s/rad | RW | Num | | | | US |
| **03.014** | Frequency Controller Integral Gain Ki2 | | 0.00 to 655.35 s²/rad | | 0.10 s²/rad | RW | Num | | | | US |
| **03.015** | Frequency Controller Differential Feedback Gain Kd2 | | 0.00000 to 0.65535 1/rad | | 0.00000 1/rad | RW | Num | | | | US |
| **03.016** | Frequency Controller Gain Select | | 0 to 2 | | 0 | RW | Num | | | | US |
| **03.017** | Gain Change Threshold | | 0.00 to 550.00 Hz | | 0.00 Hz | RW | Num | | | | FI |
| **03.018** | Motor and Load Inertia | | 0.00 to 1000.00 kgm² | | 0.00 kgm² | RW | Num | | | | US |
| **03.022** | Hard Frequency Reference | 0.00 to Pr **01.006** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **03.023** | Hard Frequency Reference Select | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **03.029** | Position (T14) | 0 to 65535 | | | | RO | Num | ND | NC | PT | FI |
| **03.032** | Position Counter Reset (T14) | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **03.035** | Position Scaling Numerator (T14) | 0.000 to 1.000 | | 1.000 | | RW | Num | | | | US |
| **03.036** | Position Scaling Denominator (T14) | 0.000 to 100.000 | | 1.000 | | RW | Num | | | | US |
| **03.037** | Frequency Output or PWM Output Scaling (T10) | 0.000 to 4.000 | | 1.000 | | RW | Num | | | | US |
| **03.038** | Maximum Output Frequency (T10) | 1 (0), 2 (1), 5 (2), 10 (3) kHz | | 5 (2) kHz | | RW | Txt | | | | US |
| **03.042** | Frequency Input High Precision | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **03.043** | Maximum Reference Frequency (T14) | 0.00 to 100.00 kHz | | 10.00 kHz | | RW | Num | | | | US |
| **03.044** | Frequency Reference Scaling (T14) | 0.000 to 4.000 | | 1.000 | | RW | Num | | | | US |
| **03.045** | Frequency Reference (T14) | 0.00 to 100.00 % | | | | RO | Num | ND | NC | PT | FI |
| **03.047** | Two Point Minimum Frequency (T14) | 0.00 to 100.00 % | | 0.00 % | | RW | Num | | | | US |
| **03.048** | Drive Reference at Minimum Frequency (T14) | 0.00 to 100.00 % | | 0.00 % | | RW | Num | | | | US |
| **03.049** | Two Point Maximum Frequency (T14) | 0.00 to 100.00 % | | 100.00 % | | RW | Num | | | | US |
| **03.050** | Drive Reference at Maximum Frequency (T14) | 0.00 to 100.00 % | | 100.00 % | | RW | Num | | | | US |
| **03.072** | Motor Speed Percent | ± 150.0 % | | | | RO | | ND | NC | PT | FI |
| **03.079** | Sensorless Mode Filter | | 4 (0), 5 (1), 6 (2), 8 (3), 12 (4), 20 (5) ms | | 4 (0) ms | RW | Txt | | | | US |
| **03.080** | Sensorless Position | | 0 to 65535 | | | RO | Num | ND | NC | PT | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

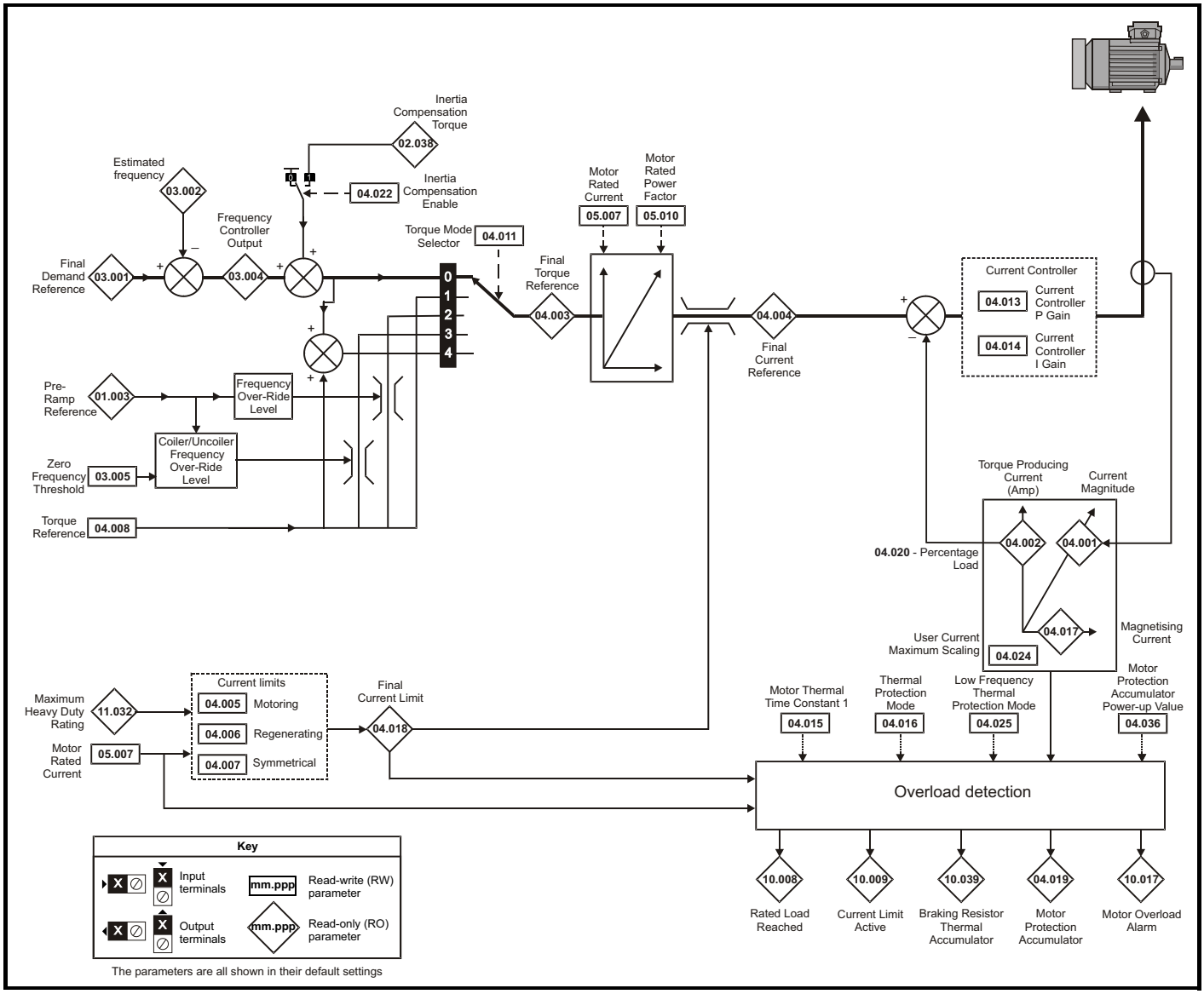
## 11.5 Menu 4: Torque and current control

**Figure 11-6 Menu 4 Open loop logic diagram**




The parameters are all shown in their default settings

**Figure 11-7 Menu 4 RFC-A logic diagram**



| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **04.001** | Current Magnitude | 0 to Drive Maximum Current A | | | | RO | Num | ND | NC | PT | FI |
| **04.002** | Torque Producing Current | ± Drive Maximum Current A | | | | RO | Num | ND | NC | PT | FI |
| **04.003** | Final Torque Reference | VM_TORQUE_CURRENT % | | | | RO | Num | ND | NC | PT | FI |
| **04.004** | Final Current Reference | VM_TORQUE_CURRENT % | | | | RO | Num | ND | NC | PT | FI |
| **04.005** | Motoring Current Limit | 0.0 to VM_MOTOR1_CURRENT_LIMIT % | | 165.0 %* | 175.0 %** | RW | Num | | RA | | US |
| **04.006** | Regenerating Current Limit | 0.0 to VM_MOTOR1_CURRENT_LIMIT % | | 165.0 %* | 175.0 %** | RW | Num | | RA | US | |
| **04.007** | Symmetrical Current Limit | 0.0 to VM_MOTOR1_CURRENT_LIMIT % | | 165.0 %* | 175.0 %** | RW | Num | | RA | | US |
| **04.008** | Torque Reference | VM_USER_CURRENT % | | 0.0 % | | RW | Num | | | | US |
| **04.011** | Torque Mode Selector | 0 to 1 | 0 to 5 | 0 | | RW | Num | | | | US |
| **04.013** | Current Controller Kp Gain | 0.00 to 4000.00 | | 20.00 | | RW | Num | | | | US |
| **04.014** | Current Controller Ki Gain | 0.000 to 600.000 | | 40.000 | | RW | Num | | | | US |
| **04.015** | Motor Thermal Time Constant 1 | 1 to 3000 s | | 179 s | | RW | Num | | | | US |
| **04.016** | Thermal Protection Mode | 0 (0) to 3 (3) | | 0 (0) | | RW | Bin | | | | US |
| **04.017** | Magnetising Current | 0 to Drive Maximum Current A | | | | RO | Num | ND | NC | PT | FI |
| **04.018** | Final Current Limit | VM_TORQUE_CURRENT % | | | | RO | Num | ND | NC | PT | |
| **04.019** | Motor Protection Accumulator | 0.0 to 100.0 % | | | | RO | Num | ND | NC | PT | PS |
| **04.020** | Percentage Load | VM_USER_CURRENT % | | | | RO | Num | ND | NC | PT | FI |
| **04.022** | Inertia Compensation Enable | | Off (0) or On (1) | | Off (0) | RW | Bit | | | | US |
| **04.024** | User Current Maximum Scaling | 0.0 to VM_TORQUE_CURRENT_UNIPOLAR % | | 165.0 %* | 175.0 %** | RW | Num | | RA | | US |
| **04.025** | Low Frequency Thermal Protection Mode | 0 to 1 | | 0 | | RW | Num | | | | US |
| **04.026** | Percentage Torque | VM_USER_CURRENT % | | | | RO | Num | ND | NC | PT | FI |
| **04.036** | Motor Protection Accumulator Power-up Value | Pr.dn (0), 0 (1), rEAL t (2) | | Pr.dn (0) | | RW | Txt | | | | US |
| **04.041** | User Over Current Trip Level | 0 to 100 % | | 100 % | | RW | Num | | RA | | US |

* For size 9 the default is 141.9 %

** For size 9 the default is 150.0 %

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.6 Menu 5: Motor control

**Figure 11-8 Menu 5 Open-loop logic diagram**

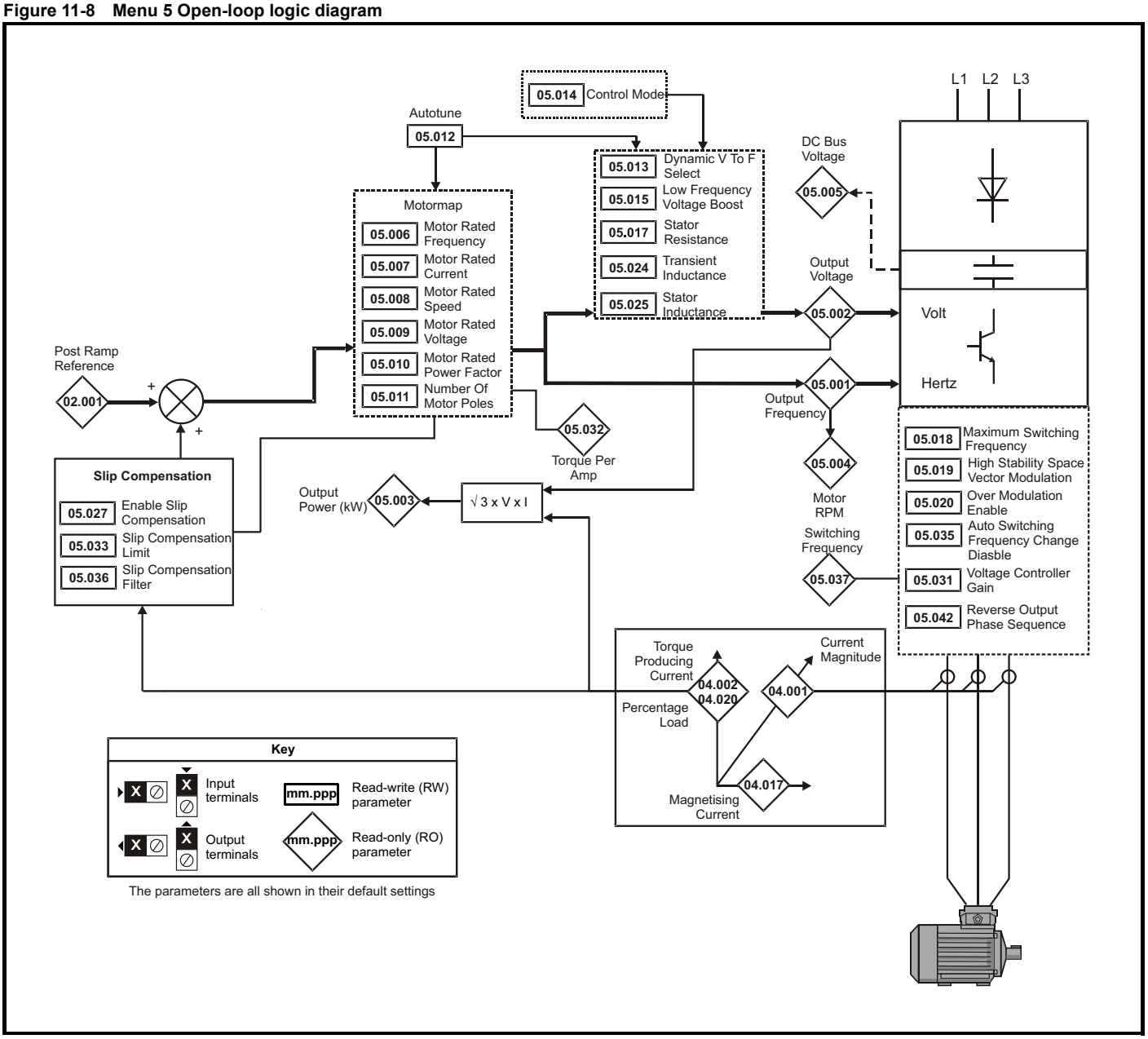
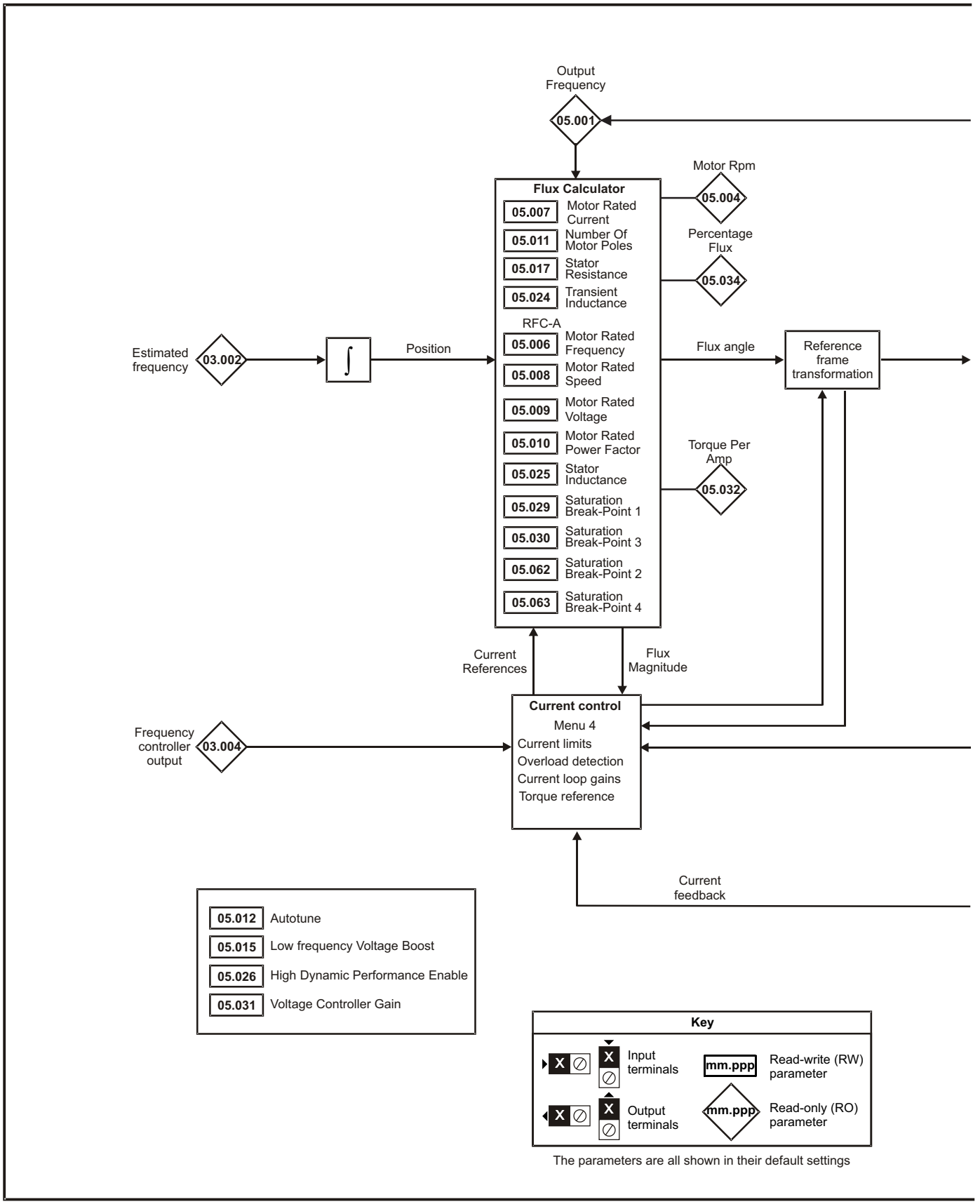
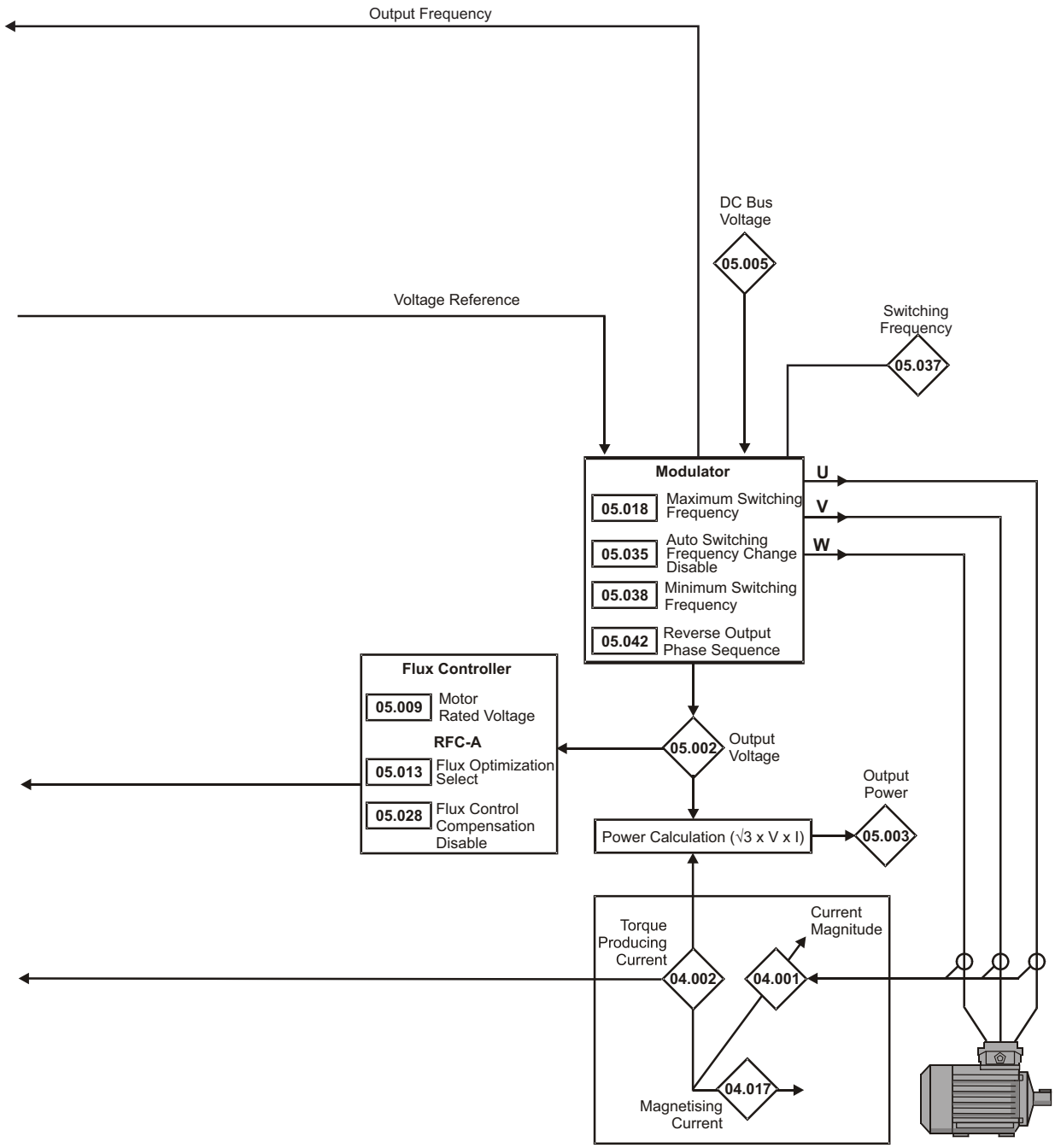


**Figure 11-9 Menu 5 RFC-A, logic diagram**




Output Frequency
DC Bus Voltage
05.005
Voltage Reference
Switching Frequency
05.037
Modulator
05.018 Maximum Switching Frequency
05.035 Auto Switching Frequency Change Disable
05.038 Minimum Switching Frequency
05.042 Reverse Output Phase Sequence
U
V
W
Flux Controller
05.009 Motor Rated Voltage
RFC-A
05.013 Flux Optimization Select
05.028 Flux Control Compensation Disable
05.002 Output Voltage
Output Power
Power Calculation (√3 x V x I)
05.003
Torque Producing Current
Current Magnitude
04.002
04.001
04.017
Magnetising Current

| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **05.001** | Output Frequency | ± 550.00 Hz | | | | RO | Num | ND | NC | PT | FI |
| **05.002** | Output Voltage | 0 to 930 V | | | | RO | Num | ND | NC | PT | FI |
| **05.003** | Output Power | VM_POWER kW | | | | RO | Num | ND | NC | PT | FI |
| **05.004** | Motor Rpm | ± 33000.0 rpm | | | | RO | Num | ND | NC | PT | FI |
| **05.005** | D.C. Bus Voltage | 0 to 1190 V | | | | RO | Num | ND | NC | PT | FI |
| **05.006** | Motor Rated Frequency | 0.00 to 550.00 Hz | | 50 Hz: 50.00 Hz, 60 Hz: 60.00 Hz | | RW | Num | | RA | | US |
| **05.007** | Motor Rated Current | 0.00 to Drive Rating A | | Maximum Heavy Duty Rating (11.032) | | RW | Num | | RA | | US |
| **05.008** | Motor Rated Speed | 0.0 to 33000.0 rpm | | 50 Hz: 1500.0 rpm<br>60 Hz: 1800.0 rpm | 50 Hz: 1450.0 rpm<br>60 Hz: 1750.0 rpm | RW | Num | | | | US |
| **05.009** | Motor Rated Voltage | 0 to 765 V | | 110 V drive: 230 V, 200 V drive: 230 V<br>400 V drive 50Hz: 400 V<br>400 V drive 60Hz: 460 V<br>575 V drive: 575 V | | RW | Num | | RA | | US |
| **05.010** | Motor Rated Power Factor | 0.00 to 1.00 | | 0.85 | | RW | Num | | RA | | US |
| **05.011** | Number Of Motor Poles* | Auto (0) to 32 (16) | | Auto (0) | | RW | Num | | | | US |
| **05.012** | Autotune | 0 to 2 | 0 to 3 | 0 | | RW | Num | | NC | | |
| **05.013** | Dynamic V To F Select / Flux Optimization Select | 0 to 1 | | 0 | | RW | Num | | | | US |
| **05.014** | Control Mode | Ur.S (0), Ur (1), Fd (2), Ur.Auto (3), Ur.I (4), SrE (5), Fd.tAP (6) | | Fd (2) | | RW | Txt | | | | US |
| **05.015** | Low Frequency Voltage Boost | 0.0 to 25.0 % | | 3.0 % | | RW | Num | | | | US |
| **05.017** | Stator Resistance | 0.0000 to 99.9999 Ω | | 0.0000 Ω | | RW | Num | | RA | | US |
| **05.018** | Maximum Switching Frequency | 0.667 (0), 1 (1), 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz | 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz | 3 (3) kHz | | RW | Txt | | RA | | US |
| **05.019** | High Stability Space Vector Modulation | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **05.020** | Over Modulation Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **05.021** | Mechanical Load Test Level | | 0 to 100 % | | 0 % | RW | Bit | | | | US |
| **05.024** | Transient Inductance | 0.000 to 500.000 mH | | 0.000 mH | | RW | Num | | RA | | US |
| **05.025** | Stator Inductance | 0.00 to 5000.00 mH | | 0.00 mH | | RW | Num | | RA | | US |
| **05.026** | High Dynamic Performance Enable | | Off (0) or On (1) | | Off (0) | RW | Bit | | | | US |
| **05.027** | Enable Slip Compensation | ± 150.0 % | | 100.0 % | | RW | Num | | | | US |
| **05.028** | Flux Control Compensation Disable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **05.029** | Saturation Breakpoint 1 | | 0.0 to 100.0 % | | 50.0 % | RW | Num | | | | US |
| **05.030** | Saturation Breakpoint 3 | | 0.0 to 100.0 % | | 75.0 % | RW | Num | | | | US |
| **05.031** | Voltage Controller Gain | 1 to 30 | | 1 | | RW | Num | | | | US |
| **05.032** | Torque Per Amp | 0.00 to 500.00 Nm/A | | | | RO | Num | ND | NC | PT | |
| **05.033** | Slip Compensation Limit | 0.00 to 10.00 Hz | | 10.00 Hz | | RW | Num | | | | US |
| **05.034** | Percentage Flux | | 0.0 to 150.0 % | | | RO | Num | ND | NC | PT | |
| **05.035** | Auto-switching Frequency Change Disable | 0 to 1 | | 0 | | RW | Num | | | | US |
| **05.036** | Slip Compensation Filter | 64 (0), 128 (1), 256 (2), 512 (3) ms | | 128 (1) ms | | RW | Txt | | | | US |
| **05.037** | Switching Frequency | 0.667 (0), 1 (1), 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz | 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz | | | RO | Txt | ND | NC | PT | |
| **05.038** | Minimum Switching Frequency | 0 to VM_MAX_SWITCHING_FREQUENCY kHz | | 0.667 (0) kHz | 2 kHz (2) | RW | Txt | | RA | | |
| **05.040** | Spin Start Boost | 0.0 to 10.0 | | 1.0 | | RW | Num | | | | US |
| **05.042** | Reverse Output Phase Sequence | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **05.059** | Maximum Deadtime Compensation | 0.000 to 10.000 µs | | | | RO | Num | | NC | PT | US |
| **05.060** | Current At Maximum Deadtime Compensation | 0.00 to 100.00 % | | | | RO | Num | | NC | PT | US |
| **05.061** | Disable Deadtime Compensation | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **05.062** | Saturation Breakpoint 2 | | 0.0 to 100.0 % | | 0.0 % | RW | Num | | | | US |
| **05.063** | Saturation Breakpoint 4 | | 0.0 to 100.0 % | | 0.0 % | RW | Num | | | | US |
| **05.074** | Boost End Voltage | 0.0 to 100.0 % | | 50.0 % | | RW | Num | | | | US |
| **05.075** | Boost End Frequency | 0.0 to 100.0 % | | 50.0 % | | RW | Num | | | | US |
| **05.076** | Second Point Voltage | 0.0 to 100.0 % | | 55.0 % | | RW | Num | | | | US |
| **05.077** | Second Point Frequency | 0.0 to 100.0 % | | 55.0 % | | RW | Num | | | | US |
| **05.078** | Third point voltage | 0.0 to 100.0 % | | 75.0 % | | RW | Num | | | | US |
| **05.079** | Third point frequency | 0.0 to 100.0 % | | 75.0 % | | RW | Num | | | | US |
| **05.080** | Low acoustic noise enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |

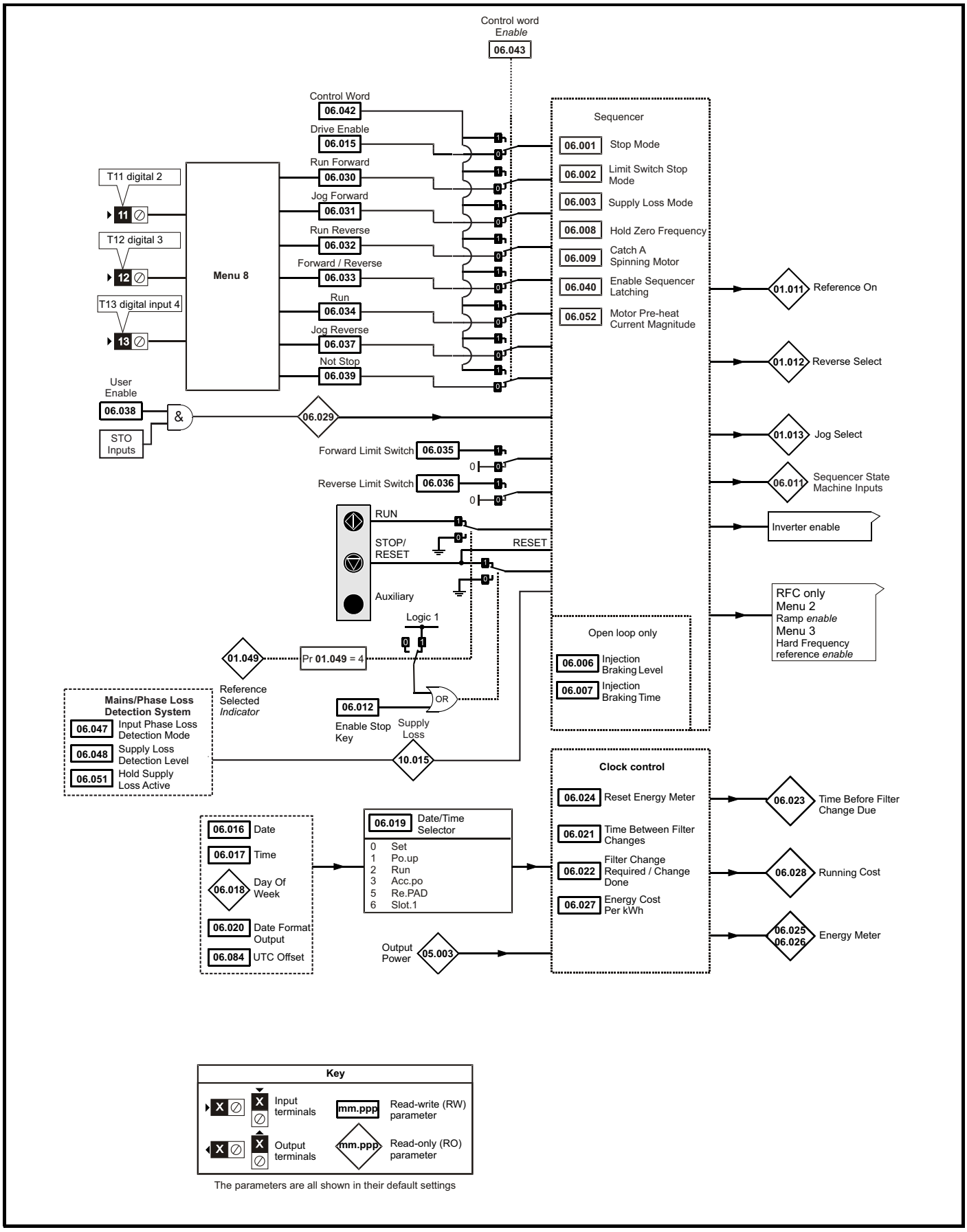
| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **05.081** | Change to maximum drive switching frequency at low output current | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **05.083** | Voltage Shelving Disable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **05.084** | Low Frequency Slip Boost | 0.0 to 100.0 % | | 0.0 % | | RW | Num | | | | US |
| | Low Frequency Estimator Threshold | | 0.0 to 100.0 % | | 0.0 % | RW | Num | | | | US |
| **05.088** | Ur Mode Pre-Flux Delay | 0.0 to 0.7 s | | 0.1 s | | RW | Num | | | | US |

* If this parameter is read via serial communications, it will show pole pairs.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.7 Menu 6: Sequencer and clock

**Figure 11-10 Menu 6 logic diagram**




The parameters are all shown in their default settings

| Parameter | | Range (⇳) | | Default(⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **06.001** | Stop Mode | CoASt (0), rP (1), rP.dc I (2), dc I (3), td.dc I (4), diS (5) | CoASt (0), rP (1), rP.dc I (2), dc I (3), td.dc I (4), diS (5), No.rP (6) | rP (1) | | RW | Txt | | | | US |
| **06.002** | Limit Switch Stop Mode | StoP (0), rP (1) | | rP (1) | | RW | Txt | | | | US |
| **06.003** | Supply Loss Mode | diS (0), rP.StoP (1), ridE.th (2), Lt.StoP (3) | | diS (0) | | RW | Txt | | | | US |
| **06.004** | Start/Stop Logic Select | 0 to 6 | | 5 | | RW | Num | | | | US |
| **06.006** | Injection Braking Level | 0.0 to 150.0 % | | 100.0 % | | RW | Num | | RA | | US |
| **06.007** | Injection Braking Time | 0.0 to 100.0 s | | 1.0 s | | RW | Num | | | | US |
| **06.008** | Hold Zero Frequency | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **06.009** | Catch A Spinning Motor | diS (0), EnAbLE (1), Fr.OnLy (2), rv.OnLy (3) | | diS (0) | | RW | Txt | | | | US |
| **06.010** | Enable Conditions | 0 to 4087 | | | | RO | Bin | ND | NC | PT | |
| **06.011** | Sequencer State Machine Inputs | 0 to 127 | | | | RO | Bin | ND | NC | PT | |
| **06.012** | Enable Stop Key | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **06.013** | Enable Auxiliary Key | diS (0), Fd.rv (1), rEv (2) | | diS (0) | | RW | Txt | | | | US |
| **06.014** | Disable Auto Reset On Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **06.015** | Drive Enable | Off (0) or On (1) | | On (1) | | RW | Bit | | | | US |
| **06.016** | Date | 00-00-00 to 31-12-99 | | | | RW | Date | ND | NC | PT | |
| **06.017** | Time | 00:00:00 to 23:59:59 | | | | RW | Time | ND | NC | PT | |
| **06.018** | Day Of Week | Sun (0), Non (1), tuE (2), UEd (3),thu (4), Fri (5), SAt (6) | | | | RO | Txt | ND | NC | PT | |
| **06.019** | Date/Time Selector | SEt (0), Po.uP (1), run (2), Acc.Po (3), rE.PAd (5), SLot.1 (6) | | Po.uP (1) | | RW | Txt | | | | US |
| **06.020** | Date Format | Std (0), US (1) | | Std (0) | | RW | Txt | | | | US |
| **06.021** | Time Between Filter Changes | 0 to 30000 Hours | | 0 Hours | | RW | Num | | | | US |
| **06.022** | Filter Change Required /Change Done | Off (0) or On (1) | | | | RW | Bit | ND | NC | | |
| **06.023** | Time Before Filter Change Due | 0 to 30000 Hours | | | | RO | Num | ND | NC | PT | PS |
| **06.024** | Reset Energy Meter | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | |
| **06.025** | Energy Meter: MWh | ±999.9 MWh | | | | RO | Num | ND | NC | PT | PS |
| **06.026** | Energy Meter: kWh | ±99.99 kWh | | | | RO | Num | ND | NC | PT | PS |
| **06.027** | Energy Cost Per kWh | 0.0 to 600.0 | | 0.0 | | RW | Num | | | | US |
| **06.028** | Running Cost | ±32000 | | | | RO | Num | ND | NC | PT | |
| **06.029** | Hardware Enable | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **06.030** | Run Forward | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **06.031** | Jog Forward | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **06.032** | Run Reverse | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **06.033** | Forward/Reverse | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **06.034** | Run | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **06.035** | Forward Limit Switch | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **06.036** | Reverse Limit Switch | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **06.037** | Jog Reverse | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **06.038** | User Enable | Off (0) or On (1) | | On (1) | | RW | Bit | | NC | | |
| **06.039** | Not Stop | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **06.040** | Enable Sequencer Latching | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **06.041** | Drive Event Flags | 0 to 3 | | 0 | | RW | Bin | | NC | | |
| **06.042** | Control Word | 0 to 32767 | | 0 | | RW | Bin | | NC | | |
| **06.043** | Control Word Enable | 0 to 1 | | 0 | | RW | Num | | | | US |
| **06.045** | Cooling Fan control | 0 to 5 | | 2 | | RW | Num | | | | US |
| **06.047** | Input Phase Loss Detection Mode | FuLL (0), rIPPLE (1), diS (2) | | FuLL (0) | | RW | Txt | | | | US |
| **06.048** | Supply Loss Detection Level | 0 to VM_SUPPLY_LOSS_LEVEL V | | 110 V drive: 205 V, 200 V drive: 205 V<br>400 V drive: 410 V, 575 V drive: 540 V | | RW | Num | | RA | | US |
| **06.051** | Hold Supply Loss Active | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **06.052** | Motor Pre-heat Current Magnitude | 0 to 100 % | | 0 % | | RW | Num | | | | US |
| **06.058** | Output Phase Loss Detection Time | 0.5 (0) to 4 (3) s | | 0.5 (0) s | | RW | Txt | | | | US |
| **06.059** | Output Phase Loss Detection Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **06.060** | Standby Mode Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **06.061** | Standby Mode Mask | 0 to 15 | | 0 | | RW | Bin | | | | US |
| **06.071** | Slow Rectifier Charge Rate Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **06.073** | Braking IGBT Lower Threshold | 0 to VM_DC_VOLTAGE_SET V | | 110 V drive: 390 V, 200 V drive: 390 V<br>400 V drive: 780 V, 575 V drive: 930 V | | RW | Num | | RA | | US |
| **06.074** | Braking IGBT Upper Threshold | 0 to VM_DC_VOLTAGE_SET V | | 110 V drive: 390 V, 200 V drive: 390 V<br>400 V drive: 780 V, 575 V drive: 930 V | | RW | Num | | RA | | US |

| Parameter | | Range (⇳) | | Default(⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **06.075** | Low Voltage Braking IGBT Threshold | 0 to VM_DC_VOLTAGE_SET V | | 0 V | | RW | Num | | RA | | US |
| **06.076** | Low Voltage Braking IGBT Threshold Select | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | |
| **06.077** | Low DC Link Operation | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **06.084** | UTC Offset | ±24.00 Hours | | 0.00 Hours | | RW | Num | | | | US |
| **06.089** | DC Injection Active | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | US |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |
| IP | IP address | Mac | Mac address | Date | Date parameter | Time | Time parameter | SMP | Slot,menu,parameter | Chr | Character parameter | Ver | Version number |

## 11.8 Menu 7: Analog I/O

**Figure 11-11 Menu 7 logic diagram**

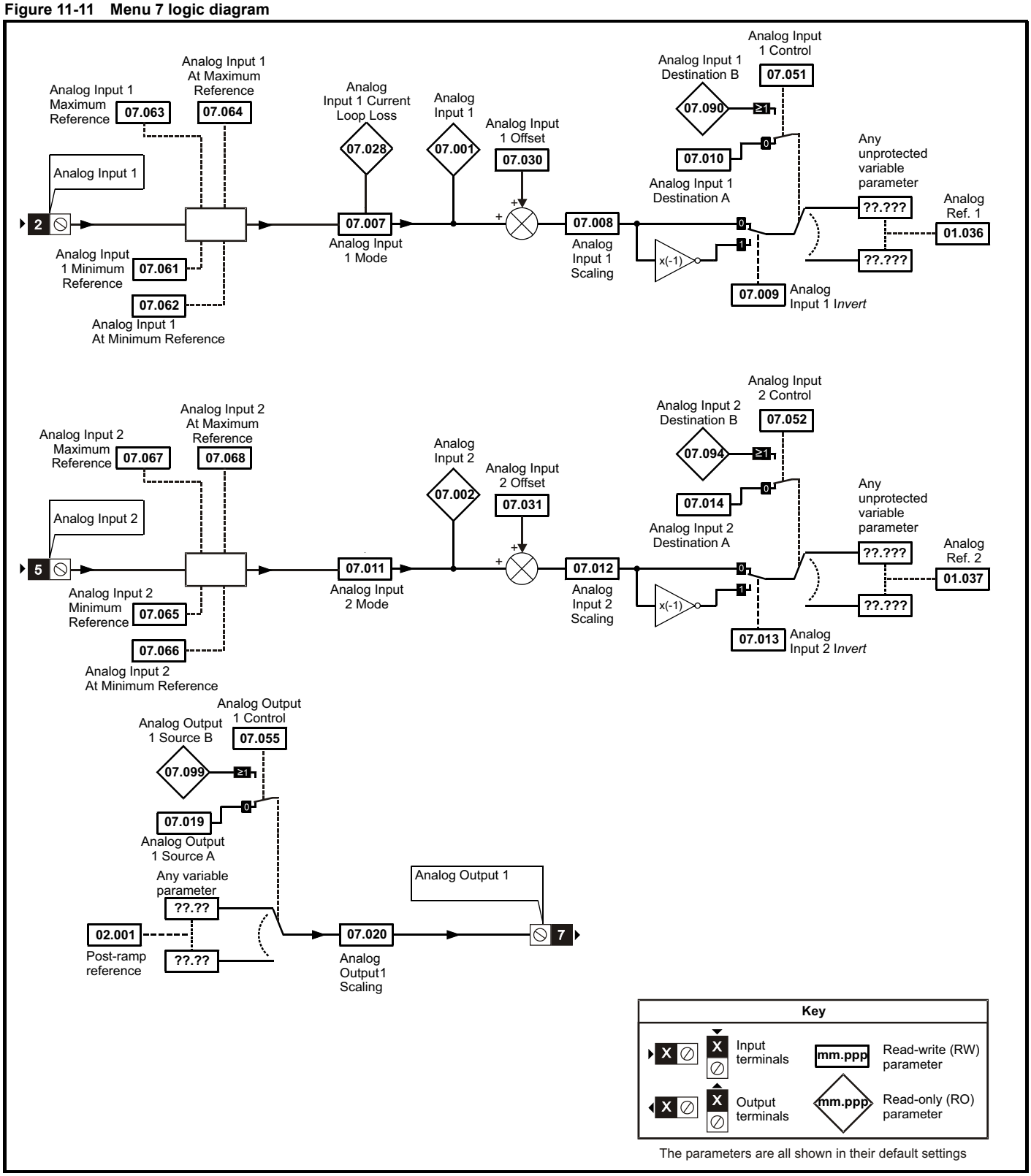
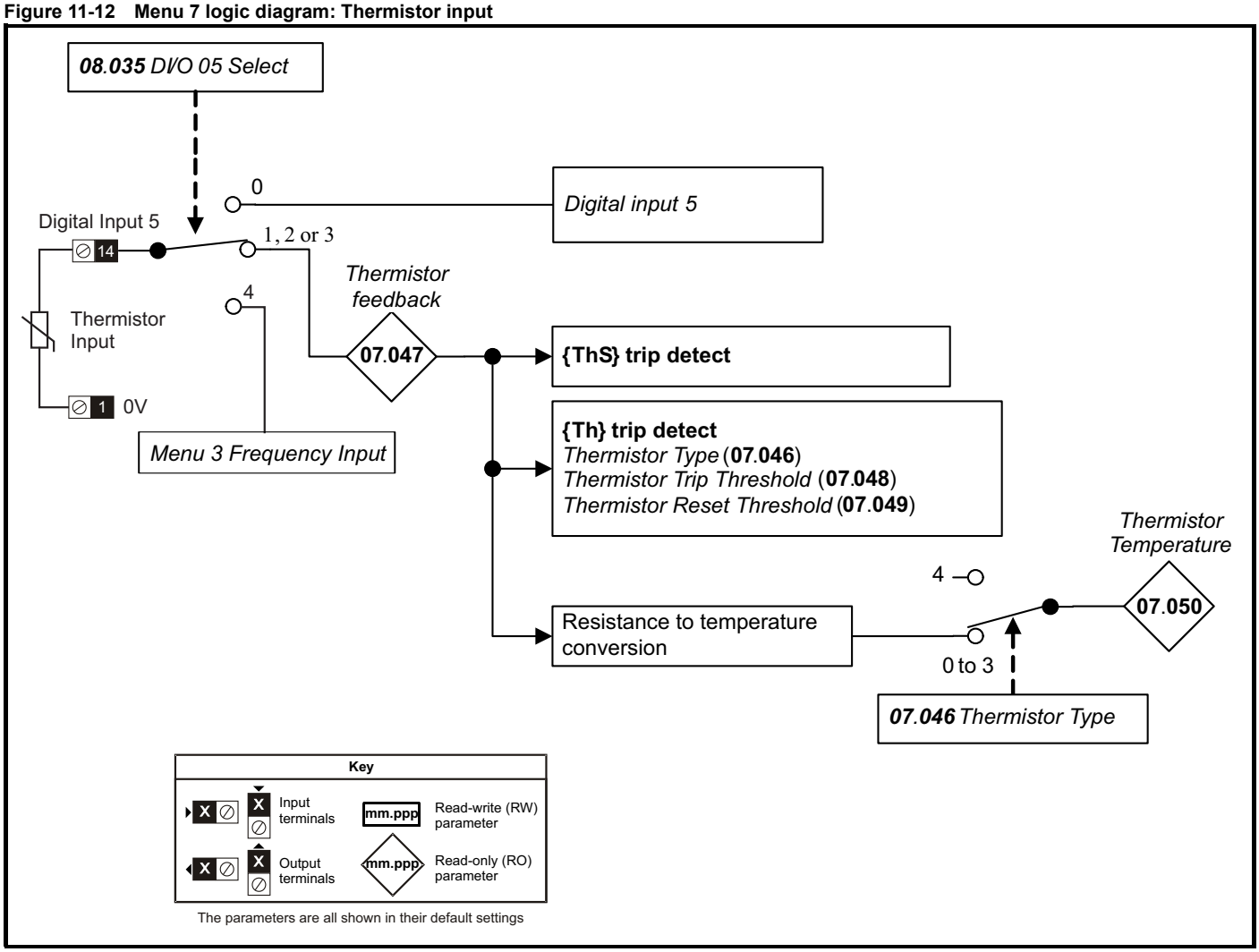


**Figure 11-12 Menu 7 logic diagram: Thermistor input**

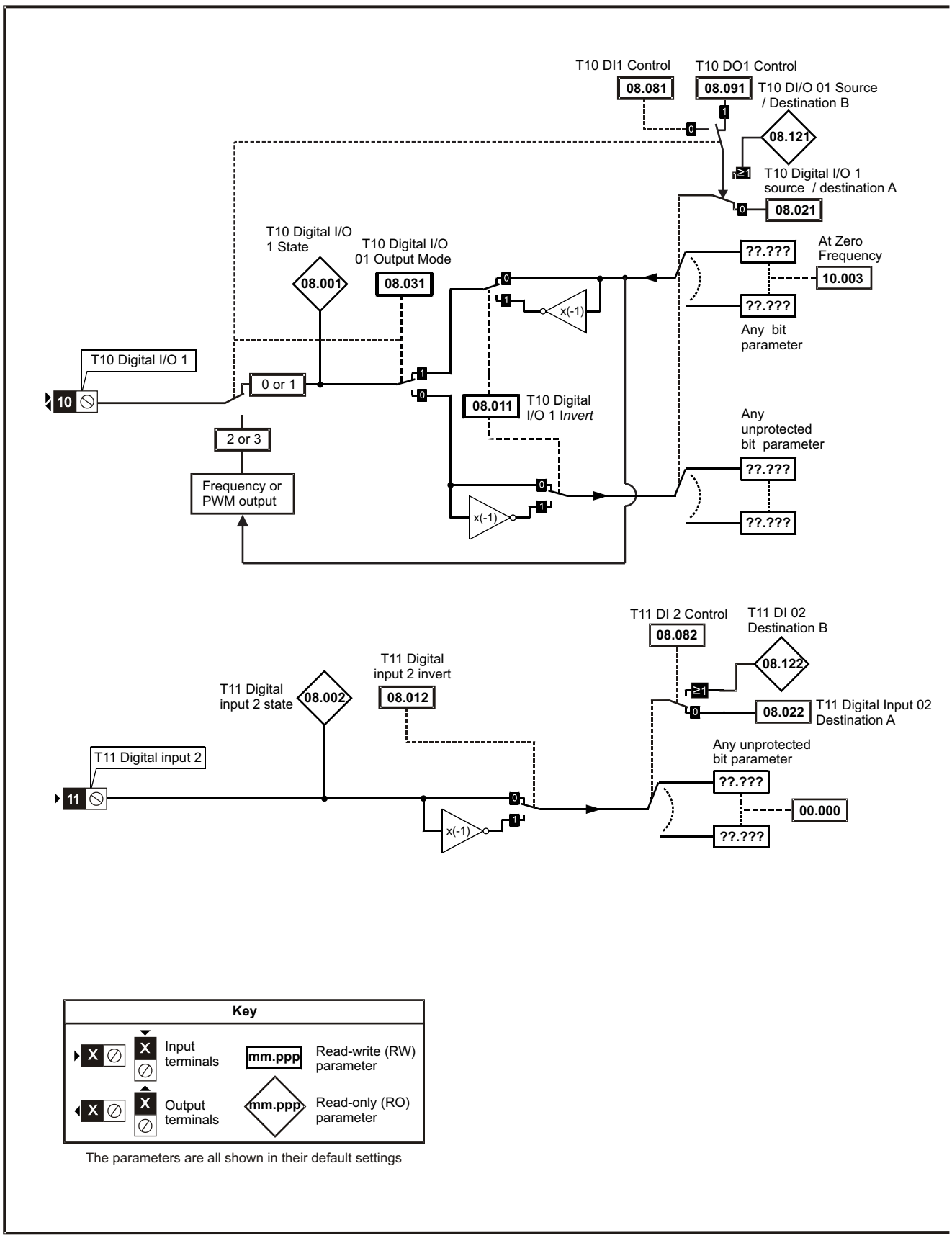


| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **07.001** | Analog Input 1 (T2) | 0.00 to 100.00 % | | | | RO | Num | ND | NC | PT | FI |
| **07.002** | Analog Input 2 (T5) | 0.00 to 100.00 % | | | | RO | Num | ND | NC | PT | FI |
| **07.004** | Stack Temperature | ± 250 °C | | | | RO | Num | ND | NC | PT | |
| **07.005** | Auxiliary Temperature | ± 250 °C | | | | RO | Num | ND | NC | PT | |
| **07.007** | Analog Input 1 Mode (T2) | 4-20.S (-6), 20-4.S (-5), 4-20.L (-4), 20-4.L (-3), 4-20.H (-2), 20-4.H (-1), 0-20 (0), 20-0 (1), 4-20.tr (2), 20-4.tr (3), 4-20 (4), 20-4 (5), VoLt (6) | | VoLt (6) | | RW | Txt | | | | US |
| **07.008** | Analog Input 1 Scaling (T2) | 0.000 to 10.000 | | 1.000 | | RW | Num | | | | US |
| **07.009** | Analog Input 1 Invert (T2) | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **07.010** | Analog Input 1 Destination A (T2) | 0.000 to 30.999 | | 1.036 | | RW | Num | DE | | PT | US |
| **07.011** | Analog Input 2 Mode (T5) | VoLt (6), dIg (7) | | VoLt (6) | | RW | Txt | | | | US |
| **07.012** | Analog Input 2 Scaling (T5) | 0.000 to 10.000 | | 1.000 | | RW | Num | | | | US |
| **07.013** | Analog Input 2 Invert (T5) | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **07.014** | Analog Input 2 Destination A (T5) | 0.000 to 30.999 | | 1.037 | | RW | Num | DE | | PT | US |
| **07.019** | Analog Output 1 Source A (T7) | 0.000 to 30.999 | | 2.001 | | RW | Num | | | PT | US |
| **07.020** | Analog Output 1 Scaling (T7) | 0.000 to 40.000 | | 1.000 | | RW | Num | | | | US |
| **07.026** | Analog Input 1 Preset on Current Loss (T2) | 4.00 to 20.00 | | 4.00 | | RW | Num | | | | US |
| **07.028** | Analog Input 1 Current Loop Loss (T2) | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **07.030** | Analog Input 1 Offset (T2) | ± 100.00 % | | 0.00 % | | RW | Num | | | | US |
| **07.031** | Analog Input 2 Offset (T5) | ± 100.00 % | | 0.00 % | | RW | Num | | | | US |
| **07.034** | Inverter Temperature | ± 250 °C | | | | RO | Num | ND | NC | PT | |
| **07.035** | Percentage Of d.c. Link Thermal Trip Level | 0 to 100 % | | | | RO | Num | ND | NC | PT | |
| **07.036** | Percentage Of Drive Thermal Trip Level | 0 to 100 % | | | | RO | Num | ND | NC | PT | |
| **07.037** | Temperature Nearest To Trip Level | 0 to 1999 | | | | RO | Num | ND | NC | PT | |
| **07.046** | Thermistor Type | d44081 (0), 84 (1), Pt1000 (2), Pt2000 (3), othEr (4) | | d44081 (0) | | RW | Txt | | | | US |
| **07.047** | Thermistor Feedback | 0 to 4000 Ω | | | | RO | Num | ND | NC | PT | FI |
| **07.048** | Thermistor Trip Threshold | 0 to 4000 Ω | | 3300 Ω | | RW | Num | | | | US |
| **07.049** | Thermistor Reset Threshold | 0 to 4000 Ω | | 1800 Ω | | RW | Num | | | | US |
| **07.050** | Thermistor Temperature | -50 to 300 °C | | | | RO | Num | ND | NC | PT | FI |
| **07.051** | Analog Input 1 Control (T2) | 0 to 5 | | 0 | | RW | Num | | | | US |
| **07.052** | Analog Input 2 Control (T5) | 0 to 5 | | 0 | | RW | Num | | | | US |
| **07.055** | Analog Output 1 Control (T7) | 0 to 15 | | 0 | | RW | Num | | | | US |
| **07.061** | Analog Input 1 Minimum Reference (T2) | 0.00 to 100.00 % | | 0.00 % | | RW | Num | | | | US |
| **07.062** | Analog Input 1 At Minimum Reference (T2) | ± 100.00 % | | 0.00 % | | RW | Num | | | | US |
| **07.063** | Analog Input 1 Maximum Reference (T2) | 0.00 to 100.00 % | | 100.00 % | | RW | Num | | | | US |
| **07.064** | Analog Input 1 At Maximum Reference (T2) | ± 100.00 % | | 100.00 % | | RW | Num | | | | US |
| **07.065** | Analog Input 2 Minimum Reference (T5) | 0.00 to 100.00 % | | 0.00 % | | RW | Num | | | | US |
| **07.066** | Analog Input 2 At Minimum Reference (T5) | ± 100.00 % | | 0.00 % | | RW | Num | | | | US |
| **07.067** | Analog Input 2 Maximum Reference (T5) | 0.00 to 100.00 % | | 100.00 % | | RW | Num | | | | US |
| **07.068** | Analog Input 2 At Maximum Reference (T5) | ± 100.00 % | | 100.00 % | | RW | Num | | | | US |
| **07.090** | Analog Input 1 Destination B (T2) | 0.000 to 30.999 | | | | RO | Num | DE | | PT | US |
| **07.094** | Analog Input 2 Destination B (T5) | 0.000 to 30.999 | | | | RO | Num | DE | | PT | US |
| **07.099** | Analog Output 1 Source B (T7) | 0.000 to 30.999 | | | | RO | Num | | | PT | US |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.9 Menu 8: Digital I/O

**Figure 11-13 Menu 8 logic diagram**




The parameters are all shown in their default settings

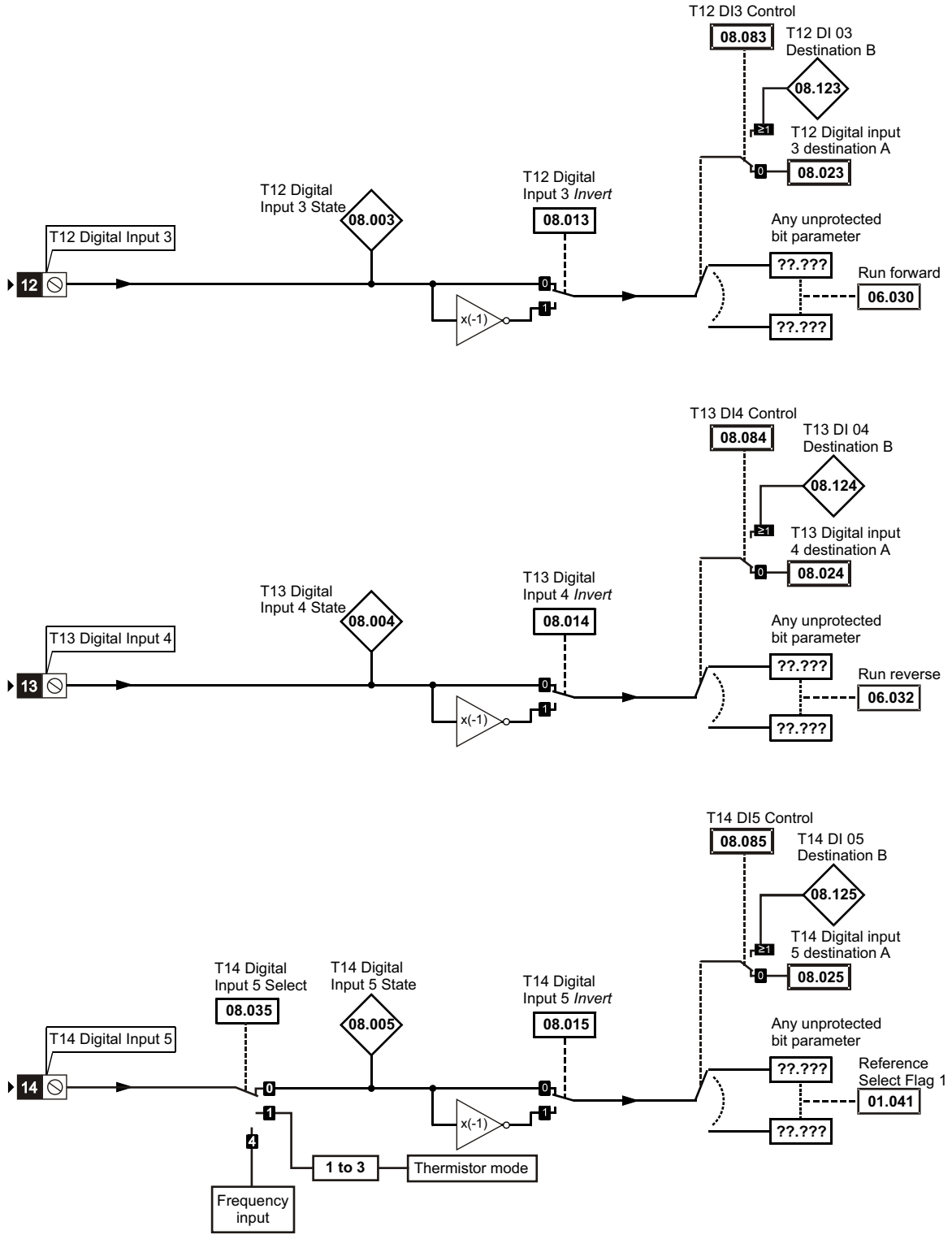

T12 DI3 Control
08.083
T12 DI 03 Destination B
08.123
T12 Digital input 3 destination A
08.023
T12 Digital Input 3 State
08.003
T12 Digital Input 3 Invert
08.013
T12 Digital Input 3
12
x(-1)
Any unprotected bit parameter
??.???
??.???
Run forward
06.030
T13 DI4 Control
08.084
T13 DI 04 Destination B
08.124
T13 Digital input 4 destination A
08.024
T13 Digital Input 4 State
08.004
T13 Digital Input 4 Invert
08.014
T13 Digital Input 4
13
x(-1)
Any unprotected bit parameter
??.???
??.???
Run reverse
06.032
T14 DI5 Control
08.085
T14 DI 05 Destination B
08.125
T14 Digital input 5 destination A
08.025
T14 Digital Input 5 Select
08.035
T14 Digital Input 5 State
08.005
T14 Digital Input 5 Invert
08.015
T14 Digital Input 5
14
x(-1)
Any unprotected bit parameter
??.???
??.???
Reference Select Flag 1
01.041
1 to 3
Thermistor mode
Frequency input

**Figure 11-14 Menu 8 logic (relay)**

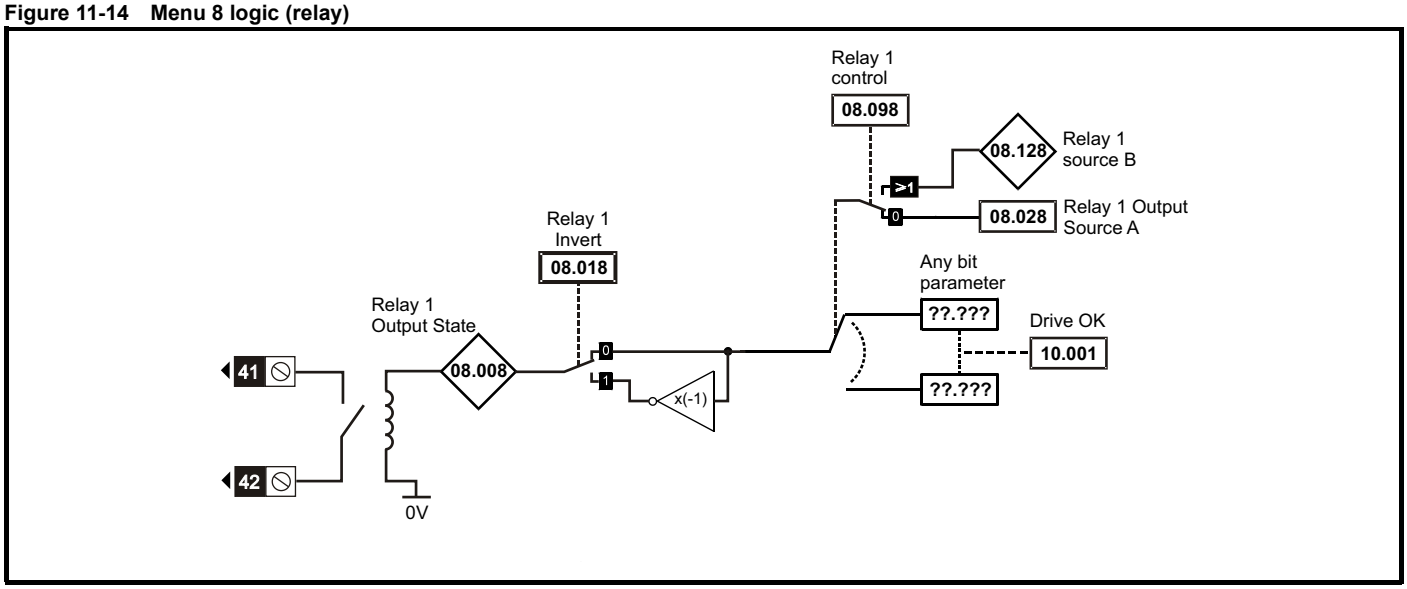



**Figure 11-15 Safe Torque Off Logic diagram (frame 1 to 4)**

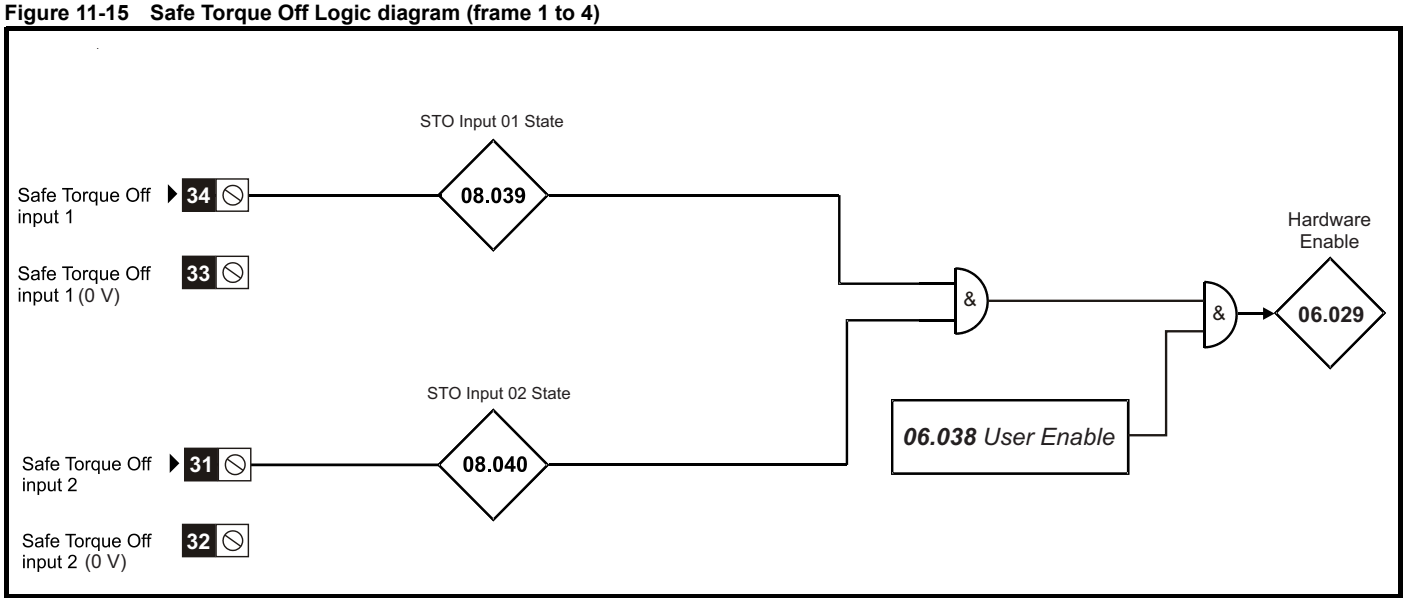



**Figure 11-16 Safe Torque Off Logic diagram (frame 5 to 9)**

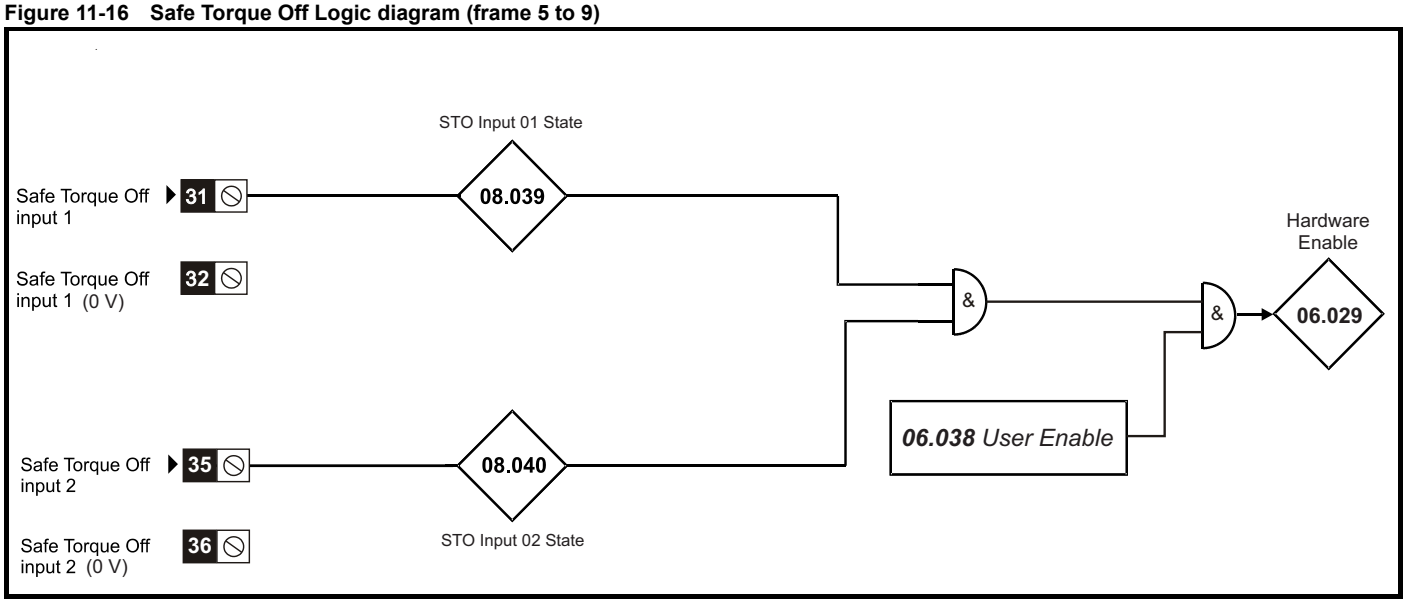
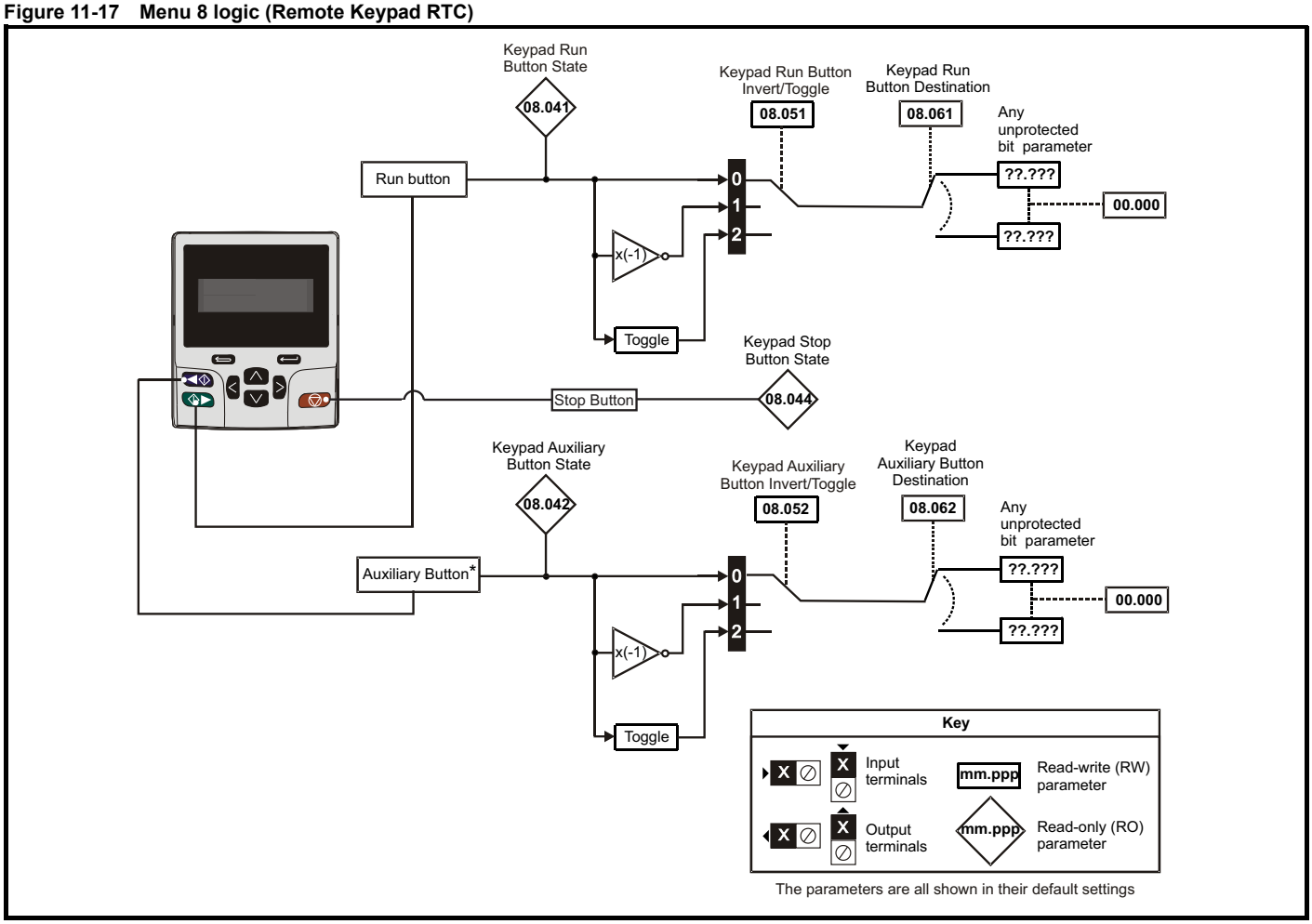


**Figure 11-17 Menu 8 logic (Remote Keypad RTC)**




* The auxiliary button is available with Remote Keypad RTC.

| Parameter | | Range (⇕) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **08.001** | Digital I/O 1 State (T10) | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **08.002** | Digital Input 2 State (T11) | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **08.003** | Digital Input 3 State (T12) | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **08.004** | Digital Input 4 State (T13) | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **08.005** | Digital Input 5 State (T14) | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **08.008** | Relay 1 Output State | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **08.011** | Digital I/O 1 Invert (T10) | Not.Inv (0), InvErt (1) | | Not.Inv (0) | | RW | Txt | | | | US |
| **08.012** | Digital Input 2 Invert (T11) | Not.Inv (0), InvErt (1) | | Not.Inv (0) | | RW | Txt | | | | US |
| **08.013** | Digital Input 3 Invert (T12) | Not.Inv (0), InvErt (1) | | Not.Inv (0) | | RW | Txt | | | | US |
| **08.014** | Digital Input 4 Invert (T13) | Not.Inv (0), InvErt (1) | | Not.Inv (0) | | RW | Txt | | | | US |
| **08.015** | Digital Input 5 Invert (T14) | Not.Inv (0), InvErt (1) | | Not.Inv (0) | | RW | Txt | | | | US |
| **08.018** | Relay 1 Invert | Not.Inv (0), InvErt (1) | | Not.Inv (0) | | RW | Txt | | | | US |
| **08.020** | Digital I/O Read Word | 0 to 2048 | | | | RO | Num | ND | NC | PT | |
| **08.021** | Digital IO1 Source / Destination A (T10) | 0.000 to 30.999 | | 10.003 | | RW | Num | DE | | PT | US |
| **08.022** | Digital Input 02 Destination A (T11) | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **08.023** | Digital Input 03 Destination A (T12) | 0.000 to 30.999 | | 6.030 | | RW | Num | DE | | PT | US |
| **08.024** | Digital Input 04 Destination A (T13) | 0.000 to 30.999 | | 6.032 | | RW | Num | DE | | PT | US |
| **08.025** | Digital Input 05 Destination A (T14) | 0.000 to 30.999 | | 1.041 | | RW | Num | DE | | PT | US |
| **08.028** | Relay 1 Output Source A | 0.000 to 30.999 | | 10.001 | | RW | Num | | | PT | US |
| **08.031** | Digital I/O 01 Output Mode (T10) | InPut (0), OutPut (1), Fr (2), PuLSE (3) | | OutPut (1) | | RW | Txt | | | | US |
| **08.035** | Digital Input 5 Select (T14) | InPut (0), th.Sct (1), th (2), th.Notr (3), Fr (4) | | InPut (0) | | RW | Txt | | | | US |
| **08.039** | STO Input 01 State | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **08.040** | STO Input 02 State | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **08.041** | Keypad Run Button State | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **08.042** | Keypad Auxiliary Button State | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **08.043** | 24 V Supply Input State | Off (0) or On (1) | | RO | Bit | ND | NC | PT | |
| **08.044** | Keypad Stop Button State | Off (0) or On (1) | | RO | Bit | ND | NC | PT | |
| **08.051** | Keypad Run Button Invert / Toggle | Not.Inv (0), InvErt (1), toggLE (2) | Not.Inv (0) | RW | Txt | | | | US |
| **08.052** | Keypad Auxiliary Button Invert / Toggle | Not.Inv (0), InvErt (1), toggLE (2) | Not.Inv (0) | RW | Txt | | | | US |
| **08.053** | 24 V Supply Input Invert | Not.Inv (0), InvErt (1), | Not.Inv (0) | RW | Txt | | | | US |
| **08.061** | Keypad Run Button Destination | 0.000 to 30.999 | 0.000 | RW | Num | DE | | PT | US |
| **08.062** | Keypad Auxiliary Button Destination | 0.000 to 30.999 | 0.000 | RW | Num | DE | | PT | US |
| **08.063** | 24 V Supply Input Destination | 0.000 to 30.999 | 0.000 | RW | Num | DE | | PT | US |
| **08.081** | DI1 Control (T10) | 0 to 26 | 0 | RW | Num | | | | US |
| **08.082** | DI2 Control (T11) | 0 to 26 | 0 | RW | Num | | | | US |
| **08.083** | DI3 Control (T12) | 0 to 26 | 0 | RW | Num | | | | US |
| **08.084** | DI4 Control (T13) | 0 to 26 | 0 | RW | Num | | | | US |
| **08.085** | DI5 Control (T14) | 0 to 26 | 0 | RW | Num | | | | US |
| **08.091** | DO1 Control (T10) | 0 to 21 | 0 | RW | Num | | | | US |
| **08.098** | Relay 1 Control | 0 to 21 | 0 | RW | Num | | | | US |
| **08.121** | DI/O 01 Source / Destination B (T10) | 0.000 to 30.999 | | RO | Num | DE | NC | PT | US |
| **08.122** | DI 02 Destination B (T11) | 0.000 to 30.999 | | RO | Num | DE | NC | PT | US |
| **08.123** | DI 03 Destination B (T12) | 0.000 to 30.999 | | RO | Num | DE | NC | PT | US |
| **08.124** | DI 04 Destination B (T13) | 0.000 to 30.999 | | RO | Num | DE | NC | PT | US |
| **08.125** | DI 05 Destination B (T14) | 0.000 to 30.999 | | RO | Num | DE | NC | PT | US |
| **08.128** | Relay 01 Source B | 0.000 to 30.999 | 0.000 | RO | Num | | NC | PT | US |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.10 Menu 9: Programmable logic, motorized pot, binary sum and timers

**Figure 11-18 Menu 9 logic diagram: Programmable logic**

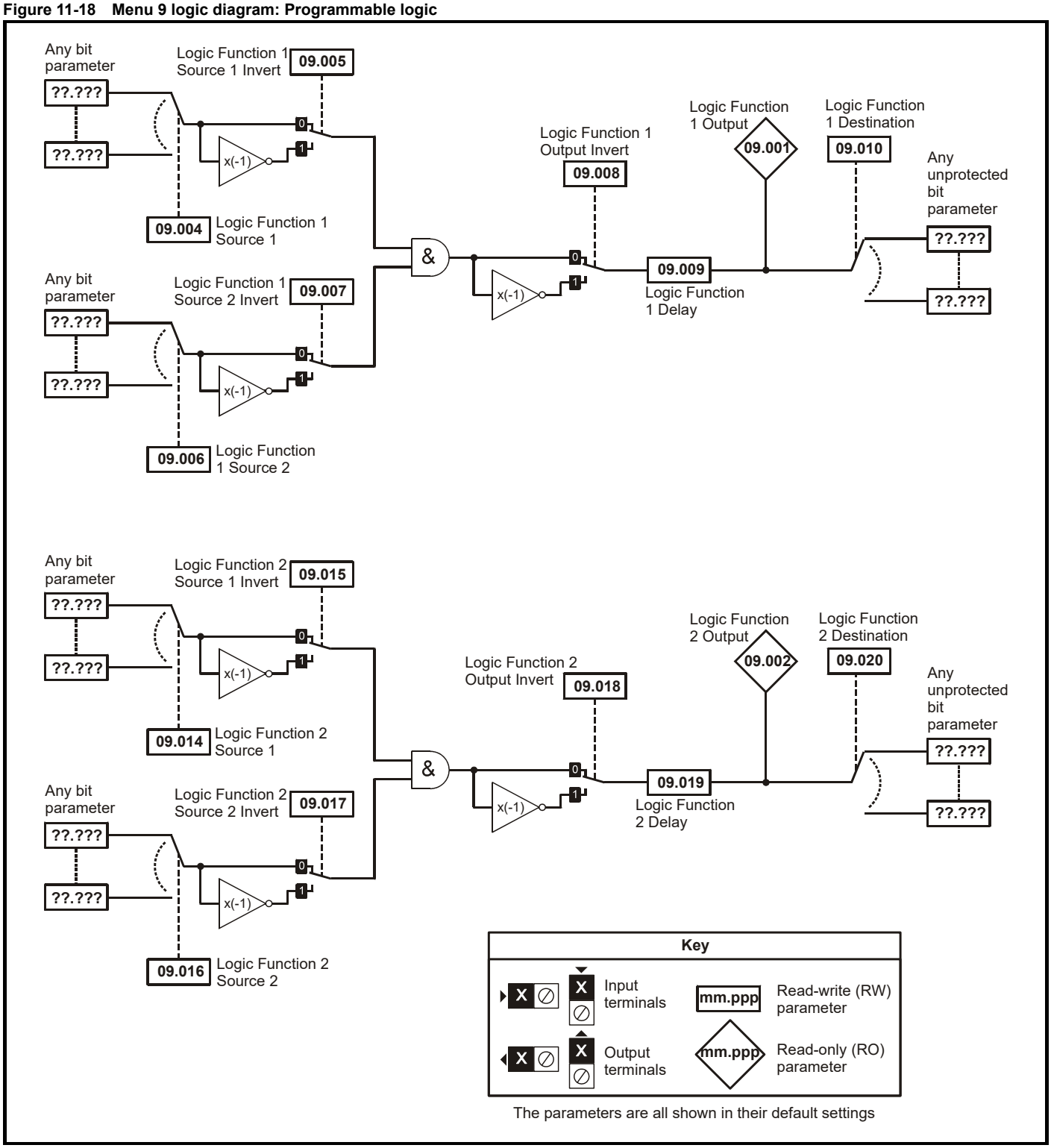
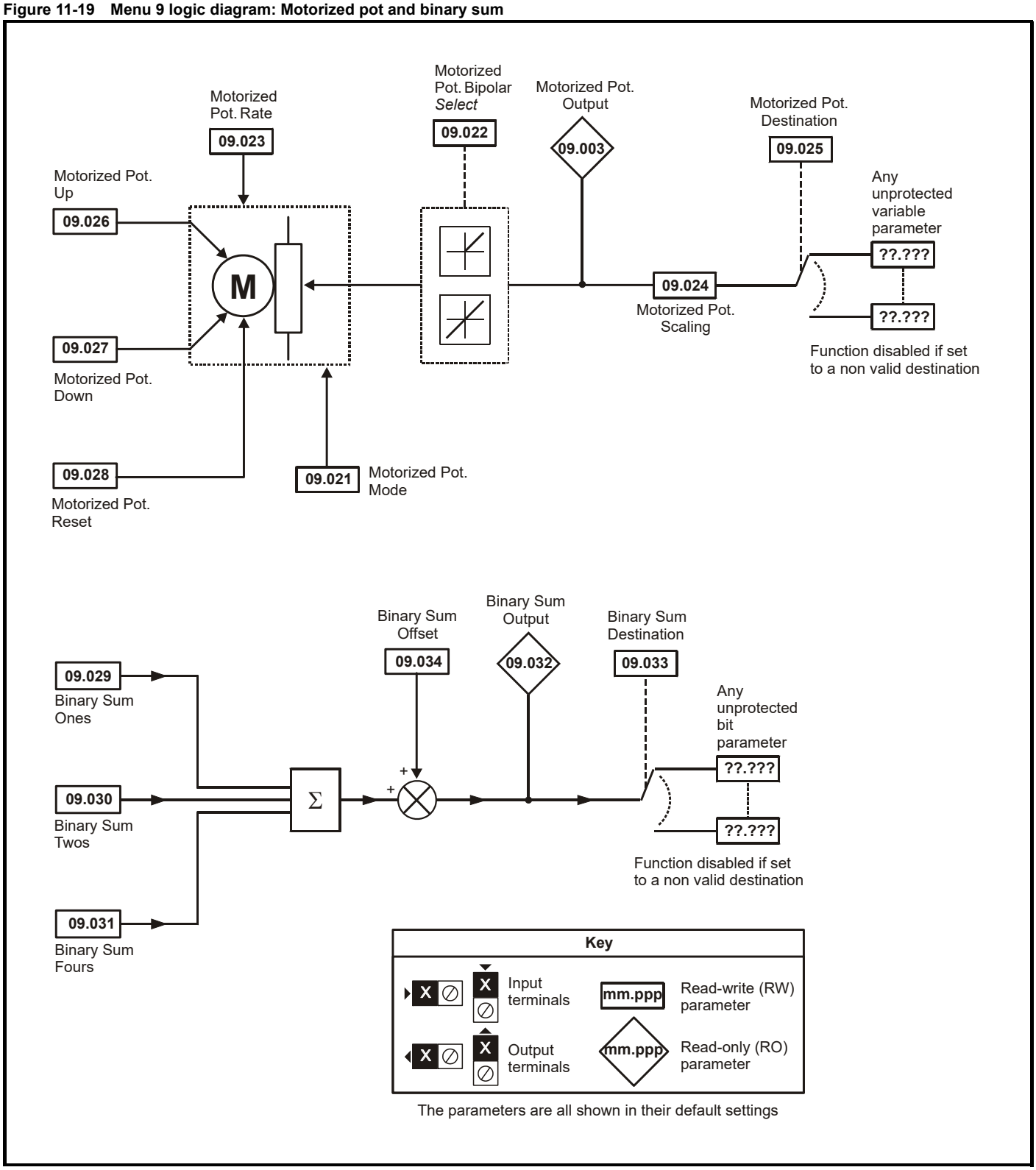
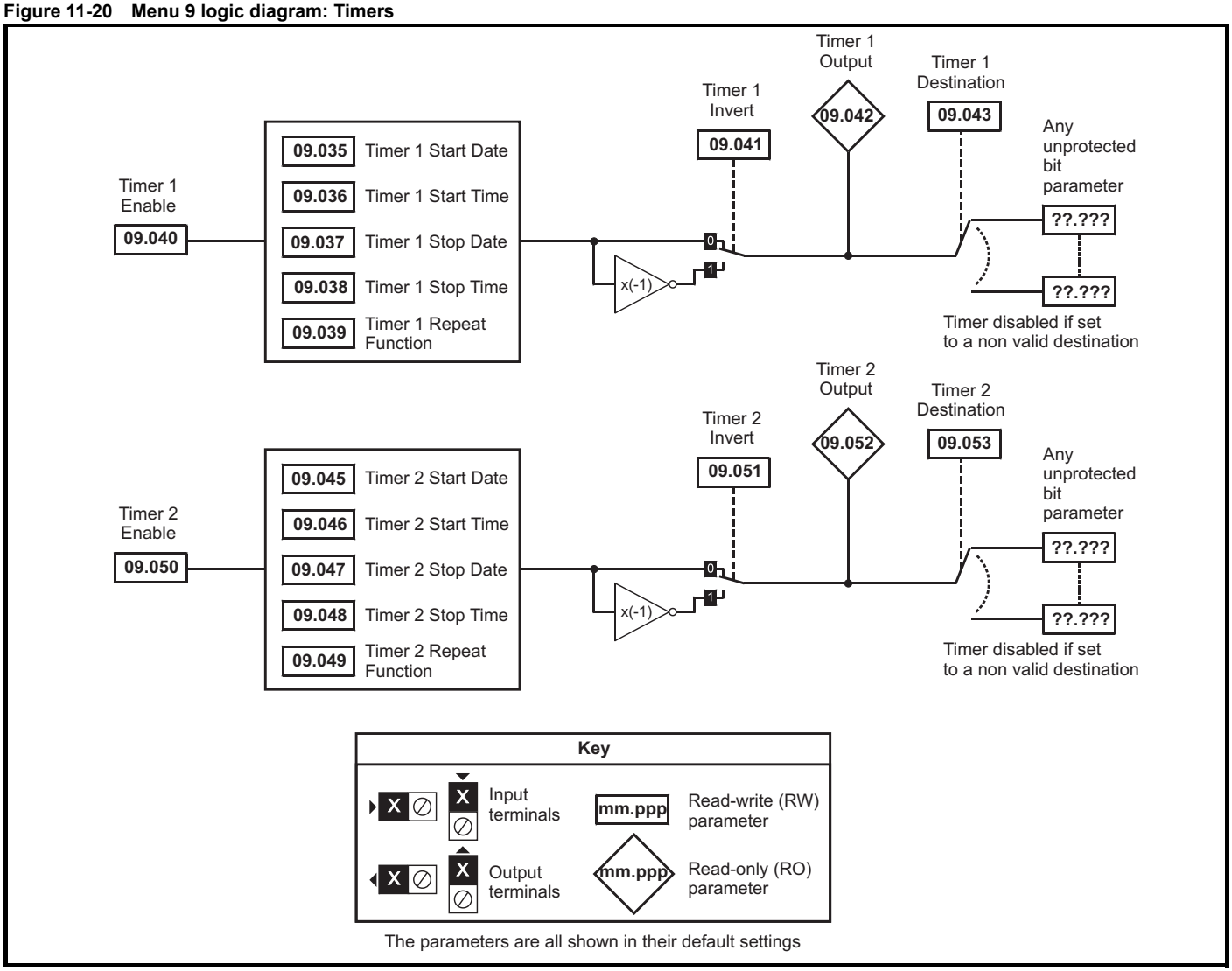


**Figure 11-19 Menu 9 logic diagram: Motorized pot and binary sum**




The parameters are all shown in their default settings

**Figure 11-20 Menu 9 logic diagram: Timers**




The parameters are all shown in their default settings

| Parameter | | Range(⇳) | | Default(⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **09.001** | Logic Function 1 Output | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **09.002** | Logic Function 2 Output | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **09.003** | Motorized Pot Output | ±100.00 % | | | | RO | Num | ND | NC | PT | PS |
| **09.004** | Logic Function 1 Source 1 | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **09.005** | Logic Function 1 Source 1 Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.006** | Logic Function 1 Source 2 | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **09.007** | Logic Function 1 Source 2 Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.008** | Logic Function 1 Output Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.009** | Logic Function 1 Delay | ±25.0 s | | 0.0 s | | RW | Num | | | | US |
| **09.010** | Logic Function 1 Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **09.014** | Logic Function 2 Source 1 | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **09.015** | Logic Function 2 Source 1 Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.016** | Logic Function 2 Source 2 | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **09.017** | Logic Function 2 Source 2 Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.018** | Logic Function 2 Output Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.019** | Logic Function 2 Delay | ±25.0 s | | 0.0 s | | RW | Num | | | | US |
| **09.020** | Logic Function 2 Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **09.021** | Motorized Pot Mode | 0 to 4 | | 0 | | RW | Num | | | | US |
| **09.022** | Motorized Pot Bipolar Select | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.023** | Motorized Pot Rate | 0 to 250 s | | 20 s | | RW | Num | | | | US |
| **09.024** | Motorized Pot Scaling | 0.000 to 4.000 | | 1.000 | | RW | Num | | | | US |
| **09.025** | Motorized Pot Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **09.026** | Motorized Pot Up | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **09.027** | Motorized Pot Down | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **09.028** | Motorized Pot Reset | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **09.029** | Binary Sum Ones | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | |
| **09.030** | Binary Sum Twos | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | |
| **09.031** | Binary Sum Fours | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | |
| **09.032** | Binary Sum Output | 0 to 255 | | | | RO | Num | ND | NC | PT | |
| **09.033** | Binary Sum Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **09.034** | Binary Sum Offset | 0 to 248 | | 0 | | RW | Num | | | | US |
| **09.035** | Timer 1 Start Date | 00-00-00 to 31-12-99 | | 00-00-00 | | RW | Date | | | | US |
| **09.036** | Timer 1 Start Time | 00:00:00 to 23:59:59 | | 00:00:00 | | RW | Time | | | | US |
| **09.037** | Timer 1 Stop Date | 00-00-00 to 31-12-99 | | 00-00-00 | | RW | Date | | | | US |
| **09.038** | Timer 1 Stop Time | 00:00:00 to 23:59:59 | | 00:00:00 | | RW | Time | | | | US |
| **09.039** | Timer 1 Repeat Function | NonE (0), 1 (1), 2 (2), 3 (3), 4 (4), 5 (5), 6 (6), 7 (7) | | NonE (0) | | RW | Txt | | | | US |
| **09.040** | Timer 1 Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.041** | Timer 1 Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.042** | Timer 1 Output | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **09.043** | Timer 1 Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **09.045** | Timer 2 Start Date | 00-00-00 to 31-12-99 | | 00-00-00 | | RW | Date | | | | US |
| **09.046** | Timer 2 Start Time | 00:00:00 to 23:59:59 | | 00:00:00 | | RW | Time | | | | US |
| **09.047** | Timer 2 Stop Date | 00-00-00 to 31-12-99 | | 00-00-00 | | RW | Date | | | | US |
| **09.048** | Timer 2 Stop Time | 00:00:00 to 23:59:59 | | 00:00:00 | | RW | Time | | | | US |
| **09.049** | Timer 2 Repeat Function | NonE (0), 1 (1), 2 (2), 3 (3), 4 (4), 5 (5), 6 (6), 7 (7) | | NonE (0) | | RW | Txt | | | | US |
| **09.050** | Timer 2 Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.051** | Timer 2 Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **09.052** | Timer 2 Output | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **09.053** | Timer 2 Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |
| IP | IP address | Mac | Mac address | Date | Date parameter | Time | Time parameter | SMP | Slot,menu,parameter | Chr | Character parameter | Ver | Version number |

## 11.11 Menu 10: Status and trips

| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **10.001** | Drive OK | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.002** | Drive Active | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.003** | Zero Frequency | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.004** | Running At Or Below Minimum Frequency | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.005** | Below Set Frequency | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.006** | At Frequency | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.007** | Above Set Frequency | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.008** | Rated Load Reached | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.009** | Current Limit Active | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.010** | Regenerating | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.011** | Braking IGBT Active | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.012** | Braking Resistor Alarm | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.013** | Reverse Direction Commanded | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.014** | Reverse Direction Running | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.015** | Supply Loss | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.016** | Under Voltage Active | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.017** | Motor Overload Alarm | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.018** | Drive Over-temperature Alarm | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.019** | Drive Warning | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.020** | Trip 0 | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| **10.021** | Trip 1 | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| **10.022** | Trip 2 | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| **10.023** | Trip 3 | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| **10.024** | Trip 4 | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| **10.025** | Trip 5 | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| **10.026** | Trip 6 | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| **10.027** | Trip 7 | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| **10.028** | Trip 8 | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| **10.029** | Trip 9 | 0 to 255 | | | | RO | Txt | ND | NC | PT | PS |
| **10.030** | Braking Resistor Rated Power | 0.0 to 99999.9 kW | | 0.0 kW | | RW | Num | | | | US |
| **10.031** | Braking Resistor Thermal Time Constant | 0.00 to 1500.00 s | | 0.00 s | | RW | Num | | | | US |
| **10.032** | External Trip | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **10.033** | Drive Reset | Off (0) or On (1) | | Off (0) | | RW | Bit | | NC | | |
| **10.034** | Number Of Auto-reset Attempts | NonE (0), 1 (1), 2 (2), 3 (3), 4 (4), 5 (5),inF (6) | | NonE (0) | | RW | Txt | | | | US |
| **10.035** | Auto-reset Delay | 0.0 to 600.0 s | | 1.0 s | | RW | Num | | | | US |
| **10.036** | Auto-reset Hold Drive OK | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **10.037** | Action On Trip Detection | 0 to 31 | | 0 | | RW | Num | | | | US |
| **10.038** | User Trip | 0 to 255 | | | | RW | Num | ND | NC | | |
| **10.039** | Braking Resistor Thermal Accumulator | 0.0 to 100.0 % | | | | RO | Num | ND | NC | PT | |
| **10.040** | Status Word | 0 to 32767 | | | | RO | Num | ND | NC | PT | |
| **10.041** | Trip 0 Date | 00-00-00 to 31-12-99 | | | | RO | Date | ND | NC | PT | PS |
| **10.042** | Trip 0 Time | 00:00:00 to 23:59:59 | | | | RO | Time | ND | NC | PT | PS |
| **10.043** | Trip 1 Date | 00-00-00 to 31-12-99 | | | | RO | Date | ND | NC | PT | PS |
| **10.044** | Trip 1 Time | 00:00:00 to 23:59:59 | | | | RO | Time | ND | NC | PT | PS |
| **10.045** | Trip 2 Date | 00-00-00 to 31-12-99 | | | | RO | Date | ND | NC | PT | PS |
| **10.046** | Trip 2 Time | 00:00:00 to 23:59:59 | | | | RO | Time | ND | NC | PT | PS |
| **10.047** | Trip 3 Date | 00-00-00 to 31-12-99 | | | | RO | Date | ND | NC | PT | PS |
| **10.048** | Trip 3 Time | 00:00:00 to 23:59:59 | | | | RO | Time | ND | NC | PT | PS |
| **10.049** | Trip 4 Date | 00-00-00 to 31-12-99 | | | | RO | Date | ND | NC | PT | PS |
| **10.050** | Trip 4 Time | 00:00:00 to 23:59:59 | | | | RO | Time | ND | NC | PT | PS |
| **10.051** | Trip 5 Date | 00-00-00 to 31-12-99 | | | | RO | Date | ND | NC | PT | PS |
| **10.052** | Trip 5 Time | 00:00:00 to 23:59:59 | | | | RO | Time | ND | NC | PT | PS |
| **10.053** | Trip 6 Date | 00-00-00 to 31-12-99 | | | | RO | Date | ND | NC | PT | PS |
| **10.054** | Trip 6 Time | 00:00:00 to 23:59:59 | | | | RO | Time | ND | NC | PT | PS |
| **10.055** | Trip 7 Date | 00-00-00 to 31-12-99 | | | | RO | Date | ND | NC | PT | PS |
| **10.056** | Trip 7 Time | 00:00:00 to 23:59:59 | | | | RO | Time | ND | NC | PT | PS |
| **10.057** | Trip 8 Date | 00-00-00 to 31-12-99 | | | | RO | Date | ND | NC | PT | PS |
| **10.058** | Trip 8 Time | 00:00:00 to 23:59:59 | | | | RO | Time | ND | NC | PT | PS |
| **10.059** | Trip 9 Date | 00-00-00 to 31-12-99 | | | | RO | Date | ND | NC | PT | PS |
| **10.060** | Trip 9 Time | 00:00:00 to 23:59:59 | | | | RO | Time | ND | NC | PT | PS |
| **10.061** | Braking Resistor Resistance | 0.00 to 10000.00 Ω | | 0.00 Ω | | RW | Num | | | | US |
| **10.064** | Remote Keypad Battery Low | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.065** | Autotune Active | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.066** | Limit Switch Active | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.068** | Hold Drive Healthy On Under Voltage | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |

| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **10.069** | Additional Status Bits | 0 to 2047 | | | | RO | Num | ND | NC | PT | |
| **10.070** | Trip 0 Sub-trip Number | 0 to 65535 | | | | RO | Num | ND | NC | PT | PS |
| **10.071** | Trip 1 Sub-trip Number | 0 to 65535 | | | | RO | Num | ND | NC | PT | PS |
| **10.072** | Trip 2 Sub-trip Number | 0 to 65535 | | | | RO | Num | ND | NC | PT | PS |
| **10.073** | Trip 3 Sub-trip Number | 0 to 65535 | | | | RO | Num | ND | NC | PT | PS |
| **10.074** | Trip 4 Sub-trip Number | 0 to 65535 | | | | RO | Num | ND | NC | PT | PS |
| **10.075** | Trip 5 Sub-trip Number | 0 to 65535 | | | | RO | Num | ND | NC | PT | PS |
| **10.076** | Trip 6 Sub-trip Number | 0 to 65535 | | | | RO | Num | ND | NC | PT | PS |
| **10.077** | Trip 7 Sub-trip Number | 0 to 65535 | | | | RO | Num | ND | NC | PT | PS |
| **10.078** | Trip 8 Sub-trip Number | 0 to 65535 | | | | RO | Num | ND | NC | PT | PS |
| **10.079** | Trip 9 Sub-trip Number | 0 to 65535 | | | | RO | Num | ND | NC | PT | PS |
| **10.080** | Stop Motor | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.081** | Phase Loss | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.090** | Drive Ready | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.101** | Drive Status | Inh (0), rdy (1), StoP (2), rES (3), rES (4), S.LoSS (5), rES (6), dc.inJ (7), rES (8), Error (9), ActivE (10), rES (11), rES (12), rES (13), HEAt (14), UU (15) | | | | RO | Txt | ND | NC | PT | |
| **10.102** | Trip Reset Source | 0 to 1023 | | | | RO | Num | ND | NC | PT | PS |
| **10.103** | Trip Time Identifier | -2147483648 to 2147483647 ms | | | | RO | Num | ND | NC | PT | |
| **10.104** | Active Alarm | NonE (0), br.rES (1), OV.Ld (2), rES (3), d.OV.Ld (4), tuning (5), LS (6), rES (7), rES (8), OPt.AL (9), rES (10), rES (11), rES(12), Lo.AC (13), I.AC.Lt (14), 24.LoSt (15) | | | | RO | Txt | ND | NC | PT | |
| **10.106** | Potential Drive Damage Conditions | 0 to 3 | | | | RO | Bin | ND | NC | PT | PS |
| **10.107** | Low AC Alarm | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **10.108** | Reversed cooling fan detected | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |
| IP | IP address | Mac | Mac address | Date | Date parameter | Time | Time parameter | SMP | Slot,menu,parameter | Chr | Character parameter | Ver | Version number |

## 11.12 Menu 11: General drive set-up

| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **11.018** | Status Mode Parameter 1 | 0.000 to 30.999 | | 2.001 | | RW | Num | | | PT | US |
| **11.019** | Status Mode Parameter 2 | 0.000 to 30.999 | | 4.020 | | RW | Num | | | PT | US |
| **11.020** | Reset Serial Communications | Off (0) or On (1) | | | | RW | Bit | ND | NC | | |
| **11.021** | Customer Defined Scaling | 0.000 to 10.000 | | 1.000 | | RW | Num | | | | US |
| **11.022** | Parameter Displayed At Power-up | 0.000 to 0.095 | | 0.010 | | RW | Num | | | PT | US |
| **11.023** | Serial Address | 1 to 247 | | 1 | | RW | Num | | | | US |
| **11.024** | Serial Mode | 8.2NP (0), 8.1NP (1), 8.1EP (2), 8.1OP (3), 8.2NP E (4), 8.1NP E (5), 8.1EP E (6), 8.1OP E (7), 7.1EP (8), 7.1OP (9), 7.1EP E (10), 7.1OP E (11) | | 8.2NP (0) | | RW | Txt | | | | US |
| **11.025** | Serial Baud Rate | 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 76800 (9), 115200 (10) | | 19200 (6) | | RW | Txt | | | | US |
| **11.026** | Minimum Comms Transmit Delay | 0 to 250 ms | | 2 ms | | RW | Num | | | | US |
| **11.027** | Silent Period | 0 to 250 ms | | 0 ms | | RW | Num | | | | US |
| **11.028** | Drive Derivative | 0 to 255 | | | | RO | Num | ND | NC | PT | |
| **11.029** | Software Version | 00.00.00 to 99.99.99 | | | | RO | Ver | ND | NC | PT | |
| **11.030** | User Security Code | 0 to 9999 | | | | RW | Num | ND | | PT | US |
| **11.031** | User Drive Mode | OPEn.LP (1), rFC-A (2) | | | | RW | Txt | ND | NC | PT | US |
| **11.032** | Maximum Heavy Duty Rating | 0.00 to Drive HD Current Rating A | | | | RO | Num | ND | NC | PT | |
| **11.033** | Drive Rated Voltage | 110V (0), 200V (1), 400V (2), 575V (3) | | | | RO | Txt | ND | NC | PT | |
| **11.034** | Drive Configuration | AV (0), AI (1), AV.Pr (2), AI.Pr (3), PrESEt (4), PAd (5), PAd.rEF (6), E.Pot (7), torquE (8), Pid (9) | | AV (0)* | | RW | Txt | | | PT | US |
| **11.035** | Power Software Version | 00.00.00 to 99.99.99 | | | | RO | Ver | ND | NC | PT | |
| **11.036** | NV Media Card File Previously Loaded | 0 to 999 | | 0 | | RO | Num | | NC | PT | |
| **11.037** | NV Media Card File Number | 0 to 999 | | 0 | | RW | Num | | | | |
| **11.038** | NV Media Card File Type | NonE (0), OPEn.LP (1), rFC-A (2) | | | | RO | Txt | ND | NC | PT | |
| **11.039** | NV Media Card File Version | 0 to 9999 | | | | RO | Num | ND | NC | PT | |
| **11.042** | Parameter Cloning | NonE (0), rEAd (1), Prog (2), Auto (3), boot (4) | | NonE (0) | | RW | Txt | | NC | | US |
| **11.043** | Load Defaults | NonE (0), Std (1), US (2) | | NonE (0) | | RW | Txt | | NC | | |
| **11.044** | User Security Status | LEVEL.1 (0), LEVEL.2 (1), ALL (2), StAtUS (3), no.Acc (4) | | LEVEL.1 (0) | | RW | Txt | ND | | PT | |
| **11.045** | Select Motor 2 Parameters | 1 (0), 2 (1) | | 1 (0) | | RW | Txt | | | | US |
| **11.046** | Defaults Previously Loaded | 0 to 2000 | | | | RO | Num | ND | NC | PT | US |
| **11.047** | Onboard User Program: Enable | Stop (0), Run (1) | | Run (1) | | RW | Txt | | | | US |
| **11.048** | Onboard User Program: Status | -2147483648 to 2147483647 | | | | RO | Num | ND | NC | PT | |
| **11.049** | Onboard User Program: Programming Events | 0 to 65535 | | | | RO | Num | ND | NC | PT | |
| **11.050** | Onboard User Program: Freewheeling Tasks Per Second | 0 to 65535 | | | | RO | Num | ND | NC | PT | |
| **11.051** | Onboard User Program: Clock Task Time Used | 0.0 to 100.0 % | | | | RO | Num | ND | NC | PT | |
| **11.052** | Serial Number LS | 0 to 999999 | | | | RO | Num | ND | NC | PT | |
| **11.053** | Serial Number MS | 0 to 999999 | | | | RO | Num | ND | NC | PT | |
| **11.054** | Drive Date Code | 0 to 9999 | | | | RO | Num | ND | NC | PT | |
| **11.055** | Onboard User Program: Clock Task Schedule Rate | 0 to 262128 | | | | RO | Num | ND | NC | PT | |
| **11.060** | Maximum Rated Current | 0.0 to 266.0 A | | | | RO | Num | ND | NC | PT | |
| **11.061** | Full Scale Current Kc | 0.0 to 498.0 A | | | | RO | Num | ND | NC | PT | |
| **11.063** | Product Type | 0 to 255 | | | | RO | Num | ND | NC | PT | |
| **11.064** | Product Identifier Characters | 300 | | | | RO | Chr | ND | NC | PT | |
| **11.065** | Frame size and voltage code | 0 to 999 | | | | RO | Num | ND | NC | PT | |
| **11.066** | Power Stage Identifier | 0 to 255 | | | | RO | Num | ND | NC | PT | |
| **11.067** | Control Board Identifier | 0 to 255 | | | | RO | Num | ND | NC | PT | |
| **11.068** | Drive current rating | 0 to 2240 | | | | RO | Num | ND | NC | PT | |
| **11.070** | Core Parameter Database Version | 0.00 to 99.99 | | | | RO | Num | ND | NC | PT | |
| **11.072** | NV Media Card Create Special File | 0 to 1 | | 0 | | RW | Num | | NC | | |
| **11.073** | NV Media Card Type | NonE (0), rES (1), Sd.CArd (2) | | | | RO | Num | ND | NC | PT | |
| **11.075** | NV Media Card Read-only Flag | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **11.076** | NV Media Card Warning Suppression Flag | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **11.077** | NV Media Card File Required Version | 0 to 9999 | | | | RW | Num | ND | NC | PT | |
| **11.079** | Drive Name Characters 1-4 | - - - - (-2147483648) to - - - - (-2147483647) | | - - - - (757935405) | | RW | Chr | | | PT | US |
| **11.080** | Drive Name Characters 5-8 | - - - - (-2147483648) to - - - - (-2147483647) | | - - - - (757935405) | | RW | Chr | | | PT | US |
| **11.081** | Drive Name Characters 9-12 | - - - - (-2147483648) to - - - - (-2147483647) | | - - - - (757935405) | | RW | Chr | | | PT | US |
| **11.082** | Drive Name Characters 13-16 | - - - - (-2147483648) to - - - - (-2147483647) | | - - - - (757935405) | | RW | Chr | | | PT | US |
| **11.084** | Drive Mode | OPEn.LP (1), rFC-A (2) | | | | RO | Txt | ND | NC | PT | |
| **11.085** | Security Status | NonE (0), r.onLy.A (1), StAtUS (2),no.Acc (3) | | | | RO | Txt | ND | NC | PT | PS |
| **11.086** | Menu Access Status | LEVEL.1 (0), LEVEL.2 (1), ALL (2) | | | | RO | Txt | ND | NC | PT | PS |
| **11.091** | Additional Identifier Characters 1 | (-2147483648) to (2147483647) | | | | RO | Chr | ND | NC | PT | |
| **11.092** | Additional Identifier Characters 2 | (-2147483648) to (2147483647) | | | | RO | Chr | ND | NC | PT | |
| **11.093** | Additional Identifier Characters 3 | (-2147483648) to (2147483647) | | | | RO | Chr | ND | NC | PT | |

| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **11.094** | Disable String Mode | Off (0) or On (1) | | Off (0) | | RW | Bit | | | PT | US |
| **11.097** | AI ID Code | NonE (0), Sd.CArd (1), rS-485 (2), boot (3), rS-485 (4) | | | | RO | Txt | ND | NC | PT | |
| **11.098** | 24V Alarm Loss Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **11.099** | Modbus Parameter Conversion | 0000 to 1111 | | 0000 | | RW | Bin | | | | US |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |
| IP | IP address | Mac | Mac address | Date | Date parameter | Time | Time parameter | SMP | Slot,menu,parameter | Chr | Character parameter | Ver | Version number |

## 11.13 Menu 12: Threshold detectors, variable selectors and brake control function

**Figure 11-21 Menu 12 logic diagram**

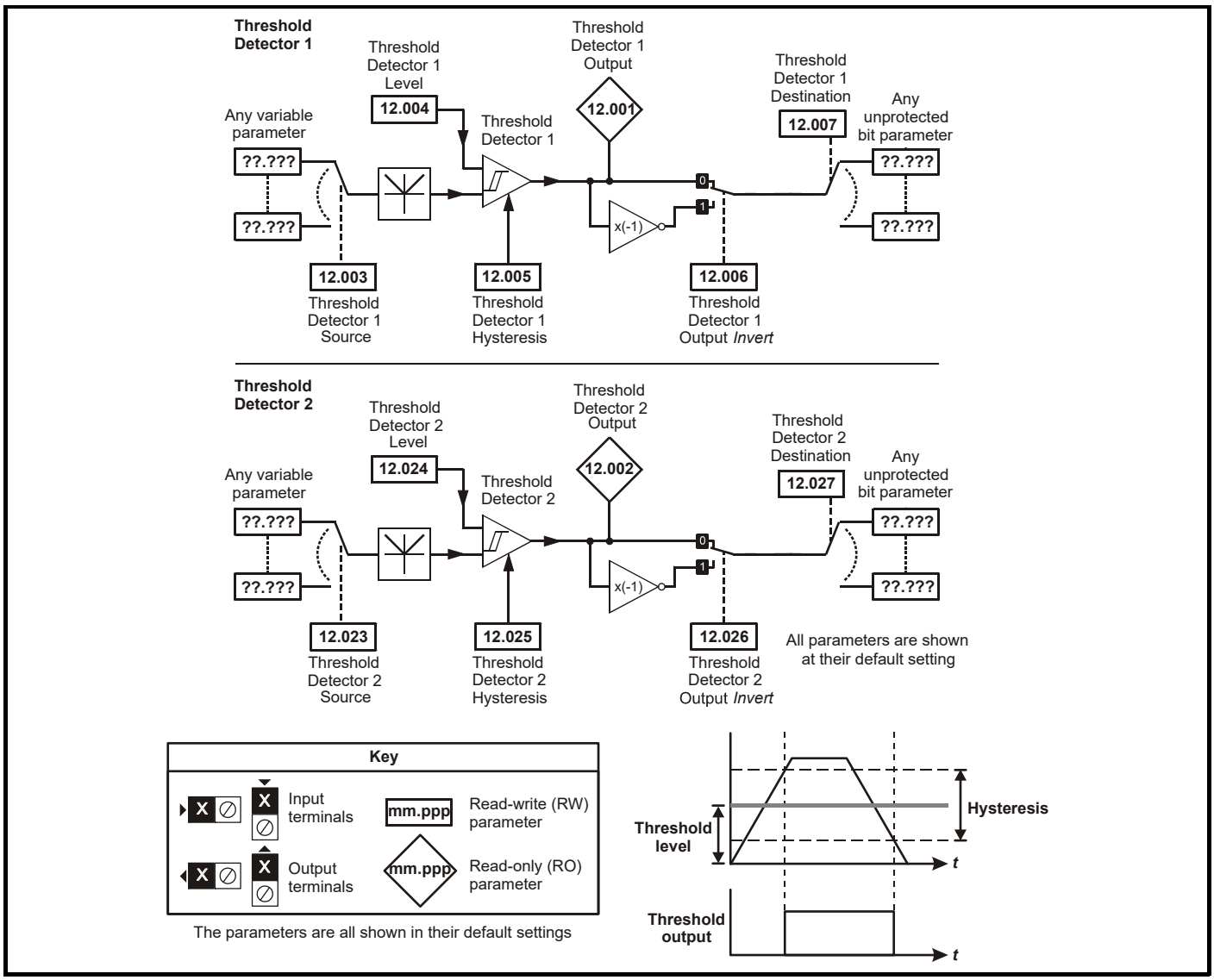
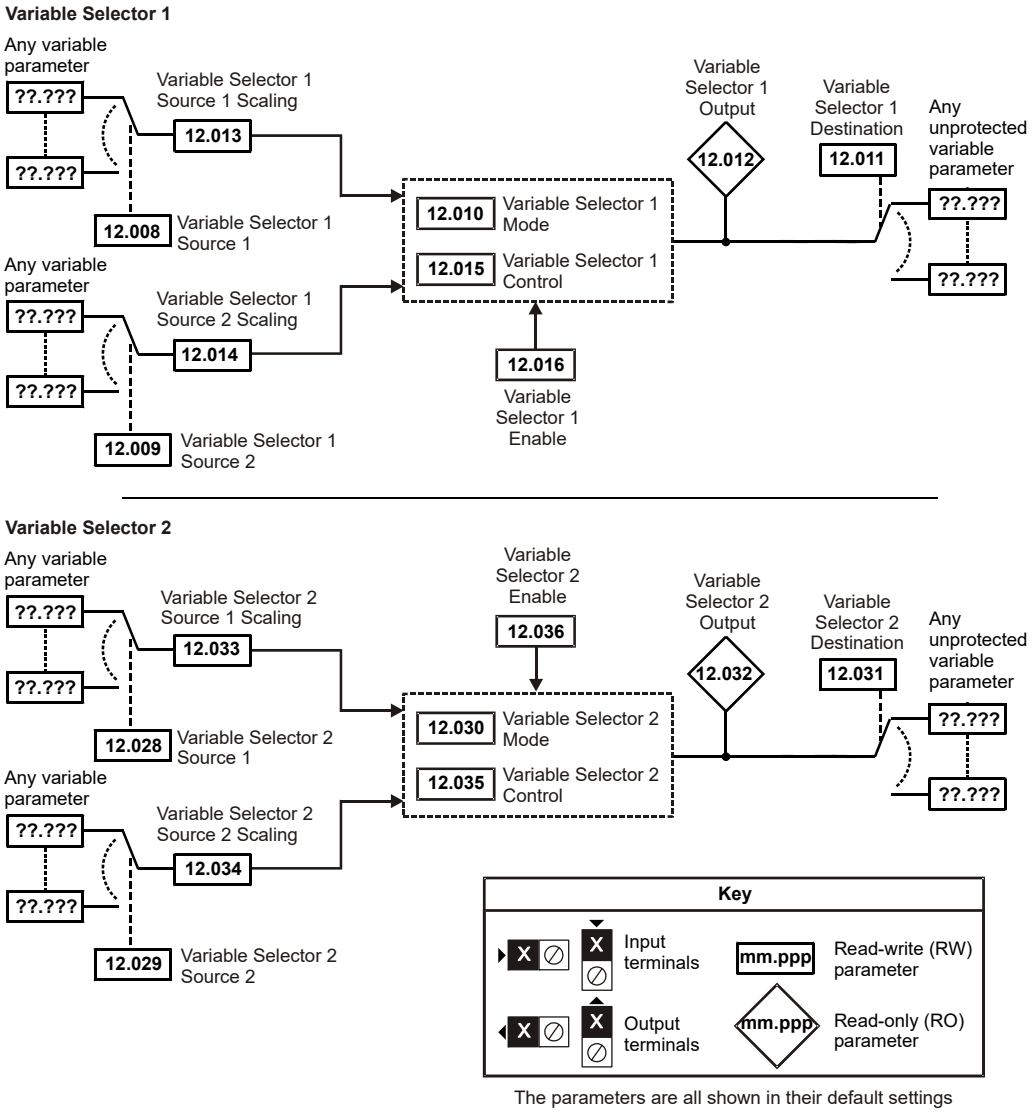


**Figure 11-22 Menu 12 logic diagram (continued)**




The parameters are all shown in their default settings

**WARNING**

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

**WARNING**

The control terminal relay can be selected as an output to release a brake. If a drive is set up in this manner and a drive replacement takes place, prior to programming the drive on initial power up, the brake may be released.
When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered. The use of an NV media card in boot mode can ensure drive parameters are immediately programmed to avoid this situation.

**Figure 11-23 Open loop brake function**

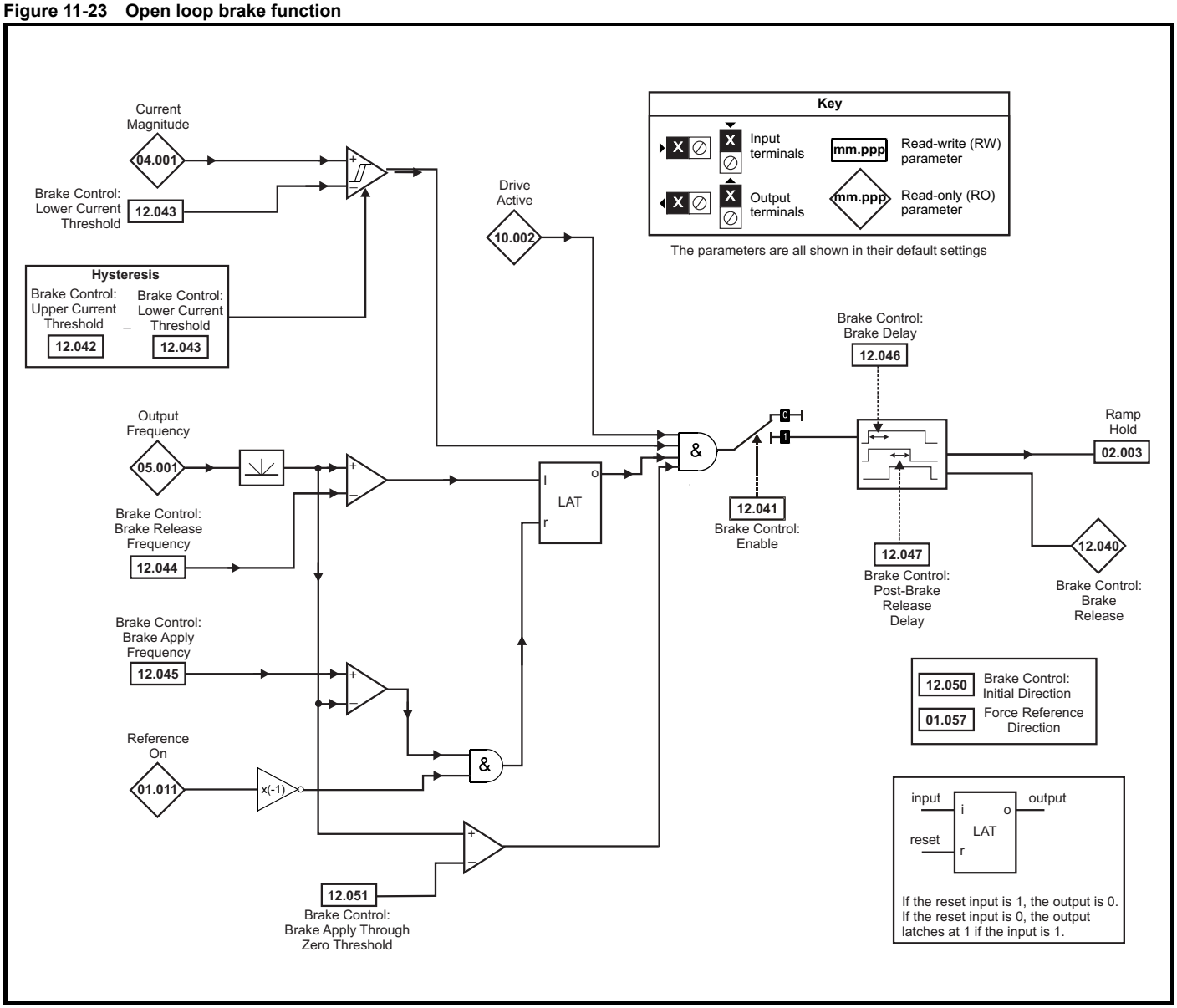


**Figure 11-24 Brake sequence**

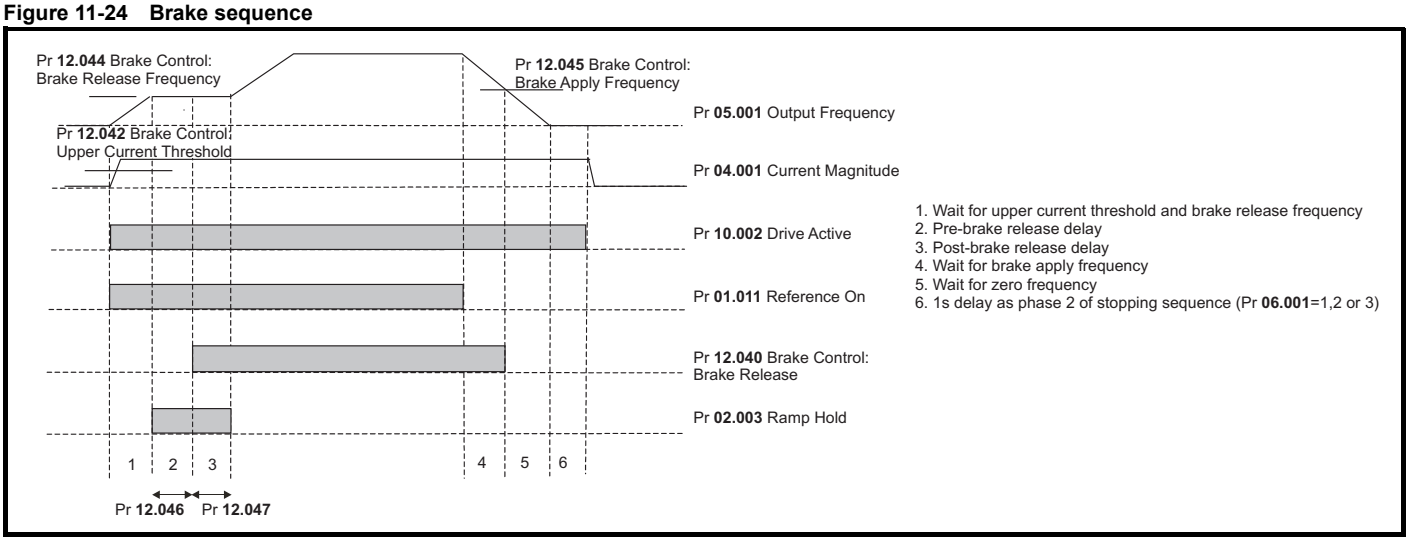
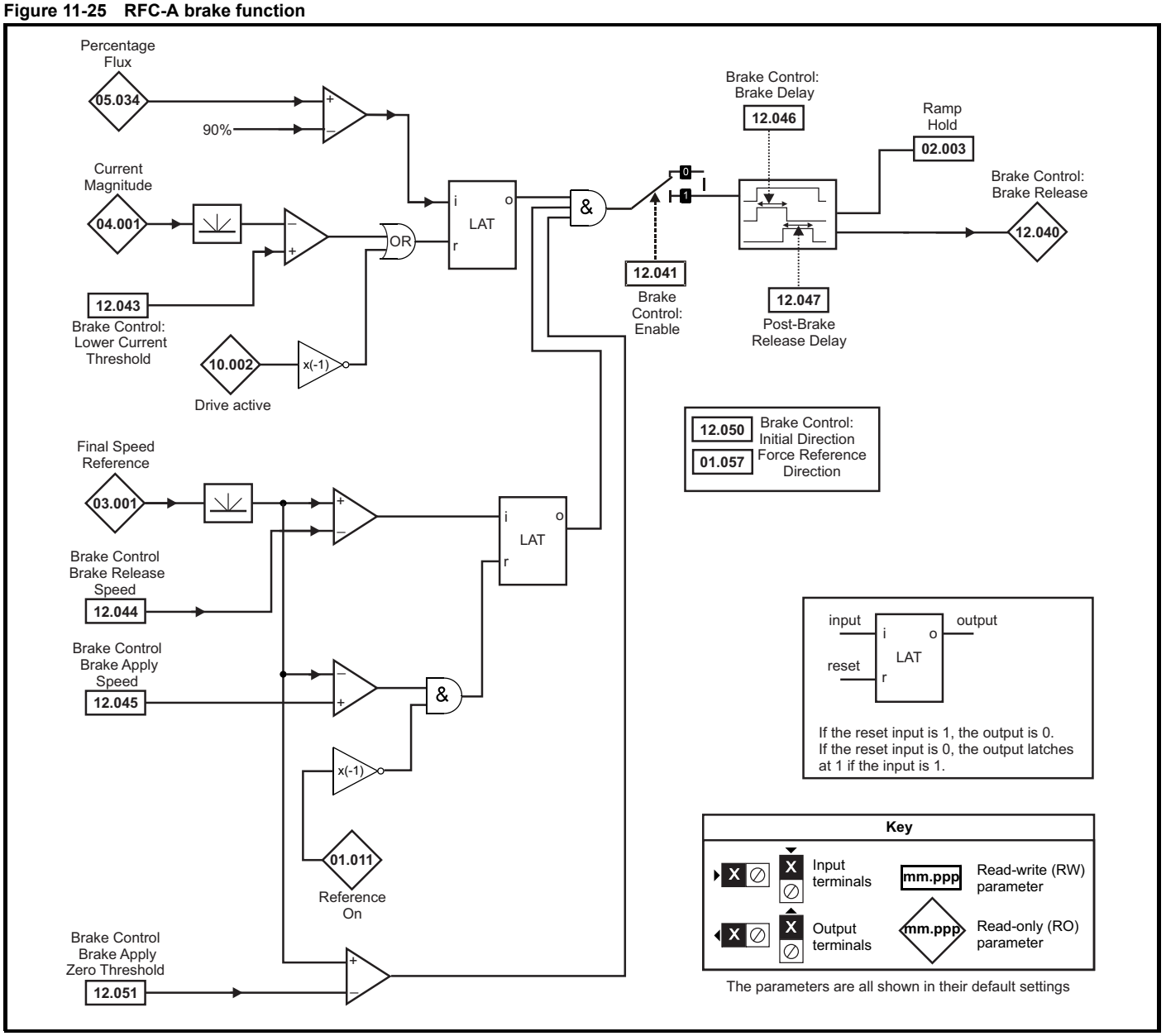



**Figure 11-25 RFC-A brake function**

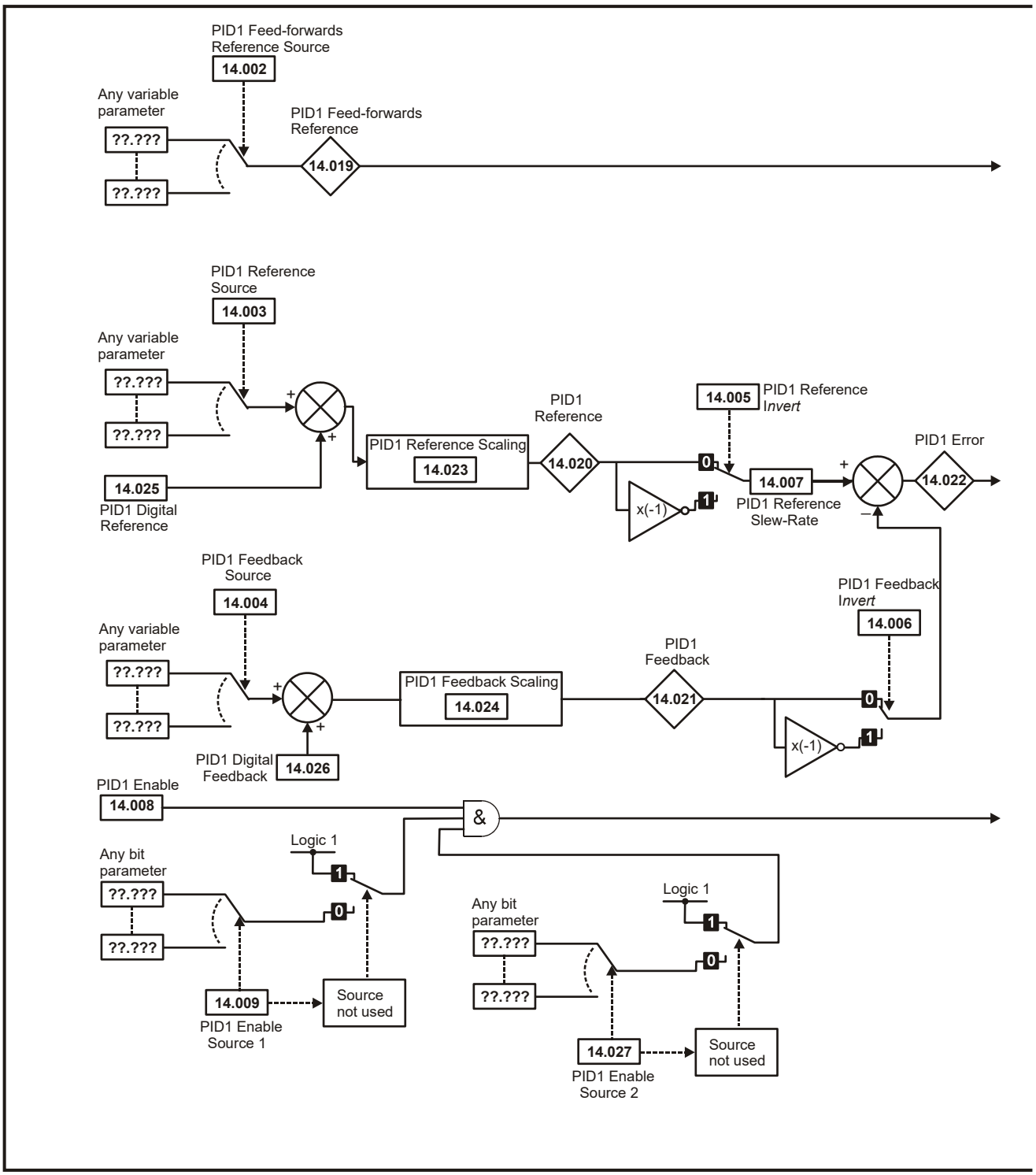


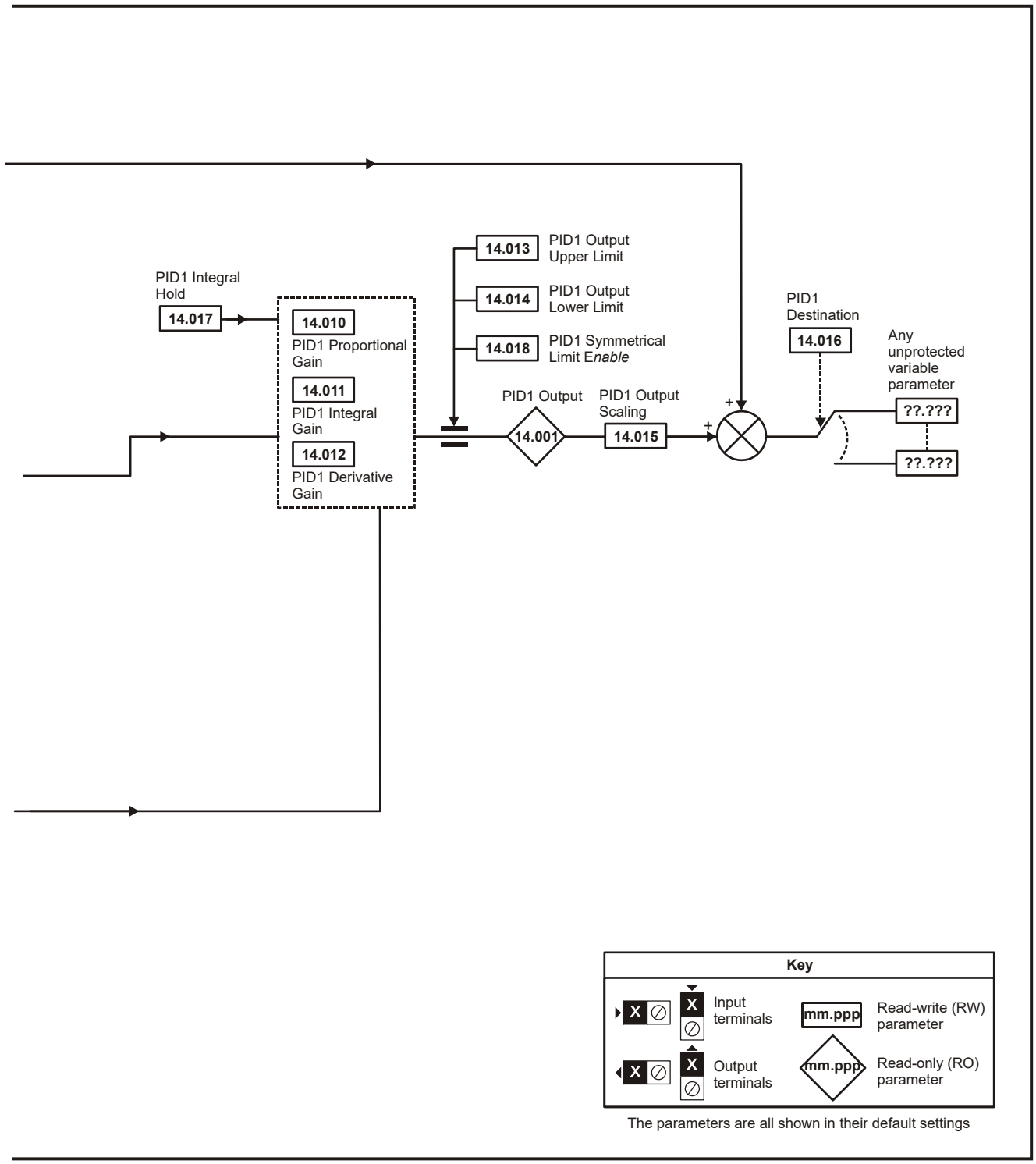
| Parameter | | Range(⇳) | | Default(⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **12.001** | Threshold Detector 1 Output | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **12.002** | Threshold Detector 2 Output | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **12.003** | Threshold Detector 1 Source | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **12.004** | Threshold Detector 1 Level | 0.00 to 100.00 % | | 0.00 % | | RW | Num | | | | US |
| **12.005** | Threshold Detector 1 Hysteresis | 0.00 to 25.00 % | | 0.00 % | | RW | Num | | | | US |
| **12.006** | Threshold Detector 1 Output Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **12.007** | Threshold Detector 1 Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **12.008** | Variable Selector 1 Source 1 | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **12.009** | Variable Selector 1 Source 2 | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **12.010** | Variable Selector 1 Mode | 0 (0), 1 (1), 2 (2), 3 (3), 4 (4), 5 (5), 6 (6), 7 (7), 8 (8), 9 (9) | | 0 (0) | | RW | Txt | | | | US |
| **12.011** | Variable Selector 1 Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **12.012** | Variable Selector 1 Output | ±100.00 % | | | | RO | Num | ND | NC | PT | |
| **12.013** | Variable Selector 1 Source 1 Scaling | ±4.000 | | 1.000 | | RW | Num | | | | US |
| **12.014** | Variable Selector 1 Source 2 Scaling | ±4.000 | | 1.000 | | RW | Num | | | | US |
| **12.015** | Variable Selector 1 Control | 0.00 to 100.00 | | 0.00 | | RW | Num | | | | US |
| **12.016** | Variable Selector 1 Enable | Off (0) or On (1) | | On (1) | | RW | Bit | | | | US |
| **12.023** | Threshold Detector 2 Source | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **12.024** | Threshold Detector 2 Level | 0.00 to 100.00 % | | 0.00 % | | RW | Num | | | | US |
| **12.025** | Threshold Detector 2 Hysteresis | 0.00 to 25.00 % | | 0.00 % | | RW | Num | | | | US |
| **12.026** | Threshold Detector 2 Output Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **12.027** | Threshold Detector 2 Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **12.028** | Variable Selector 2 Source 1 | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **12.029** | Variable Selector 2 Source 2 | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **12.030** | Variable Selector 2 Mode | 0 (0), 1 (1), 2 (2), 3 (3), 4 (4), 5 (5), 6 (6), 7 (7), 8 (8), 9 (9) | | 0 (0) | | RW | Txt | | | | US |
| **12.031** | Variable Selector 2 Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **12.032** | Variable Selector 2 Output | ±100.00 % | | | | RO | Num | ND | NC | PT | |
| **12.033** | Variable Selector 2 Source 1 Scaling | ±4.000 | | 1.000 | | RW | Num | | | | US |
| **12.034** | Variable Selector 2 Source 2 Scaling | ±4.000 | | 1.000 | | RW | Num | | | | US |
| **12.035** | Variable Selector 2 Control | 0.00 to 100.00 | | 0.00 | | RW | Num | | | | US |
| **12.036** | Variable Selector 2 Enable | Off (0) or On (1) | | On (1) | | RW | Bit | | | | US |
| **12.040** | BC Brake Release | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **12.041** | BC Enable | diS (0), rELAy (1), dig IO (2), USEr (3) | | diS (0) | | RW | Txt | | | | US |
| **12.042** | BC Upper Current Threshold | 0 to 200 % | | 50 % | | RW | Num | | | | US |
| **12.043** | BC Lower Current Threshold | 0 to 200 % | | 10 % | | RW | Num | | | | US |
| **12.044** | BC Brake Release Frequency | 0.00 to 20.00 Hz | | 1.00 Hz | | RW | Num | | | | US |
| **12.045** | BC Brake Apply Frequency | 0.00 to 20.00 Hz | | 2.00 Hz | | RW | Num | | | | US |
| **12.046** | BC Brake Delay | 0.0 to 25.0 s | | 1.0 s | | RW | Num | | | | US |
| **12.047** | BC Post-brake Release Delay | 0.0 to 25.0 s | | 1.0 s | | RW | Num | | | | US |
| **12.050** | BC Initial Direction | rEf (0), For (1), rEv (2) | | rEf (0) | | RW | Txt | | | | US |
| **12.051** | BC Brake Apply Through Zero Threshold | 0.00 to 25.00 Hz | | 1.00 Hz | | RW | Num | | | | US |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.14 Menu 14: User PID controller

**Figure 11-26 Menu 14 Logic diagram**





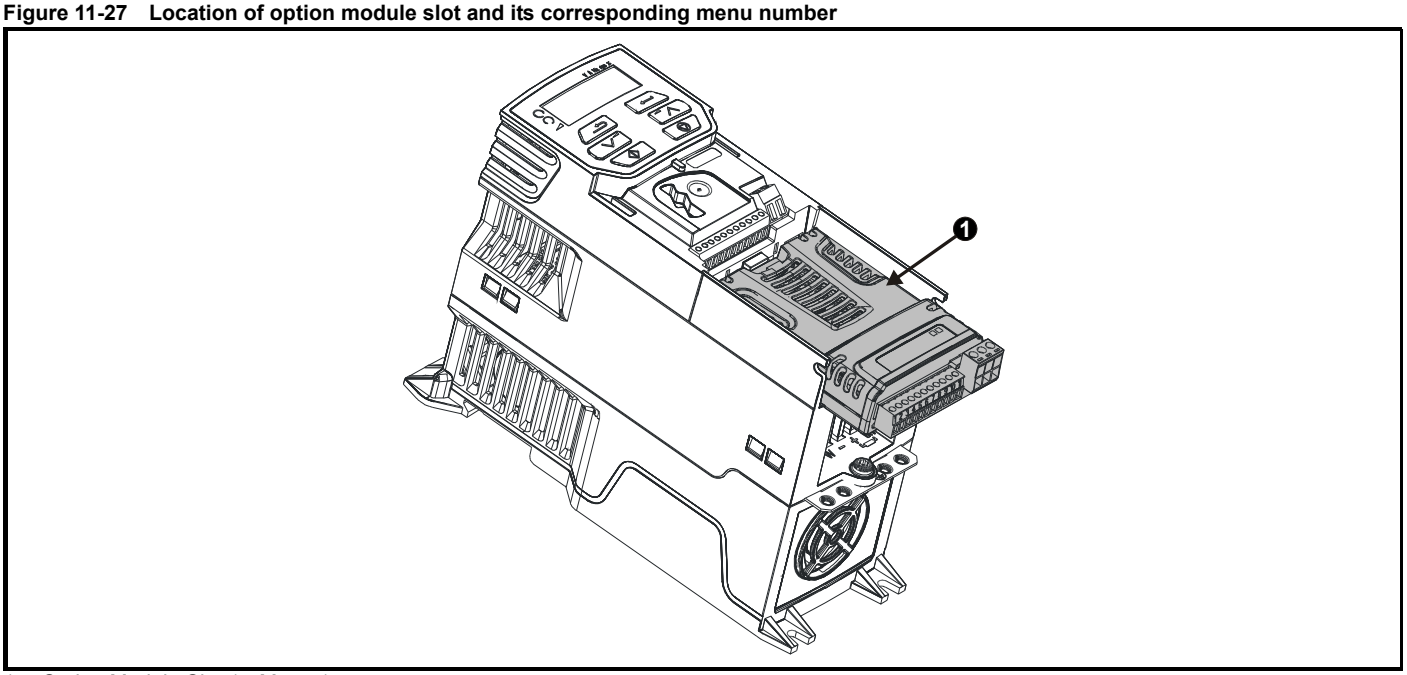

The parameters are all shown in their default settings

| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **14.001** | PID1 Output | ±100.00 % | | | | RO | Num | ND | NC | PT | |
| **14.002** | PID1 Feed-forwards Reference Source | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **14.003** | PID1 Reference Source | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **14.004** | PID1 Feedback Source | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **14.005** | PID1 Reference Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **14.006** | PID1 Feedback Invert | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **14.007** | PID1 Reference Slew Rate | 0.0 to 3200.0 s | | 0.0 s | | RW | Num | | | | US |
| **14.008** | PID1 Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **14.009** | PID1 Enable Source 1 | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **14.010** | PID1 Proportional Gain | 0.000 to 4.000 | | 1.000 | | RW | Num | | | | US |
| **14.011** | PID1 Integral Gain | 0.000 to 4.000 | | 0.500 | | RW | Num | | | | US |
| **14.012** | PID1 Differential Gain | 0.000 to 4.000 | | 0.000 | | RW | Num | | | | US |
| **14.013** | PID1 Output Upper Limit | 0.00 to 100.00 % | | 100.00 % | | RW | Num | | | | US |
| **14.014** | PID1 Output Lower Limit | ±100.00 % | | -100.00 % | | RW | Num | | | | US |
| **14.015** | PID1 Output Scaling | 0.000 to 4.000 | | 1.000 | | RW | Num | | | | US |
| **14.016** | PID1 Destination | 0.000 to 30.999 | | 0.000 | | RW | Num | DE | | PT | US |
| **14.017** | PID1 Integral Hold | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | |
| **14.018** | PID1 Symmetrical Limit Enable | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **14.019** | PID1 Feed-forwards Reference | ±100.00 % | | | | RO | Num | ND | NC | PT | |
| **14.020** | PID1 Reference | ±100.00 % | | | | RO | Num | ND | NC | PT | |
| **14.021** | PID1 Feedback | ±100.00 % | | | | RO | Num | ND | NC | PT | |
| **14.022** | PID1 Error | ±100.00 % | | | | RO | Num | ND | NC | PT | |
| **14.023** | PID1 Reference Scaling | 0.000 to 4.000 | | 1.000 | | RW | Num | | | | US |
| **14.024** | PID1 Feedback Scaling | 0.000 to 4.000 | | 1.000 | | RW | Num | | | | US |
| **14.025** | PID1 Digital Reference | ±100.00 % | | 0.00 % | | RW | Num | | | | US |
| **14.026** | PID1 Digital Feedback | ±100.00 % | | 0.00 % | | RW | Num | | | | US |
| **14.027** | PID1 Enable Source 2 | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.15 Menu 15: Option module set-up

**Figure 11-27 Location of option module slot and its corresponding menu number**




1. Option Module Slot 1 - Menu 15

### 11.15.1 Parameters common to all categories

| Parameter | | Range(⇳) | Default(⇨) | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **15.001** | Module ID | 0 to 65535 | | RO | Num | ND | NC | PT | |
| **15.002** | Software Version | 00.00.00 to 99.99.99 | | RO | Ver | ND | NC | PT | |
| **15.003** | Hardware Version | 0.00 to 99.99 | | RO | Num | ND | NC | PT | |
| **15.004** | Serial Number LS | 0 to 999999 | | RO | Num | ND | NC | PT | |
| **15.005** | Serial Number MS | | | RO | Num | ND | NC | PT | |
| **15.006** | Module Status | -2 to 3 | | RO | Txt | ND | NC | PT | |
| **15.007** | Module Reset | Off (0) or On (1) | Off (0) | RW | Bit | | NC | | |

The option module ID indicates the type of module that is installed in the corresponding slot. See the relevant option module user guide for more information regarding the module.

| Option module ID | Module | Category |
|---|---|---|
| 0 | No module installed | |
| 209 | SI-I/O | Automation (I/O Expansion) |
| 431 | SI-EtherCAT | Fieldbus |
| 433 | SI-Ethernet | |
| 434 | SI-PROFINET V2 | |
| 443 | SI-PROFIBUS | |
| 447 | SI-DeviceNet | |
| 448 | SI-CANopen | |

## 11.16 Menu 18: Application menu 1

| Parameter | | Range (⇕) | | Default(⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **18.001** | Application Menu 1 Power-down Save Integer | -32768 to 32767 | | 0 | | RW | Num | | | | PS |
| **18.002** | Application Menu 1 Read-only Integer 2 | | | | | RO | Num | ND | NC | | |
| **18.003** | Application Menu 1 Read-only Integer 3 | | | | | RO | Num | ND | NC | | |
| **18.004** | Application Menu 1 Read-only Integer 4 | | | | | RO | Num | ND | NC | | |
| **18.005** | Application Menu 1 Read-only Integer 5 | | | | | RO | Num | ND | NC | | |
| **18.006** | Application Menu 1 Read-only Integer 6 | | | | | RO | Num | ND | NC | | |
| **18.007** | Application Menu 1 Read-only Integer 7 | | | | | RO | Num | ND | NC | | |
| **18.008** | Application Menu 1 Read-only Integer 8 | | | | | RO | Num | ND | NC | | |
| **18.009** | Application Menu 1 Read-only Integer 9 | | | | | RO | Num | ND | NC | | |
| **18.010** | Application Menu 1 Read-only Integer 10 | | | | | RO | Num | ND | NC | | |
| **18.011** | Application Menu 1 Read-write Integer 11 | | | 0 | | RW | Num | | | | US |
| **18.012** | Application Menu 1 Read-write Integer 12 | | | | | RW | Num | | | | US |
| **18.013** | Application Menu 1 Read-write Integer 13 | | | | | RW | Num | | | | US |
| **18.014** | Application Menu 1 Read-write Integer 14 | | | | | RW | Num | | | | US |
| **18.015** | Application Menu 1 Read-write Integer 15 | | | | | RW | Num | | | | US |
| **18.016** | Application Menu 1 Read-write Integer 16 | | | | | RW | Num | | | | US |
| **18.017** | Application Menu 1 Read-write Integer 17 | | | | | RW | Num | | | | US |
| **18.018** | Application Menu 1 Read-write Integer 18 | | | | | RW | Num | | | | US |
| **18.019** | Application Menu 1 Read-write Integer 19 | | | | | RW | Num | | | | US |
| **18.020** | Application Menu 1 Read-write Integer 20 | | | | | RW | Num | | | | US |
| **18.021** | Application Menu 1 Read-write Integer 21 | | | | | RW | Num | | | | US |
| **18.022** | Application Menu 1 Read-write Integer 22 | | | | | RW | Num | | | | US |
| **18.023** | Application Menu 1 Read-write Integer 23 | | | | | RW | Num | | | | US |
| **18.024** | Application Menu 1 Read-write Integer 24 | | | | | RW | Num | | | | US |
| **18.025** | Application Menu 1 Read-write Integer 25 | | | | | RW | Num | | | | US |
| **18.026** | Application Menu 1 Read-write Integer 26 | | | | | RW | Num | | | | US |
| **18.027** | Application Menu 1 Read-write Integer 27 | | | | | RW | Num | | | | US |
| **18.028** | Application Menu 1 Read-write Integer 28 | | | | | RW | Num | | | | US |
| **18.029** | Application Menu 1 Read-write Integer 29 | | | | | RW | Num | | | | US |
| **18.030** | Application Menu 1 Read-write Integer 30 | | | | | RW | Num | | | | US |
| **18.031** | Application Menu 1 Read-write bit 31 | Off (0) or On (1) | | Off (0) | | RW | Bit | | | | US |
| **18.032** | Application Menu 1 Read-write bit 32 | | | | | RW | Bit | | | | US |
| **18.033** | Application Menu 1 Read-write bit 33 | | | | | RW | Bit | | | | US |
| **18.034** | Application Menu 1 Read-write bit 34 | | | | | RW | Bit | | | | US |
| **18.035** | Application Menu 1 Read-write bit 35 | | | | | RW | Bit | | | | US |
| **18.036** | Application Menu 1 Read-write bit 36 | | | | | RW | Bit | | | | US |
| **18.037** | Application Menu 1 Read-write bit 37 | | | | | RW | Bit | | | | US |
| **18.038** | Application Menu 1 Read-write bit 38 | | | | | RW | Bit | | | | US |
| **18.039** | Application Menu 1 Read-write bit 39 | | | | | RW | Bit | | | | US |
| **18.040** | Application Menu 1 Read-write bit 40 | | | | | RW | Bit | | | | US |
| **18.041** | Application Menu 1 Read-write bit 41 | | | | | RW | Bit | | | | US |
| **18.042** | Application Menu 1 Read-write bit 42 | | | | | RW | Bit | | | | US |
| **18.043** | Application Menu 1 Read-write bit 43 | | | | | RW | Bit | | | | US |
| **18.044** | Application Menu 1 Read-write bit 44 | | | | | RW | Bit | | | | US |
| **18.045** | Application Menu 1 Read-write bit 45 | | | | | RW | Bit | | | | US |
| **18.046** | Application Menu 1 Read-write bit 46 | | | | | RW | Bit | | | | US |
| **18.047** | Application Menu 1 Read-write bit 47 | | | | | RW | Bit | | | | US |
| **18.048** | Application Menu 1 Read-write bit 48 | | | | | RW | Bit | | | | US |
| **18.049** | Application Menu 1 Read-write bit 49 | | | | | RW | Bit | | | | US |
| **18.050** | Application Menu 1 Read-write bit 50 | | | | | RW | Bit | | | | US |
| **18.051** | Application Menu 1 Power-down Save long Integer | -2147483648 to 2147483647 | | 0 | | RW | Num | | | | PS |
| **18.052** | Application Menu 1 Power-down Save long Integer | -2147483648 to 2147483647 | | 0 | | RW | Num | | | | PS |
| **18.053** | Application Menu 1 Power-down Save long Integer | -2147483648 to 2147483647 | | 0 | | RW | Num | | | | PS |
| **18.054** | Application Menu 1 Power-down Save long Integer | -2147483648 to 2147483647 | | 0 | | RW | Num | | | | PS |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.17 Menu 20: Application menu 2

| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **20.021** | Application Menu 2 Read-write Long Integer 21 | -2147483648 to 2147483647 | | 0 | | RW | Num | | | | |
| **20.022** | Application Menu 2 Read-write Long Integer 22 | | | | | RW | Num | | | | |
| **20.023** | Application Menu 2 Read-write Long Integer 23 | | | | | RW | Num | | | | |
| **20.024** | Application Menu 2 Read write Long Integer 24 | | | | | RW | Num | | | | |
| **20.025** | Application Menu 2 Read-write Long Integer 25 | | | | | RW | Num | | | | |
| **20.026** | Application Menu 2 Read-write Long Integer 26 | | | | | RW | Num | | | | |
| **20.027** | Application Menu 2 Read-write Long Integer 27 | | | | | RW | Num | | | | |
| **20.028** | Application Menu 2 Read-write Long Integer 28 | | | | | RW | Num | | | | |
| **20.029** | Application Menu 2 Read-write Long Integer 29 | | | | | RW | Num | | | | |
| **20.030** | Application Menu 2 Read-write Long Integer 30 | | | | | RW | Num | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.18 Menu 21: Second motor parameters

| Parameter | | Range (⇳) | | Default (⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **21.001** | M2 Maximum Speed | 0.00 to 550.00 Hz | | 50Hz: 50.00 Hz, 60Hz: 60.00 Hz | | RW | Num | | | | US |
| **21.002** | M2 Minimum Speed | 0.00 to Pr **21.001** Hz | | 0.00 Hz | | RW | Num | | | | US |
| **21.003** | M2 Reference Selector | A1.A2 (0), A1.Pr (1), A2.Pr (2), PrESEt (3), PAd (4), rES (5), PAd.rEF (6) | | A1.A2 (0) | | RW | Txt | | | | US |
| **21.004** | M2 Acceleration Rate 1 | 0.0 to 32000.0 s/Maximum Frequency | | 5.0 s/Maximum Frequency | | RW | Num | | | | US |
| **21.005** | M2 Deceleration Rate 1 | 0.0 to 32000.0 s/Maximum Frequency | | 10.0 s/Maximum Frequency | | RW | Num | | | | US |
| **21.006** | M2 Motor Rated Frequency | 0.00 to 550.00 Hz | | 50Hz: 50.00 Hz<br>60Hz: 60.00 Hz | | RW | Num | | RA | | US |
| **21.007** | M2 Motor Rated Current | 0.00 to Drive Rating A | | Maximum Heavy Duty Rating (11.032) | | RW | Num | | RA | | US |
| **21.008** | M2 Motor Rated Speed | 0.0 to 33000.0 rpm | | 50 Hz: 1500.0 rpm<br>60 Hz: 1800.0 rpm | 50 Hz: 1450.0rpm<br>60 Hz 1750.0 rpm | RW | Num | | | | US |
| **21.009** | M2 Motor Rated Voltage | 0 to 765 V | | 110 V drive: 230 V<br>200 V drive: 230 V<br>400 V drive 50Hz: 400 V<br>400 V drive 60Hz: 460 V<br>575 V drive: 575 V | | RW | Num | | RA | | US |
| **21.010** | M2 Motor Rated Power Factor | 0.00 to 1.00 | | 0.85 | | RW | Num | | RA | | US |
| **21.011** | M2 Number of Motor Poles* | Auto (0) to 32 (16) | | Auto (0) | | RW | Num | | | | US |
| **21.012** | M2 Stator Resistance | 0.0000 to 99.9999 Ω | | 0.0000 Ω | | RW | Num | | RA | | US |
| **21.014** | M2 Transient Inductance | 0.000 to 500.000 mH | | 0.000 mH | | RW | Num | | RA | | US |
| **21.015** | Motor 2 Active | Off (0) or On (1) | | | | RO | Bit | ND | NC | PT | |
| **21.016** | M2 Motor Thermal Time Constant 1 | 1 to 3000 s | | 179 s | 179 s | RW | Num | | | | US |
| **21.017** | M2 Frequency Controller Proportional Gain Kp1 | | 0.000 to 200.000 s/rad | | 0.100 s/rad | RW | Num | | | | US |
| **21.018** | M2 Frequency Controller Integral Gain Ki1 | | 0.00 to 655.35 s²/rad | | 0.10 s²/rad | RW | Num | | | | US |
| **21.019** | M2 Frequency Controller Differential Feedback Gain Kd1 | | 0.00000 to 0.65535 1/rad | | 0.00000 1/rad | RW | Num | | | | US |
| **21.022** | M2 Current Controller Kp Gain | 0.00 to 4000.00 | | 20.00 | | RW | Num | | | | US |
| **21.023** | M2 Current Controller Ki Gain | 0.000 to 600.000 | | 40.000 | | RW | Num | | | | US |
| **21.024** | M2 Stator Inductance | 0.00 to 5000.00 mH | | 0.00 mH | | RW | Num | | RA | | US |
| **21.025** | M2 Saturation Breakpoint 1 | | 0.0 to 100.0 % | | 50.0 % | RW | Num | | | | US |
| **21.026** | M2 Saturation Breakpoint 3 | | 0.0 to 100.0 % | | 75.0 % | RW | Num | | | | US |
| **21.027** | M2 Motoring Current Limit | 0.0 to VM_MOTOR2_CURRENT_LIMIT % | | 165.0 %** | 175.0 %*** | RW | Num | | RA | | US |
| **21.028** | M2 Regenerating Current Limit | 0.0 to VM_MOTOR2_CURRENT_LIMIT % | | 165.0 %** | 175.0 %*** | RW | Num | | RA | | US |
| **21.029** | M2 Symmetrical Current Limit | 0.0 to VM_MOTOR2_CURRENT_LIMIT % | | 165.0 %** | 175.0 %*** | RW | Num | | RA | | US |
| **21.033** | M2 Low Frequency Thermal Protection Mode | 0 to 1 | | 0 | | RW | Num | | | | US |
| **21.041** | M2 Saturation Breakpoint 2 | | 0.0 to 100.0 % | | 0.0 % | RW | Num | | | | US |
| **21.042** | M2 Saturation Breakpoint 4 | | 0.0 to 100.0 % | | 0.0 % | RW | Num | | | | US |

* When read via serial communications, this parameter will show pole pairs.

** For size 9, the default is 141.9 %

*** For size 9, the default is 150.0 %

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.19 Menu 22: Additional Menu 0 set-up

| Parameter | | Range(⇳) | | Default(⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **22.011** | Parameter 00.011 Set-up | 0.000 to 30.999 | | 6.004 | | RW | Num | | | PT | US |
| **22.012** | Parameter 00.012 Set-up | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **22.013** | Parameter 00.013 Set-up | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **22.014** | Parameter 00.014 Set-up | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **22.015** | Parameter 00.015 Set-up | 0.000 to 30.999 | | 1.005 | | RW | Num | | | PT | US |
| **22.016** | Parameter 00.016 Set-up | 0.000 to 30.999 | | 7.007 | | RW | Num | | | PT | US |
| **22.017** | Parameter 00.017 Set-up | 0.000 to 30.999 | | 1.010 | | RW | Num | | | PT | US |
| **22.018** | Parameter 00.018 Set-up | 0.000 to 30.999 | | 1.021 | | RW | Num | | | PT | US |
| **22.019** | Parameter 00.019 Set-up | 0.000 to 30.999 | | 1.022 | | RW | Num | | | PT | US |
| **22.020** | Parameter 00.020 Set-up | 0.000 to 30.999 | | 1.023 | | RW | Num | | | PT | US |
| **22.021** | Parameter 00.021 Set-up | 0.000 to 30.999 | | 1.024 | | RW | Num | | | PT | US |
| **22.022** | Parameter 00.022 Set-up | 0.000 to 30.999 | | 11.019 | | RW | Num | | | PT | US |
| **22.023** | Parameter 00.023 Set-up | 0.000 to 30.999 | | 11.018 | | RW | Num | | | PT | US |
| **22.024** | Parameter 00.024 Set-up | 0.000 to 30.999 | | 11.021 | | RW | Num | | | PT | US |
| **22.025** | Parameter 00.025 Set-up | 0.000 to 30.999 | | 11.030 | | RW | Num | | | PT | US |
| **22.026** | Parameter 00.026 Set-up | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **22.027** | Parameter 00.027 Set-up | 0.000 to 30.999 | | 1.051 | | RW | Num | | | PT | US |
| **22.028** | Parameter 00.028 Set-up | 0.000 to 30.999 | | 2.004 | | RW | Num | | | PT | US |
| **22.029** | Parameter 00.029 Set-up | 0.000 to 30.999 | | 0.000 | 2.002 | RW | Num | | | PT | US |
| **22.030** | Parameter 00.030 Set-up | 0.000 to 30.999 | | 11.042 | | RW | Num | | | PT | US |
| **22.031** | Parameter 00.031 Set-up | 0.000 to 30.999 | | 6.001 | | RW | Num | | | PT | US |
| **22.032** | Parameter 00.032 Set-up | 0.000 to 30.999 | | 5.013 | | RW | Num | | | PT | US |
| **22.033** | Parameter 00.033 Set-up | 0.000 to 30.999 | | 6.009 | | RW | Num | | | PT | US |
| **22.034** | Parameter 00.034 Set-up | 0.000 to 30.999 | | 8.035 | | RW | Num | | | PT | US |
| **22.035** | Parameter 00.035 Set-up | 0.000 to 30.999 | | 8.091 | | RW | Num | | | PT | US |
| **22.036** | Parameter 00.036 Set-up | 0.000 to 30.999 | | 7.055 | | RW | Num | | | PT | US |
| **22.037** | Parameter 00.037 Set-up | 0.000 to 30.999 | | 5.018 | | RW | Num | | | PT | US |
| **22.038** | Parameter 00.038 Set-up | 0.000 to 30.999 | | 5.012 | | RW | Num | | | PT | US |
| **22.039** | Parameter 00.039 Set-up | 0.000 to 30.999 | | 5.006 | | RW | Num | | | PT | US |
| **22.040** | Parameter 00.040 Set-up | 0.000 to 30.999 | | 5.011 | | RW | Num | | | PT | US |
| **22.041** | Parameter 00.041 Set-up | 0.000 to 30.999 | | 5.014 | | RW | Num | | | PT | US |
| **22.042** | Parameter 00.042 Set-up | 0.000 to 30.999 | | 5.015 | | RW | Num | | | PT | US |
| **22.043** | Parameter 00.043 Set-up | 0.000 to 30.999 | | 11.025 | | RW | Num | | | PT | US |
| **22.044** | Parameter 00.044 Set-up | 0.000 to 30.999 | | 11.023 | | RW | Num | | | PT | US |
| **22.045** | Parameter 00.045 Set-up | 0.000 to 30.999 | | 11.020 | | RW | Num | | | PT | US |
| **22.046** | Parameter 00.046 Set-up | 0.000 to 30.999 | | 12.042 | | RW | Num | | | PT | US |
| **22.047** | Parameter 00.047 Set-up | 0.000 to 30.999 | | 12.043 | | RW | Num | | | PT | US |
| **22.048** | Parameter 00.048 Set-up | 0.000 to 30.999 | | 12.044 | | RW | Num | | | PT | US |
| **22.049** | Parameter 00.049 Set-up | 0.000 to 30.999 | | 12.045 | | RW | Num | | | PT | US |
| **22.050** | Parameter 00.050 Set-up | 0.000 to 30.999 | | 12.046 | | RW | Num | | | PT | US |
| **22.051** | Parameter 00.051 Set-up | 0.000 to 30.999 | | 12.047 | | RW | Num | | | PT | US |
| **22.052** | Parameter 00.052 Set-up | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **22.053** | Parameter 00.053 Set-up | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **22.054** | Parameter 00.054 Set-up | 0.000 to 30.999 | | 12.051 | | RW | Num | | | PT | US |
| **22.055** | Parameter 00.055 Set-up | 0.000 to 30.999 | | 12.041 | | RW | Num | | | PT | US |
| **22.056** | Parameter 00.056 Set-up | 0.000 to 30.999 | | 10.020 | | RW | Num | | | PT | US |
| **22.057** | Parameter 00.057 Set-up | 0.000 to 30.999 | | 10.021 | | RW | Num | | | PT | US |
| **22.058** | Parameter 00.058 Set-up | 0.000 to 30.999 | | 10.022 | | RW | Num | | | PT | US |
| **22.059** | Parameter 00.059 Set-up | 0.000 to 30.999 | | 11.047 | | RW | Num | | | PT | US |
| **22.060** | Parameter 00.060 Set-up | 0.000 to 30.999 | | 11.048 | | RW | Num | | | PT | US |
| **22.061** | Parameter 00.061 Set-up | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **22.062** | Parameter 00.062 Set-up | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **22.063** | Parameter 00.063 Set-up | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |
| **22.064** | Parameter 00.064 Set-up | 0.000 to 30.999 | | 02.039 | | RW | Num | | | PT | US |
| **22.065** | Parameter 00.065 Set-up | 0.000 to 30.999 | | 0.000 | 3.010 | RW | Num | | | PT | US |
| **22.066** | Parameter 00.066 Set-up | 0.000 to 30.999 | | 0.000 | 3.011 | RW | Num | | | PT | US |

| Parameter | | Range(⇳) | | Default(⇨) | | Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OL | RFC-A | OL | RFC-A | | | | | | |
| **22.067** | Parameter 00.067 Set-up | 0.000 to 30.999 | | 0.000 | 3.079 | RW | Num | | | PT | US |
| **22.068** | Parameter 00.068 Set-up | 0.000 to 30.999 | | 0.000 | 0.000 | RW | Num | | | PT | US |
| **22.069** | Parameter 00.069 Set-up | 0.000 to 30.999 | | 5.040 | | RW | Num | | | PT | US |
| **22.070** | Parameter 00.070 Set-up | 0.000 to 30.999 | | 14.001 | | RW | Num | | | PT | US |
| **22.071** | Parameter 00.071 Set-up | 0.000 to 30.999 | | 14.010 | | RW | Num | | | PT | US |
| **22.072** | Parameter 00.072 Set-up | 0.000 to 30.999 | | 14.011 | | RW | Num | | | PT | US |
| **22.073** | Parameter 00.073 Set-up | 0.000 to 30.999 | | 14.006 | | RW | Num | | | PT | US |
| **22.074** | Parameter 00.074 Set-up | 0.000 to 30.999 | | 14.013 | | RW | Num | | | PT | US |
| **22.075** | Parameter 00.075 Set-up | 0.000 to 30.999 | | 14.014 | | RW | Num | | | PT | US |
| **22.076** | Parameter 00.076 Set-up | 0.000 to 30.999 | | 10.037 | | RW | Num | | | PT | US |
| **22.077** | Parameter 00.077 Set-up | 0.000 to 30.999 | | 11.032 | | RW | Num | | | PT | US |
| **22.078** | Parameter 00.078 Set-up | 0.000 to 30.999 | | 11.029 | | RW | Num | | | PT | US |
| **22.079** | Parameter 00.079 Set-up | 0.000 to 30.999 | | 11.031 | | RW | Num | | | PT | US |
| **22.080** | Parameter 00.080 Set-up | 0.000 to 30.999 | | 0.000 | | RW | Num | | | PT | US |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | Binary parameter | FI | Filtered |
| ND | No default value | NC | Not copied | PT | Protected parameter | RA | Rating dependent | US | User save | PS | Power-down save | DE | Destination |

## 11.20 Menu 24: Option Module Application

# 12 Diagnostics

The keypad display on the drive gives various information about the status of the drive. The keypad display provides information on the following categories:

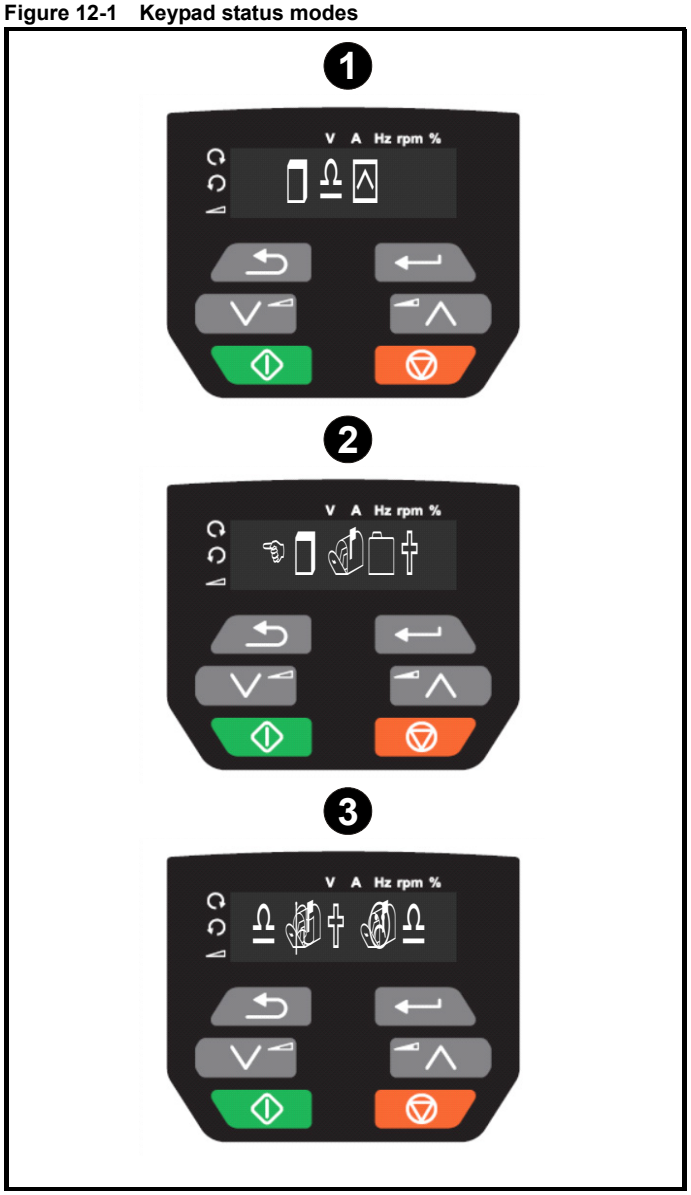
- Trip indications
- Alarm indications
- Status indications

**WARNING**

Users must not attempt to repair a drive if it is faulty, nor carry out fault diagnosis other than through the use of the diagnostic features described in this chapter.
If a drive is faulty, it must be returned to an authorized Control Techniques distributor for repair.

## 12.1 Status modes (Keypad and LED status)

**Figure 12-1 Keypad status modes**




**1** Drive OK status

**2** Trip status

**3** Alarm status

## 12.2 Trip indications

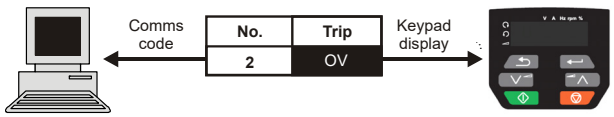
The output of the drive is disabled under any trip condition so that the drive stops controlling the motor. If the motor is running when the trip occurs it will coast to a stop.

During a trip condition, the display indicates that a trip has occurred and the keypad will display the trip string. Some trips have a sub-trip number to provide additional information about the trip. If a trip has a sub-trip number, the sub-trip number is flashed alternately with the trip string.

Trips are listed alphabetically in Table 12-2 based on the trip indication shown on the drive display. Alternatively, the drive status can be read in Pr **10.001** 'Drive OK' using communication protocols. The most recent trip can be read in Pr **10.020** providing a trip number. It must be noted that the hardware trips (HF01 to HF23) do not have trip numbers (except HF08, HF11, HF12 & HF18 which have sub-trip number/s). The trip number must be checked in Table 12-2 to identify the specific trip.

### Example

1. Trip code 2 is read from Pr **10.020** via serial communications.
2. Checking Table 12-3 shows Trip 2 is an OV trip.




3. Look up OV in Table 12-2.
4. Perform checks detailed under *Diagnosis*.

## 12.3 Identifying a trip / trip source

Some trips only contain a trip string whereas some other trips have a trip string along with a sub-trip number which provides the user with additional information about the trip.

A trip can be generated from a control system or from a power system. The sub-trip number associated with the trips listed in Table 12-1 is in the form xxyzz and used to identify the source of the trip.

**Table 12-1 Trips associated with xxyzz sub-trip number**

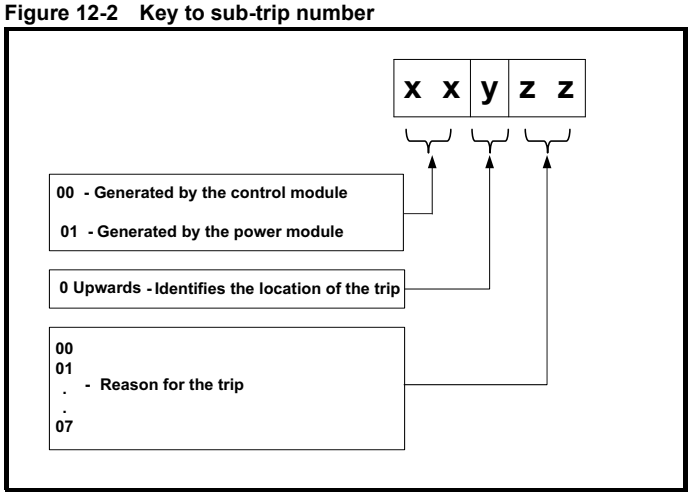
| | |
|---|---|
| OV | PH.Lo |
| PSU | OI.Sn |
| Oht.I | tH.Fb |
| Oht.P | P.dAt |
| Oh.dc | |

The digits xx are 00 for a trip generated by the control system. For a drive, if the trip is related to the power system then xx will have a value of 01, when displayed the leading zeros are suppressed.

For a control system trip (xx is zero), the y digit where relevant is defined for each trip. If not relevant, the y digit will have a value of zero.

The zz digits give the reason for the trip and are defined in each trip description.

**Figure 12-2 Key to sub-trip number**



## 12.4 Trips, Sub-trip numbers

**Table 12-2 Trip indications**

| Trip | Diagnosis |
|---|---|
| **C.Acc** | **NV Media Card Write fail** |
| **185** | The *C.Acc* trip indicates that the drive was unable to access the NV Media Card. If the trip occurs during the data transfer to the card then the file being written may be corrupted. If the trip occurs when the data being transferred to the drive then the data transfer may be incomplete. If a parameter file is transferred to the drive and this trip occurs during the transfer, the parameters are not saved to non-volatile memory, and so the original parameters can be restored by powering the drive down and up again.<br>**Recommended actions:**<br>• Check NV Media Card is installed / located correctly<br>• Replace the NV Media Card |
| **C.by** | **NV Media Card cannot be accessed as it is being accessed by an option module** |
| **178** | The *C.by* trip indicates that an attempt has been made to access a file on NV Media Card, but the NV Media Card is already being accessed by an Option Module. No data is transferred.<br>**Recommended actions:**<br>• Wait for the option module to finish accessing the NV Media Card and re-attempt the required function |
| **C.cPr** | **NV Media Card file/data is different to the one in the drive** |
| **188** | A compare has been carried out between a file on the NV Media Card and the drive, a *C.cPr* trip is initiated if the parameters on the NV Media Card are different to the drive.<br>**Recommended actions:**<br>• Set Pr **00** to 0 and reset the trip<br>• Check to ensure the correct data block on the NV Media Card has been used for the compare |
| **C.d.E** | **NV Media Card data location already contains data** |
| **179** | The *C.d.E* trip indicates that an attempt has been made to store data on a NV Media Card in a data block which already contains data.<br>**Recommended actions:**<br>• Erase the data in data location<br>• Write data to an alternative data location |
| **C.dAt** | **NV Media Card data not found** |
| **183** | The *C.dAt* trip indicates that an attempt has been made to access a non-existent file on the NV Media Card.<br>No data is transferred.<br>**Recommended actions:**<br>• Ensure data file number is correct |
| **C.Err** | **NV Media Card data structure error** |
| **182** | The *C.Err* trip indicates that an attempt has been made to access the NV Media Card but an error has been detected in the data structure on the card. Resetting the trip will cause the drive to erase and create the correct folder structure. On an SD card, whilst this trip is present, missing directories will be created and if the header file is missing it will be created. The cause of the trip can be identified by the sub-trip.<br>**Sub-trip** / **Reason**<br>1 – The required folder and file structure is not present<br>2 – The 000.DAT file is corrupted<br>3 – Two or more files in the <MCDF\> folder have the same file identification number<br>**Recommended actions:**<br>• Erase all the data block and re-attempt the process<br>• Ensure the card is located correctly<br>• Replace the NV Media Card |
| **C.Ful** | **NV Media Card full** |
| **184** | The *C.Ful* trip indicates that an attempt has been made to create a data block on a NV Media Card, but there is not enough space left on the card. No data is transferred.<br>**Recommended actions:**<br>• Delete a data block or the entire NV Media Card to create space<br>• Use a different NV Media Card |

| Trip | Diagnosis |
|---|---|
| **C.OPt** | **NV Media Card trip; option module installed is different between source drive and destination drive** |
| **180** | The *C.OPt* trip indicates that parameter data is being transferred from the NV Media Card to the drive, but the option module category is different between the source and destination drives. This trip does not stop the data transfer, but is a warning that the data for the option module that is different will be set to the default values and not the values from the card. This trip also applies if a compare is performed between the data block on the card and the drive, and the option module fitted is different between the source and target.<br>**Recommended actions:**<br>• Ensure the correct option module is installed.<br>• Press the red reset button to acknowledge that the parameters for the option module installed will be at their default values<br>• This trip can be suppressed by setting Pr **00** to 9666 and resetting the drive. |
| **C.Pr** | **NV Media Card data blocks are not compatible with the drive derivative** |
| **175** | The *C.Pr* trip is initiated either at power-up or when the card is accessed, If *Drive Derivative* (11.028) or *Product Type* (11.063) are different between the source and target drives. This trip can be reset and data can be transferred in either direction between the drive and the card.<br><br>**Sub-trip** / **Reason**<br>1 – If *Drive Derivative* (11.028) is different between the source and target drives. This trip is initiated either at power-up or when the SD card is accessed. This trip can be reset and data can be transferred in either direction between the drive and the card.<br>2 – If *Product Type* (11.063) is different between the source and target drives or the file is corrupted or incompatible. This trip is initiated either at power-up or when the SD card is accessed. This trip can be reset but no data are transferred in either direction between the drive and the card.<br><br>**Recommended actions:**<br>• Use a different NV Media Card<br>• This trip can be suppressed by setting Pr **00** to 9666 and resetting the drive<br>• Choose a file compatible between the source and target drives, if sub-trip 2. |
| **C.rdo** | **NV Media Card has the Read Only bit set** |
| **181** | The *C.rdo* trip indicates that an attempt has been made to modify data on a read-only NV Media Card or to modify a read-only data block. A NV Media Card is read-only if the read-only flag has been set.<br>**Recommended actions:**<br>• Clear the read only flag by setting Pr **00** to 9777 and reset the drive. This will clear the read-only flag for all data blocks in the NV Media Card |
| **C.rtg** | **NV Media Card Trip; The voltage and / or current rating of the source and destination drives are different** |
| **186** | The *C.rtg* trip indicates that parameter data is being transferred from the NV Media Card to the drive, but the current and / or voltage ratings are different between source and destination drives. This trip also applies if a compare (using Pr **mm.000** set to 8yyy) is performed between the data block on a NV Media Card and the drive. The *C.rtg* trip does not stop the data transfer but is a warning that rating specific parameters with the RA attribute may not be transferred to the destination drive.<br>**Recommended actions:**<br>• Reset the drive to clear the trip<br>• Ensure that the drive rating dependent parameters have transferred correctly<br>• This trip can be suppressed by setting Pr **00** to 9666 and resetting the drive. |
| **C.SL** | **NV Media Card trip; Option module file transfer has failed** |
| **174** | The *C.SL* trip is initiated, if the transfer of an option module file to or from a module failed because the option module does not respond correctly. If this happens this trip is produced with the sub-trip number indicating the option module slot number. |
| **C.tyP** | **NV Media Card parameter set not compatible with current drive mode** |
| **187** | The *C.tyP* trip is produced during a compare if the drive mode in the data block on the NV Media Card is different from the current drive mode. This trip is also produced if an attempt is made to transfer parameters from a NV Media Card to the drive if the operating mode in the data block is outside the allowed range of operating modes, for the target drive.<br>**Recommended actions:**<br>• Ensure the destination drive supports the drive operating mode in the parameter file.<br>• Clear the value in Pr **00** and reset the drive<br>• Ensure destination drive operating mode is the same as the source parameter file |

| Trip | Diagnosis |
|---|---|
| **cL.A1** | **Analog input 1 current loss** |
| **28** | The *cL.A1* trip indicates that a current loss was detected in current mode on Analog input 1 (Terminal 2). In 4-20 mA and 20-4 mA modes loss of input is detected if the current falls below 3 mA.<br>**Recommended actions:**<br>• Check control wiring is correct<br>• Check control wiring is undamaged<br>• Check the *Analog Input 1 Mode* (07.007)<br>• Current signal is present and greater than 3 mA |
| **CL.bt** | **Trip initiated from the *Control Word* (06.042)** |
| **35** | The *CL.bt* trip is initiated by setting bit 12 on the control word in Pr **06.042** when the control word is enabled (Pr **06.043** = On).<br>**Recommended actions:**<br>• Check the value of Pr **06.042.**<br>• Disable the control word in *Control Word Enable* (Pr **06.043**)<br>Bit 12 of the control word set to a one causes the drive to trip on Control Word<br>When the control word is enabled, the trip can only be cleared by setting bit 12 to zero |
| **Cur.c** | **Current calibration range** |
| **231** | Current calibration range error.<br>**Recommended actions:**<br>• Hardware fault - Contact the supplier of the drive. |
| **Cur.O** | **Current feedback offset error** |
| **225** | The *Cur.O* trip indicates that the current offset is too large to be trimmed.<br>**Recommended actions:**<br>• Ensure that there is no possibility of current flowing in the output phases of the drive when the drive is not enabled<br>• Hardware fault – Contact the supplier of the drive |
| **d.Ch** | **Drive parameters are being changed** |
| **97** | A user action or a file system write is active that is changing the drive parameters and the drive has been commanded to enable, i.e. *Drive Active* (10.002) = 1.<br>The user actions that change drive parameters are loading defaults, changing drive mode, or transferring data from an NV memory card to the drive. The file system actions that will cause this trip to be initiated if the drive is enabled during the transfer is writing a parameter or macro file to the drive. It should be noted that none of these actions can be started if the drive is active, and so the trip only occurs if the action is started and then the drive is enabled.<br>**Recommended actions:**<br>• Ensure the drive is not enabled when one of the following is being carried out:<br>Loading defaults<br>Changing drive mode<br>Transferring data from NV media card |
| **dcct** | **dcct reference out of range for size 5 upwards only** |
| **110** | The sub-trip number indicates the DCCT that has caused the trip.<br>**Recommended actions:**<br>• Hardware fault - Contact the supplier of the drive |
| **dEr.E** | **Derivative file error** |
| **246** | Derivative file error with sub-trips:<br>**Sub-trip** / **Reason** / **Comments**<br>1 / The derivative file is missing or is invalid / Occurs when the drive powers-up. Load valid derivative file matching the control board hardware.<br>2 / The derivative file does not match the control board hardware / Occurs when the drive powers-up. Load valid derivative file matching the control board hardware.<br>3 / The derivative file has been changed for a file with a different derivative number. / Occurs when the drive powers-up or the file is programmed. The file tasks will not run.<br>**Recommended actions:**<br>• Contact the supplier of the drive |

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>dEr.I</td><td>Derivative product image error</td></tr>
<tr><td>248</td><td>The dEr.I trip indicates that an error has been detected in the derivative product image. The reason for the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th><th>Comments</th></tr>
<tr><td>1</td><td>Divide by zero</td><td></td></tr>
<tr><td>2</td><td>Undefined trip</td><td></td></tr>
<tr><td>3</td><td>Attempted fast parameter access set-up with non-existent parameter</td><td></td></tr>
<tr><td>4</td><td>Attempted access to non-existent parameter</td><td></td></tr>
<tr><td>5</td><td>Attempted write to read-only parameter</td><td></td></tr>
<tr><td>6</td><td>Attempted an over-range write</td><td></td></tr>
<tr><td>7</td><td>Attempted read from write-only parameter</td><td></td></tr>
<tr><td>30</td><td>The image has failed because either its CRC is incorrect, or there are less than 6 bytes in the image or the image header version is less than 5</td><td>Occurs when the drive powers-up or the image is programmed. The image tasks will not run</td></tr>
<tr><td>31</td><td>The image requires more RAM for heap and stack than can be provided by the drive.</td><td>As 30</td></tr>
<tr><td>32</td><td>The image requires an OS function call that is higher than the maximum allowed.</td><td>As 30</td></tr>
<tr><td>33</td><td>The ID code within the image is not valid</td><td>As 30</td></tr>
<tr><td>34</td><td>The derivative image has been changed for an image with a different derivative number</td><td>As 30</td></tr>
<tr><td>40</td><td>The timed task has not completed in time and has been suspended</td><td>Reduce code in timed task or power down repeat rate.</td></tr>
<tr><td>41</td><td>Undefined function called, i.e. a function in the host system vector table that has not been assigned</td><td>As 40</td></tr>
<tr><td>51</td><td>Core menu customization table CRC check failed</td><td>As 30</td></tr>
<tr><td>52</td><td>Customizable menu table CRC check failed</td><td>As 30</td></tr>
<tr><td>53</td><td>Customizable menu table changed</td><td>Occurs when the drive powers-up or the image is programmed and the table has changed. Defaults are loaded for the derivative menu and the trip will keep occurring until drive parameters are saved.</td></tr>
<tr><td>61</td><td>The option module installed in slot 1 is not allowed with the derivative image</td><td>As 30</td></tr>
<tr><td>80</td><td>Image is not compatible with the control board</td><td>Initiated from within the image code</td></tr>
<tr><td>81</td><td>Image is not compatible with the control board serial number</td><td>As 80</td></tr>
</table>
Recommended actions:<br>• Contact the supplier of the drive</td></tr>
<tr><td>dESt</td><td>Two or more parameters are writing to the same destination parameter</td></tr>
<tr><td>199</td><td>The dESt trip indicates that destination parameters of two or more functions (Menus 7, 8, 9, 12 or 14) within the drive are writing to the same parameter.<br>Recommended actions:<br>• Set Pr 00 to ‘dest’ or 12001 and check all visible parameters in all menus for parameter write conflicts.</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>dr.CF</td><td>Drive configuration</td></tr>
<tr><td>232</td><td>The hardware ID does not match the user software ID.<br><table><tr><th>Sub-trip</th><th>Reason</th></tr><tr><td>1</td><td>The hardware ID does not match the user software ID (size 5 upwards only).</td></tr><tr><td>2</td><td>Invalid hardware ID.</td></tr><tr><td>3</td><td>The hardware ID does not match the user software ID (Size 1-4)</td></tr></table>Recommended actions:<br>• Hardware fault - Contact the supplier of the drive</td></tr>
<tr><td>EEF</td><td>Default parameters have been loaded</td></tr>
<tr><td>31</td><td>The EEF trip indicates that default parameters have been loaded. The exact cause/reason of the trip can be identified from the sub-trip number.<br><table><tr><th>Sub-trip</th><th>Reason</th></tr><tr><td>1</td><td>The most significant digit of the internal parameter database version number has changed</td></tr><tr><td>2</td><td>The CRC's applied to the parameter data stored in internal non-volatile memory indicate that a valid set of parameters cannot be loaded</td></tr><tr><td>3</td><td>The drive mode restored from internal non-volatile memory is outside the allowed range for the product or the derivative image does not allow the previous drive mode</td></tr><tr><td>4</td><td>The drive derivative image has changed</td></tr><tr><td>5</td><td>The power stage hardware has changed</td></tr><tr><td>6</td><td>Reserved</td></tr><tr><td>7</td><td>Reserved</td></tr><tr><td>8</td><td>The control board hardware has changed</td></tr><tr><td>9</td><td>The checksum on the non-parameter area of the EEPROM has failed</td></tr></table>The drive holds two banks of user save parameters and two banks of power down save parameters in non-volatile memory. If the last bank of either set of parameters that was saved is corrupted a U.S or Pd.S trip is produced. If one of these trips occurs the parameters values that were last saved successfully are used. It can take some time to save parameters when requested by the user and if the power is removed from the drive during this process it is possible to corrupt the data in the non-volatile memory.<br>If both banks of user save parameters or both banks of power down save parameters are corrupted or one of the other conditions given in the table above occurs EEF.xxx trip is produced. If this trip occurs it is not possible to use the data that has been saved previously, and so the drive will be loaded with default parameters. The trip can only be reset if Parameter 00 (mm.000) is set to 10, 11, 1233 or 1244 or if Load Defaults (11.043) is set to a non-zero value.<br>Recommended actions:<br>• Default the drive and perform a reset<br>• Allow sufficient time to perform a save before the supply to the drive is removed<br>• If the trip persists - return drive to supplier</td></tr>
<tr><td>Et</td><td>An External trip is initiated</td></tr>
<tr><td>6</td><td>An Et trip has occurred. The cause of the trip can be identified from the sub trip number displayed after the trip string. See table below. An external trip can also be initiated by writing a value of 6 in Pr 10.038.<br><table><tr><th>Sub-trip</th><th>Reason</th></tr><tr><td>3</td><td>External Trip (10.032) = 1</td></tr></table>Recommended actions:<br>• Check the value of Pr 10.032.<br>• Select ‘dest’ (or enter 12001) in Pr 00 and check for a parameter controlling Pr 10.032.<br>• Ensure Pr 10.032 or Pr 10.038 (= 6) is not being controlled by serial comms</td></tr>
<tr><td>FAn.F</td><td>Fan fail</td></tr>
<tr><td>173</td><td>This trip cannot be reset until 10 s after the trip was initiated.<br>Recommended actions:<br>• Check that the fan is installed and connected correctly.<br>• Check that the fan is not obstructed.<br>• Contact the supplier of the drive to replace the fan.</td></tr>
<tr><td>Fi.Ch</td><td>File changed</td></tr>
<tr><td>247</td><td>Recommended actions:<br>• Power cycle the drive.</td></tr>
</table>

| Trip | Diagnosis |
|---|---|
| **FI.In** | **Firmware incompatibility** |
| **237** | The FI.In trip indicates that the user firmware is incompatible with the power firmware.<br>**Recommended actions:**<br>Re-program the drive with the latest version of the drive firmware for the Commander C200/C300, using Connect. |
| **HF01** | **Data processing error: CPU hardware fault** |
| | The *HF01* trip indicates that a CPU address error has occurred. This trip indicates that the control PCB on the drive has failed.<br>**Recommended actions:**<br>• Hardware fault – Contact the supplier of the drive |
| **HF02** | **Data processing error: CPU memory management fault** |
| | The *HF02* trip indicates that a DMAC address error has occurred. This trip indicates that the control PCB on the drive has failed.<br>**Recommended actions:**<br>• Hardware fault – Contact the supplier of the drive |
| **HF03** | **Data processing error: CPU has detected a bus fault** |
| | The *HF03* trip indicates that a bus fault has occurred. This trip indicates that the control PCB on the drive has failed.<br>**Recommended actions:**<br>• Hardware fault – Contact the supplier of the drive |
| **HF04** | **Data processing error: CPU has detected a usage fault** |
| | The *HF04* trip indicates that a usage fault has occurred.This trip indicates that the control PCB on the drive has failed.<br>**Recommended actions:**<br>• Hardware fault – Contact the supplier of the drive |
| **HF05** | **Reserved** |
| | |
| **HF06** | **Reserved** |
| | |
| **HF07** | **Data processing error: Watchdog failure** |
| | The *HF07* trip indicates that a watchdog failure has occurred. This trip indicates that the control PCB on the drive has failed.<br>**Recommended actions:**<br>• Hardware fault – Contact the supplier of the drive |
| **HF08** | **Data processing error: CPU Interrupt crash** |
| | The *HF08* trip indicates that a CPU interrupt crash has occurred. This trip indicates that the control PCB on the drive has failed. The crash level is indicated by the sub-trip number.<br>**Recommended actions:**<br>• Hardware fault – Contact the supplier of the drive |
| **HF09** | **Data processing error: Free store overflow** |
| | The *HF09* trip indicates that a free store overflow has occurred. This trip indicates that the control PCB on the drive has failed.<br>**Recommended actions:**<br>• Hardware fault – Contact the supplier of the drive |
| **HF10** | **Reserved** |
| | |
| **HF11** | **Data processing error: Non-volatile memory comms error** |
| | The *HF11* trip indicates that a non-volatile memory comms error has occurred. This trip indicates that the control PCB on the drive has failed. The crash level is indicated by the sub-trip number. |

| Sub-trip | Reason | Recommended action |
|---|---|---|
| 1 | Non-volatile memory comms error. | Hardware fault – contact the supplier of the drive. |
| 2 | EEPROM size is incompatible with the user firmware. | Re-program drive with compatible user firmware. |

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>HF12</td><td>Data processing error: Main program stack overflow</td></tr>
<tr><td></td><td>The HF12 trip indicates that the main program stack over flow has occurred. The stack can be identified by the sub-trip number. This trip indicates that the control PCB on the drive has failed.<br><br><table><tr><th>Sub-trip</th><th>Reason</th></tr><tr><td>1</td><td>Derivative background stack overflow</td></tr><tr><td>2</td><td>Derivative timed stack overflow</td></tr><tr><td>3</td><td>Main system interrupt stack overflow</td></tr><tr><td>4</td><td>Main system background stack overflow</td></tr></table><br>Recommended actions:<br>• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF13</td><td>Reserved</td></tr>
<tr><td></td><td></td></tr>
<tr><td>HF14</td><td>Reserved</td></tr>
<tr><td></td><td></td></tr>
<tr><td>HF15</td><td>Reserved</td></tr>
<tr><td></td><td></td></tr>
<tr><td>HF16</td><td>Data processing error: RTOS error</td></tr>
<tr><td></td><td>The HF16 trip indicates that a RTOS error has occurred. This trip indicates that the control PCB on the drive has failed.<br>Recommended actions:<br>• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF17</td><td>Reserved</td></tr>
<tr><td></td><td></td></tr>
<tr><td>HF18</td><td>Data processing error: Internal flash memory has failed</td></tr>
<tr><td></td><td>The HF18 trip indicates that the internal flash memory has failed when writing option module parameter data. The reason for the trip can be identified by the sub-trip number.<br><br><table><tr><th>Sub-trip</th><th>Reason</th></tr><tr><td>1</td><td>Programming error while writing menu in flash</td></tr><tr><td>2</td><td>Erase flash block containing setup menus failed</td></tr><tr><td>3</td><td>Erase flash block containing application menus failed</td></tr></table><br>Recommended actions:<br>Hardware fault - contact the supplier of the drive.</td></tr>
<tr><td>HF19</td><td>Data processing error: CRC check on the firmware has failed</td></tr>
<tr><td></td><td>The HF19 trip indicates that the CRC check on the drive firmware has failed. The drive is now in its bootloader mode and is waiting for a new image to be downloaded using Connect. Once a new image is downloaded, the drive can run normally.<br>Recommended actions:<br>• Re-program the drive with latest control and power firmware using Connect.<br>• Hardware fault - Contact the supplier of the drive</td></tr>
<tr><td>HF23</td><td>Hardware fault</td></tr>
<tr><td></td><td>Recommended actions:<br>• If this trip occurs, contact the supplier of the drive.</td></tr>
<tr><td>It.Ac</td><td>Output current overload timed out (I$^2$t)</td></tr>
<tr><td>20</td><td>The It.Ac trip indicates a motor thermal overload based on the Motor Rated Current (Pr 05.007) and Motor Thermal Time Constant (Pr 04.015). Pr 04.019 displays the motor temperature as a percentage of the maximum value. The drive will trip on It.AC when Pr 04.019 gets to 100 %.<br>Recommended actions:<br>• Ensure the load is not jammed / sticking<br>• Check the load on the motor has not changed<br>• Tune the motor rated speed parameter (Pr 05.008) (RFC-A mode only)<br>• Ensure the motor rated current is not zero</td></tr>
</table>

| Trip | Diagnosis |
|---|---|
| **It.br** | **Braking resistor overload timed out ($I^2t$)** |
| **19** | The *It.br* trip indicates that braking resistor overload has timed out. The value in *Braking Resistor Thermal Accumulator* (10.039) is calculated using *Braking Resistor Rated Power* (10.030), *Braking Resistor Thermal Time Constant* (10.031) and *Braking Resistor Resistance* (10.061). The *It.br* trip is initiated when the *Braking Resistor Thermal Accumulator* (10.039) reaches 100 %.<br>**Recommended actions:**<br>• Ensure the values entered in Pr **10.030**, Pr **10.031** and Pr **10.061** are correct.<br>• Check resistor value and power rating.<br>• If an external thermal protection device is being used and the braking resistor software overload protection is not required, set Pr **10.030**, Pr **10.031** or Pr **10.061** to 0 to disable the trip. |
| **LF.Er** | **Communication has been lost / errors detected between power, control and rectifier modules** |
| **90** | This trip is initiated if there is no communications between power, control or the rectifier module or if excessive communication errors have been detected. The reason for the trip can be identified by the sub-trip number.<br>**Source** / **xx** / **y** / **zz**<br>Control system / 00 / 0 / 01: No communications between the control system and the power system.<br>Control system / 00 / 0 / 02: Excessive communication errors between the control system and power system.<br>Power system / 01 / 1 / 00: Excessive communications errors detected by the rectifier module.<br>**Recommended actions:**<br>• Hardware fault - contact the supplier of the drive. |
| **no.PS** | **No power board** |
| **236** | No communication between the power and control boards.<br>**Recommended actions**:<br>• Hardware fault - contact the supplier of the drive. |
| **O.Ld1** | **Digital output overload** |
| **26** | This trip indicates that the total current drawn from the AI Adaptor 24 V or from the digital output has exceeded the limit.<br>**Sub-trip** / **Reason**<br>1 / Digital output or 24 V supply load on control terminal is too high.<br>2 / AI Adaptor 24 V load is too high<br>**Recommended actions:**<br>• Check total loads on digital outputs and 24 V<br>• Check control wiring is correct<br>• Check output wiring is undamaged |
| **O.SPd** | **Motor frequency has exceeded the over frequency threshold** |
| **7** | In open-loop mode, if the *Post-ramp Reference* (02.001) exceeds the threshold set in the *Over Frequency Threshold* (03.008) in either direction, an O.SPd trip is produced. In RFC-A mode, if the *Estimated Frequency* (03.002) exceeds the Over Frequency Threshold in Pr **03.008** in either direction an O.SPd trip is produced. If Pr **03.008** is set to 0.00 the threshold is then equal to 1.2 x the value set in Pr **01.006**.<br>**Recommended actions:**<br>• Reduce the *Frequency Controller Proportional Gain* (03.010) to reduce the frequency overshoot (RFC-A mode only)<br>• Check that a mechanical load is not driving motor<br>• Reduce *Current Controller Ki Gain* (04.014). |
| **Oht.C** | **Control stage over temperature** |
| **219** | This trip indicates that a control stage over-temperature has been detected if Cooling Fan control (06.045) = 0.<br>This trip causes the option module to go to standby and *Potential Drive Damage Conditions* (10.106) bit 1 to be set.<br>**Recommended actions:**<br>• Increase ventilation by setting Cooling Fan control (06.045) > 0. |

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Oh.dc</td><td>DC bus over temperature</td></tr>
<tr><td>27</td><td>
The Oh.dc trip indicates a DC bus component over temperature based on a software thermal model. The drive includes a thermal protection system to protect the DC bus components within the drive. This includes the effects of the output current and DC bus ripple. The estimated temperature is displayed as a percentage of the trip level in Pr 07.035. If this parameter reaches 100 % then an Oh.dc trip is initiated. The drive will attempt to stop the motor before tripping. If the motor does not stop in 10 seconds the drive trips immediately.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>2</td><td>00</td><td>DC bus thermal model gives trip with sub-trip 0</td></tr>
</table>
Recommended actions:<br>
• Check the AC supply voltage balance and levels<br>
• Check DC bus ripple level<br>
• Reduce duty cycle<br>
• Reduce motor load<br>
• Check the output current stability. If unstable;<br>
Check the motor map settings with motor nameplate (Pr 05.006, Pr 05.007, Pr 05.008, Pr 05.009, Pr 05.010, Pr 05.011) – (All Modes)<br>
Disable slip compensation (Pr 05.027 = 0) – (Open loop)<br>
Disable dynamic V to F operation (Pr 05.013 = 0) - (Open loop)<br>
Select fixed boost (Pr 05.014 = Fixed) – (Open loop)<br>
Select high stability space vector modulation (Pr 05.019 = 1) – (Open loop)<br>
Disconnect the load and complete a rotating auto-tune (Pr 05.012)<br>
Reduce frequency loop gains (Pr 03.010, Pr 03.011, Pr 03.012) – (RFC-A)
</td></tr>
<tr><td>Oht.I</td><td>Inverter over temperature based on thermal model</td></tr>
<tr><td>21</td><td>
This trip indicates that an IGBT junction over-temperature has been detected based on a software thermal model.The Oht.I trip is initiated when the temperature based on the thermal model reaches 145 °C. The trip reset temperature is 139 °C.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>1</td><td>00</td><td>Inverter thermal model gives {Oht.I} trip with sub-trip 100</td></tr>
</table>
Recommended actions:<br>
• Reduce the selected drive switching frequency<br>
• Ensure Auto-switching Frequency Change Disable (05.035) is set to Off<br>
• Reduce duty cycle<br>
• Increase acceleration / deceleration rates<br>
• Reduce motor load<br>
• Check DC bus ripple<br>
• Ensure all three input phases are present and balanced
</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Oht.P</td><td>Power stage over temperature</td></tr>
<tr><td>22</td><td>This trip indicates that a power stage over-temperature has been detected. From the sub-trip ‘xxyzz’, the Thermistor location is identified by ‘zz’.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Power system</td><td>01</td><td>0</td><td>zz</td><td>Thermistor location in the drive defined by zz</td></tr>
</table>
<table>
<tr><th>Drive size</th><th>Trip temperature (°C)</th><th>Trip reset temperature (°C)</th></tr>
<tr><td>1 to 4</td><td>95</td><td>90</td></tr>
<tr><td>5</td><td>115</td><td>110</td></tr>
<tr><td>06200XXX</td><td>115</td><td>110</td></tr>
<tr><td>06400XXX</td><td>125</td><td>120</td></tr>
<tr><td>06500XXX</td><td>120</td><td>115</td></tr>
</table>
Recommended actions:<br>
• Check enclosure / drive fans are still functioning correctly<br>
• Force the heatsink fans to run at maximum speed<br>
• Check enclosure ventilation paths<br>
• Check enclosure door filters<br>
• Increase ventilation<br>
• Reduce the drive switching frequency<br>
• Reduce duty cycle<br>
• Increase acceleration / deceleration rates<br>
• Use S-ramp (Pr 02.006)<br>
• Reduce motor load<br>
• Check the derating tables and confirm the drive is correctly sized for the application.<br>
• Use a drive with larger current / power rating</td></tr>
<tr><td>OI.A1</td><td>Analog input 1 over-current</td></tr>
<tr><td>189</td><td>Current input on analog input 1 exceeds 24 mA.</td></tr>
<tr><td>OI.AC</td><td>Instantaneous output over current detected</td></tr>
<tr><td>3</td><td>The instantaneous drive output current has exceeded VM_DRIVE_CURRENT_MAX.<br>This trip cannot be reset until 10 s after the trip was initiated.<br>Recommended actions/checks:<br>
• Increase acceleration/deceleration rate<br>
• If seen during auto-tune reduce the voltage boost<br>
• Check for short circuit on the output cabling<br>
• Check integrity of the motor insulation using an insulation tester<br>
• Is the motor cable length within limits for the frame size?<br>
• Reduce the values in the frequency loop gain parameters - (Pr 03.010, 03.011, 03.012) or (Pr 03.013, 03.014, 03.015)<br>
• Reduce the values in the current loop gain parameters</td></tr>
<tr><td>OI.br</td><td>Braking IGBT over current detected: short circuit protection for the braking IGBT activated</td></tr>
<tr><td>4</td><td>The OI.br trip indicates that over current has been detected in braking IGBT or braking IGBT protection has been activated.<br>This trip cannot be reset until 10 s after the trip was initiated.<br>Recommended actions:<br>
• Check brake resistor wiring<br>
• Check braking resistor value is greater than or equal to the minimum resistance value<br>
• Check braking resistor insulation</td></tr>
<tr><td>OI.SC</td><td>Output phase short-circuit</td></tr>
<tr><td>228</td><td>Over-current detected on drive output when enabled. Possible motor earth fault.<br>Recommended actions:<br>
• Check for short circuit on the output cabling<br>
• Check integrity of the motor insulation using an insulation tester<br>
• Is the motor cable length within limits for the frame size?</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>OI.Sn</td><td>Snubber over-current detected</td></tr>
<tr><td>92</td><td>This trip indicates that an over-current condition has been detected in the rectifier snubbing circuit, The exact cause of the trip can be identified by the sub-trip number.<br><br>
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th></tr>
<tr><td>Power system</td><td>01</td><td>1</td><td>00: Rectifier snubber over-current trip detected</td></tr>
</table>
<br>Recommended actions:<br>
• Ensure the internal EMC filter is installed.<br>
• Ensure the motor cable length does not exceed the maximum for selected switching frequency.<br>
• Check for supply voltage imbalance.<br>
• Check for supply disturbance such as notching from a DC drive.<br>
• Check the motor and motor cable insulation with an insulation tester.<br>
• Fit an output line reactor or sinusoidal filter.</td></tr>
<tr><td>Out.P</td><td>Output phase loss detected</td></tr>
<tr><td>98</td><td>The Out.P trip indicates that phase loss has been detected at the drive output. A test can be made for output phase loss when the drive is enabled or the output phase loss condition can be detected while the drive is running as defined by Output Phase Loss Detection Enable (06.059).<br><br>
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>U phase detected as disconnected when drive enabled to run.</td></tr>
<tr><td>2</td><td>V phase detected as disconnected when drive enabled to run.</td></tr>
<tr><td>3</td><td>W phase detected as disconnected when drive enabled to run.</td></tr>
<tr><td>4</td><td>The drive output frequency is above 4 Hz and a phase is disconnected for the time specified by Output Phase Loss Detection Time (06.058).</td></tr>
</table>
<br>NOTE<br>
If Pr 05.042 = 1, the physical output phases are reversed, and so sub-trip 3 refers to physical output phase V and sub-trip 2 refers to physical output phase W.<br><br>
Recommended actions:<br>
• Check motor and drive connections<br>
• To disable the trip set Output Phase Loss Detection Enable (06.059) = 0</td></tr>
<tr><td>OV</td><td>DC bus voltage has exceeded the peak level or maximum continuous level for 15 seconds</td></tr>
<tr><td>2</td><td>The OV trip indicates that the DC bus voltage has exceeded the VM_DC_VOLTAGE[MAX] or VM_DC_VOLTAGE_SET[MAX] for 15 s. The trip threshold varies depending on voltage rating of the drive as shown below.<br><br>
<table>
<tr><th>Voltage rating</th><th>VM_DC_VOLTAGE[MAX]<br>Frame 1 to 4</th><th>VM_DC_VOLTAGE[MAX]<br>Frame 5 to 9</th><th>VM_DC_VOLTAGE_SET[MAX]</th></tr>
<tr><td>100</td><td>510</td><td>415</td><td>400</td></tr>
<tr><td>200</td><td>510</td><td>415</td><td>400</td></tr>
<tr><td>400</td><td>870</td><td>830</td><td>800</td></tr>
<tr><td>575</td><td>N/A</td><td>990</td><td>955</td></tr>
</table>
<br>Sub-trip Identification<br><br>
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX].</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>02: Time delayed trip indicating that the DC bus voltage is above VM_DC_VOLTAGE_SET[MAX].</td></tr>
<tr><td>Power system</td><td>01</td><td>0</td><td>00: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX].</td></tr>
</table>
<br>Recommended actions:<br>
• Increase deceleration ramp (Pr 04)<br>
• Decrease the braking resistor value (staying above the minimum value)<br>
• Check nominal AC supply level<br>
• Check for supply disturbances which could cause the DC bus to rise<br>
• Check motor insulation using an insulation tester</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>P.dAt</td><td>Power system configuration data error</td></tr>
<tr><td>220</td><td>The P.dAt trip indicates that there is an error in the configuration data stored in the power system. This trip can be generated from either the drive control system or from the power system. The trip is related to the table uploaded from the power system at power-up.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>01</td><td>No data was obtained from the power board.</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>02</td><td>There is no data table.</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>03</td><td>The power system data table is bigger than the space available in the control pod to store it.</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>04</td><td>The size of the table given in the table is incorrect.</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>05</td><td>Table CRC error.</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>06</td><td>The version number of the generator software that produced the table is too low.</td></tr>
<tr><td>Control system</td><td>0</td><td>0</td><td>07</td><td>The power data table failed to be stored in the power board.</td></tr>
<tr><td>Power system</td><td>01</td><td>0</td><td>00</td><td>The power data table used internally by the power module has an error.</td></tr>
<tr><td>Power system</td><td>01</td><td>0</td><td>01</td><td>The power data table that is uploaded to the control system on power up has an error.</td></tr>
<tr><td>Power system</td><td>01</td><td>0</td><td>02</td><td>The power data table used internally by the power module does not match the hardware identification of the power module.</td></tr>
</table>
Recommended actions:<br>• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>PAd</td><td>Keypad has been removed when the drive is receiving the reference from the keypad</td></tr>
<tr><td>34</td><td>The PAd trip indicates that the drive is in keypad mode [Reference Selector (01.014) = 4 or 6] and the keypad has been removed or disconnected from the drive.<br>Recommended actions:<br>• Re-install keypad and reset<br>• Change Reference Selector (01.014) to select the reference from another source</td></tr>
<tr><td>Pb.bt</td><td>Power board is in bootloader mode</td></tr>
<tr><td>245</td><td>Power board is in bootloader mode<br>Recommended actions:<br>• Send power board firmware file to reprogram the power board using Connect and power cycle drive.</td></tr>
<tr><td>Pb.Er</td><td>Communication has been lost / errors detected between control and power processor</td></tr>
<tr><td>93</td><td>The Pb.Er trip is initiated if there is no communications between the control board processor and the power board processor. The reason for the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>PLL operating region out of lock</td></tr>
<tr><td>2</td><td>Power board lost communication with user board</td></tr>
<tr><td>3</td><td>User board lost communication with power board</td></tr>
<tr><td>4</td><td>Communication CRC error</td></tr>
</table>
Recommended actions:<br>• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>Pb.HF</td><td>Power board HF</td></tr>
<tr><td>235</td><td>Power processor hardware fault. The sub-trip number is the HF code.<br>Recommended actions:<br>• Hardware fault - Contact the supplier of the drive</td></tr>
<tr><td>Pd.S</td><td>Power down save error</td></tr>
<tr><td>37</td><td>The Pd.S trip indicates that an error has been detected in the power down save parameters saved in non-volatile memory.<br>Recommended actions:<br>• Perform a 1001 save in Pr 00 to ensure that the trip doesn’t occur the next time the drive is powered up.</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>PH.Lo</td><td>Supply phase loss</td></tr>
<tr><td>32</td><td>
The PH.Lo trip indicates that the drive has detected an input phase loss or large supply imbalance. The drive will attempt to stop the motor before this trip is initiated. If the motor cannot be stopped in 10 seconds the trip occurs immediately. The PH.Lo trip works by monitoring the ripple voltage on the DC bus of the drive, if the DC bus ripple exceeds the threshold, the drive will trip on PH.Lo. Potential causes of the DC bus ripple are input phase loss, Large supply impedance and severe output current instability.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>00: Phase loss detected based on control system feedback. The drive attempts to stop the drive before tripping unless bit 2 of Action On Trip Detection (10.037) is set to one.</td></tr>
<tr><td>Power system</td><td>01</td><td>0</td><td>00: Phase loss has been detected by the rectifier module.</td></tr>
</table>
Input phase loss detection can be disabled when the drive is required to operate from the DC supply or from a single phase supply in Input Phase Loss Detection Mode (06.047).<br>
Recommended actions:<br>
• Check the AC supply voltage balance and level at full load<br>
• Check the DC bus ripple level with an isolated oscilloscope<br>
• Check the output current stability<br>
• Check for mechanical resonance with the load<br>
• Reduce the duty cycle<br>
• Reduce the motor load<br>
• Disable the phase loss detection, set Pr 06.047 to 2.
</td></tr>
<tr><td>PSU</td><td>Internal power supply fault</td></tr>
<tr><td>5</td><td>
The PSU trip indicates that one or more internal power supply rails are outside limits or overloaded.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td rowspan="2">00</td><td rowspan="2">Internal power supply overload.</td></tr>
<tr><td>Power system</td><td>01</td><td>1</td></tr>
</table>
Recommended actions:<br>
• Remove the option module and perform a reset<br>
• There is a hardware fault within the drive – return the drive to the supplier
</td></tr>
<tr><td>r.All</td><td>RAM allocation error</td></tr>
<tr><td>227</td><td>
The r.All trip indicates that an option module derivative image has requested more parameter RAM than is allowed. The RAM allocation is checked in order of resulting sub-trip numbers, and so the failure with the highest sub-trip number is given. The sub-trip is calculated as (parameter size) + (parameter type) + sub-array number.
<table>
<tr><th>Parameter size</th><th>Value</th></tr>
<tr><td>1 bit</td><td>1</td></tr>
<tr><td>8 bit</td><td>2</td></tr>
<tr><td>16 bit</td><td>3</td></tr>
<tr><td>32 bit</td><td>4</td></tr>
<tr><td>64 bit</td><td>5</td></tr>
</table>
<table>
<tr><th>Parameter type</th><th>Value</th></tr>
<tr><td>Volatile</td><td>0</td></tr>
<tr><td>User save</td><td>1</td></tr>
<tr><td>Power-down save</td><td>2</td></tr>
</table>
Derivatives can customize menus 18 and 20.
<table>
<tr><th>Sub-array</th><th>Menus</th><th>Value</th></tr>
<tr><td>Applications menus</td><td>18-20</td><td>1</td></tr>
<tr><td>Derivative image</td><td>29</td><td>2</td></tr>
<tr><td>Option slot 1 set-up</td><td>15</td><td>4</td></tr>
<tr><td>Option slot 1 applications</td><td>25</td><td>5</td></tr>
</table>
</td></tr>
</table>

| Trip | Diagnosis |
|---|---|
| **r.b.ht** | **Hot rectifier/brake** |
| **250** | Over-temperature detected on input rectifier or braking IGBT.<br>**Recommended action:**<br>• Increase ventilation by setting *Cooling Fan Control* (06.045) > 0. |
| **Reserved**<br>**01**<br>**09**<br>**12**<br>**14 - 17**<br>**23, 29**<br>**38 - 39**<br>**91, 94 - 96**<br>**99**<br>**101 - 109**<br>**111**<br>**168 - 172**<br>**176 - 177**<br>**190 - 198**<br>**205 - 217**<br>**222 - 224**<br>**229 - 230, 233**<br>**238 - 244**<br>**249**<br>**251 - 254** | **Reserved trips**<br>These trip numbers are reserved trip numbers for future use.<br>**Trip Number** / **Description**<br>01, 09, 12, 14-17, 23, 29, 38, 39 — Reserved resettable trip<br>91, 94 -96, 99 — Reserved resettable trip<br>101 - 109, 111 — Reserved resettable trip<br>168 - 172, 176 -177 — Reserved resettable trip<br>190 – 198 — Reserved resettable trip<br>205 - 217 — Reserved resettable trip<br>222 - 224 — Reserved non-resettable trip<br>229 - 230, 233 — Reserved non-resettable trip<br>238 - 244, 249 — Reserved non-resettable trip<br>251 - 254 — Reserved non-resettable trip |
| **rS**<br>**33** | **Measured resistance has exceeded the parameter range**<br>The *rS* trip indicates that the measured stator resistance of the motor during an auto-tune test has exceeded the maximum possible value of *Stator Resistance* (05.017).<br>If the measured value or a value written to this parameter by the user exceeds ($V_{FS}$/√2) / *Full Scale Current Kc* (11.061), where $V_{FS}$ is the full scale DC bus voltage then this trip is initiated.<br>The stationary auto-tune is initiated using the auto-tune function (Pr **05.012**) or in open loop vector mode (Pr **05.014**) on the first run command after power up in mode 4 (Ur_I) or on every run command in modes 0 (Ur_S) or 3 (Ur_Auto). This trip can occur if the motor is very small in comparison to the rating of the drive.<br>If the value is the result of a measurement made by the drive then sub-trip 0 is applied, or if it is because the parameter has been changed by the user then sub-trip 3 is applied. During the stator resistance section of auto-tuning an additional test is performed to measure the drive inverter characteristics to provide the compensation necessary for dead-times. If the inverter characteristic measurement fails then sub-trip 2 is applied.<br>The reason for the trip can be identified by the sub-trip number.<br>**Sub-trip** / **Reason**<br>0 — Stator resistance (5.017/21.012) is greater than ($V_{FS}$ / √2) / *Full Scale Current Kc* (11.061), where $V_{FS}$ is the full scale d.c. bus voltage; or the result is = 100 ohms.<br>2 — The measured Transient Inductance (5.024/21.014) is greater than 500 mH or the measured Stator Inductance (05.025/21.024) is greater than 5000 mH.<br>3 — A resistance value entered by the user is greater than ($V_{FS}$ / √2) / *Full Scale Current Kc* (11.061), where $V_{FS}$ is the full scale d.c. bus voltage. Clear this trip by setting *Stator Resistance* (05.017) to a value that is in range and resetting the drive.<br>4 — The measured stator resistance is not greater than the sub-trip 0 check but is outside the firmware usable range for this drive size.<br>**Recommended actions:**<br>• Ensure the stator resistance of the motor falls within the range of the drive model. The most likely cause of this trip is trying to measure a motor much smaller than the drive rating. Ratio's of drive size to motor size of greater than 15:1 are likely to lead to a problem.<br>• Check that a value has not been entered in the stator resistance for the presently selected motor map that exceeds the allowed range.<br>• Check the motor cable / connections<br>• Check the integrity of the motor stator winding using an insulation tester<br>• Check the motor phase to phase resistance at the drive terminals<br>• Check the motor phase to phase resistance at the motor terminals<br>• Ensure the stator resistance of the motor falls within the range of the drive model<br>• Select fixed boost mode (Pr **05.014** = Fd) and verify the output current waveforms with an oscilloscope<br>• Replace the motor |

| Trip | Diagnosis |
|---|---|
| **SCL** | **Control word watchdog has timed out** |
| **30** | The *SCL* trip indicates that the control word has been enabled and has timed out.<br>**Recommended actions:**<br>• Once Pr **06.042** bit 14 has been changed from 0 to 1 to enable the watchdog, this must be repeated every 1s or a *SCL* trip will be initiated. The watchdog is disabled when the trip occurs and must be re-enabled if required when the trip is reset. |
| **SL.dF** | **Option module in option slot 1 has changed** |
| **204** | The *SL.dF* trip indicates that the option module in option slot 1 on the drive is a different type to that installed when parameters were last saved on the drive. The reason for the trip can be identified by the sub-trip number.<br>**Sub-trip** / **Reason**<br>1 – No module was installed previously<br>2 – A module with the same identifier is installed, but the set-up menu for this option slot has been changed, and so default parameters have been loaded for this menu.<br>3 – A module with the same identifier is installed, but the applications menu for this option slot has been changed, and so default parameters have been loaded for this menu.<br>4 – A module with the same identifier is installed, but the set-up and applications menu for this option slot have been changed, and so default parameters have been loaded for these menus.<br>>99 – Shows the identifier of the module previously installed.<br>**Recommended actions:**<br>• Turn off the power, ensure the correct option module is installed in the option slot and re-apply the power.<br>• Confirm that the currently installed option module is correct, ensure option module parameters are set correctly and perform a user save in Pr **mm.000.** |
| **SL.Er** | **Option module in option slot 1 has detected a fault** |
| **202** | The *SL.Er* trip indicates that the option module in option slot 1 on the drive has detected an error. The reason for the error can be identified by the sub-trip number. As default, the sub-trip number is shown as a number on the display. However, it is possible for the option module to supply sub-trip number strings which will be displayed instead of the number if available.<br>**Recommended actions:**<br>• See relevant *option module User Guide* for details of the trip |
| **SL.HF** | **Option module 1 hardware fault** |
| **200** | The *SL.HF* trip is generated by the drive. The possible causes of the trip can be identified by the sub-trip number.<br>**Sub-trip** / **Reason**<br>1 – The module category cannot be identified<br>2 – All the required customized menu table information has not been supplied or the tables supplied are corrupt<br>3 – There is insufficient memory available to allocate the comms buffers for this module<br>4 – The module has not indicated that it is running correctly during drive power-up<br>5 – Module has been removed after power-up or it has stopped working<br>6 – The module has not indicated that it has stopped accessing drive parameters during a drive mode change<br>7 – The module has failed to acknowledge that a request has been made to reset the drive processor<br>8 – The drive failed to read correctly the menu table from the module during drive power-up.<br>9 – The drive failed to upload menu tables from the module and timed-out (5s).<br>10 – Menu table CRC invalid.<br>**Recommended actions:**<br>• Ensure the option module is installed correctly<br>• Replace the option module<br>• Replace the drive |
| **SL.nF** | **Option module in option slot 1 has been removed** |
| **203** | The *SL.nF* trip indicates that the option module in option slot 1 on the drive has been removed since the last power up.<br>The sub-trip number gives the ID code of the option module that has been removed.<br>**Recommended actions:**<br>• Ensure the option module is installed correctly.<br>• Re-install the option module.<br>• To confirm that the removed option module is no longer required perform a save function in Pr **00**. |

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>SL.tO</td><td>Option module watchdog function service error</td></tr>
<tr><td>201</td><td>The SL.tO trip indicates that the option module installed in Slot 1 has started the option watchdog function and then failed to service the watchdog correctly.<br>Recommended actions:<br>• Replace the option module</td></tr>
<tr><td>So.St</td><td>Soft start relay failed to close, soft start monitor failed</td></tr>
<tr><td>226</td><td>The So.St trip indicates that the soft start relay in the drive failed to close or the soft start monitoring circuit has failed. The cause of the trip can be identified by the sub-trip number.<br><table><tr><th>Sub-trip</th><th>Reason</th></tr><tr><td>1</td><td>Soft-start failure</td></tr><tr><td>2</td><td>DC bus capacitor failure on 110 V drive (size 2 only)</td></tr></table>Recommended actions:<br>• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>St.HF</td><td>Hardware trip has occurred during last power down</td></tr>
<tr><td>221</td><td>The St.HF trip indicates that a hardware trip (HF01 –HF18) has occurred and the drive has been power cycled. The sub-trip number identifies the HF trip.<br>Recommended actions:<br>• Enter 1299 in Pr 00 and press reset to clear the trip</td></tr>
<tr><td>Sto</td><td>No Safe Torque Off board fitted</td></tr>
<tr><td>234</td><td>STO board not fitted correctly.<br>Recommended actions:<br>Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>th</td><td>Motor thermistor over-temperature</td></tr>
<tr><td>24</td><td>The th trip indicates that the motor thermistor connected to terminal 14 (digital input 5) on the control connections has indicated a motor over temperature. If digital input 5 mode (08.035) is 2 then a th trip is initiated if the feedback value is higher than Thermistor Trip Threshold (07.048).<br>Recommended actions:<br>• Check motor temperature<br>• Check threshold level (Pr 07.048).<br>• Check thermistor continuity</td></tr>
<tr><td>th.br</td><td>Brake resistor over temperature</td></tr>
<tr><td>10</td><td>The th.br trip is initiated if the hardware based braking resistor thermal monitoring is connected and the resistor overheats. If the braking resistor is not used, then this trip must be disabled with bit 3 of Action On Trip Detection (10.037) to prevent this trip.<br>Recommended actions:<br>• Check brake resistor wiring<br>• Check braking resistor value is greater than or equal to the minimum resistance value<br>• Check braking resistor insulation</td></tr>
<tr><td>tH.Fb</td><td>Internal thermistor has failed</td></tr>
<tr><td>218</td><td>The tH.Fb trip indicates that an internal thermistor has failed in the drive (i.e. open circuit or short circuit). The thermistor location can be identified by the sub-trip number.<br><table><tr><th>Source</th><th>xx</th><th>y</th><th>zz</th></tr><tr><td>Power system</td><td>01</td><td>0</td><td>Thermistor location defined by zz</td></tr><tr><td>Power system</td><td>01</td><td>1</td><td>Thermistor location defined by zz in the rectifier.</td></tr></table>Recommended actions:<br>• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>thS</td><td>Motor thermistor short circuit</td></tr>
<tr><td>25</td><td>The thS trip indicates that the motor thermistor connected to terminal 14 (digital input 5) on the control connections, is short circuit or low impedance (<50 Ω).<br>Recommended actions:<br>• Check thermistor continuity<br>• Replace motor / motor thermistor</td></tr>
</table>

| Trip | Diagnosis |
|---|---|
| **tun.S** | **Autotune test stopped before completion** |
| **18** | The drive was prevented from completing an autotune test, because either the drive enable or the drive run were removed.<br>**Recommended actions:**<br>• Check the drive enable signal (Terminal 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9) were active during the autotune.<br>• Check the run command was active in digital input 3 or 4 state (Pr **08.003** or Pr **08.004**) during the autotune. |
| **tun.1** | **Required speed could not be reached** |
| **11** | The drive has tripped during an autotune. The cause of the trip can be identified from the sub-trip number.<br>**Sub-trip** / **Reason**<br>2 – The motor did not reach the required speed during rotating autotune or mechanical load measurement<br>**Recommended actions:**<br>• Ensure the motor is free to turn i.e. mechanical brake is released<br>• Ensure *Mechanical Load Test Level* (05.021) is set correctly |
| **tun.3** | **Measured inertia has exceeded the parameter range (RFC-A mode only)** |
| **13** | The drive has tripped during a rotating autotune or mechanical load measurement test. The cause of the trip can be identified from the associated sub-trip number.<br>**Sub-trip** / **Reason**<br>1 – Measured inertia has exceeded the parameter range during a mechanical load measurement<br>3 – The mechanical load test has been unable to identify the motor inertia<br>**Recommended actions:**<br>• Check motor cable wiring is correct |
| **U.OI** | **User OI ac** |
| **8** | A U.OI trip is initiated if the output current of the drive exceeds the trip level set by *User Over Current Trip Level* (04.041). |
| **U.S** | **User Save error / not completed** |
| **36** | The *U.S* trip indicates that an error has been detected in the user save parameters saved in non-volatile memory.<br>For example, following a user save command, If the power to the drive was removed when the user parameters were being saved.<br>**Recommended actions:**<br>• Perform a user save in Pr **00** to ensure that the trip doesn't occur the next time the drive is powered up.<br>• Ensure that the drive has enough time to complete the save before removing the power to the drive. |
| **UP.uS** | **Trip generated by an onboard user program** |
| **96** | This trip can be initiated from within an onboard user program using a function call which defines the sub-trip number.<br>**Recommended actions:**<br>• Check the user program |

| Trip | Diagnosis |
|---|---|
| **UPrG** | **Onboard user program error** |

**249**

An error has been detected in the onboard user program image. The sub-trip indicated the reason for the trip.

| Sub-trip | Reason | Comments |
|---|---|---|
| 1 | Divide by zero. | |
| 2 | Undefined trip. | |
| 3 | Attempted fast parameter access set-up with non-existent parameter. | |
| 4 | Attempted access to non-existent parameter. | |
| 5 | Attempted write to read-only parameter. | |
| 6 | Attempted an over-range write. | |
| 7 | Attempted read from write-only parameter. | |
| 30 | The image has failed because either its CRC is incorrect, or there are less than 6 bytes in the image or the image header version is less than 5. | Occurs when the drive powers-up or the image is programmed. The image tasks will not run. |
| 31 | The image requires more RAM for heap and stack than can be provided by the drive. | As 30. |
| 32 | The image requires an OS function call that is higher than the maximum allowed. | As 30. |
| 33 | The ID code within the image is not valid. | As 30. |
| 34 | The user program image has been changed for an image with a different user program number. | As 30. |
| 40 | The timed task has not completed in time and has been suspended. | *Onboard User Program: Enable* (11.047) is reset to zero when the trip is initiated. |
| 41 | Undefined function called, i.e. a function in the host system vector table that has not been assigned. | As 40. |
| 52 | Customizable menu table CRC check failed. | As 30. |
| 53 | Customizable menu table changed. | Occurs when the drive powers-up or the image is programmed and the table has changed. Defaults are loaded for the user program menu and the trip will keep occurring until drive parameters are saved. |
| 80 | *Image is not compatible with the control board | Initiated from within the image code. |
| 81 | *Image is not compatible with the control board serial number | |
| 100 | Image has detected and prevented attempted pointer access outside of the IEC task's heap area. | |
| 101 | Image has detected and prevented misaligned pointer usage. | |
| 102 | Image has detected an array bounds violation and prevented its access. | |
| 103 | Image has attempted to convert a data type to or from an unknown data type, has failed and has shut itself down. | |
| 104 | Image has attempted to use an unknown user service function. | |
| 200 | User program has invoked a "divide" service with a denominator of zero. (Note that this is raised by the downloaded image and has therefore been given a distinct error code despite being the same fundamental problem as sub-trip 1.) | |
| 201 | Parameter access is not supported. An attempt to read database other than the host drive. | |
| 202 | Parameter does not exist. Database was host drive but the specified parameter does not exist. | |
| 203 | Parameter is read-only. | |
| 204 | Parameter is write-only. | |
| 205 | Unknown parameter error. | |
| 206 | Invalid bit present in parameter. The parameter does not contain the specified bit. | |
| 207 | Parameter format lookup failed. Failed to get parameter information data. | |
| 208 | An over-range write has been attempted. | |

The following table shows the differences when compared to the derivative product image.

| Sub-trip | Difference |
|---|---|
| 40,41 | Onboard User Program: Enable (11.047) is reset to zero when the trip is initiated. |
| 51 | Not applicable as core menu Customization not allowed. |
| 6x | Not applicable as option module restrictions not allowed. |
| 7x | Not applicable as option module restrictions not allowed. |
| 100 | Image has detected and prevented attempted pointer access outside of the IEC task's heap area. |
| 101 | Image has detected and prevented misaligned pointer usage. |
| 102 | Image has detected an array bounds violation and prevented its access. |
| 103 | Image has attempted to convert a data type to or from an unknown data type, has failed and has shut itself down. |
| 104 | Image has attempted to use an unknown user service function. |
| 200 | User program has invoked a "divide" service with a denominator of zero. (Note that this is raised by the downloaded image and has therefore been given a distinct error code despite being the same fundamental problem as sub-trip 1) |

**Table 12-3 Serial communications look up table**

| No | Trip | No | Trip | No | Trip |
|---|---|---|---|---|---|
| 1 | **rES** | 90 | **LF.Er** | 199 | **dESt** |
| 2 | **OV** | 91 | **rES** | 200 | **SL.HF** |
| 3 | **OI.AC** | 92 | **OI.Sn** | 201 | **SL.tO** |
| 4 | **OI.br** | 93 | **Pb.Er** | 202 | **SL.Er** |
| 5 | **PSU** | 94 - 95 | **rES** | 203 | **SL.nF** |
| 6 | **Et** | 96 | **UP.uS** | 204 | **SL.dF** |
| 7 | **O.SPd** | 97 | **d.Ch** | 205 - 214 | **rES** |
| 8 | **U.OI** | 98 | **Out.P** | 215 | **rES** |
| 9 | **rES** | 99 | **rES** | 216 - 217 | **rES** |
| 10 | **th.br** | 100 | **rESEt** | 218 | **tH.Fb** |
| 11 | **tun.1** | 101 | **rES** | 219 | **Oht.C** |
| 12 | **rES** | 102 | **rES** | 220 | **P.dAt** |
| 13 | **tun.3** | 103 - 108 | **rES** | 221 | **St.HF** |
| 14 - 17 | **rES** | 109 | **rES** | 222 | **rES** |
| 18 | **tun.S** | 110 | **dcct** | 223 - 224 | **rES** |
| 19 | **It.br** | 111 | **rES** | 225 | **Cur.O** |
| 20 | **It.Ac** | 112 - 167 | **t112 - t167** | 226 | **So.St** |
| 21 | **Oht.I** | 168 - 172 | **rES** | 227 | **r.All** |
| 22 | **Oht.P** | 173 | **FAn.F** | 228 | **OI.SC** |
| 23 | **rES** | 174 | **C.SL** | 229 | **rES** |
| 24 | **th** | 175 | **C.Pr** | 230 | **rES** |
| 25 | **thS** | 176 | **rES** | 231 | **Cur.c** |
| 26 | **O.Ld1** | 177 | **rES** | 232 | **dr.CF** |
| 27 | **Oh.dc** | 178 | **C.by** | 233 | **rES** |
| 28 | **cL.A1** | 179 | **C.d.E** | 234 | **Sto** |
| 29 | **rES** | 180 | **C.OPt** | 235 | **Pb.HF** |
| 30 | **SCL** | 181 | **C.rdo** | 236 | **no.PS** |
| 31 | **EEF** | 182 | **C.Err** | 237 | **FI.In** |
| 32 | **PH.Lo** | 183 | **C.dAt** | 238 - 244 | **rES** |
| 33 | **rS** | 184 | **C.Ful** | 245 | **Pb.bt** |
| 34 | **PAd** | 185 | **C.Acc** | 246 | **dEr.E** |
| 35 | **CL.bt** | 186 | **C.rtg** | 247 | **Fi.Ch** |
| 36 | **U.S** | 187 | **C.tyP** | 248 | **dEr.I** |
| 37 | **Pd.S** | 188 | **C.cPr** | 249 | **UPrG** |
| 38 | **rES** | 189 | **OI.A1** | 250 | **r.b.ht** |
| 39 | **rES** | 190 | **rES** | 251 - 254 | **rES** |
| 40 - 89 | **t040 - t089** | 191 - 198 | **rES** | 255 | **rSt.L** |

The trips can be grouped into the following categories. It should be noted that a trip can only occur when the drive is not tripped or is already tripped but with a trip with a lower priority number.

**Table 12-4 Trip categories**

| Priority | Category | Trips | Comments |
|---|---|---|---|
| 1 | Internal faults | HFxx | These indicate internal problems and cannot be reset. All drive features are inactive after any of these trips occur. |
| 1 | Stored HF trip | {St.HF} | This trip cannot be cleared unless 1299 is entered into *Parameter* **00** and a reset is initiated. |
| 2 | Non-resettable trips | Trip numbers 218 to 247, {SL.HF} | These trips cannot be reset. |
| 3 | Volatile memory failure | {EEF} | This can only be reset if Parameter **00** is set to 1233 or 1244, or if *Load Defaults* (11.043) is set to a non-zero value. |
| 4 | NV Media Card trips | Trip numbers 174, 175 and 177 to 188 | These trips are priority 5 during power-up. |
| 4 | Internal 24V | {PSU} | Rectifier 24V |
| 5 | Trips with extended reset times | {OI.AC}, {OI.br} and {FAn.F} | These trips cannot be reset until 10 s after the trip was initiated. |
| 5 | Phase loss and d.c. link power circuit protection | {PH.Lo} and {Oh.dc} | The drive will attempt to stop the motor before tripping if a {PH.Lo} trip occurs unless this feature has been disabled (see *Action On Trip Detection* (10.037). The drive will always attempt to stop the motor before tripping if an {Oh.dc} occurs. |
| 5 | Standard trips | All other trips | |

## 12.5 Internal / Hardware trips

Trips {HF01} to {HF23} are internal faults that do not have trip numbers except HF08, HF11, HF12 & HF18. If one of these trips occurs, the main drive processor has detected an irrecoverable error. All drive functions are stopped and the trip message will be displayed on the drive keypad. If a non permanent trip occurs this may be reset by power cycling the drive. On power up after it has been power cycled the drive will trip on St.HF (the sub-trip number indicates the HF fault code). Enter 1299 in Pr **00** to clear the Stored HF trip.

## 12.6 Alarm indications

In any mode, an alarm is an indication given on the display by alternating the alarm string with the drive status string display. If an action is not taken to eliminate any alarm except "tuning", “LS" and “24.LoSt” the drive may eventually trip. Alarms are not displayed when a parameter is being edited.

**Table 12-5 Alarm indications**

| Alarm string | Description |
|---|---|
| **br.res** | Brake resistor overload. *Braking Resistor Thermal Accumulator* (10.039) in the drive has reached 75.0 % of the value at which the drive will trip. |
| **OV.Ld** | *Motor Protection Accumulator* (04.019) in the drive has reached 75.0 % of the value at which the drive will trip and the load on the drive is >100 %. |
| **d.OV.Ld** | Drive over temperature. *Percentage Of Drive Thermal Trip Level* (07.036) in the drive is greater than 90 %. |
| **tuning** | The autotune procedure has been initialized and an autotune in progress. |
| **LS** | Limit switch active. Indicates that a limit switch is active and that is causing the motor to be stopped. |
| **Opt.Al** | Option slot alarm. |
| **Lo.AC** | Low voltage mode. See *Low AC Alarm* (10.107). |
| **I.AC.Lt** | Current limit active. See *Current Limit Active* (10.009). |
| **24.LoSt** | 24V Backup not present. See *24V Alarm Loss Enable* (11.098). |

## 12.7 Status indications

**Table 12-6 Status indications**

| String | Description | Drive output stage |
|---|---|---|
| **inh** | The drive is inhibited and cannot be run. The Safe Torque Off signal is not applied to Safe Torque Off terminals or Pr **06.015** is set to 0. | Disabled |
| **rdy** | The drive is ready to run. The drive enable is active, but the drive inverter is not active because the final drive run is not active. | Disabled |
| **Stop** | The drive is stopped / holding zero speed. | Enabled |
| **S.Loss** | Supply loss condition has been detected. | Enabled |
| **dc.inj** | The drive is applying dc injection braking. | Enabled |
| **Er** | The drive has tripped and no longer controlling the motor. The trip code appears in the display. | Disabled |
| **UV** | The drive is in the under voltage state either in low voltage or high voltage mode. | Disabled |
| **HEAt** | The motor pre-heat function is active | Enabled |

**Table 12-7 Option module and other status indications at power-up**

| String | Status |
|---|---|
| **PS.LOAD** | Waiting for power stage. |
| The drive is waiting for the processor in the power stage to respond after power-up. | |
| **LOAD OPtion** | Waiting for an option module |
| The drive is waiting for the option module to respond after power-up. | |
| **UPLOAD** | Loading parameter database |
| At power-up it may be necessary to update the parameter database held in the drive because an Option module has changed. This may involve data transfer between the drive and option module. During this period 'UPLOAD' is displayed. | |
| **LOAD.I** | Bootloading drive firmware |
| The drive is waiting for the bootloader file to be transferred to the processor. | |

## 12.8 Displaying the trip history

The drive retains a log of the last ten trips that have occurred. *Trip 0* (10.020) to *Trip 9* (10.029) store the most recent 10 trips that have occurred where *Trip 0* (10.020) is the most recent and *Trip 9* (10.029) is the oldest. When a new trip occurs it is written to *Trip 0* (10.020) and all the other trips move down the log, with oldest being lost. The date and time when each trip occurs are also stored in the date and time log, i.e. *Trip 0 Date* (10.041) to *Trip 9 Time* (10.060). The date and time are taken from *Date* (06.016) and *Time* (06.017). Some trips have sub-trip numbers which give more detail about the reason for the trip. If a trip has a sub-trip number its value is stored in the sub-trip log, i.e. *Trip 0 Sub-trip Number* (10.070) to *Trip 9 Sub-trip Number* (10.079). If the trip does not have a sub-trip number then zero is stored in the sub-trip log.

If any parameter between Pr **10.020** and Pr **10.029** inclusive is read by serial communication, then the trip number in Table 12-2 is the value transmitted.

**NOTE**

The trip logs can be reset by writing a value of 255 in Pr **10.038** (via serial communications only).

## 12.9 Behaviour of the drive when tripped

If the drive trips, the output of the drive is disabled so the load coasts to a stop. If any trip occurs, the following read only parameters are frozen until the trip is cleared. This is to help diagnose the cause of the trip.

| Parameter | Description |
|---|---|
| **01.001** | Frequency reference |
| **01.002** | Pre-skip filter reference |
| **01.003** | Pre-ramp reference |
| **01.069** | Reference in rpm |
| **01.070** | Clamped reference |
| **02.001** | Post-ramp reference |
| **03.001** | Final demand ref |
| **03.002** | Estimated frequency |
| **03.003** | Frequency error |
| **03.004** | Frequency controller output |
| **03.045** | Frequency reference |
| **04.001** | Current magnitude |
| **04.002** | Active current |
| **04.017** | Reactive current |
| **05.001** | Output frequency |
| **05.002** | Output voltage |
| **05.003** | Power |
| **05.005** | DC bus voltage |
| **07.001** | Analog input 1 |
| **07.002** | Analog input 2 |

If the parameters are not required to be frozen then this can be disabled by setting bit 4 of Pr **10.037**.

# 13 UL Listing

## 13.1 UL file reference

All models are UL Listed to both Canadian and US requirements. The UL file reference is: NMMS/7.E171230.

Products that incorporate the Safe Torque Off function have been investigated by UL. The UL file reference is: FSPC.E171230.

## 13.2 Option modules, kits and accessories

Option Modules, Control Pods, Installation Kits and other accessories for use with these drives are UL Listed.

## 13.3 Enclosure ratings

All models are Open Type as supplied.

The drive enclosure is not classified as a fire enclosure. A separate fire enclosure must be provided. A UL/ NEMA Type 12 enclosure is suitable.

When fitted with a conduit box the drives meet the requirements for UL Type 1. Type 1 enclosures are intended for indoor use, primarily to provide a degree of protection against limited amounts of falling dirt.

The drives meet the requirements for UL Type 12 when installed inside a Type 12 enclosure and through-hole mounted using the sealing kit and the high-IP insert (where provided).

When through-hole mounted, the drives have been evaluated as suitable for use in surrounding air temperatures up to 40 °C.

Remote Keypads are UL Type 12 when installed with the sealing washer and fixing kit provided.

When installed in a Type 1 or Type 12 enclosure, the drives may be operated in a compartment handling conditioned air.

## 13.4 Mounting

Drives may be surface, through-panel or tile mounted using the appropriate brackets. Drives may be mounted singly or side by side with suitable space between them (bookcase mounting).

## 13.5 Environment

Drives must be installed in a Pollution Degree 2 environment or better (dry, non-conductive pollution only).

The drives have been evaluated for use at ambient temperatures up to 40 °C. The drives have additionally been evaluated for 50 °C and 55 °C ambient air temperatures with a derated output.

## 13.6 Electrical Installation

**OVERVOLTAGE CATEGORY**

OVC III

**SUPPLY**

(Frame 1 to 4 drives)

The drives are suitable for use on a circuit capable of delivering not more than 10,000 RMS Symmetrical Amperes, at rated voltage when protected by fuses as specified in the Installation Instructions.

Some smaller drives are suitable for use on a circuit capable of delivering not more than 10,000 RMS Symmetrical Amperes, at rated voltage when protected by circuit breakers.

(Frame 5 to 9 drives)

The drives are suitable for use on a circuit capable of delivering not more than 100,000 RMS Symmetrical Amperes, at rated voltage when protected by fuses as specified in the Installation Instructions.

**TERMINAL TORQUE**

Terminals must be tightened to the rated torque as specified in the Installation Instructions.

**WIRING TERMINALS**

Drives must be installed using cables rated for 75 °C operation, copper wire only.

Where possible, UL Listed closed-loop connectors sized according to the field wiring shall be used for all field power wiring connections.

**GROUND CONNECTION INSTRUCTIONS**

UL Listed closed-loop connectors sized according to the field wiring shall be used for grounding connections.

**BRANCH CIRCUIT PROTECTION**

The fuses and circuit breakers required for branch circuit protection are specified in the Installation Instructions.

**OPENING OF BRANCH CIRCUIT**

Opening of the branch-circuit protective device may be an indication that a fault has been interrupted. To reduce the risk of fire or electric shock, the equipment should be examined and replaced if damaged. If burnout of the current element of an overload relay occurs, the complete overload relay must be replaced.

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code (NEC), The Canadian Electrical Code, and any additional local codes.

**DYNAMIC BRAKING**

C200 & C300, frame sizes 1 to 4 have been evaluated for dynamic braking applications. Other drive models have not been evaluated for dynamic braking.

## 13.7 Motor overload protection and thermal memory retention

All drives incorporate internal overload protection for the motor load that does not require the use of an external or remote overload protection device.

The protection level is adjustable and the method of adjustment is provided in section 8.4 *Motor thermal protection* on page 70. Maximum current overload is dependent on the values entered into the current limit parameters (motoring current limit, regenerative current limit and symmetrical current limit entered as percentage) and the motor rated current parameter (entered in amperes).

The duration of the overload is dependent on motor thermal time constant. The maximum programmable time constant depends on the drive model. The method of adjustment of the overload protection is provided.

The drives are provided with user terminals that can be connected to a motor thermistor to protect the motor from high temperature, in the event of a motor cooling fan failure.

## 13.8 External Class 2 supply

The external power supply used to power the 24 V control circuit shall be marked: “UL Class 2”. The power supply voltage shall not exceed 24 Vdc.

## 13.9 Modular Drive Systems

Drives with DC+ and DC- supply connections, rated 230 V or 480 V have been investigated for use in Modular Drive Systems as inverters when supplied by the converter sections from the Commander range. In these applications the inverters are required to be additionally protected by supplemental fuses.

Alternatively, the inverters may be supplied by converter models: Mentor MP25A, 45A, 75A, 105A, 155A or 210A.

Contact the supplier of the drive for more information.

## 13.10 Requirement for Transient Surge Suppression

This requirement only applies to Frame Size 7 drives with rated input voltage = 575 V.

TRANSIENT SURGE SUPPRESSION SHALL BE INSTALLED ON THE LINE SIDE OF THIS EQUIPMENT AND SHALL BE RATED 575 Vac (PHASE TO GROUND), 575 Vac (PHASE TO PHASE), SUITABLE FOR OVERVOLTAGE CATEGORY III, AND SHALL PROVIDE PROTECTION FOR A RATED IMPULSE VOLTAGE TO WITHSTAND VOLTAGE PEAK OF 6 kV AND A CLAMPING VOLTAGE OF MAXIMUM 2400 V.

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