EMERSON
Industrial Automation

User Guide

Unidrive M400

Model size 1 to 8

Variable Speed AC drive for induction motors

Part Number: 0478-0044-06
Issue: 6

CONTROL TECHNIQUES

www.controltechniques.com

Original Instructions

For the purposes of compliance with the EU Machinery Directive 2006/42/EC

General information

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

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

Drive firmware version

This product is supplied with the latest firmware version. If this drive is to be connected to an existing system or machine, all drive firmware versions should be verified to confirm the same functionality as drives of the same model already present. This may also apply to drives returned from a Control Techniques Service Centre or Repair Centre. If there is any doubt please contact the supplier of the product.

The firmware version of the drive can be checked by looking at Pr **11.029**.

Environmental statement

Control Techniques is committed to minimising the environmental impacts of its manufacturing operations and of its products throughout their life cycle. To this end, we operate an Environmental Management System (EMS) which is certified to the International Standard ISO 14001. Further information on the EMS, our Environmental Policy and other relevant information is available on request, or can be found at www.greendrives.com.

The electronic variable-speed drives manufactured by Control Techniques have the potential to save energy and (through increased machine/process efficiency) reduce raw material consumption and scrap throughout their long working lifetime. In typical applications, these positive environmental effects far outweigh the negative impacts of product manufacture and end-of-life disposal.

Nevertheless, when the products eventually reach the end of their useful life, they must not be discarded but should instead be recycled by a specialist recycler of electronic equipment. Recyclers will find the products easy to dismantle into their major component parts for efficient recycling. Many parts snap together and can be separated without the use of tools, while other parts are secured with conventional fasteners. Virtually all parts of the product are suitable for recycling.

Product packaging is of good quality and can be re-used. Large products are packed in wooden crates, while smaller products come in strong cardboard cartons which themselves have a high recycled fibre content. If not re-used, these containers can be recycled. Polythene, used on the protective film and bags for wrapping product, can be recycled in the same way. Control Techniques' packaging strategy prefers easily-recyclable materials of low environmental impact, and regular reviews identify opportunities for improvement.

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.

For current information on how this requirement applies in relation to specific Control Techniques products, please approach your usual contact in the first instance. Control Techniques position statement can be viewed at: http://www.controltechniques.com/REACH

Issue Number: 6
Drive Firmware: 01.03.00 onwards

How to use this guide

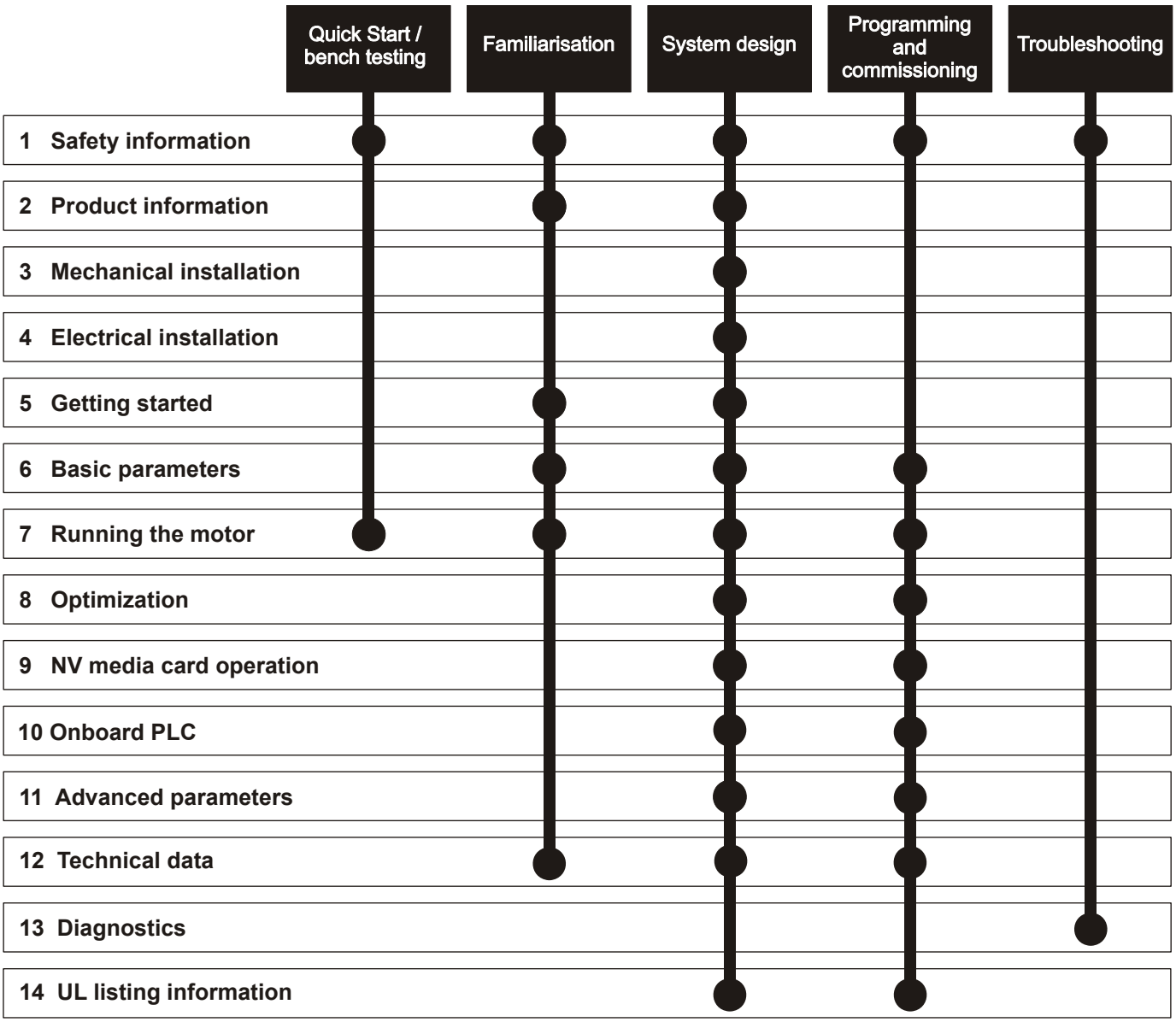
This user guide provides complete information for installing and operating the drive from start to finish.

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

NOTE

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

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



Contents

Declaration of Conformity

Control Techniques Ltd
The Gro
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Powys
UK
SY16 3BE

Moteurs Leroy-Somer
Usine des Agriers
Boulevard Marcellin Leroy
CS10015
16915 Angoulême Cedex 9
France

This declaration applies to Unidrive M variable speed drive products, comprising models numbers as shown below:

M*aaa-bbcddddd* Valid characters:	
aaa	100, 101, 200, 201, 300, 400
bb	01, 02, 03, 04, 05, 06, 07, 08
c	1, 2, 4, 5 or 6
ddddd	00017, 00024, 00033, 00042 00013, 00018, 00023, 00024, 00032, 00033, 00041, 00042, 00056, 00075 00056, 00073, 00094, 00100 00133, 00135, 00170, 00176 00030, 00040, 00069, 00250, 00270, 00300 00100, 00150, 00190, 00230, 00290, 00330, 00350, 00420, 00440, 00470 00190, 00240, 00290, 00380, 00440, 00540, 00550, 00610, 00660, 00750, 00770, 00830, 01000 00630, 00860, 01160, 01320, 01340, 01570

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

EN 61800-5-1:2007	Adjustable speed electrical power drive systems - safety requirements - electrical, thermal and energy
EN 61800-3:2004	Adjustable speed electrical power drive systems. EMC product standard including specific test methods
EN 61000-6-2:2005	Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments
EN 61000-6-4:2007	Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments
EN 61000-3-2:2006	Electromagnetic compatibility (EMC), Limits, Limits for harmonic current emissions (equipment input current <16 A per phase)
EN 61000-3-3:2008	Electromagnetic compatibility (EMC), Limits, Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current <16 A

EN 61000-3-2:2006 Applicable where input current <16 A. No limits apply for professional equipment where input power >1 kW.

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

T. Alexander
Vice President, Technology
Newtown

Date: 29th May 2014

These electronic drive products are intended to be used with appropriate motors, controllers, electrical protection components and other equipment to form complete end products or systems. Compliance with safety and EMC regulations depends upon installing and configuring drives correctly, including using the specified input filters. The drives must be installed only by professional assemblers who are familiar with requirements for safety and EMC. The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used. Refer to the User Guide. An EMC Data Sheet is also available giving detailed EMC information.

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This declaration applies to the Unidrive M variable speed drive product range, comprising model numbers composed as shown below:

M*aaa-bbbbbbbbb* Valid characters:	
aaa	300, 400
bbbbbbbbb	01100017A, 01100024A, 01200017A, 01200024A, 01200033A, 01200042 02100042A, 02100056A, 02200024A, 02200033A, 02200042A, 02200056A, 02200075A, 02400013A, 02400018A, 02400023A, 02400032A, 02400041A 03200100A, 03400056A, 03400073A, 03400094A 04200133A, 04200176A, 04400135A, 04400170A

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 Directive 2006/42/EC (The Machinery Directive).

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

TÜV Rheinland Industrie Service GmbH

Alboinstraße 56

12103 Berlin, Germany

Notified Body identification number: 0035

EC type-examination certificate number: 01/205/5383.00/14

The harmonised standards used are shown below:

EN 61800-5-1:2007	Adjustable speed electrical power drive systems. Safety requirements. Electrical, thermal and energy
EN 61800-5-2:2007	Adjustable speed electrical power drive systems. Safety requirements. Functional
EN ISO 13849-1:2008	Safety of machinery. Safety-related parts of control systems. General principles for design
EN ISO 13849-2:2008	Safety of machinery. Safety-related parts of control systems. Validation
EN 62061:2005	Safety of machinery. Functional safety of safety related electrical, electronic and programmable electronic control systems

Person authorised to compile the technical file:

C Hargis

Chief Engineer

Newtown, Powys. UK

T. Alexander
VP Technology
Date: 9th April 2014
Place: Newtown, Powys. UK

IMPORTANT NOTICE

These drive products are intended to be used with appropriate motors, sensors, electrical protection components and other equipment to form complete 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 inverters correctly. The inverters must be installed only by professional assemblers who are familiar with requirements for safety and EMC. The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used. Refer to the User Guide.

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M*aaa-bbbbbbbbb* Valid characters:	
aaa	300, 400
bbbbbbbbb	05200250A, 05400270A, 05400300A, 05500030A, 05500040A, 05500069A 06200330A, 06200440A, 06400350A, 06400420A, 06400470A, 06500100A, 06500150A, 06500190A, 06500230A, 06500290A, 06500350A 07200610A, 07200750A, 07200830A, 07400660A, 07400770A, 07401000A, 07500440A, 07500550A, 07600190A, 07600240A, 07600290A, 07600380A, 07600440A, 07600540A 08201160A, 08201320A, 08401340A, 08401570A, 08500630A, 08500860A, 08600630A, 08600860A

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 Directive 2006/42/EC (The Machinery Directive).

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EN ISO 13849-2:2008	Safety of machinery. Safety-related parts of control systems. Validation
EN 62061:2005	Safety of machinery. Functional safety of safety related electrical, electronic and programmable electronic control systems

Person authorised to compile the technical file:

C Hargis

Chief Engineer

Newtown, Powys. UK

T. Alexander
VP Technology
Date: 13th May 2014
Place: Newtown, Powys. UK

IMPORTANT NOTICE

These drive products are intended to be used with appropriate motors, sensors, electrical protection components and other equipment to form complete 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 inverters correctly. The inverters must be installed only by professional assemblers who are familiar with requirements for safety and EMC. The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used. Refer to the User Guide.

1 Safety information

1.1 Warnings, Cautions and Notes

WARNING

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

CAUTION

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

NOTE

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

1.2 Electrical safety - general warning

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.

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

1.3 System design and safety of personnel

The drive is intended as a component for professional incorporation into complete equipment or a system. If installed incorrectly, the drive may present a safety hazard.

The drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control 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 experience. They must read this safety information and this User Guide carefully.

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

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.

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

The 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.

1.4 Environmental limits

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

1.5 Access

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

1.6 Fire protection

The drive enclosure is not classified as a fire enclosure. A separate fire enclosure must be provided. For further information, refer to section 3.2.5 *Fire protection* on page 23.

1.7 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 User Guide contains instruction for achieving compliance with specific EMC standards.

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

2006/42/EC Safety of machinery.
2004/108/EC: Electromagnetic Compatibility.

1.8 Motor

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

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

Low speeds may cause the motor to overheat because the cooling fan becomes less effective. 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 should not be relied upon.

It is essential that the correct value is entered in Pr **00.006** motor rated current. This affects the thermal protection of the motor.

1.9 Mechanical brake control

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.

1.10 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.

1.11 Electrical installation

1.11.1 Electric shock risk

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

AC supply cables and connections

Output cables and connections

Many internal parts of the drive, and external option units

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

1.11.2 Stored charge

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

1.12 Hazard

1.12.1 Falling hazard

The drive presents a falling or toppling hazard. This can still cause injury to personnel and therefore should be handled with care.

Maximum weight:

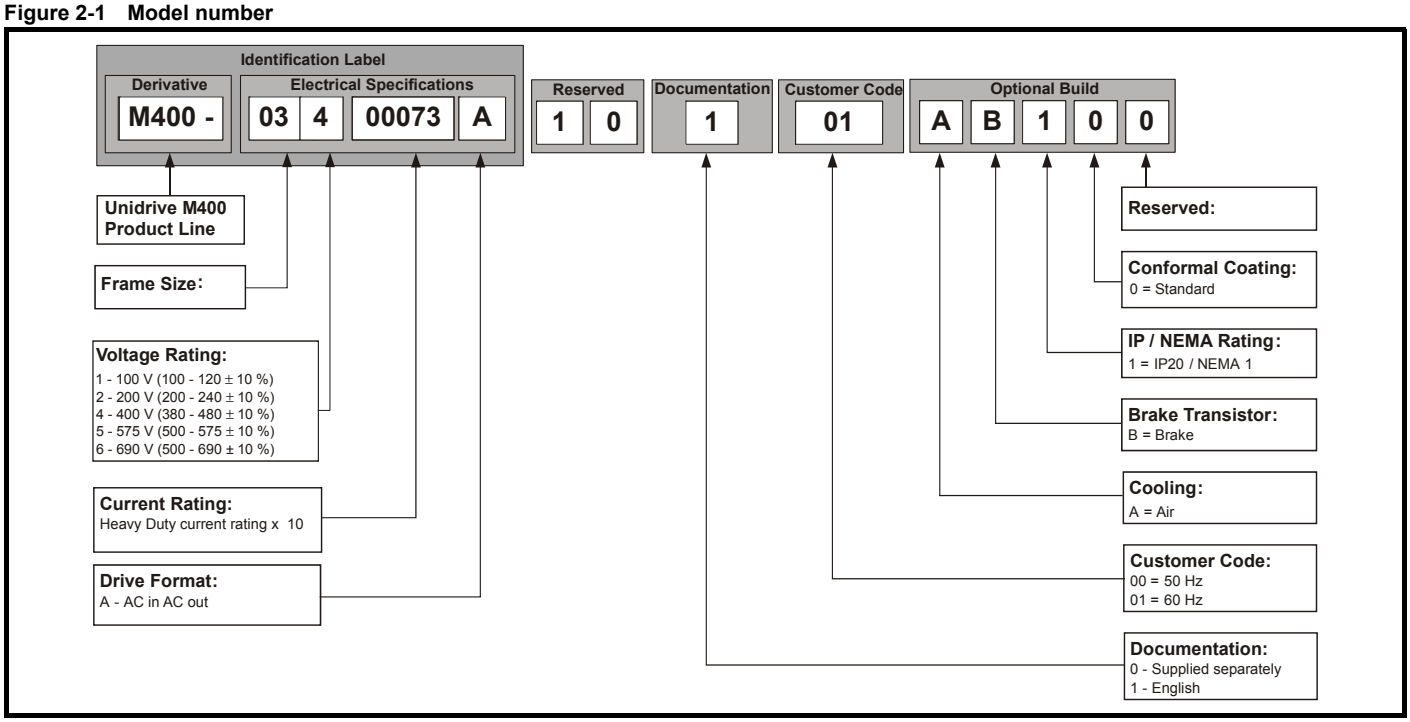
Size 1: 0.75 kg (1.65 lb)
Size 2: 1.3 kg (3.0 lb)
Size 3: 1.5 kg (3.3 lb)
Size 4: 3.13 kg (6.9 lb)
Size 5: 7.4 kg (16.3 lb)
Size 6: 14 kg (30.9 lb)
Size 7: 28 kg (61.7 lb)
Size 8: 50 kg (110.2 lb)

2 Product information

2.1 Model number

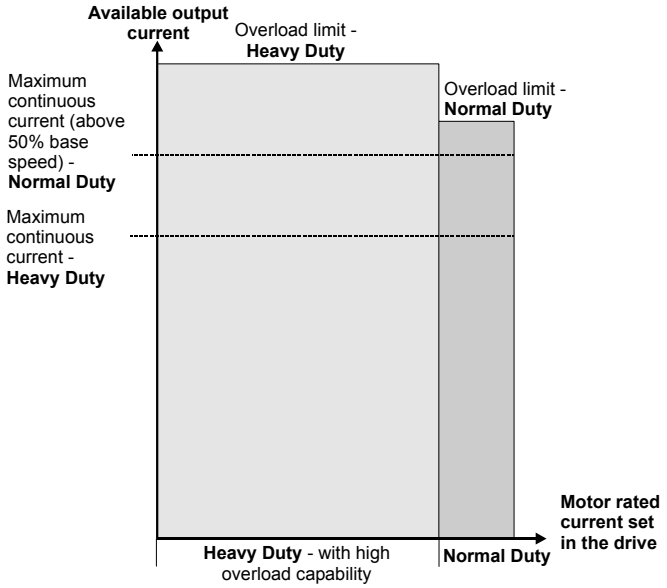
The way in which the model numbers for the Unidrive M range are formed is illustrated below:

Figure 2-1 Model number



2.2 Ratings

The size 1 to 4 drive is Heavy Duty rated only.
The size 5 to 8 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 I^2t 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)

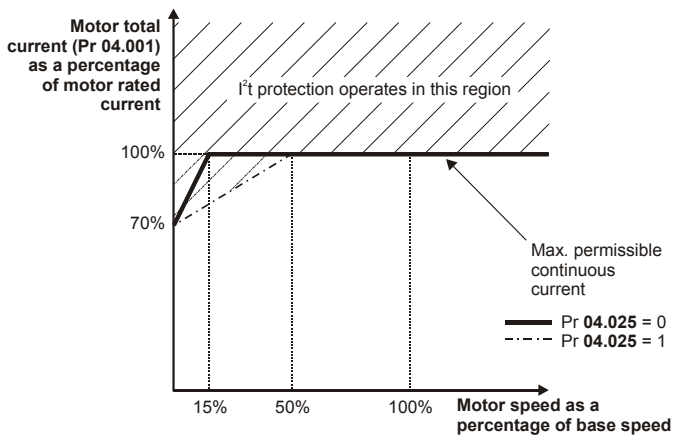
For constant torque applications or applications which require a high overload capability, or full torque is required at low speeds (e.g. winders, hoists).
The thermal protection is set to protect force ventilated induction motors by default.

NOTE

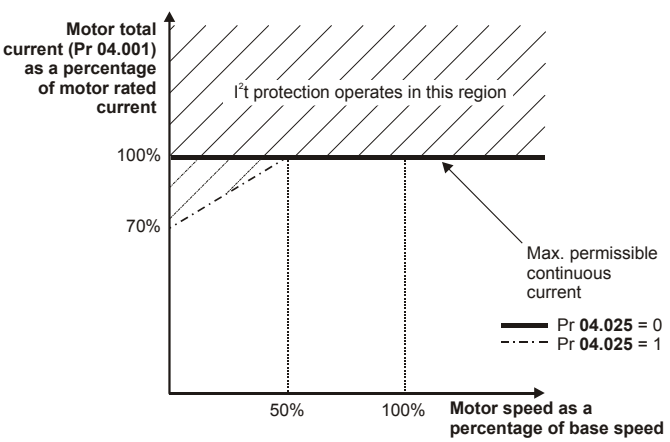
If the application uses a self ventilated (TENV/TEFC) induction motor and increased thermal protection is required for speeds below 50 % base speed, then this can be enabled by setting *Low Speed Thermal Protection Mode* (04.025) = 1.

Operation of motor I^2t protection

Motor I^2t protection is fixed as shown below and is compatible with:
- Self ventilated (TENV/TEFC) induction motors



Motor I^2t protection defaults to be compatible with:
- Forced ventilation induction motors



The continuous current ratings given are for maximum 40 °C (104 °F), 1000 m altitude and 3.0 kHz switching. Derating is required for higher switching frequencies, ambient temperature >40 °C (104 °F) and high altitude. For further information, refer to Chapter 12 *Technical data* on page 183.

Table 2-1 100 V drive ratings (100 V to 120 V ±10 %)

Model		Heavy Duty				
		Maximum continuous output current	Open loop peak current	RFC peak current	Nominal power at 100 V	Motor power at 100 V
		A	A	A	kW	hp
Frame size 1	01100017	1.7	2.6	3.1	0.25	0.33
	01100024	2.4	3.6	4.3	0.37	0.5
Frame size 2	02100042	4.2	6.3	7.6	0.75	1
	02100056	5.6	8.4	10.1	1.1	1.5

Table 2-2 200 V drive ratings (200 V to 240 V ±10 %)

Model		Normal Duty				Heavy Duty				
		Maximum continuous output current	Nominal power at 230 V	Motor power at 230 V	Peak current	Maximum continuous output current	Open loop peak current	RFC peak current	Nominal power at 230 V	Motor power at 230 V
		A	kW	hp	A	A	A	A	kW	hp
Frame size 1	01200017					1.7	2.6	3.1	0.25	0.33
	01200024					2.4	3.6	4.3	0.37	0.5
	01200033					3.3	5	5.9	0.55	0.75
	01200042					4.2	6.3	7.6	0.75	1
Frame size 2	02200024					2.4	3.6	4.3	0.37	0.5
	02200033					3.3	5	5.9	0.55	0.75
	02200042					4.2	6.3	7.6	0.75	1
	02200056					5.6	8.4	10.1	1.1	1
	02200075					7.5	11.3	13.5	1.5	2
Frame size 3	03200100					10	15	18	2.2	3
Frame size 4	04200133					13.3	20	23.9	3	3
	04200176					17.6	16.4	31.7	4	5
Frame size 5	05200250	30	7.5	10	33	25	37.5	50	5.5	7.5
Frame size 6	06200330	50	11	15	55	33	49.5	66	7.5	10
	06200440	58	15	20	63.8	44	66	88	11	15
Frame size 7	07200610	75	18.5	25	82.5	61	91.5	122	15	20
	07200750	94	22	30	103.4	75	112.5	150	18.5	25
	07200830	117	30	40	128.7	83	124.5	166	22	30
Frame size 8	08201160	149	37	50	163.9	116	174	232	30	40
	08201320	180	45	60	198	132	192	264	37	50

Table 2-3 400 V drive ratings (380 V to 480 V ±10 %)

Model		Normal Duty				Heavy Duty				
		Maximum continuous output current	Nominal power at 400 V	Motor power at 460 V	Peak current	Maximum continuous output current	Open loop peak current	RFC peak current	Nominal power at 400 V	Motor power at 460 V
		A	kW	hp	A	A	A	A	kW	hp
Frame size 2	02400013					1.3	2	2.3	0.37	0.5
	02400018					1.8	2.7	3.2	0.55	0.75
	02400023					2.3	3.5	4.1	0.75	1
	02400032					3.2	4.8	5.8	1.1	1.5
	02400041					4.1	6.2	7.4	1.5	2
Frame size 3	03400056					5.6	8.4	10.1	2.2	3
	03400073					7.3	11	13.1	3	3
	03400094					9.4	14.1	16.9	4	5
Frame size 4	04400135					13.5	20.3	24.3	5.5	7.5
	04400170					17	25.5	30.6	7.5	10
Frame size 5	05400270	30	15	20	33	27	40.5	54	11	20
	05400300	31	15	20	34.1	30	45	60	15	20
Frame size 6	06400350	38	18.5	25	41.8	35	52.5	70	15	25
	06400420	48	22	30	52.8	42	63	84	18.5	30
	06400470	63	30	40	69.3	47	70.5	94	22	30
Frame size 7	07400660	79	37	50	86.9	66	99	132	30	50
	07400770	94	45	60	103.4	77	115.5	154	37	60
	07401000	112	55	75	123.2	100	150	200	45	75
Frame size 8	08401340	155	75	100	170.5	134	201	268	55	100
	08401570	184	90	125	202.4	157	235.5	314	75	125

Table 2-4 575 V drive ratings (500 V to 575 V ±10 %)

Model		Normal Duty				Heavy Duty				
		Maximum continuous output current	Nominal power at 575 V	Motor power at 575 V	Peak current	Maximum continuous output current	Open loop peak current	RFC peak current	Nominal power at 575 V	Motor power at 575 V
		A	kW	hp	A	A	A	A	kW	hp
Frame size 5	05500030	3.9	2.2	3	4.3	3	4.5	6	1.5	2
	05500040	6.1	4	5	6.7	4	6	8	2.2	3
	05500069	10	5.5	7.5	11	6.9	10.3	13.8	4	5
Frame size 6	06500100	12	7.5	10	13.2	10	15	20	5.5	7.5
	06500150	17	11	15	18.7	15	22.5	30	7.5	10
	06500190	22	15	20	24.2	19	28.5	38	11	15
	06500230	27	18.5	25	29.7	23	34.5	46	15	20
	06500290	34	22	30	37.4	29	43.5	58	18.5	25
	06500350	43	30	40	47.3	35	52.5	70	22	30
Frame size 7	07500440	53	45	50	58.3	44	66	88	30	40
	07500550	73	55	60	80.3	55	82.5	110	37	50
Frame size 8	08500630	86	75	75	94.6	63	94.5	126	45	60
	08500860	108	90	100	118.8	86	129	172	55	75

Table 2-5 690 V drive ratings (500 V to 690 V ±10 %)

Model		Normal Duty				Heavy Duty				
		Maximum continuous output current	Nominal power at 690 V	Motor power at 690 V	Peak current	Maximum continuous output current	Open loop peak current	RFC peak current	Nominal power at 690 V	Motor power at 690 V
		A	kW	hp	A	A	A	A	kW	hp
Frame size 7	07600190	23	18.5	25	25.3	19	28.5	38	15	20
	07600240	30	22	30	33	24	36	48	18.5	25
	07600290	36	30	40	39.6	29	43.5	58	22	30
	07600380	46	37	50	50.6	38	57	76	30	40
	07600440	52	45	60	57.2	44	66	88	37	50
	07600540	73	55	75	80.3	54	81	108	45	60
Frame size 8	08600630	86	75	100	94.6	63	94.5	126	55	75
	08600860	108	90	125	118.8	86	129	172	75	100

2.2.1 Typical short term overload limits

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

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

Table 2-6 Typical overload limits

Operating mode	RFC From cold	RFC From 100 %	Open loop from cold	Open loop from 100 %
Normal Duty overload with motor rated current = drive rated current	110 % for 165 s	110 % for 9 s	110 % for 165 s	110 % for 9 s
Heavy Duty overload with motor rated current = drive rated current	180 % for 3 s	180 % for 3 s	150 % for 60 s	150 % for 8 s

Generally the drive rated current is higher than the matching motor rated current allowing a higher level of overload than the default setting.

The time allowed in the overload region is proportionally reduced at very low output frequency on some drive ratings.

NOTE

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

2.3 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

2.3.1 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.

2.3.2 RFC-A mode

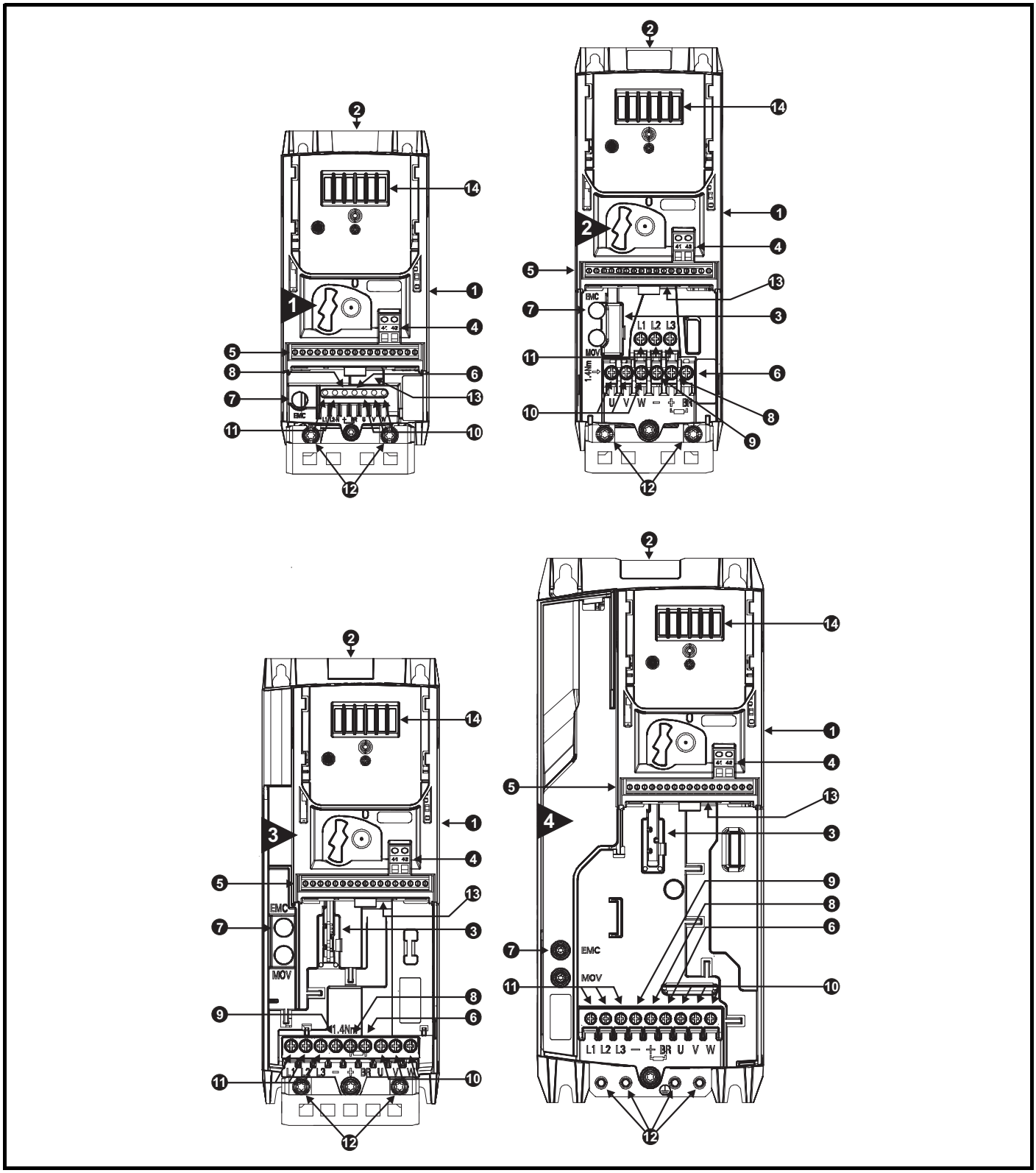
Rotor Flux Control for Asynchronous (induction) motors (RFC-A) encompasses closed loop vector control without a position feedback device

Without position feedback sensor

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.

2.4 Drive features

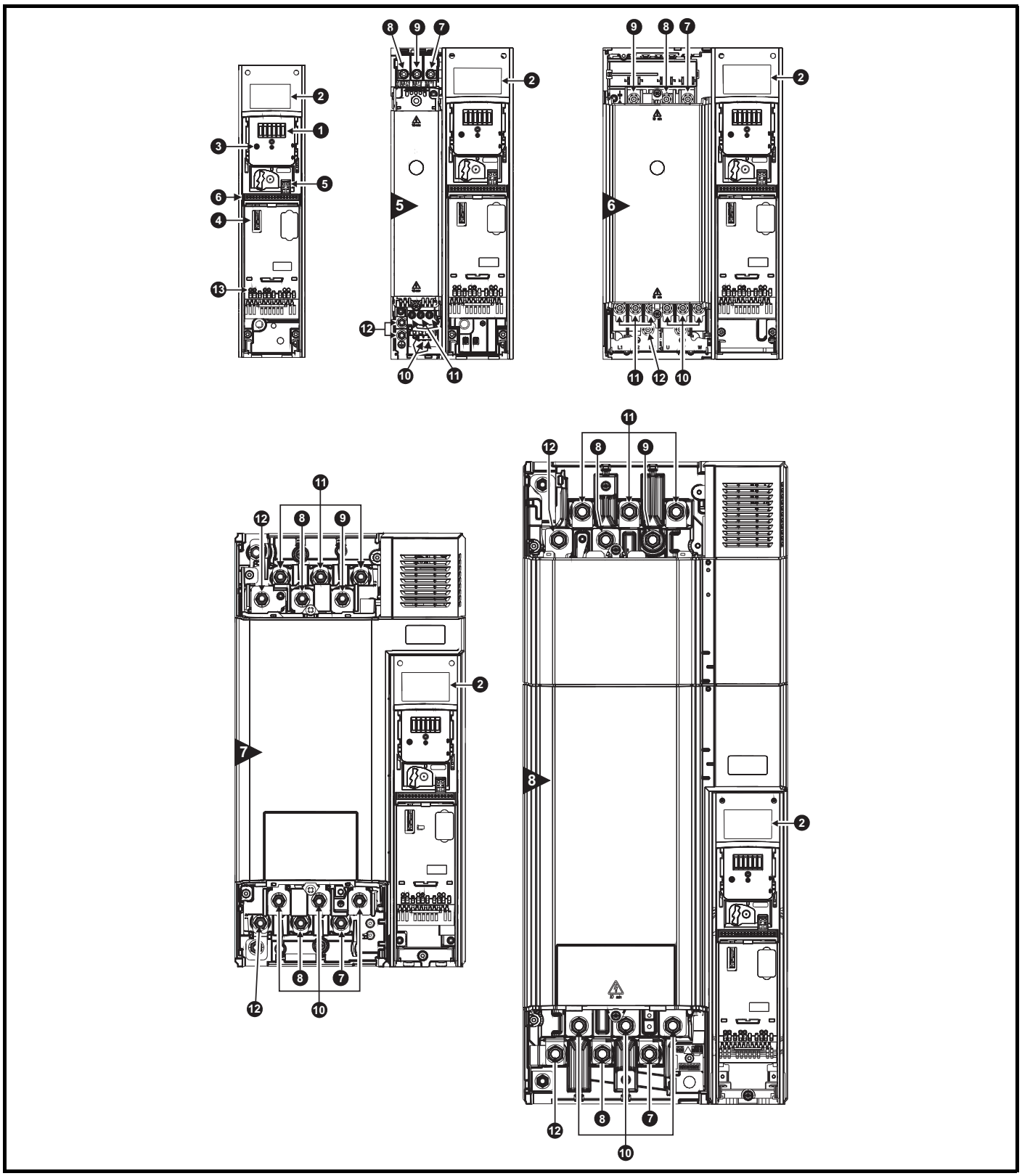
Figure 2-2 Features of the drive (size 1 to 4)



Key

1. Rating label (On side of drive)
2. Identification label
3. Option module connection
4. Relay connections
5. Control connections
6. Braking terminal
7. Internal EMC filter screw
8. DC bus +
9. DC bus -
10. Motor connections
11. AC supply connections
12. Ground connections
13. SAFE TORQUE OFF connections
14. Keypad connection

Figure 2-3 Features of the drive (size 5 to 8)



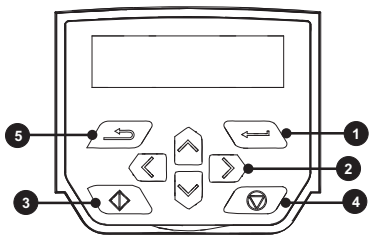
Key

1. Keypad connection
2. Rating label
3. Status LED
4. Option module slot 1
5. Relay connections
6. Control connections
7. Braking terminal
8. DC bus +
9. DC bus -
10. Motor connections
11. AC supply connections
12. Ground connections
13. SAFE TORQUE OFF connections

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 2-4 Unidrive M400 keypad detail



(1) The *Enter* button is used to enter parameter view or edit mode, or to accept a parameter edit.

(2) The *Navigation* keys can be used to select individual parameters or to edit parameter values. In keypad mode, the '*Up*' and '*Down*' keys are also used to increase or decrease the motor speed.

(3) The *Start* key is used to start the drive in keypad mode.

(4) The *Stop / Reset* key is used to stop and reset the drive in keypad mode. It can also be used to reset the drive in terminal mode.

(5) The *Escape* key is used to exit from the parameter edit / view mode or disregard a parameter edit.

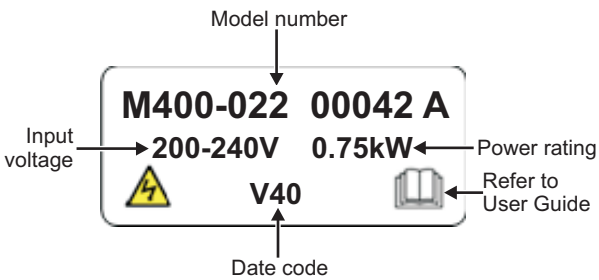
NOTE

The keypad is not supplied with the drive.

2.6 Nameplate description

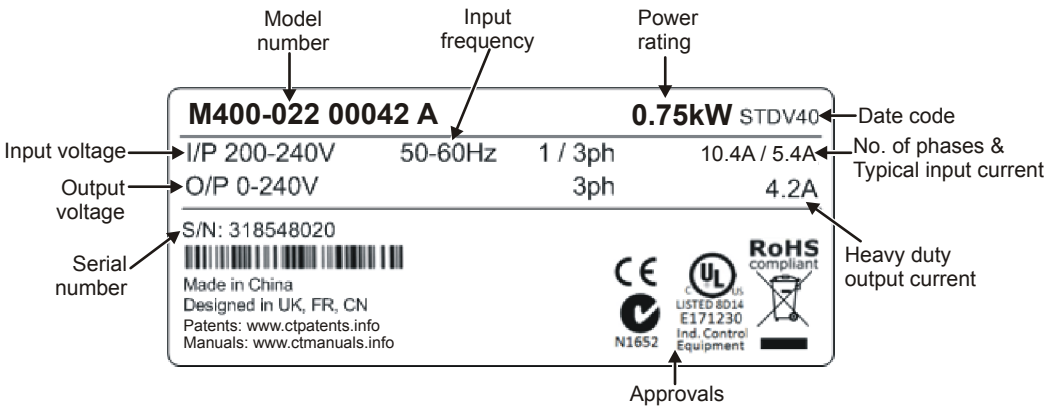
See Figure 2-2 for location of rating labels.

Figure 2-5 Typical drive rating labels size 2



Key to approvals

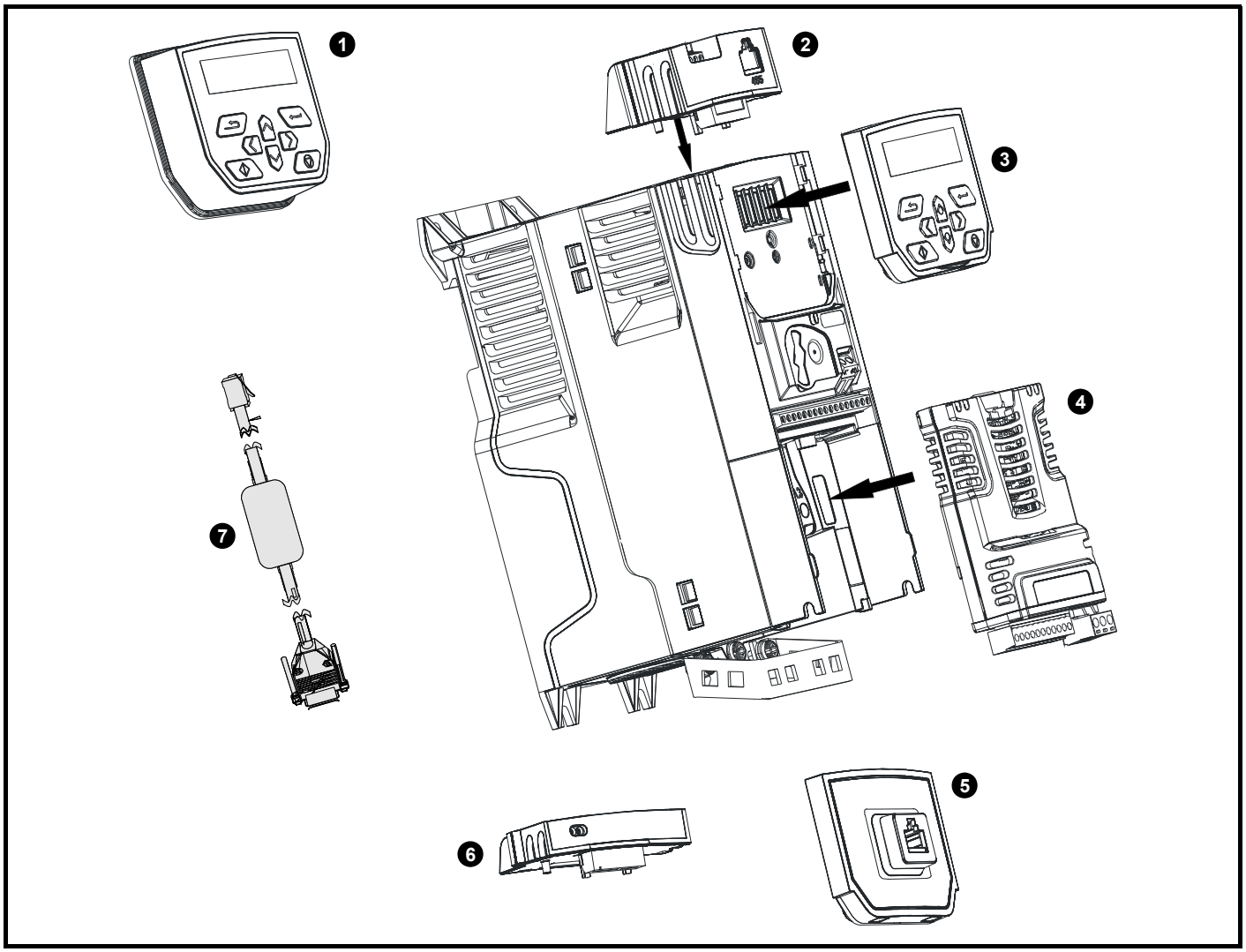
CE	CE approval	Europe
C Tick N1652	C Tick approval	Australia
cULus	UL / cUL approval	USA & Canada
RoHS Compliant	RoHS compliant	Europe



Refer to Figure 2-1 *Model number* on page 11 for further information relating to the labels.

2.7 Options

Figure 2-6 Options available with the drive

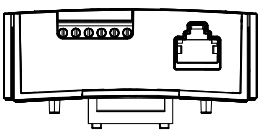
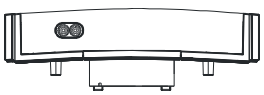


1. Remote mountable LCD keypad
2. Adaptor Interface (AI) Module
3. Compact Interface (CI) keypad
4. System Integration (SI) module
5. CI-485 Adaptor interface
6. AI-Backup adaptor
7. CT Comms cable

Table 2-7 System Integration (SI) option module identification

Type	Option module	Color	Name	Further details
Fieldbus		Purple	SI-PROFIBUS	**Profibus option** PROFIBUS adaptor for communications with the drive
		Medium Grey	SI-DeviceNet	**DeviceNet option** DeviceNet adaptor for communications with the drive
		Light Grey	SI-CANopen	**CANopen option** CANopen adaptor for communications with the drive
Automation (I/O expansion)		Orange	SI-I/O	**Extended I/O** Increases the I/O capability by adding the following combinations: • Digital I/O • Digital Inputs • Analog Inputs (differential or single ended) • Analog Output • Relays

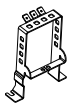
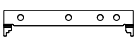
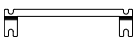
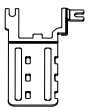
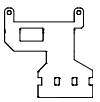
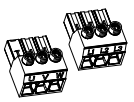
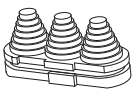
Table 2-8 Adaptor Interface (AI) option module identification

Type	Option module	Name	Further details
Communications		AI-485 adaptor	**485 serial communications option** Provides a 485 serial communications interface via an RJ45 connector or alternative screw terminals.
Backup		AI-Backup adaptor	**+24 V Backup and SD card interface**

2.8 Items supplied with the drive

The drive is supplied with a copy of the Quick Start Guide, a safety information booklet, the Certificate of Quality and an accessory kit box (size 5 to 8 only) including the items shown in Table 2-9.

Table 2-9 Parts supplied with the drive

Description	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6	Size 7	Size 8
STO connector	 x 1							
Grounding bracket	 x 1							
M4 x 8 Double Sem Torx screw	 x 2							
Grounding bracket					 x 1			
Surface mounting brackets					 x 2	 x 2	 x 2	 x 2
Grounding clamp					 x 1	 x 1		
Terminal nuts						 M6 x 11	 M8 x 12	 M10 x 12
Supply and motor connector					 x 1 x 1			
Finger guard grommets					 x 3	 x 2		

3 Mechanical installation

This chapter describes how to use all mechanical details to install the drive. The drive is intended to be installed in an enclosure. Key features of this chapter include:

- Through hole mounting
- High IP as standard or Through-panel mounting
- Enclosure sizing and layout
- Option module installing
- Terminal location and torque settings

3.1 Safety information

WARNING

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

WARNING

Competence of the installer
The drive must be installed by professional assemblers who are familiar with the requirements for safety and EMC. The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used.

WARNING

Enclosure
The drive is intended to be mounted in an enclosure which prevents access except by trained and authorized personnel, and which prevents the ingress of contamination. It is designed for use in an environment classified as pollution degree 2 in accordance with IEC 60664-1. This means that only dry, non-conducting contamination is acceptable.

3.2 Planning the installation

The following considerations must be made when planning the installation:

3.2.1 Access

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

The IP (Ingress Protection) rating of the drive is installation dependent. For further information, refer to section 3.9 *Enclosing size 5 to 8 drive for high environmental protection* on page 45.

3.2.2 Environmental protection

The drive must be protected from:

- Moisture, including dripping water or spraying water and condensation. An anti-condensation heater may be required, which must be switched off when the drive is running.
- Contamination with electrically conductive material
- Contamination with any form of dust which may restrict the fan, or impair airflow over various components
- Temperature beyond the specified operating and storage ranges
- Corrosive gasses

NOTE

During installation it is recommended that the vents on the drive are covered to prevent debris (e.g. wire off-cuts) from entering the drive.

3.2.3 Cooling

The heat produced by the drive must be removed without its specified operating temperature being exceeded. Note that a sealed enclosure gives much reduced cooling compared with a ventilated one, and may need to be larger and/or use internal air circulating fans.

For further information, refer to section 3.5.3 *Mounting brackets* on page 41.

3.2.4 Electrical safety

The installation must be safe under normal and fault conditions. Electrical installation instructions are given in Chapter 4 *Electrical installation on page 54*.

3.2.5 Fire protection

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

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

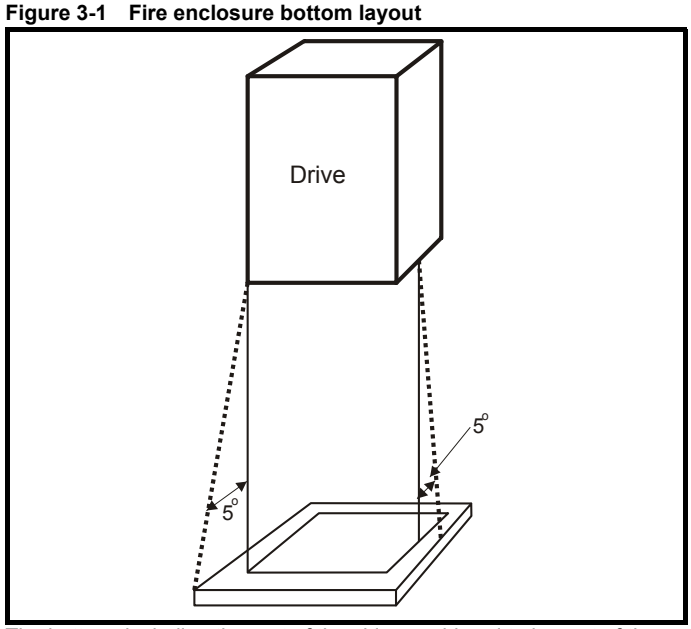
For installation outside the USA, the following (based on IEC 62109-1, standard for PV inverters) is recommended.

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

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

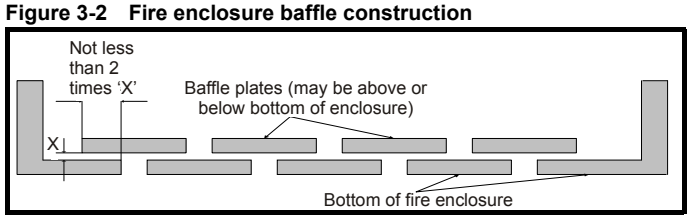
The location and size of the bottom shall cover the area shown in Figure 3-1. Any part of the side which is within the area traced out by the 5° angle is also considered to be part of the bottom of the fire enclosure.

Figure 3-1 Fire enclosure bottom layout



The bottom, including the part of the side considered to be part of the bottom, must be designed to prevent escape of burning material - either by having no openings or by having a baffle construction. This means that openings for cables etc. must be sealed with materials meeting the 5VB requirement, or else have a baffle above. See Figure 3-2 for acceptable baffle construction. This does not apply for mounting in an enclosed electrical operating area (restricted access) with concrete floor.

Figure 3-2 Fire enclosure baffle construction



3.2.6 Electromagnetic compatibility

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

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

If it is necessary to meet strict emission limits, or if it is known that electromagnetically sensitive equipment is located nearby, then full precautions must be observed. In-built into the drive, is an internal EMC filter, which reduces emissions under certain conditions. If these conditions are exceeded, then the use of an external EMC filter may be required at the drive inputs, which must be located very close to the drives. Space must be made available for the filters and allowance made for carefully segregated wiring. Both levels of precautions are covered in section 4.8 *EMC (Electromagnetic compatibility) on page 74*.

3.2.7 Hazardous areas

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

3.3 Terminal cover removal

WARNING

Isolation device

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

WARNING

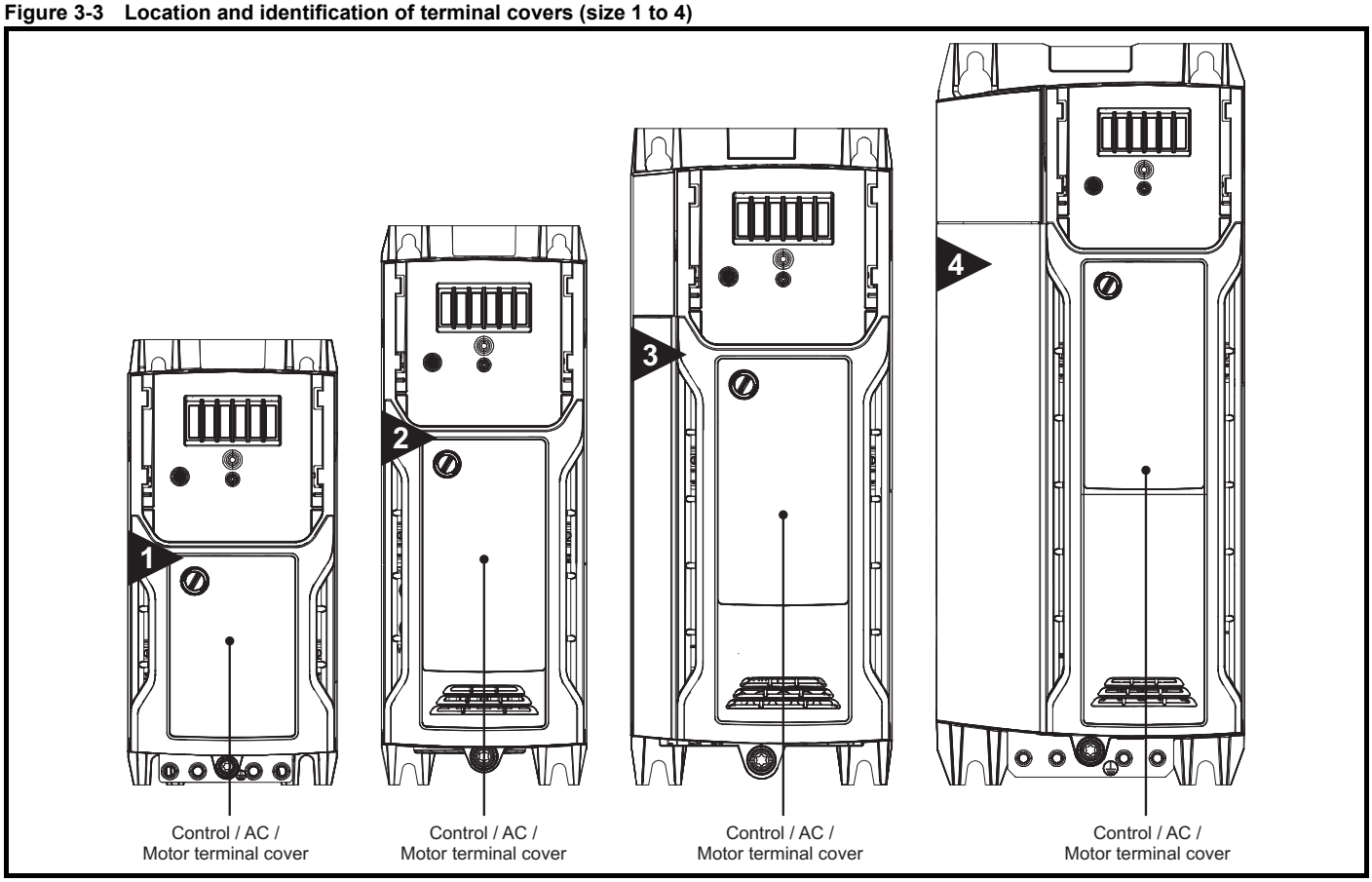
Stored charge

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

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

3.3.1 Removing the terminal covers

Figure 3-3 Location and identification of terminal covers (size 1 to 4)



NOTE

The drives shown in Figure 3-3 above, have a single removable terminal cover which provides access to all electrical connections, i.e. Control, AC, Motor and Brake functions. Figure 3-5 on page 26 illustrates the three steps required to remove the drive terminal covers.

Figure 3-4 Location and Identification of terminal covers (size 5 to 8)

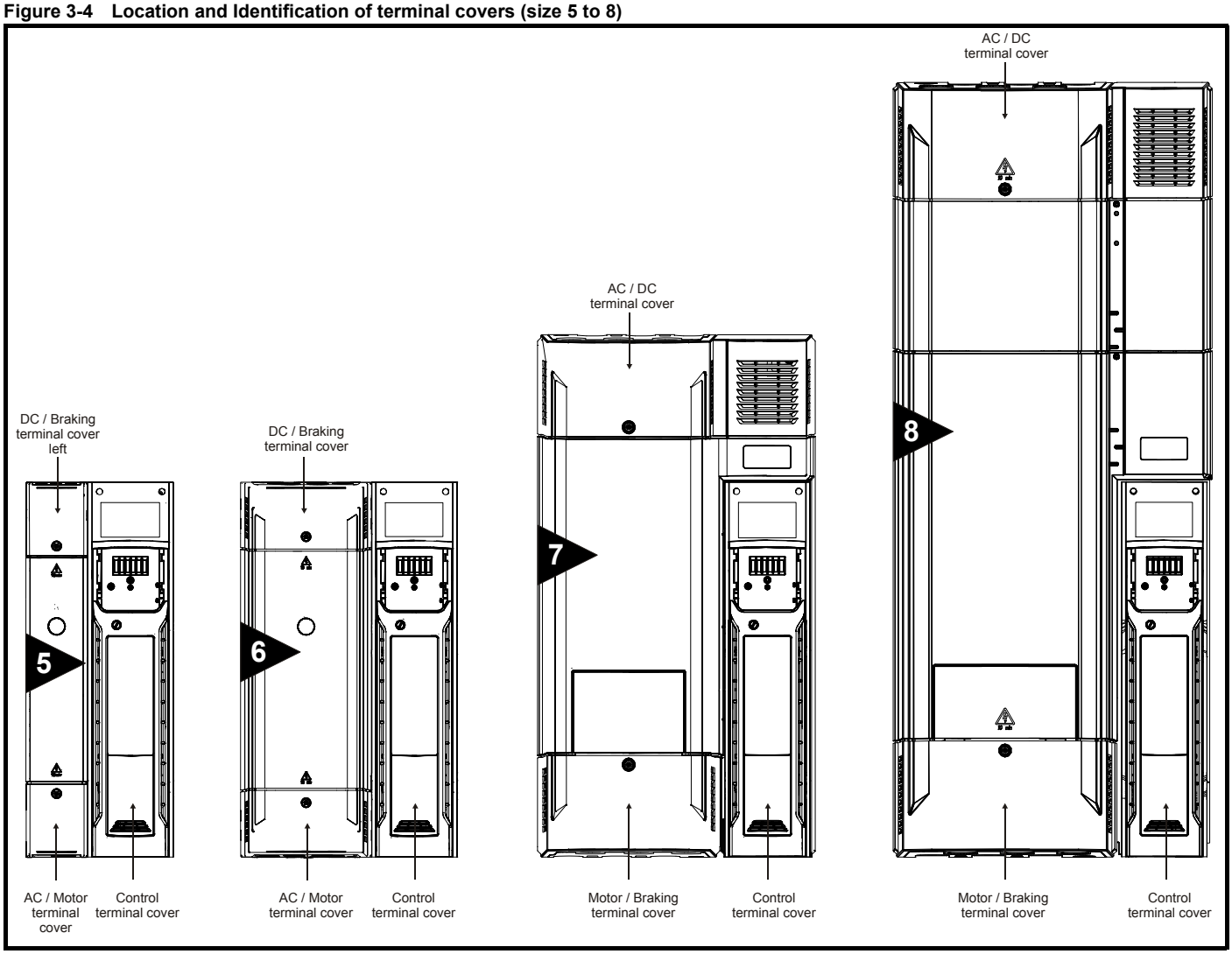
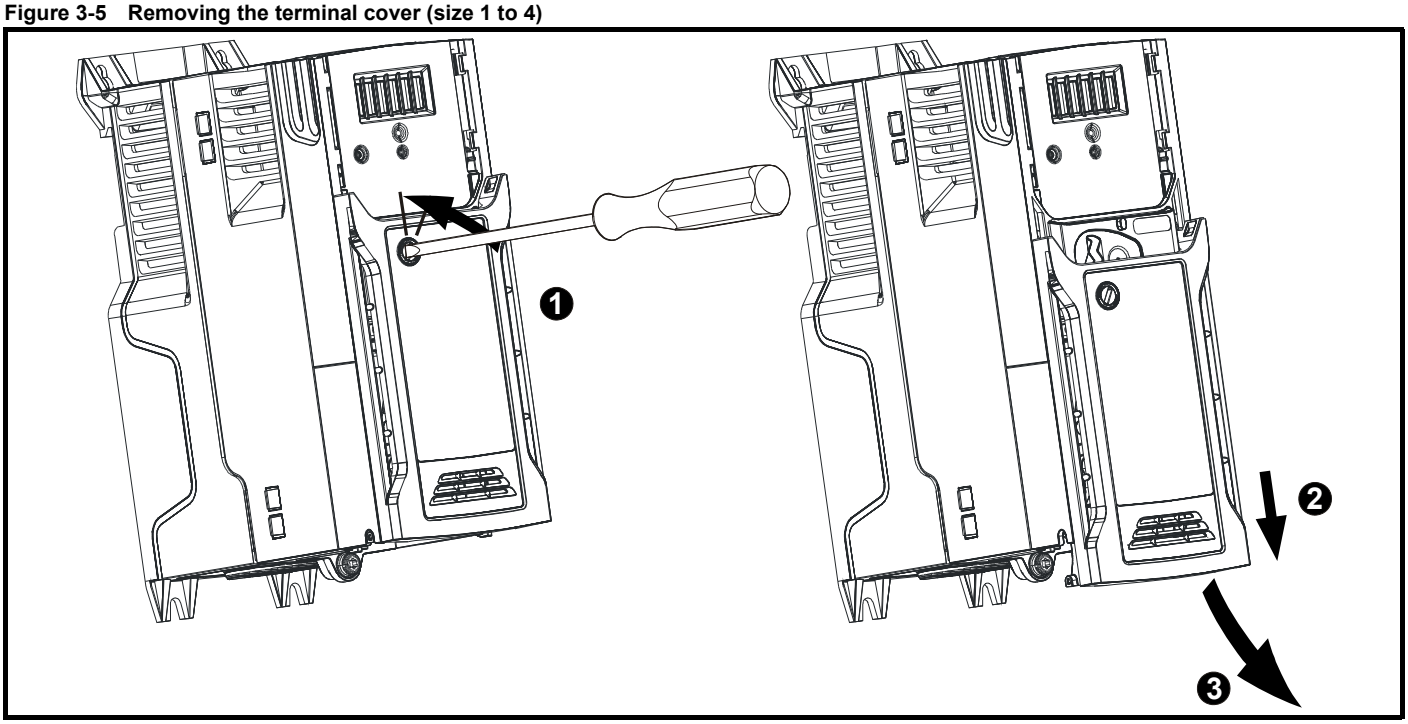
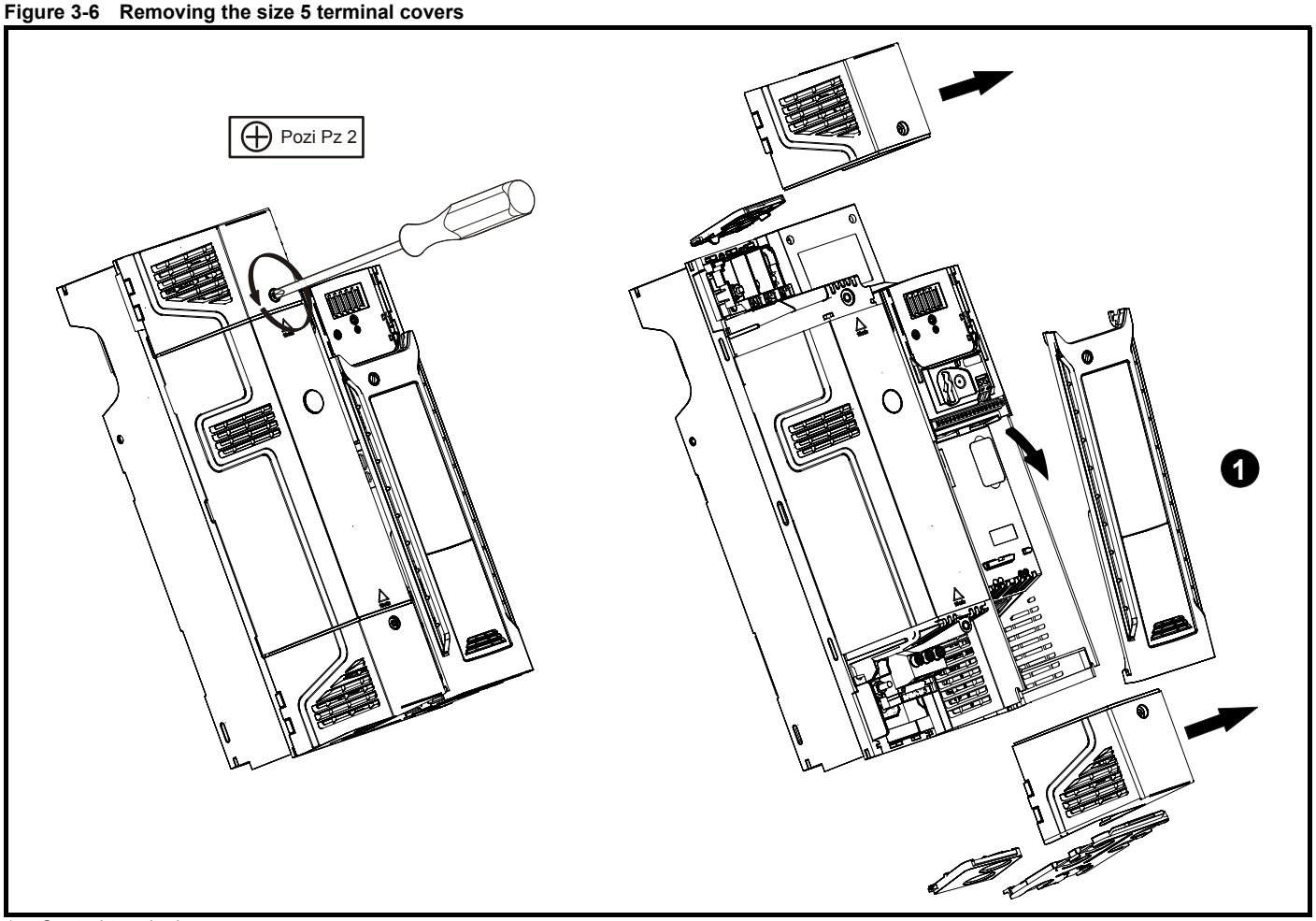


Figure 3-5 Removing the terminal cover (size 1 to 4)



1. Using a flat bladed screwdriver, turn the terminal cover locking clip anti-clockwise by approximately 30°
2. Slide the terminal cover down
3. Remove terminal cover in direction shown.

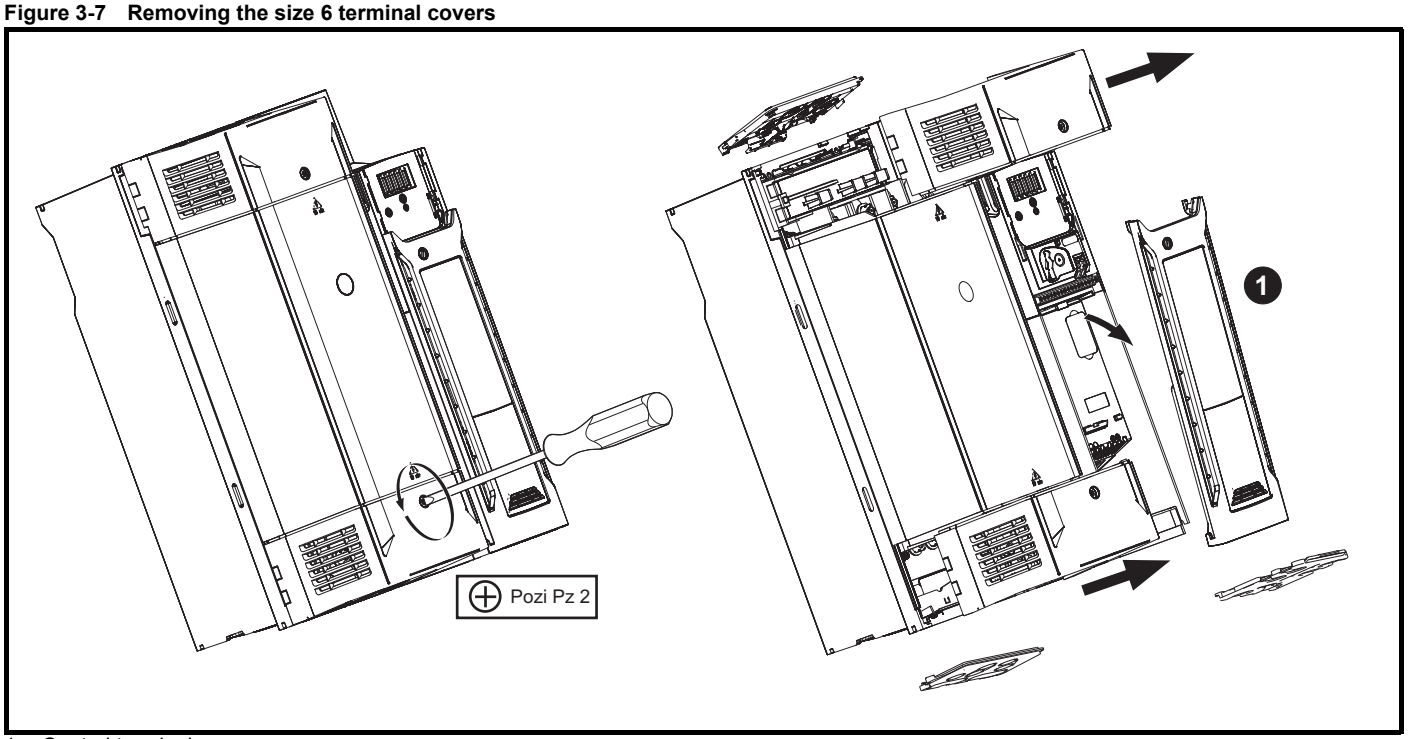
Figure 3-6 Removing the size 5 terminal covers



1. Control terminal cover

When replacing the terminal covers, the screws should be tightened to a maximum torque of 1 N m (0.7 lb ft).

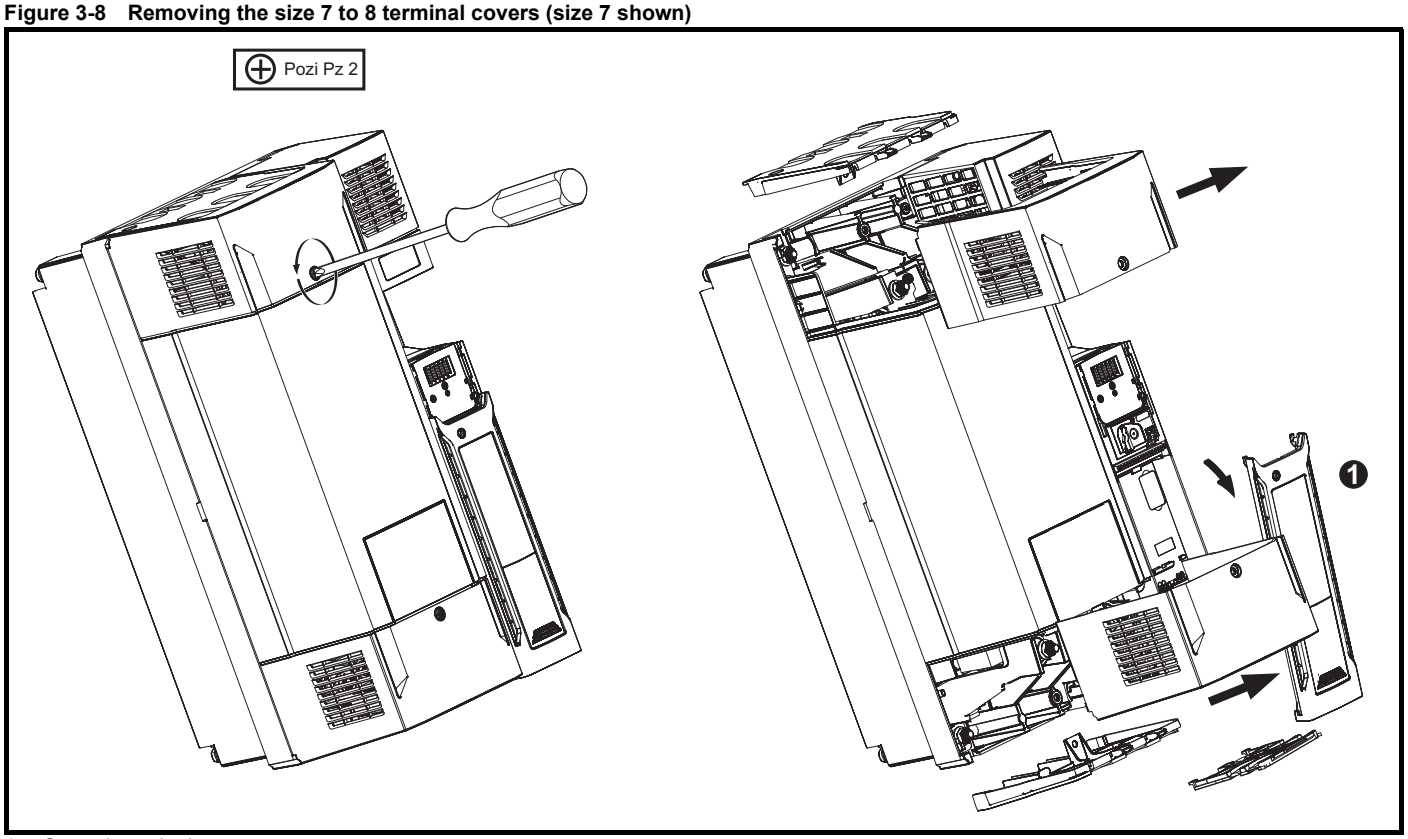
Figure 3-7 Removing the size 6 terminal covers



1. Control terminal cover

When replacing the terminal covers, the screws should be tightened to a maximum torque of 1 N m (0.7 lb ft).

Figure 3-8 Removing the size 7 to 8 terminal covers (size 7 shown)

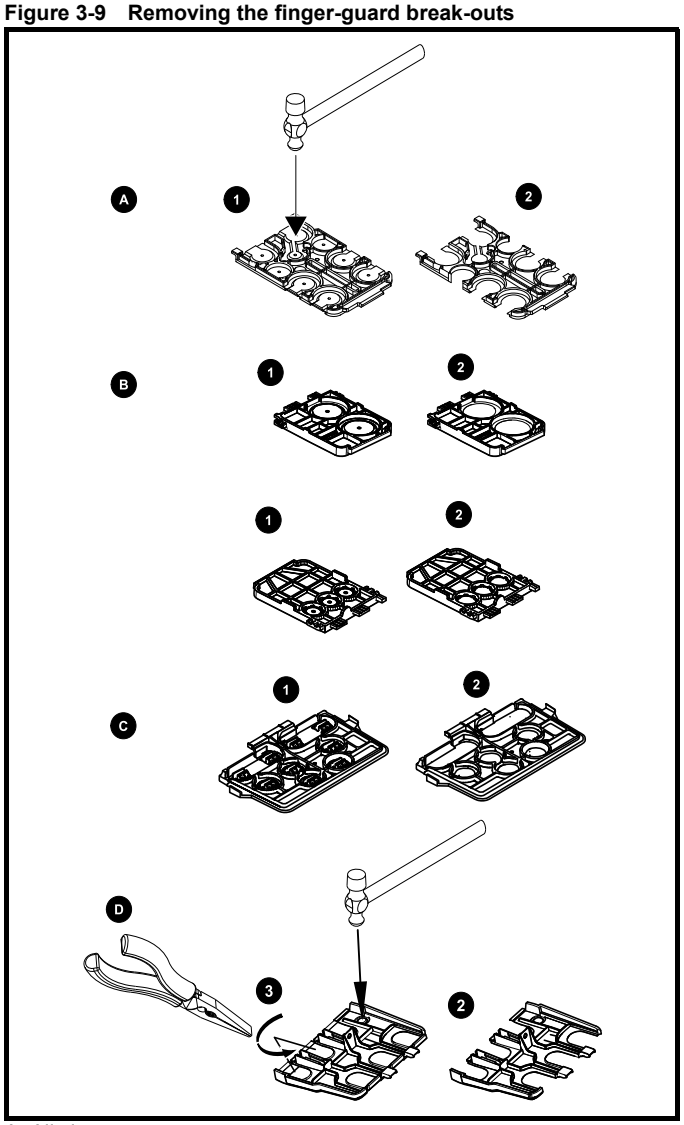


1. Control terminal cover

When replacing the terminal covers, the screws should be tightened to a maximum torque of 1 N m (0.7 lb ft).

3.3.2 Removing the finger-guard and DC terminal cover break-outs

Figure 3-9 Removing the finger-guard break-outs



A: All sizes

B: Size 5 only

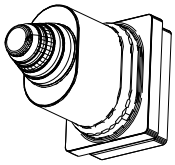
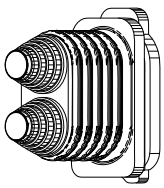
C: Size 6 only

D: Size 7 to 8

Place finger-guard on a flat solid surface and hit relevant break-outs with hammer as shown (1). For sizes 7 to 8 pliers can be used to remove the break-outs, grasp the relevant break-out with the pliers and twist it as shown (3). Continue until all required break-outs are removed (2). Remove any flash / sharp edges once the break-outs are removed.

Grommet kits are available for size 7 to 8 finger guards. For size 8, two versions are available allowing for either single or double cable entries.

Table 3-1 Grommet kits

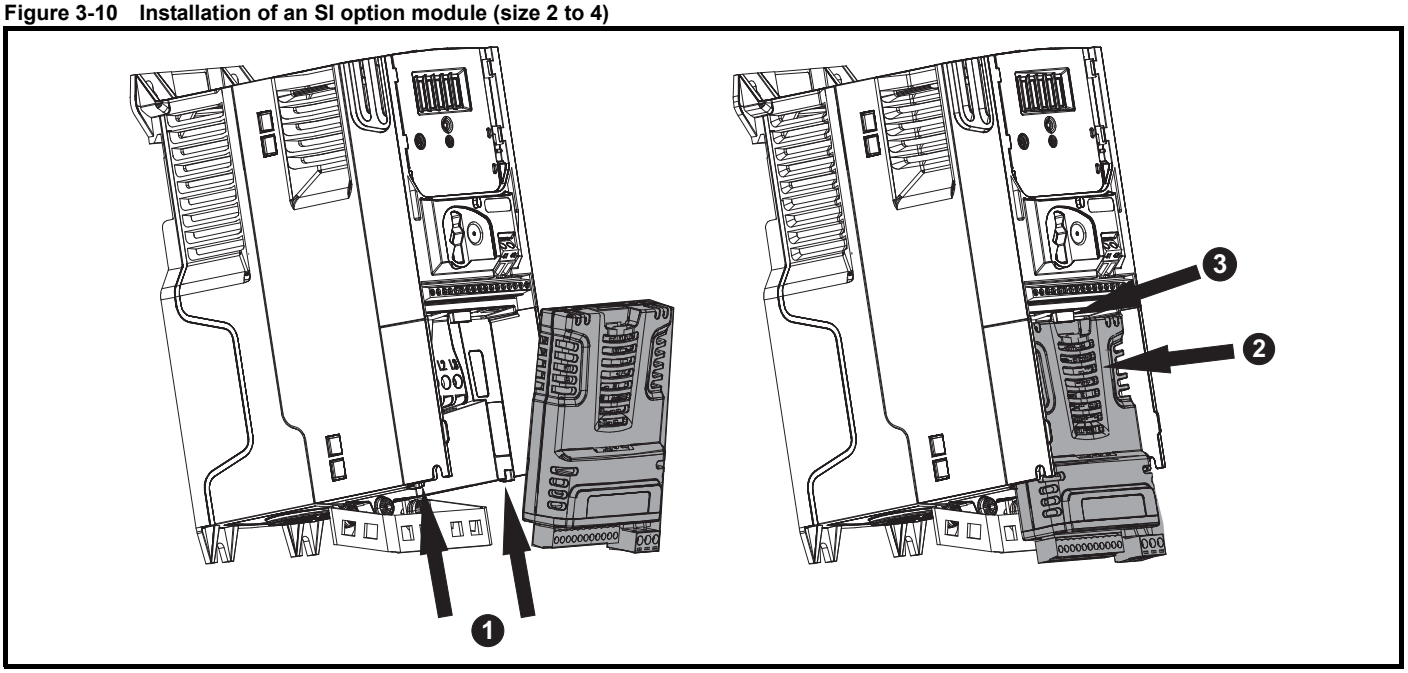
Drive size	Part number	Picture
Size 7 - Kit of 8 x single entry grommets	3470-0086-00	
Size 8 - Kit of 8 x single entry grommets	3470-0089-00	
Size 8 - Kit of 8 x double entry grommets	3470-0090-00	

3.4 Installing / removing options and keypad

CAUTION

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

Figure 3-10 Installation of an SI option module (size 2 to 4)

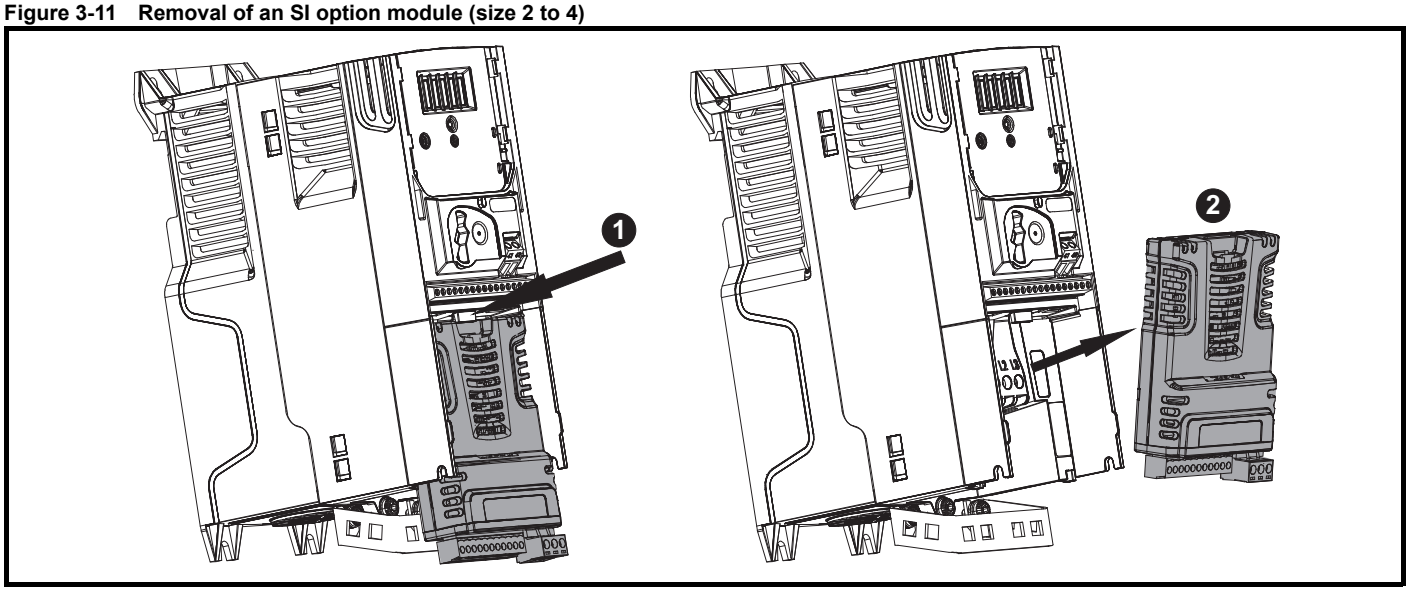


- With the option module tilted slightly backwards, align and locate the two holes in the rear of the option module onto the two tabs (1) on the drive.
- Press the option module onto the drive as shown in (2) until the connector mates with the drive, ensuring that the tab (3) retains the option module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

NOTE

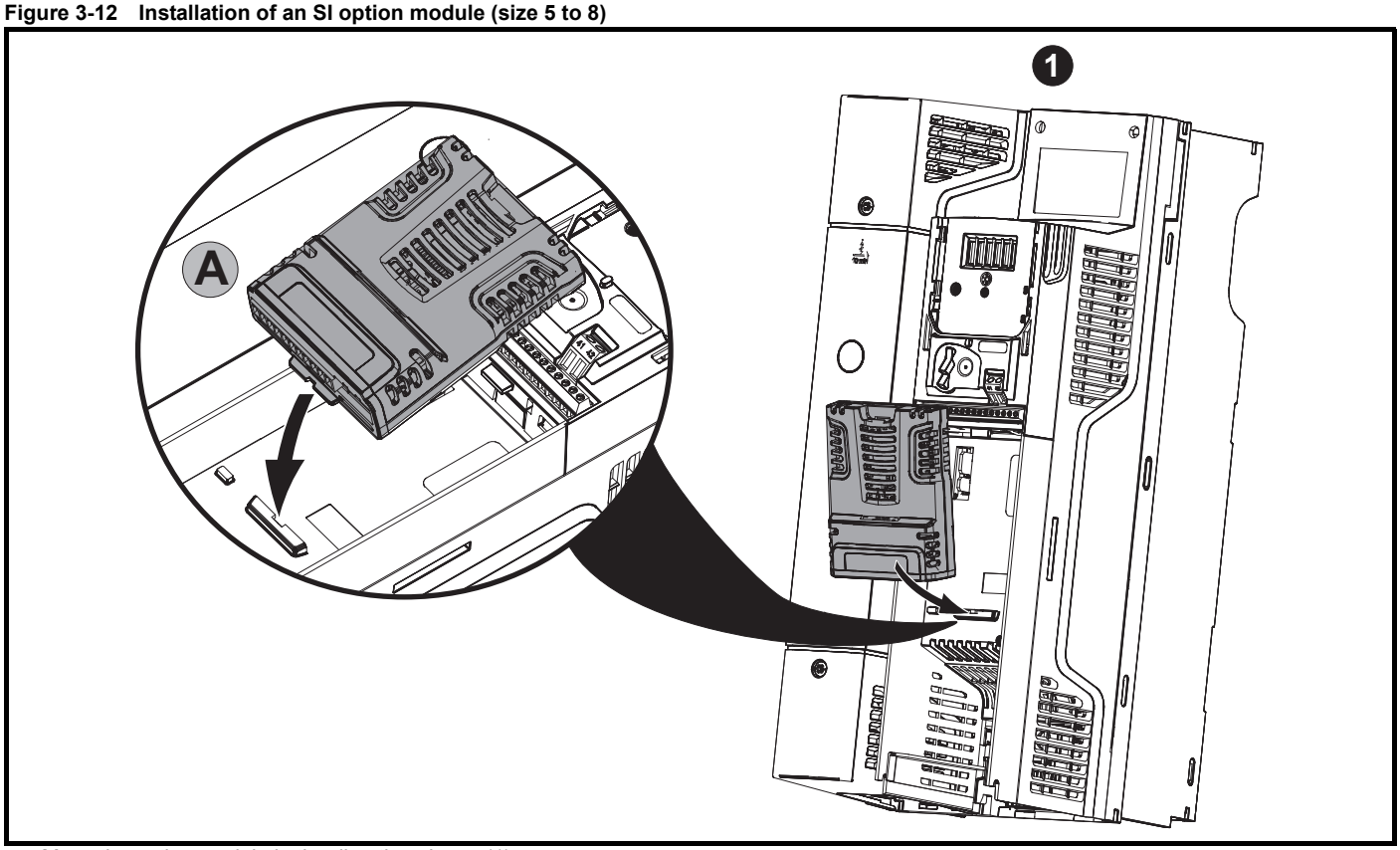
Check that the option module is securely located on the drive. Always ensure that the terminal cover is always replaced before use as this ensures that the option module is firmly secured.

Figure 3-11 Removal of an SI option module (size 2 to 4)



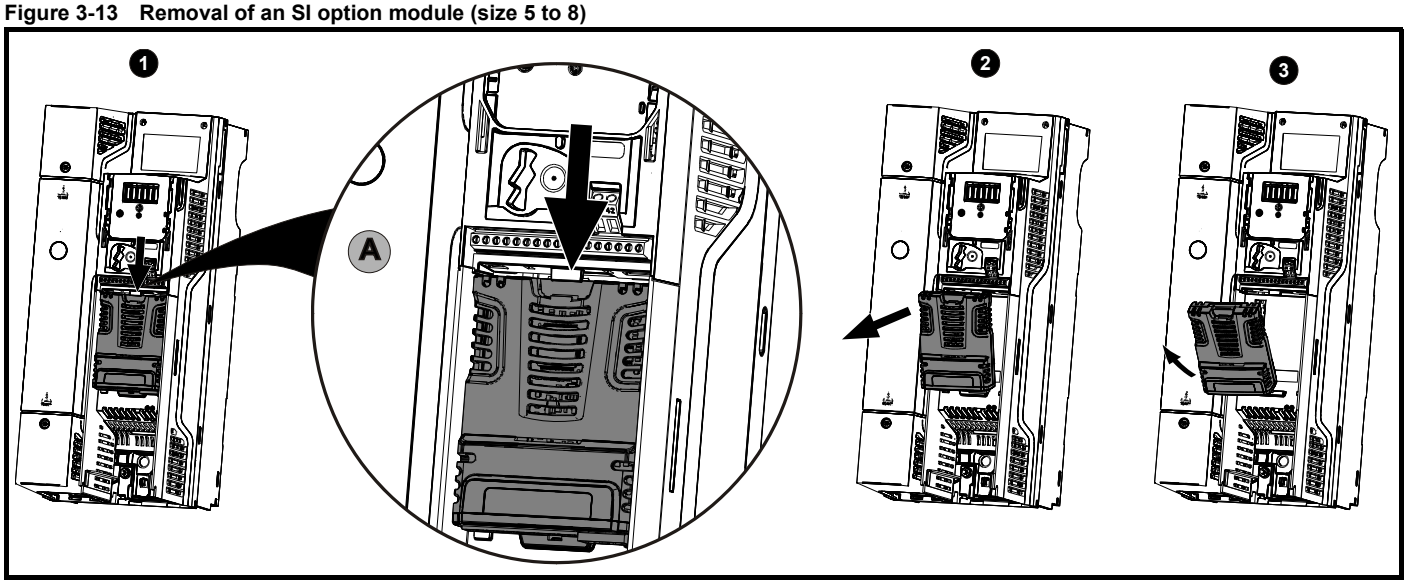
- Press down on the tab (1) to release the option module from the drive housing as shown.
- Tilt the option module slightly towards you and pull away from the drive housing (2).

Figure 3-12 Installation of an SI option module (size 5 to 8)



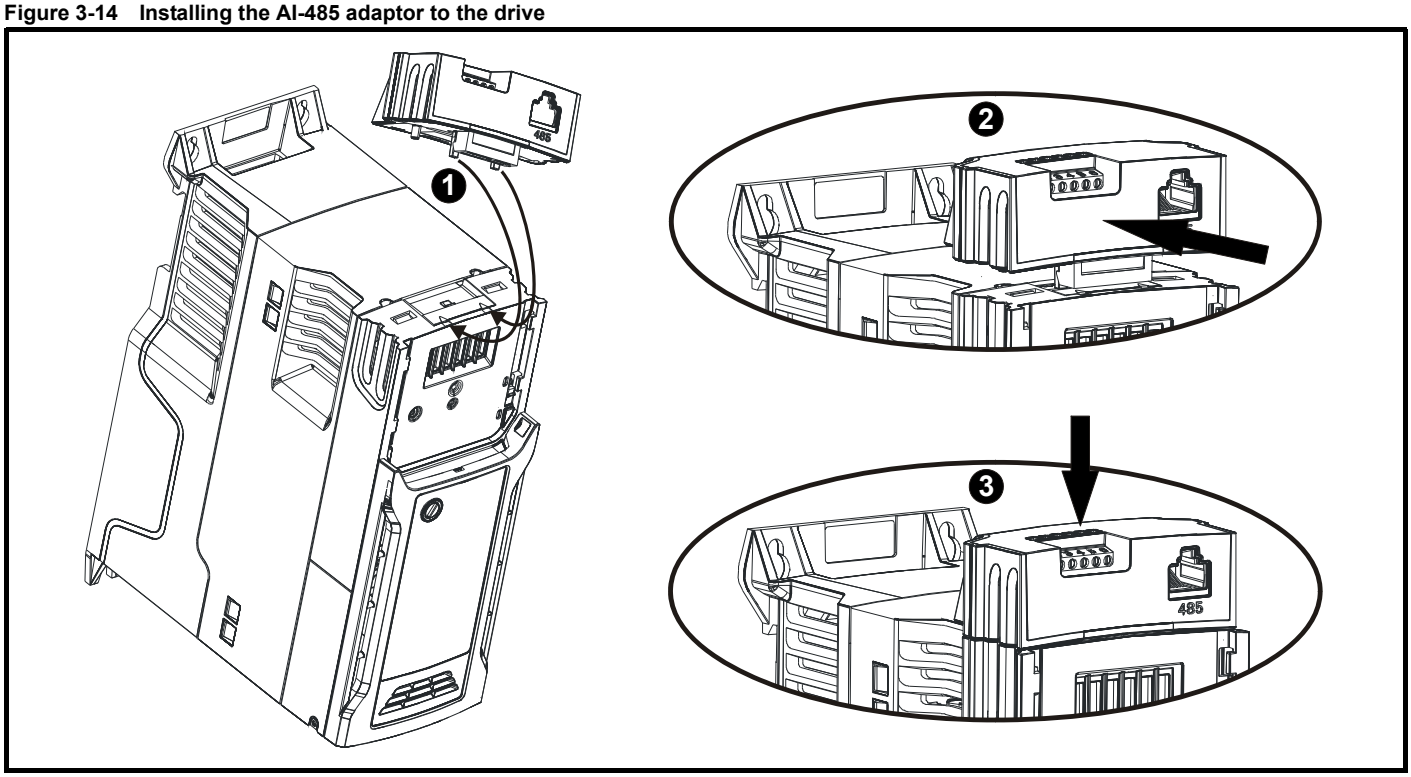
- Move the option module in the direction shown (1).
- Align and insert the option module tab into the slot provided. This is shown in the detailed view (A).
- Press down on the option module until it locks into place.

Figure 3-13 Removal of an SI option module (size 5 to 8)



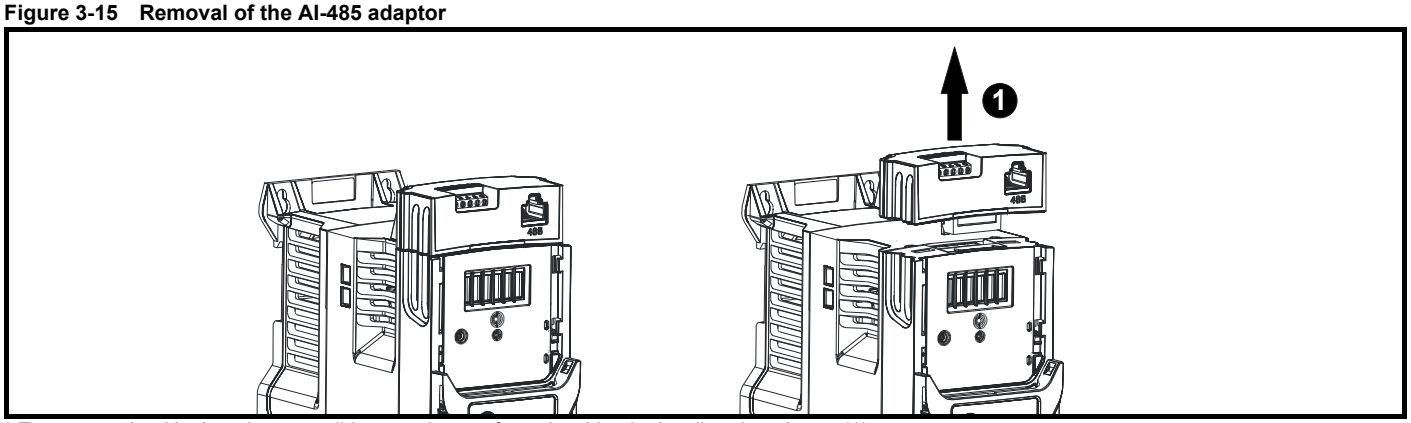
- To release the option module from the drive housing, press down on the tab (1) as shown in detailed view (A).
- Tilt the option module towards you as shown in (2).
- Remove the option module by lifting away from the drive as shown in (3).

Figure 3-14 Installing the AI-485 adaptor to the drive



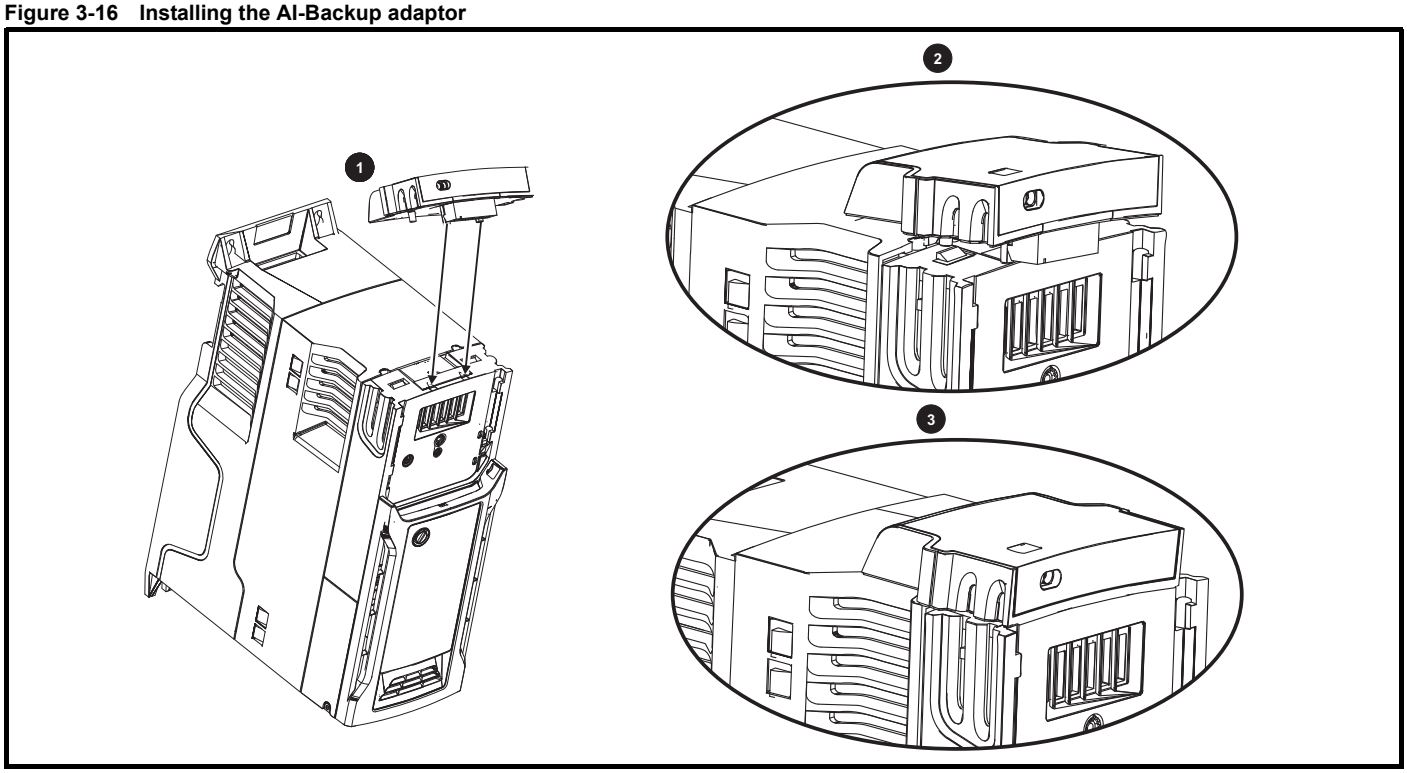
1. Identify the two plastic fingers on the underside of the AI-485 adaptor (1) - then insert the two fingers into the corresponding slots in the spring loaded sliding cover on the top of the drive.
2. Hold the adaptor firmly and push the spring loaded protective cover towards the back of the drive to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

Figure 3-15 Removal of the AI-485 adaptor



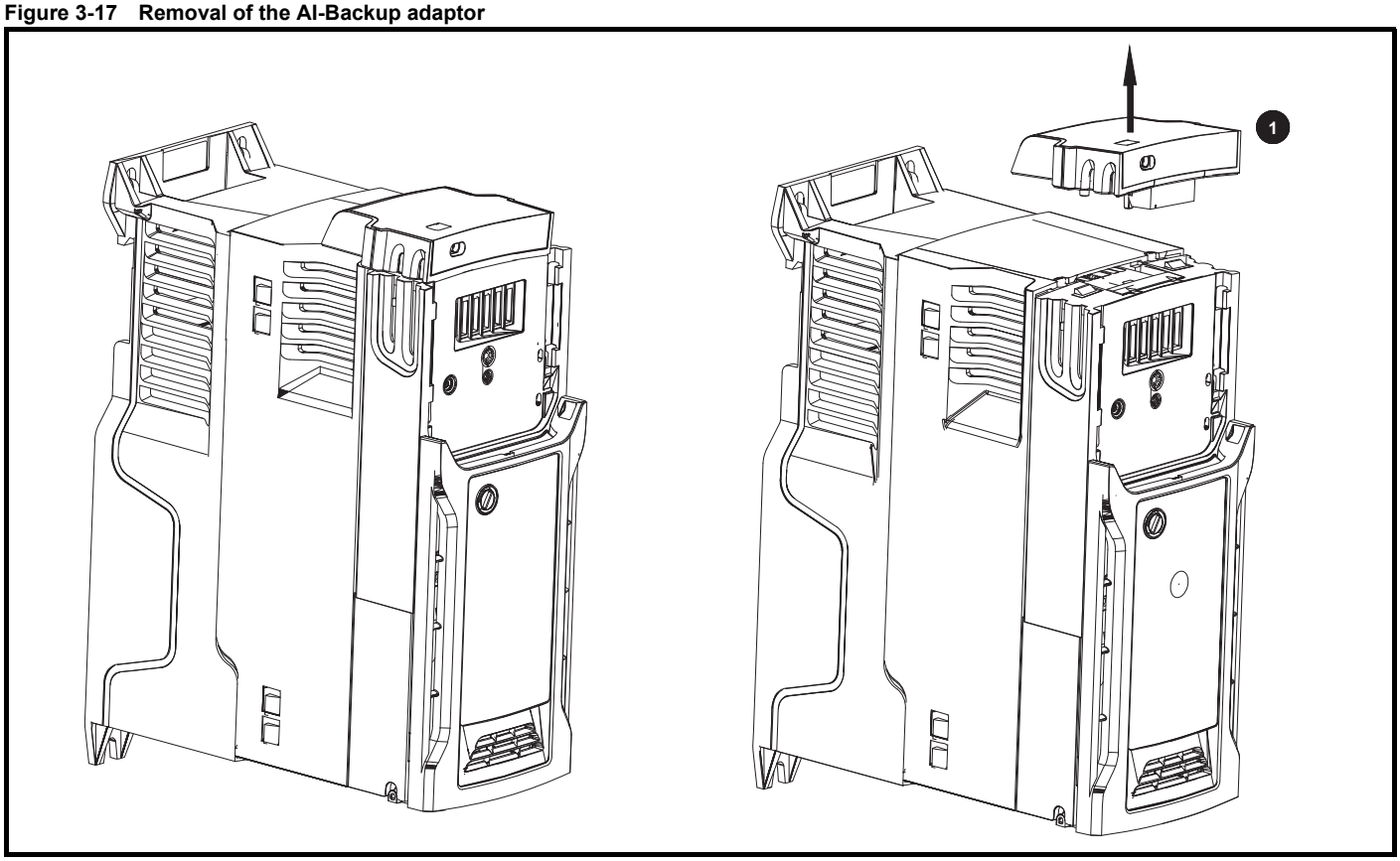
* To remove the AI-485 adaptor, pull it up and away from the drive in the direction shown (1)

Figure 3-16 Installing the AI-Backup adaptor



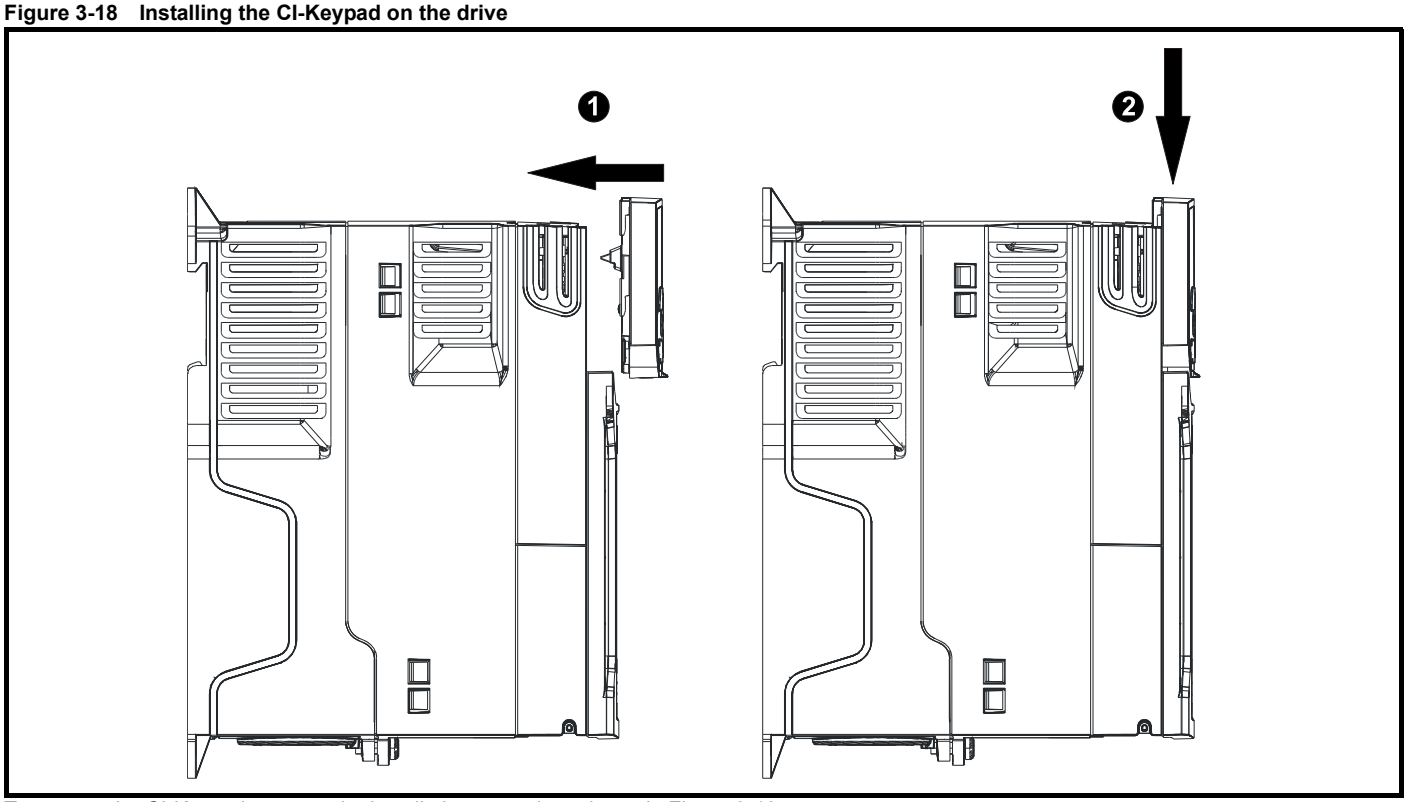
1. Identify the two plastic fingers on the underside of the AI-Backup adaptor (1) - then insert the two fingers into the corresponding slots in the spring-loaded sliding cover on the top of the drive.
2. Hold the adaptor firmly and push the spring loaded protective cover towards the back of the drive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

Figure 3-17 Removal of the AI-Backup adaptor



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

Figure 3-18 Installing the CI-Keypad on the drive

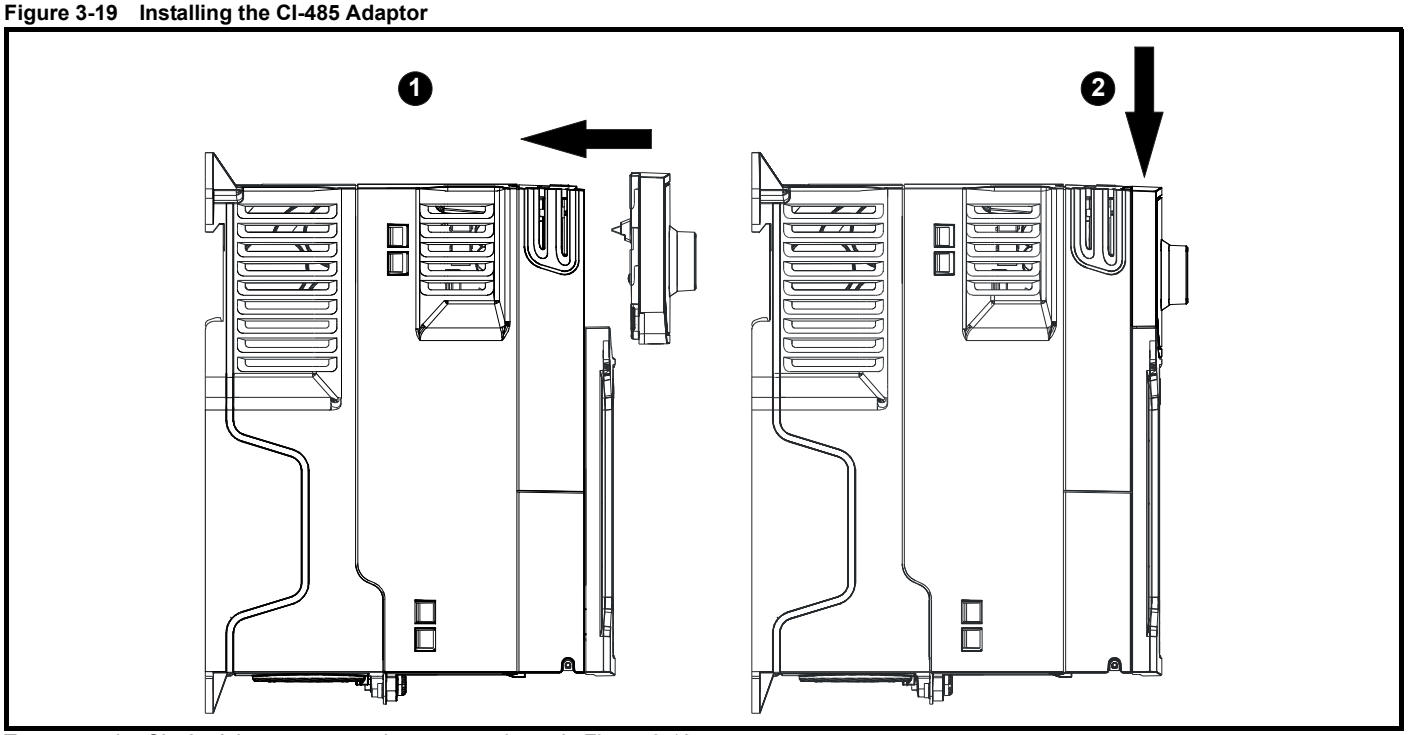


To remove the CI-Keypad, reverse the installation procedure shown in Figure 3-18.

NOTE

The keypad can be installed / removed while the drive is powered up and running motor, providing that the drive is not operating in keypad mode.

Figure 3-19 Installing the CI-485 Adaptor



To remove the CI-485 Adaptor, reverse the process shown in Figure 3-19.

NOTE

The CI-485 Adaptor can be installed / removed while the drive is powered up and running a motor, providing that the drive is not operating in keypad mode.

3.5 Dimensions and mounting methods

The drive can be either surface or through-panel mounted using the appropriate brackets. The following drawings show the dimensions of the drive and mounting holes for each method to allow a back plate to be prepared.

The Through-panel mounting kit is not supplied with the drive and can be purchased separately, below are the relevant part numbers:

Table 3-2 Through-panel mounting kit part numbers for size 3 to 8

Size	CT part number
5	3470-0067
6	3470-0055
7	3470-0079
8	3470-0083

WARNING

If the drive has been used at high load levels for a period of time, the heatsink can reach temperatures in excess of 70 °C (158 °F). Human contact with the heatsink should be prevented.

WARNING

Many of the drives in this product range weigh in excess of 15 kg (33 lb). Use appropriate safeguards when lifting these models. A full list of drive weights can be found in section 12.1.19 *Weights* on page 195.

3.5.1 Surface mounting

Figure 3-20 Surface mounting the size 1 drive

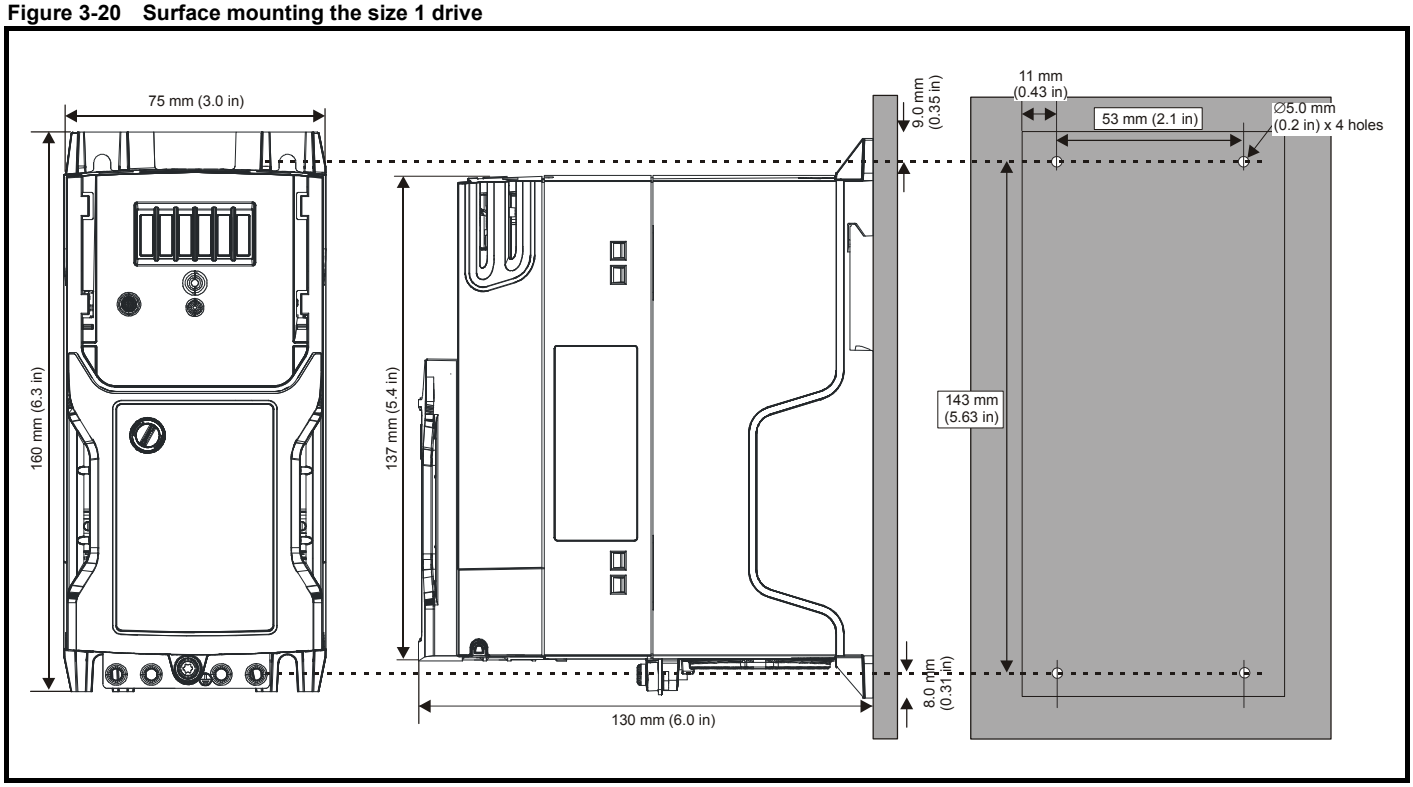


Figure 3-21 Surface mounting the size 2 drive

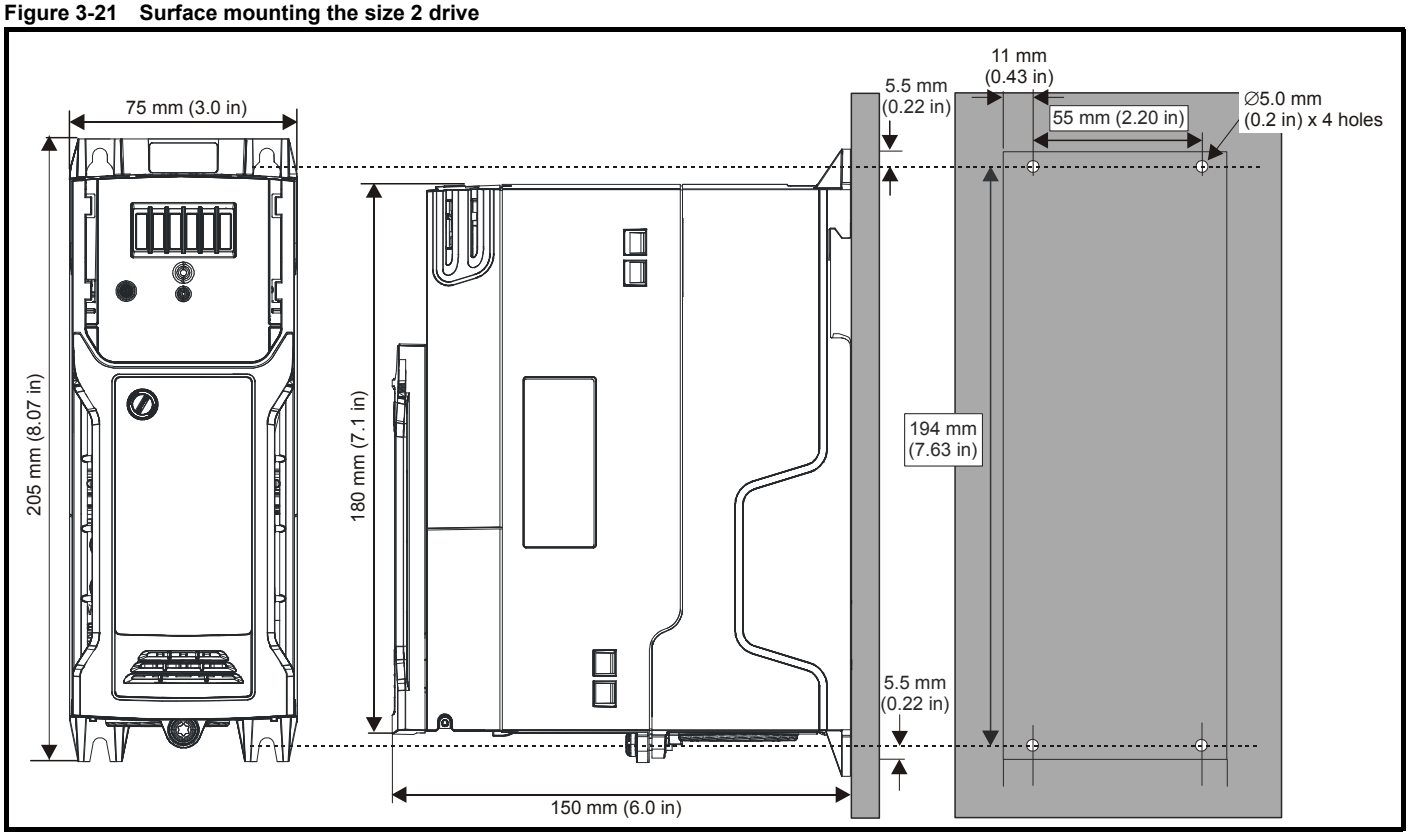


Figure 3-22 Surface mounting the size 3 drive

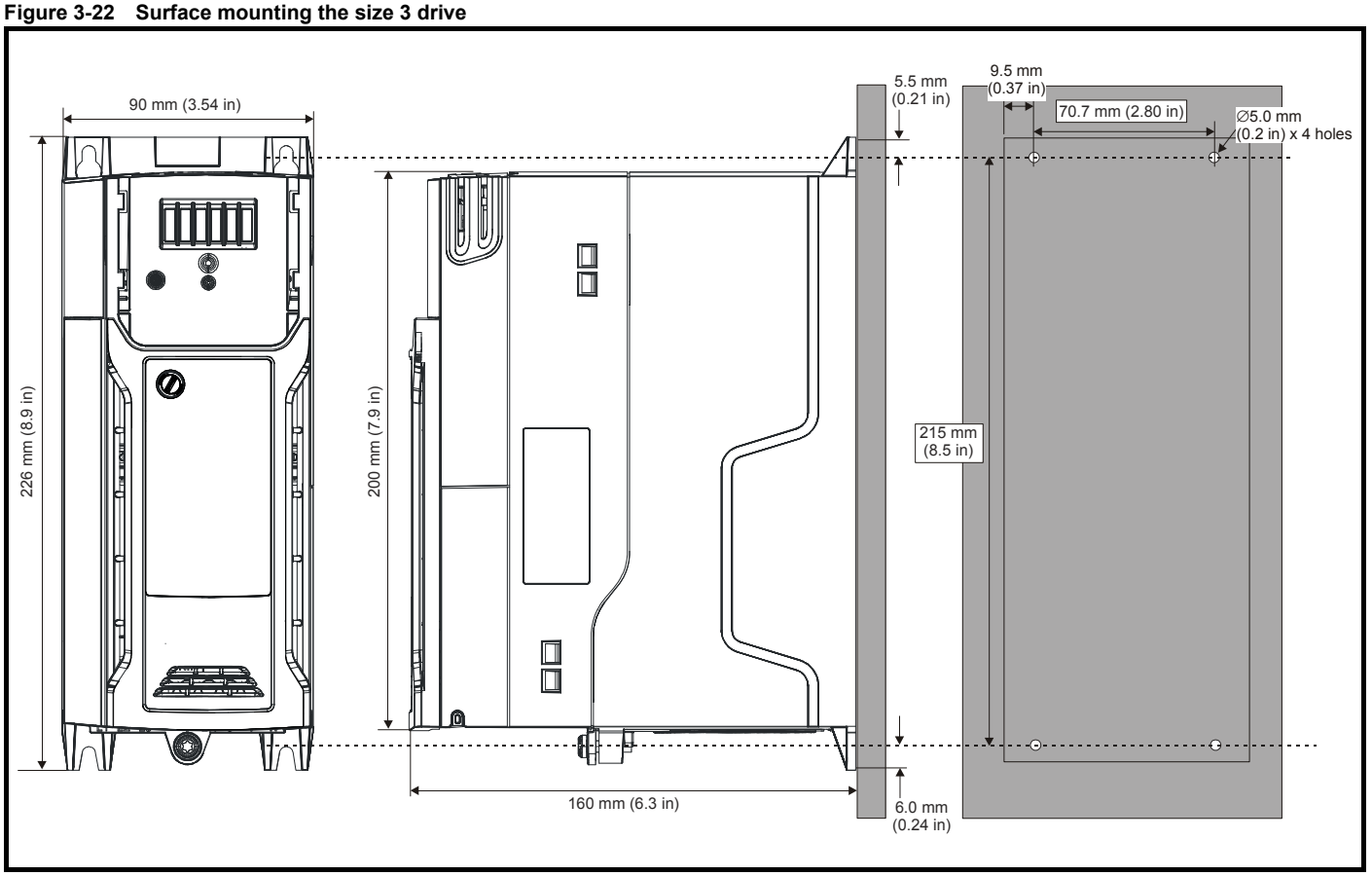


Figure 3-23 Surface mounting the size 4 drive

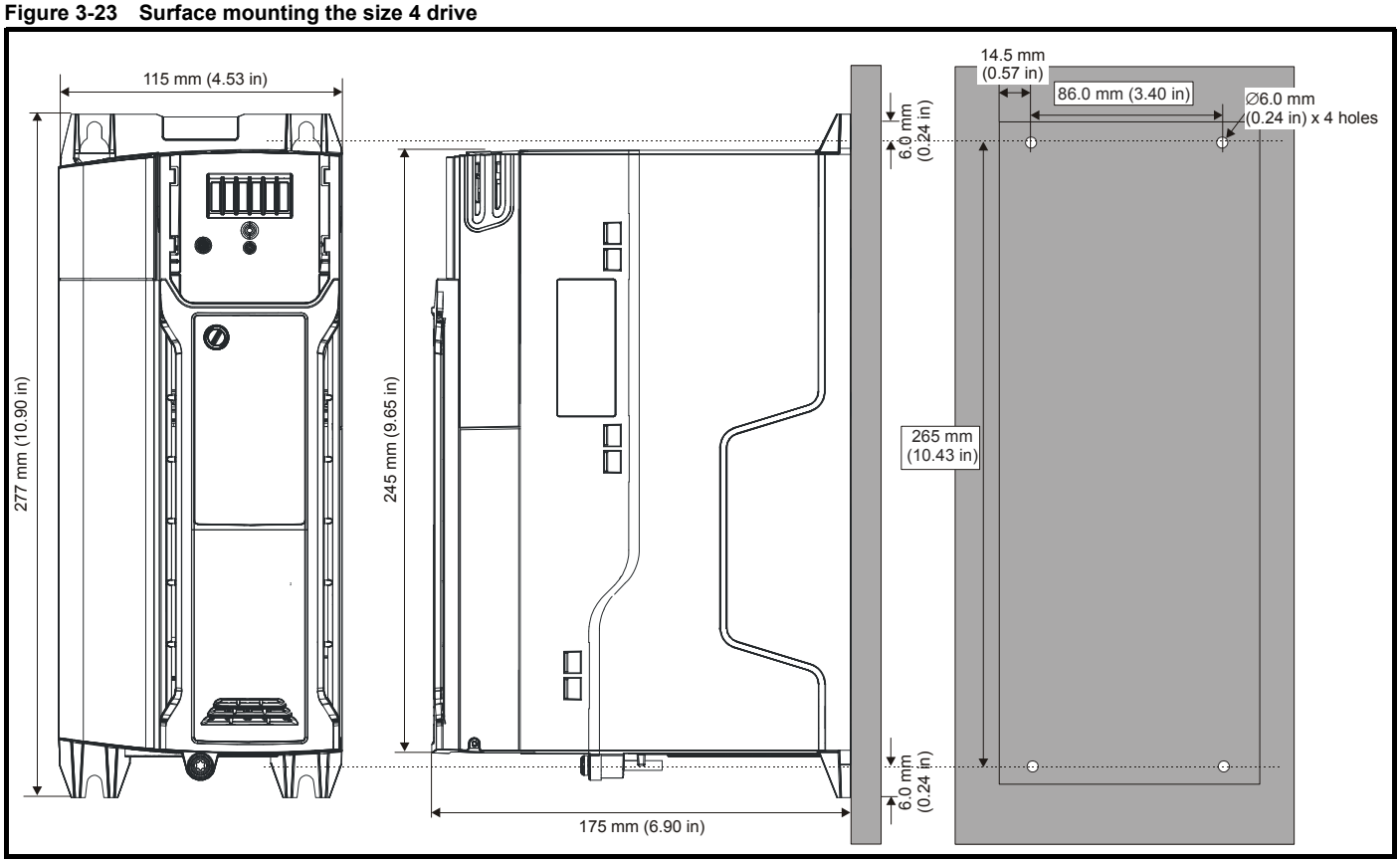


Figure 3-24 Surface mounting the size 5 drive

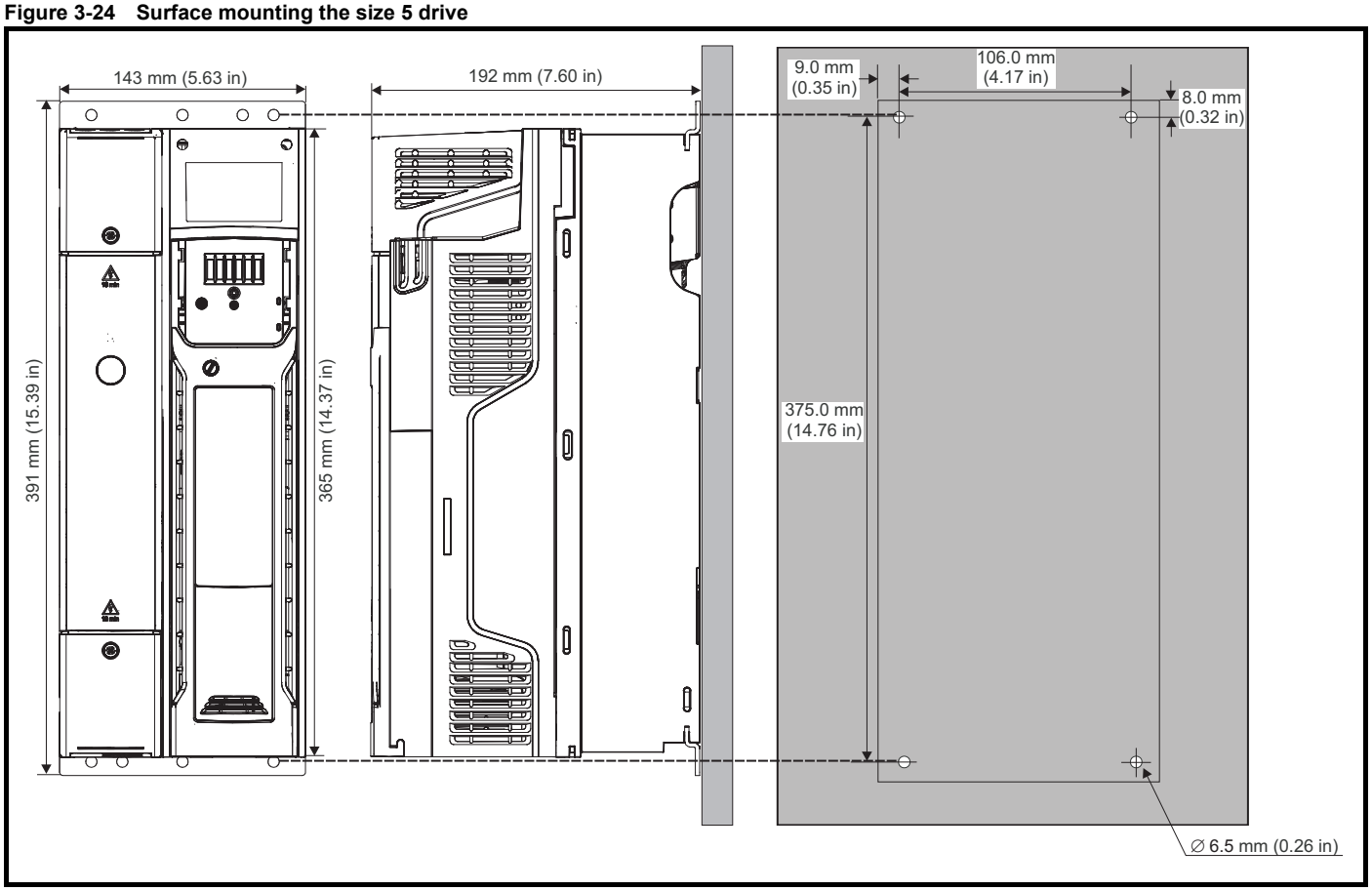


Figure 3-25 Surface mounting the size 6 drive

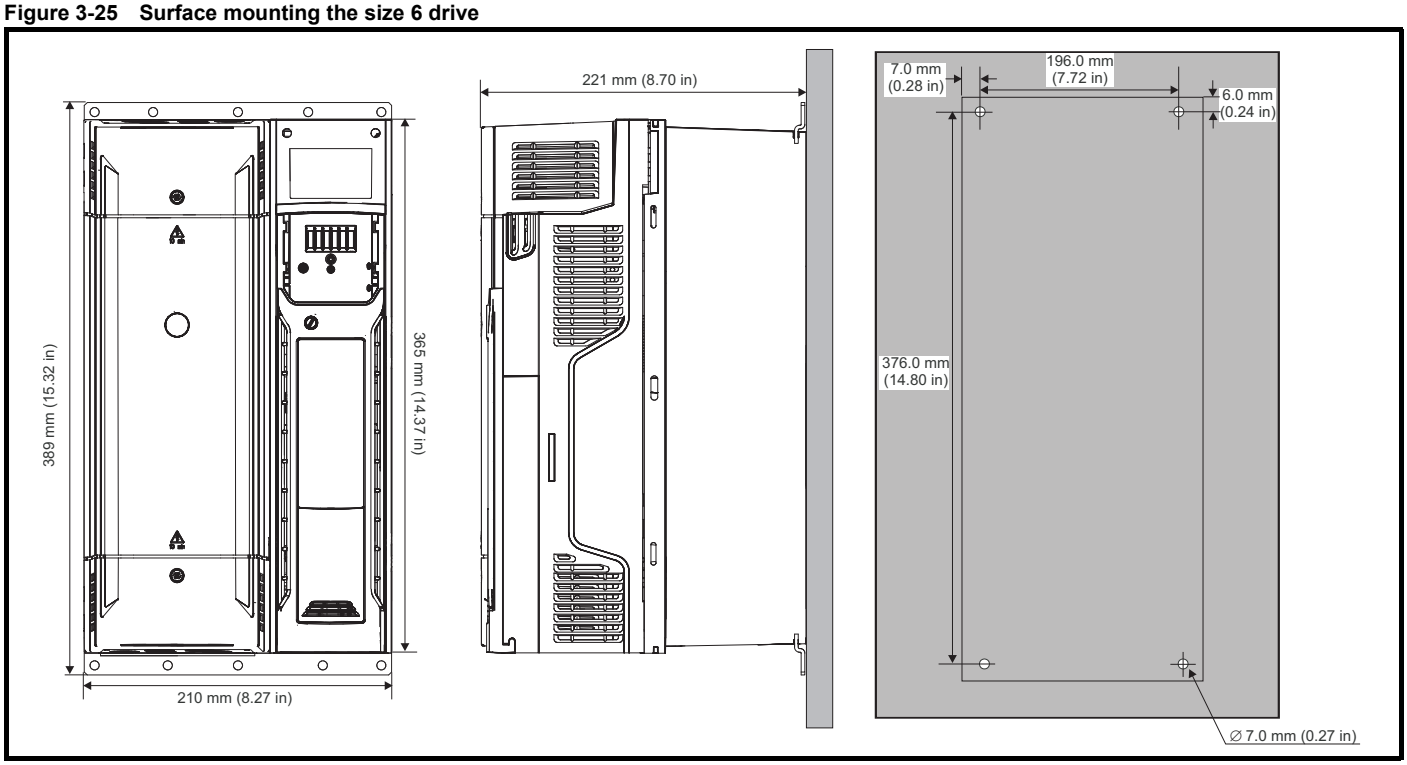


Figure 3-26 Surface mounting the size 7 drive

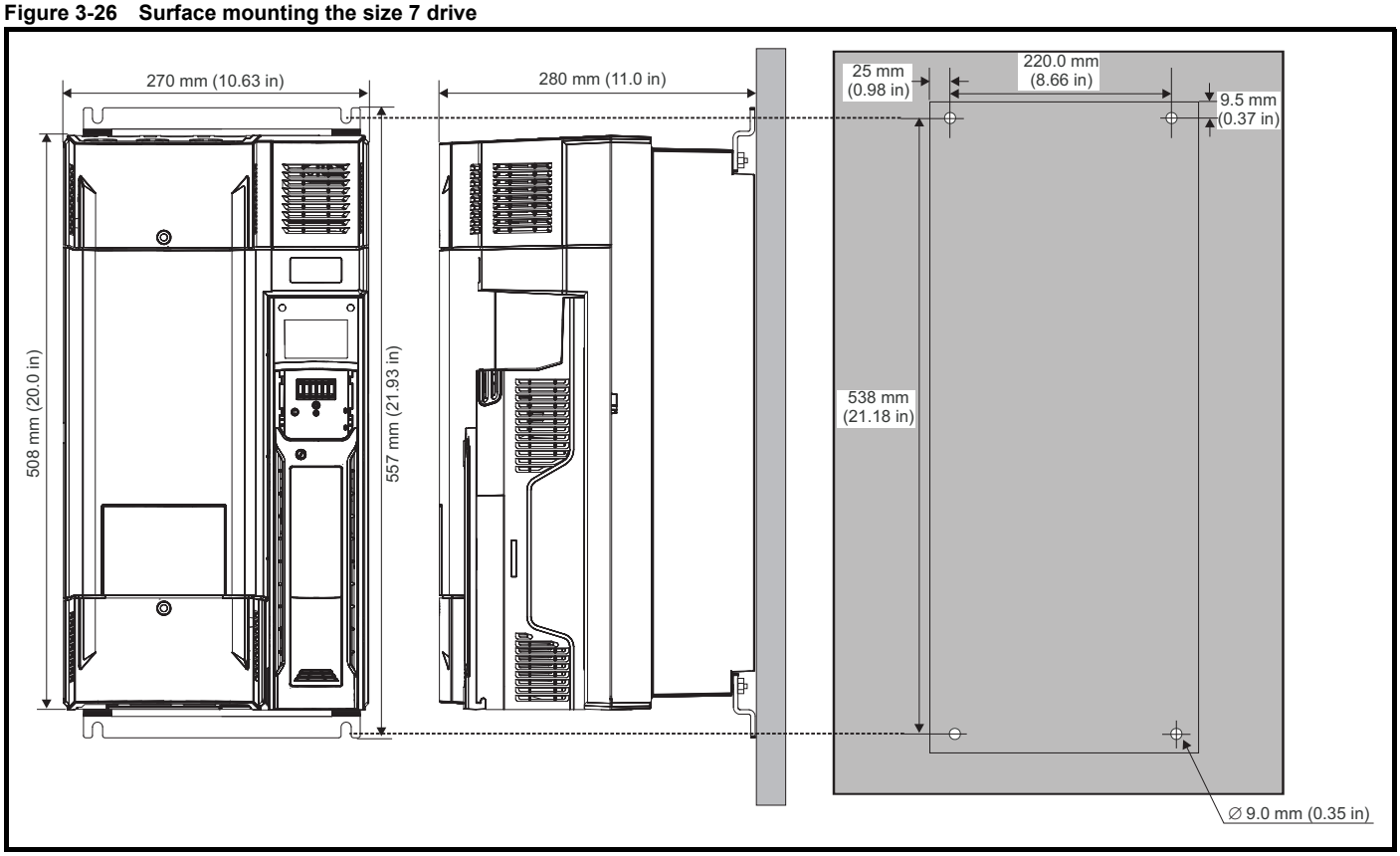
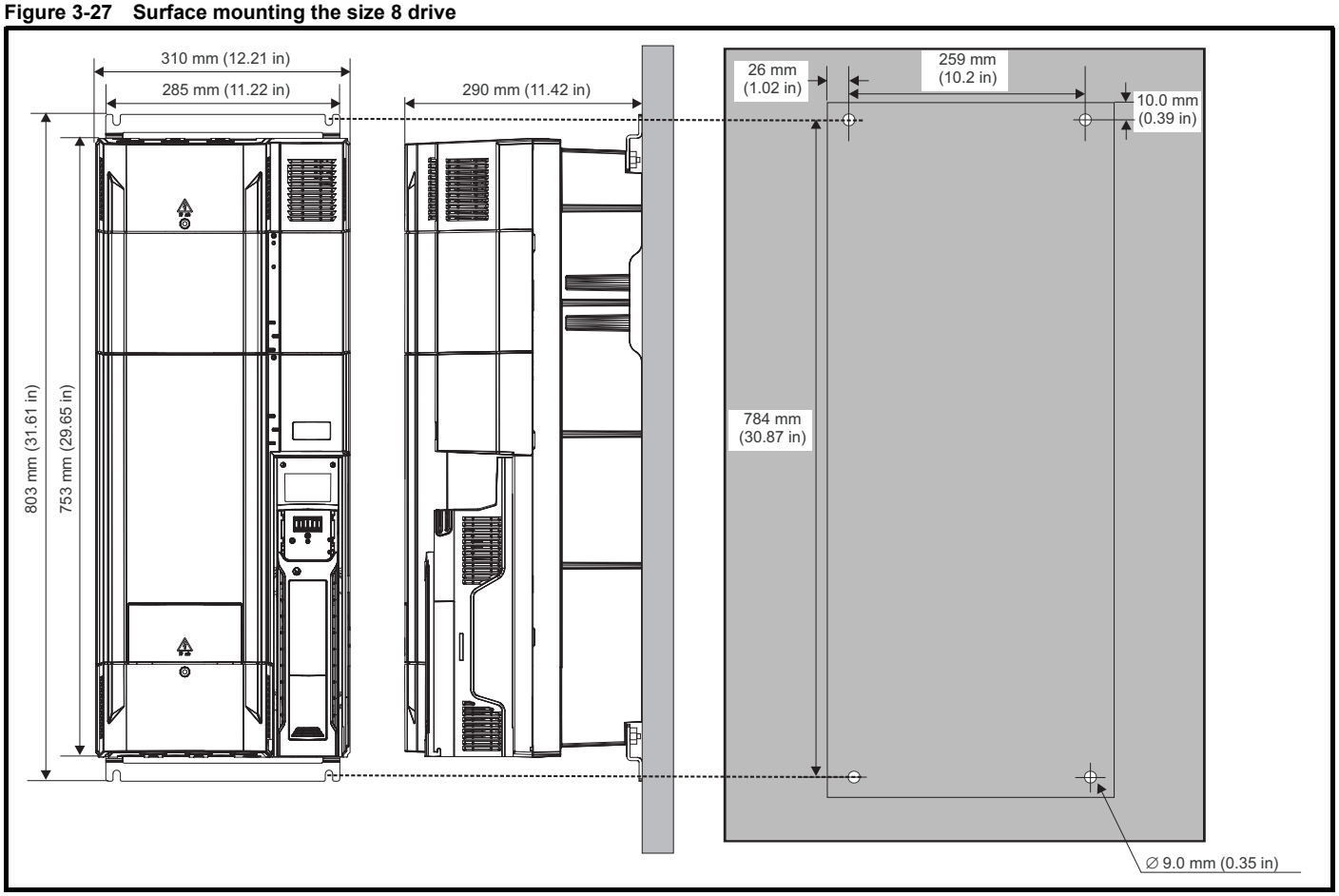


Figure 3-27 Surface mounting the size 8 drive



3.5.2 Through-panel mounting

Figure 3-28 Through-panel mounting the size 5 drive

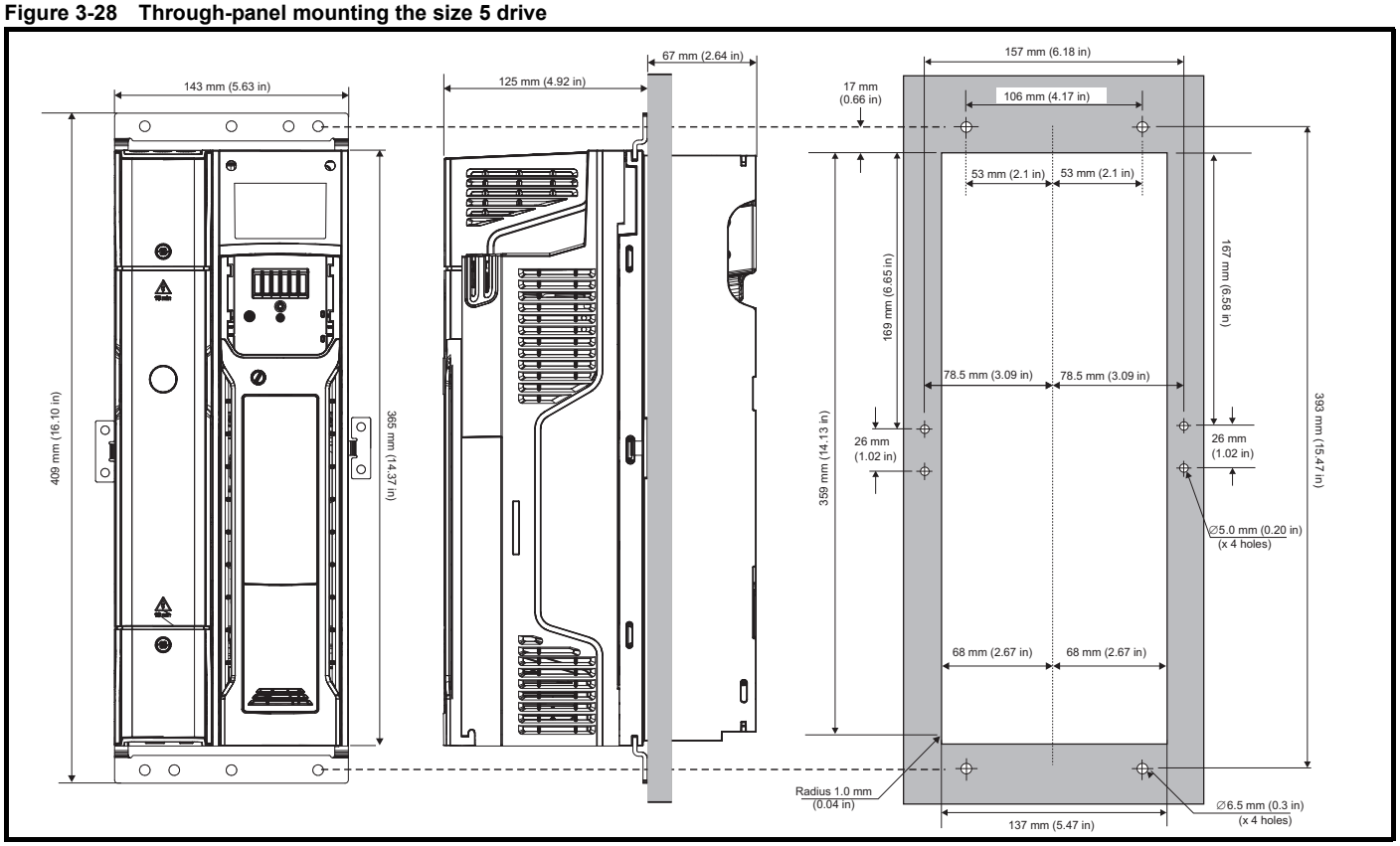
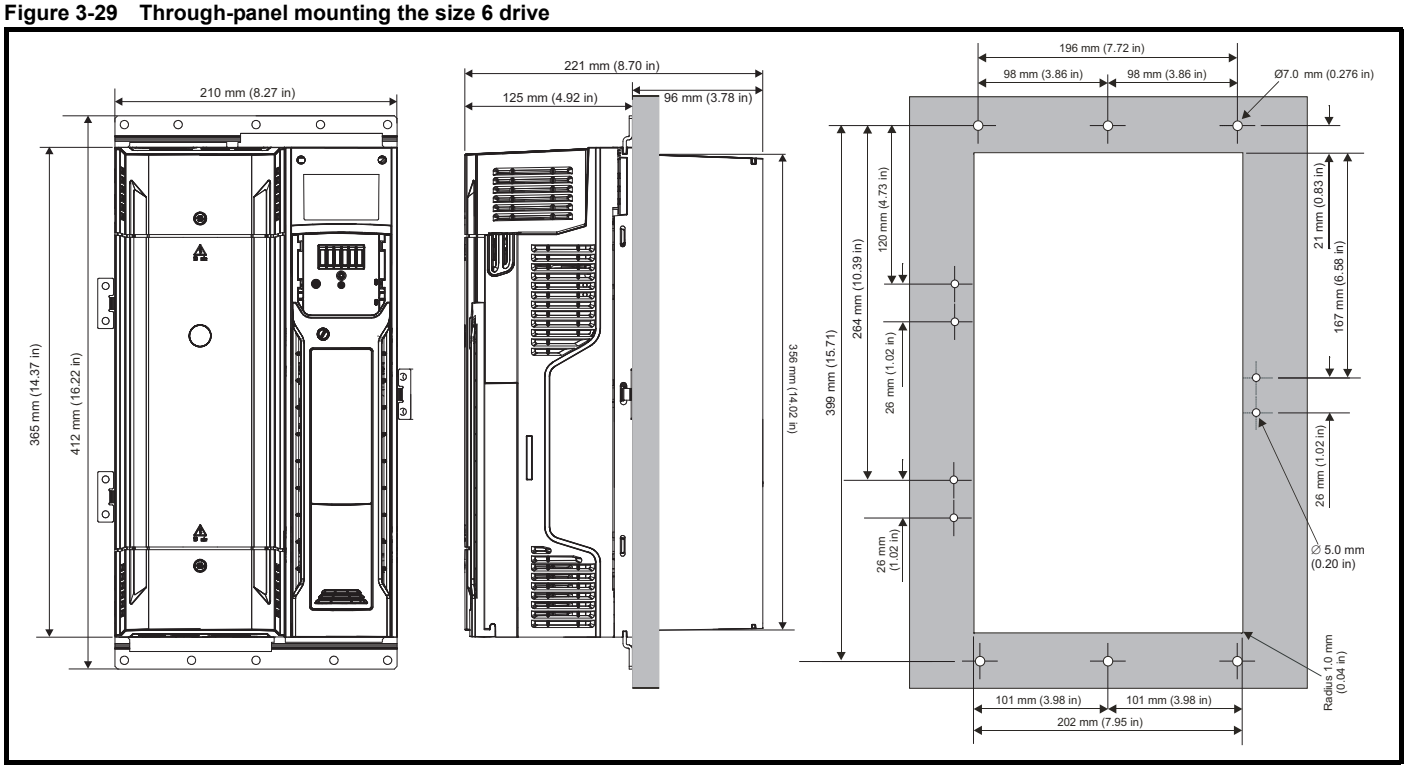


Figure 3-29 Through-panel mounting the size 6 drive



NOTE

The outer holes plus the hole located in the center of the bracket are to be used for through panel mounting.

Figure 3-30 Through-panel mounting the size 7 drive

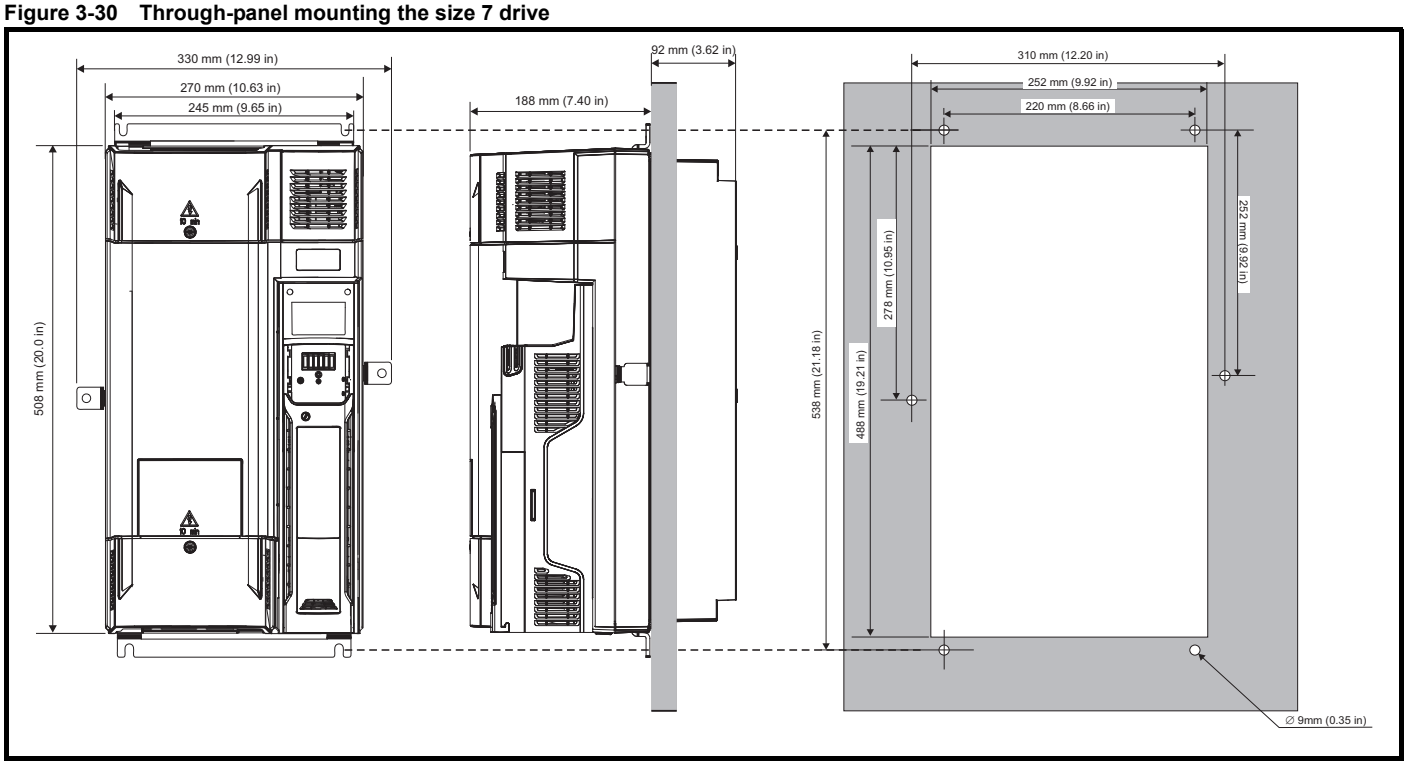
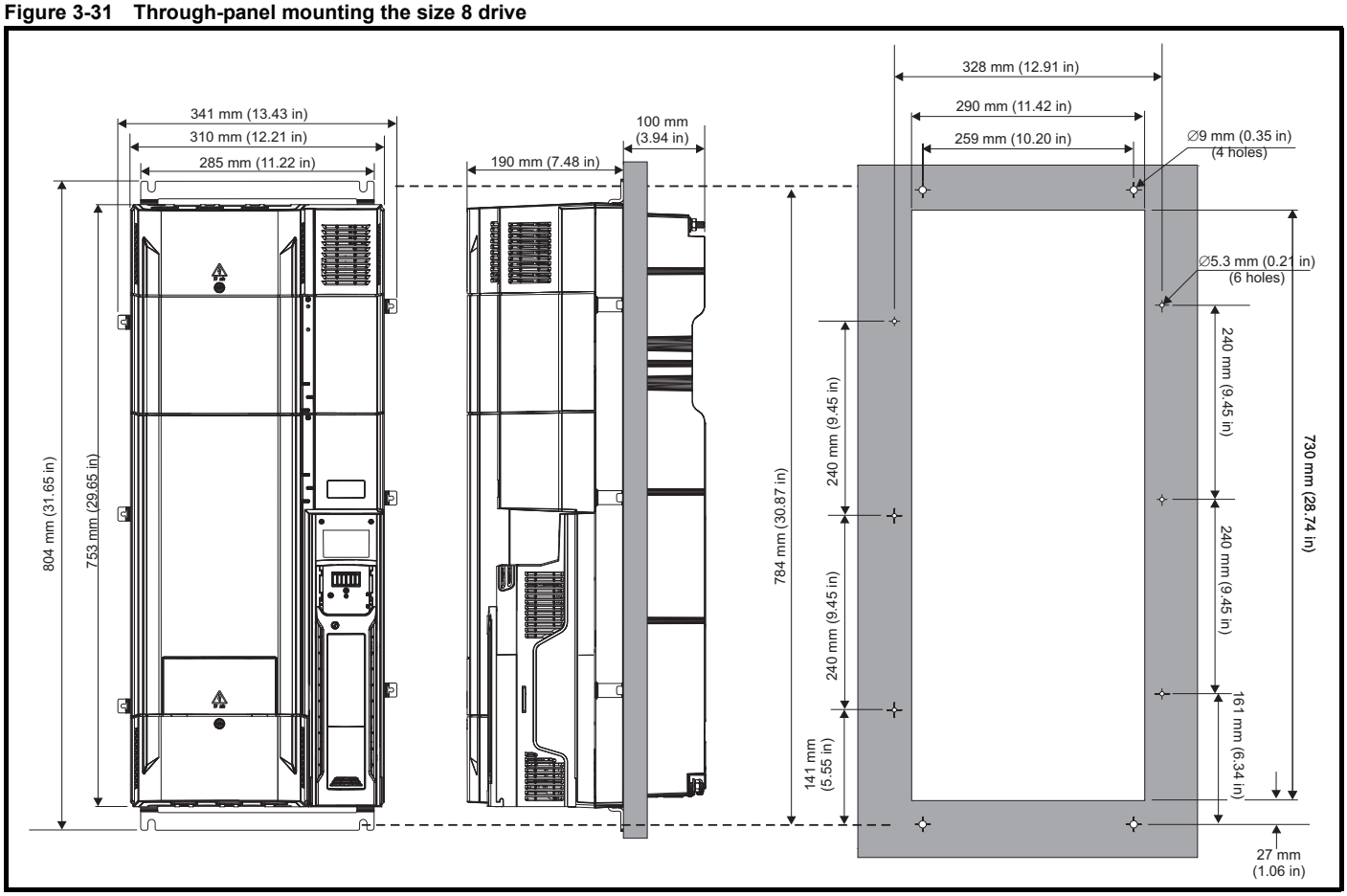
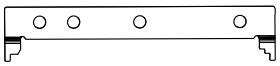
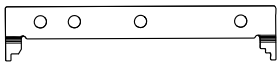
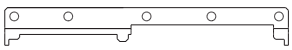
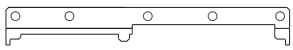
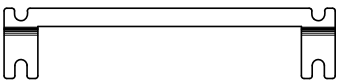
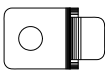
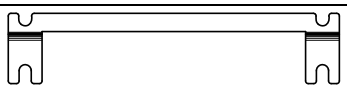
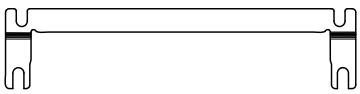
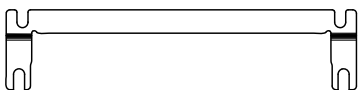


Figure 3-31 Through-panel mounting the size 8 drive



3.5.3 Mounting brackets

Table 3-3 Mounting brackets (size 5 to 8)

Frame size	Surface	Qty	Through-panel	Qty
5	 Hole size: 6.5 mm (0.26 in)	x 2	 Hole size: 5.2 mm (0.21 in)	x 2
			 Hole size: 6.5 mm (0.26 in)	x 2
6	 Hole size: 6.5 mm (0.26 in)	x 2	 Hole size: 5.2 mm (0.21 in)	x 3
			 Hole size: 6.5 mm (0.26 in)	x 2
7	 Hole size: 9 mm (0.35 in)	x 2	 Hole size: 9 mm (0.35 in)	x 2
			 Hole size: 9 mm (0.35 in)	x 2
8	 Hole size: 9 mm (0.35 in)	x 2	 Hole size: 5.3 mm (0.21 in)	x 6
			 Hole size: 9 mm (0.35 in)	x 2

3.6 Enclosure for standard drives

3.6.1 Recommended spacing between the drives

Figure 3-32 Recommended spacing between the drives

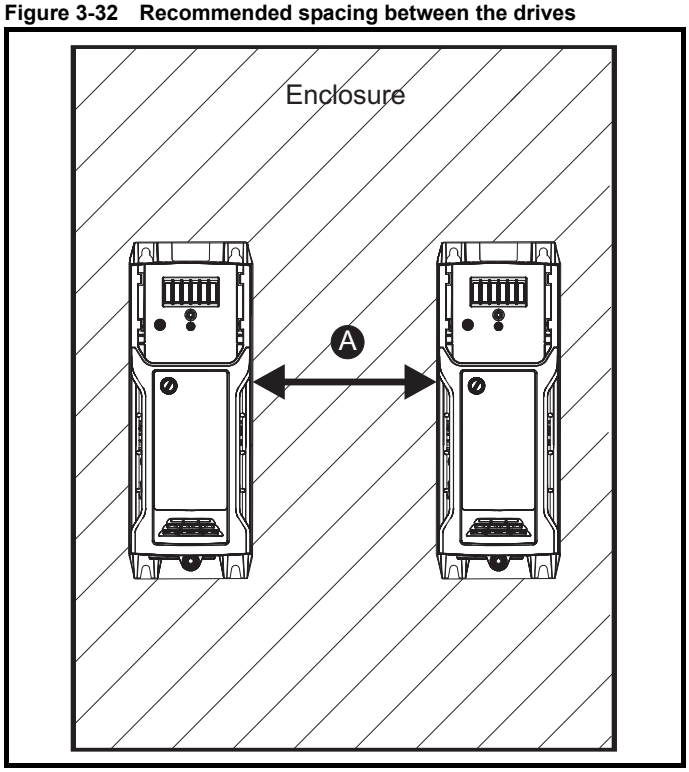


Table 3-4 Spacing required between the drives (without high IP bung)

Drive size	Spacing (A)	
	40 °C	**50 °C***
1	0 mm (0.00)	
2		
3		
4		
5	0 mm (0.00)	30 mm (1.18 in)
6	0 mm (0.00 in)	
7	30 mm (1.18 in)	
8	30 mm (1.18 in)	

* 50 °C derating applies, refer to Table 12-5 *Maximum permissible continuous output current @ 50 °C (122 °F) (size 5 to 8)* on page 187.

NOTE

When through-panel mounted, ideally drives should be spaced 30 mm (1.18 in) to maximize panel stiffness.

3.6.2 Enclosure layout

Please observe the clearances in the diagram below taking into account any appropriate notes for other devices / auxiliary equipment when planning the installation.

Figure 3-33 Enclosure layout

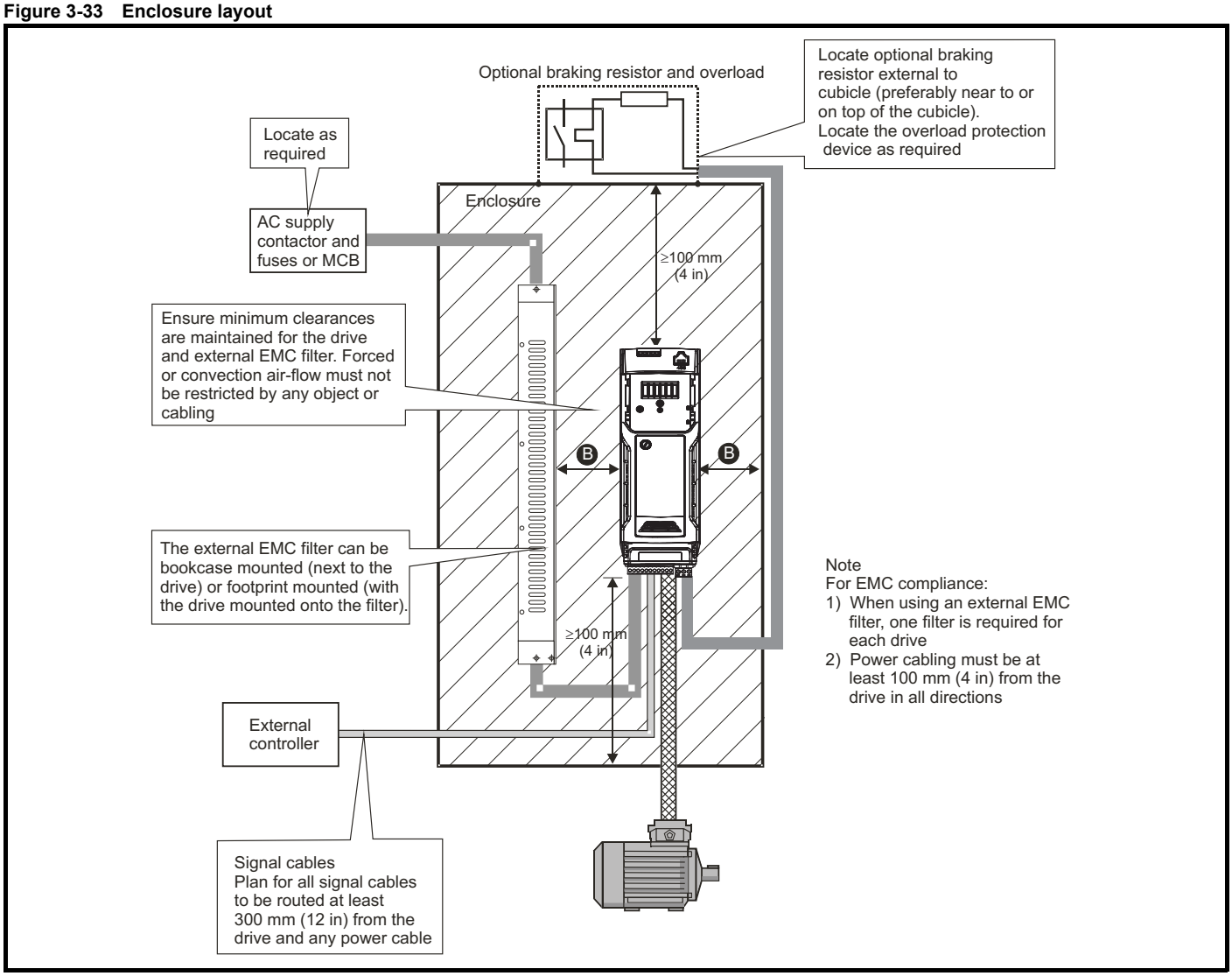


Table 3-5 Spacing required between drive / enclosure and drive / EMC filter

Drive size	Spacing (B)
1	0 mm (0.00 in)
2	
3	
4	
5	30 mm (1.18 in)
6	
7	
8	

3.6.3 Enclosure sizing

1. Add the dissipation figures from section 12.1.2 *Power dissipation* on page 188 for each drive that is to be installed in the enclosure.
2. If an external EMC filter is to be used with each drive, add the dissipation figures from section 12.2.1 *EMC filter ratings* on page 206 for each external EMC filter that is to be installed in the enclosure.
3. If the braking resistor is to be mounted inside the enclosure, add the average power figures from for each braking resistor that is to be installed in the enclosure.
4. Calculate the total heat dissipation (in Watts) of any other equipment to be installed in the enclosure.
5. Add the heat dissipation figures obtained above. This gives a figure in Watts for the total heat that will be dissipated inside the enclosure.

Calculating the size of a sealed enclosure

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

Calculate the minimum required unobstructed surface area $\mathbf{A_e}$ for the enclosure from:

$$\mathbf{A_e} = \frac{\mathbf{P}}{\mathbf{k}(\mathbf{T_{int}} - \mathbf{T_{ext}})}$$

Where:

$\mathbf{A_e}$	Unobstructed surface area in m^2 (1 m^2 = 10.9 ft^2)
$\mathbf{T_{ext}}$	Maximum expected temperature in ^oC *outside* the enclosure
$\mathbf{T_{int}}$	Maximum permissible temperature in ^oC *inside* the enclosure
P	Power in Watts dissipated by *all* heat sources in the enclosure
k	Heat transmission coefficient of the enclosure material in $W/m^2/^oC$

Example

To calculate the size of an enclosure for the following:

- Two drives operating at the Normal Duty rating
- External EMC filter for each drive
- Braking resistors are to be mounted outside the enclosure
- Maximum ambient temperature inside the enclosure: 40°C
- Maximum ambient temperature outside the enclosure: 30°C

For example, if the power dissipation from each drive is 187 W and the power dissipation from each external EMC filter is 9.2 W.

Total dissipation: 2 x (187 + 9.2) =392.4 W

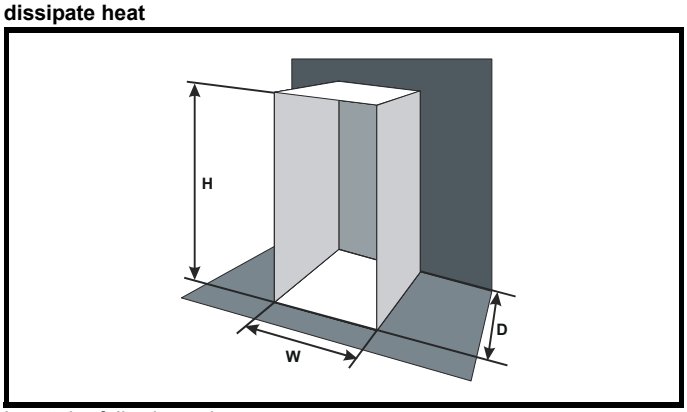
NOTE

Power dissipation for the drives and the external EMC filters can be obtained from Chapter 12 *Technical data* on page 183.

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

The value of 5.5 $W/m^2/^oC$ can generally be used with a sheet steel enclosure (exact values can be obtained from the supplier of the material). If in any doubt, allow for a greater margin in the temperature rise.

Figure 3-34 Enclosure having front, sides and top panels free to dissipate heat



Insert the following values:

$\mathbf{T_{int}}$	40 °C
$\mathbf{T_{ext}}$	30 °C
k	5.5
P	392.4 W

The minimum required heat conducting area is then:

$$\mathbf{A_e} = \frac{\mathbf{392.4}}{\mathbf{5.5(40-30)}}$$

= 7.135 m^2 (77.8 ft^2) (1 m^2 = 10.9 ft^2)

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

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

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

$$\mathbf{W} = \frac{\mathbf{7.135 - (2 \times 2 \times 0.6)}}{\mathbf{2 + 0.6}}$$

=1.821 m (71.7 in)

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

- Using a lower PWM switching frequency to reduce the dissipation in the drives
- Reducing the ambient temperature outside the enclosure, and/or applying forced-air cooling to the outside of the enclosure
- Reducing the number of drives in the enclosure
- Removing other heat-generating equipment

Calculating the air-flow in a ventilated enclosure

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

Calculate the minimum required volume of ventilating air from:

$$\mathbf{V} = \frac{\mathbf{3kP}}{\mathbf{T_{int} - T_{ext}}}$$

Where:

V	Air-flow in m^3 per hour (1 m^3/hr = 0.59 ft^3/min)
$\mathbf{T_{ext}}$	Maximum expected temperature in °C *outside* the enclosure
$\mathbf{T_{int}}$	Maximum permissible temperature in °C *inside* the enclosure
P	Power in Watts dissipated by *all* heat sources in the enclosure
k	Ratio of $\frac{\mathbf{P_o}}{\mathbf{P_l}}$

Where:

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

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

Typically use a factor of 1.2 to 1.3, to allow also for pressure-drops in dirty air-filters.

Example

To calculate the size of an enclosure for the following:

- Three drives operating at the Normal Duty rating
- External EMC filter for each drive
- Braking resistors are to be mounted outside the enclosure
- Maximum ambient temperature inside the enclosure: 40 °C
- Maximum ambient temperature outside the enclosure: 30 °C

For example, dissipation of each drive: 101 W and dissipation of each external EMC filter: 6.9 W (max).

Total dissipation: 3 x (101 + 6.9) = 323.7 W

Insert the following values:

T_{int} 40 °C
T_{ext} 30 °C
k 1.3
P 323.7 W

Then:

$$V = \frac{3 \times 1.3 \times 323.7}{40 - 30}$$

= **126.2 m^3/hr (74.5 ft^3 /min)** (1 m^3/ hr = 0.59 ft^3/min)

3.7 Enclosure design and drive ambient temperature

Drive derating is required for operation in high ambient temperatures

Totally enclosing or through panel mounting the drive in either a sealed cabinet (no airflow) or in a well ventilated cabinet makes a significant difference on drive cooling.

The chosen method affects the ambient temperature value (T_{rate}) which should be used for any necessary derating to ensure sufficient cooling for the whole of the drive.

The ambient temperature for the four different combinations is defined below:

1. Totally enclosed with no air flow (<2 m/s) over the drive
   T_{rate} = T_{int} + 5 °C
2. Totally enclosed with air flow (>2 m/s) over the drive
   T_{rate} = T_{int}
3. Through panel mounted with no airflow (<2 m/s) over the drive
   T_{rate} = the greater of T_{ext} +5 °C, or T_{int}
4. Through panel mounted with air flow (>2 m/s) over the drive
   T_{rate} = the greater of T_{ext} or T_{int}

Where:

T_{ext} = Temperature outside the cabinet
T_{int} = Temperature inside the cabinet
T_{rate} = Temperature used to select current rating from tables in Chapter 12 *Technical data* on page 183.

3.8 Heatsink fan operation

The drive is ventilated by an internal heatsink fan. The fan channels air through the heatsink chamber.

Ensure the minimum clearances around the drive are maintained to allow air to flow freely.

The heatsink fan on all drive sizes is a variable speed fan. The drive controls the speed at which the fan runs based on the temperature of the heatsink and the drive's thermal model system. The maximum speed at which the fan operates can be limited in Pr **06.045**. This could incur an output current derating. Refer to section 3.12.1 *Fan removal procedure* on page 52 for information on fan removal. The size 6 is also installed with a variable speed fan to ventilate the capacitor bank. The heatsink fan on the size 5 to 8 is supplied internally by the drive.

3.9 Enclosing size 5 to 8 drive for high environmental protection

An explanation of the environmental protection rating is provided in section 12.1.9 *IP / UL Rating* on page 193.

The standard drive is rated to IP20 pollution degree 2 (dry, non-conductive contamination only). However, it is possible to configure the size 5 to 8 drive to achieve IP65 rating at the rear of the heatsink for through-panel mounting (some current derating is required).

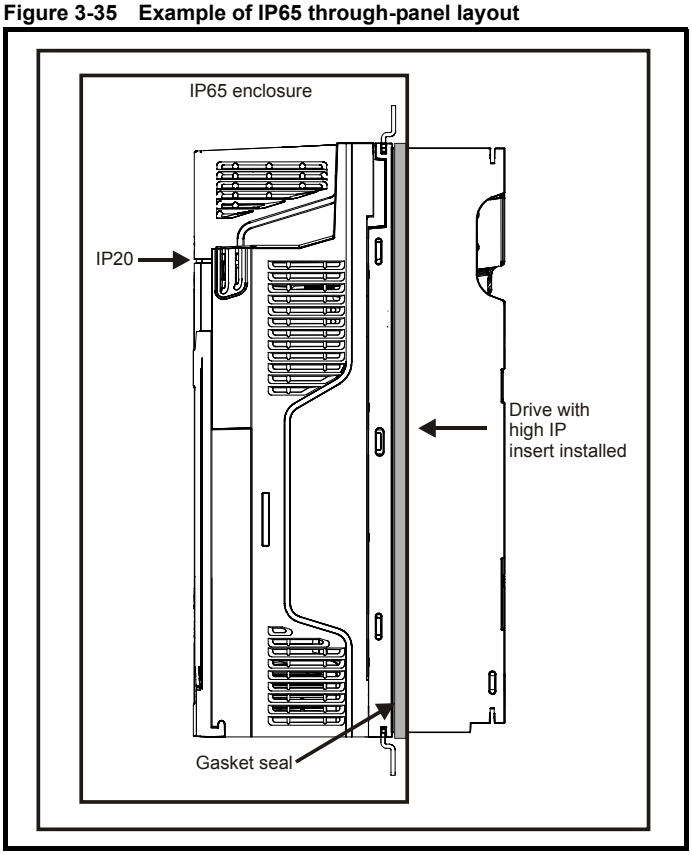
Refer to Table 12-3 on page 185.

This allows the front of the size 5 to 8 drive, along with the various switchgear, to be housed in an IP65 enclosure with the heatsink protruding through the panel to the external environment. The majority of the heat generated by the drive is dissipated outside the enclosure, thereby maintaining a reduced temperature inside the enclosure.

NOTE

This relies on a good seal being made between the heatsink and the rear of the enclosure using the gaskets provided.

Figure 3-35 Example of IP65 through-panel layout



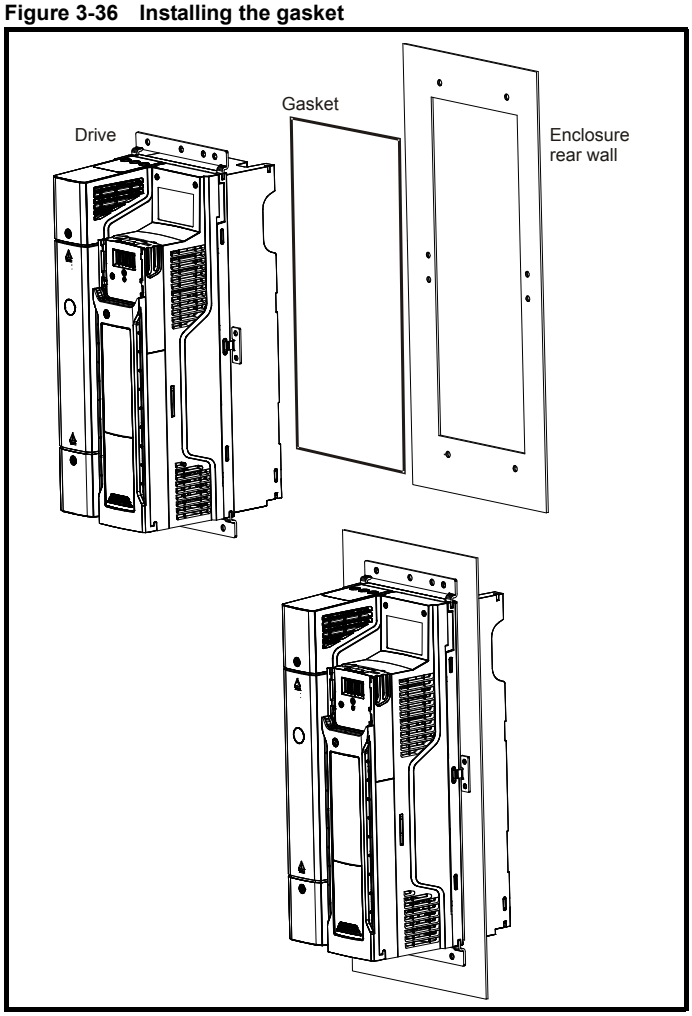
The main gasket should be installed as shown in Figure 3-36.

In order to achieve the high IP rating on the size 5 drive, it is necessary to seal a heatsink vent by installing the high IP insert as shown in Figure 3-38 *Installation of high IP insert for size 5* .

Table 3-6 Through-panel mounting kit part numbers

Size	CT part umber
5	3470-0067
6	3470-0055
7	3470-0079
8	3470-0083

Figure 3-36 Installing the gasket



To seal the space between the drive and the backplate, use the two securing brackets as shown in Figure 3-37. The securing brackets, gasket and high IP inserts are included in the through-panel mounting kit. The part numbers are shown in Table 3-6.

Figure 3-37 Through-panel mounting detail

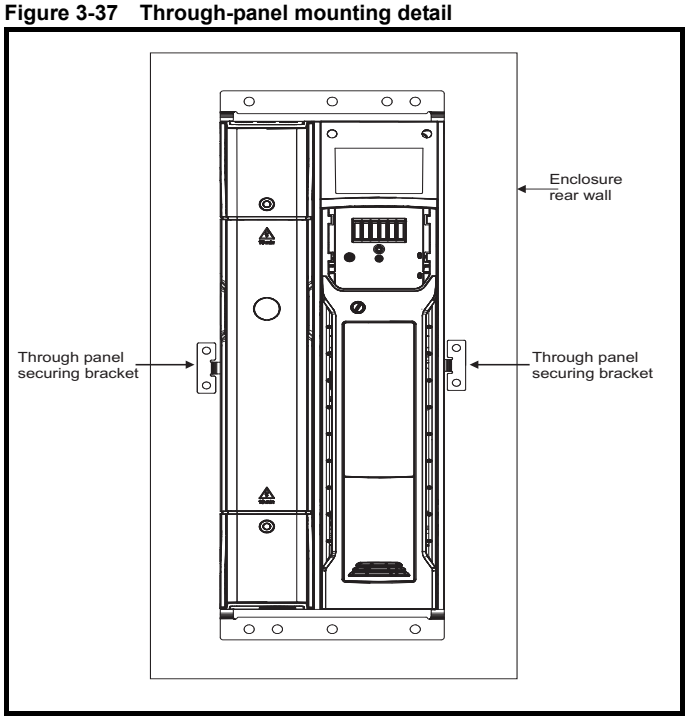
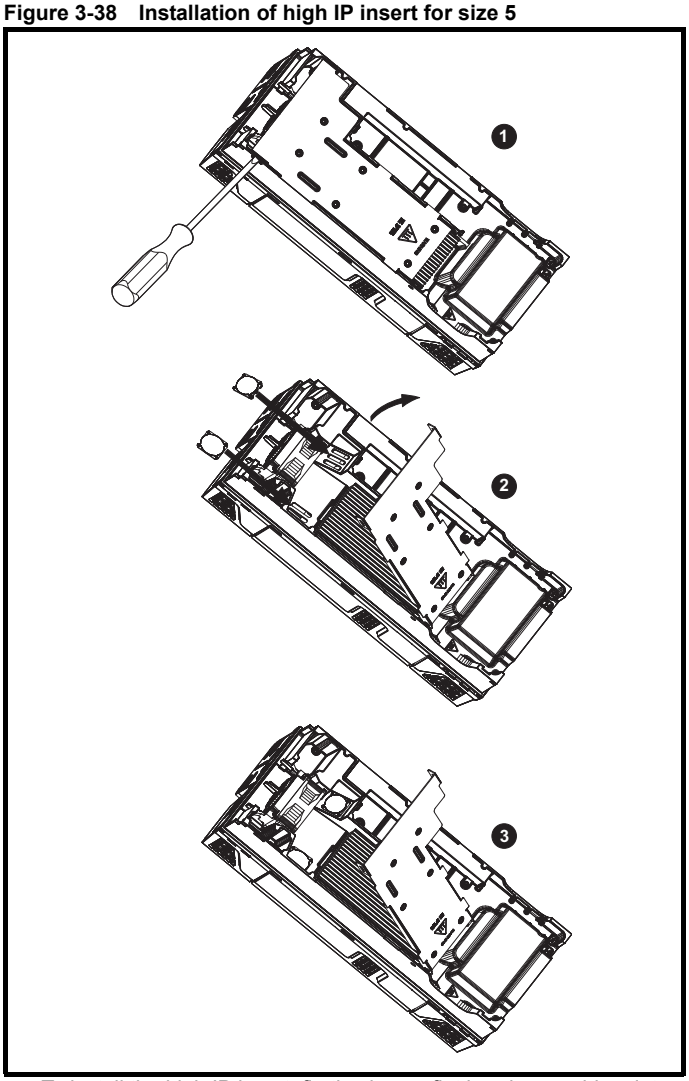


Figure 3-38 Installation of high IP insert for size 5



- To install the high IP insert, firstly place a flat head screwdriver into the slot highlighted (1).
- Pull the hinged baffle up to expose the ventilation holes, install the high IP inserts into the ventilation holes in the heatsink (2).
- Ensure the high IP inserts are securely installed by firmly pressing them into place (3).
- Close the hinged baffle as shown (1).

To remove the high IP inserts, reverse the above instructions.

The guidelines in Table 3-7 should be followed.

Table 3-7 Environmental considerations

Environment	High IP insert	Comments
Clean	Not installed	
Dry, dusty (non-conductive)	Installed	Regular cleaning recommended
Dry, dusty (conductive)	Installed	
IP65 compliance	Installed	

A current derating must be applied to the drive if the high IP insert is installed. Derating information is provided in section 12.1.1 *Power and current ratings (Derating for switching frequency and temperature)* on page 183.

Failure to do so may result in nuisance tripping.

NOTE

When designing an IP65 enclosure, refer to Figure 3-35 on page 45 for an example of an IP65 through-panel layout. Consideration should be made with regard to the heat dissipation from the front of the drive.

Table 3-8 Power losses from the front of the drive when through-panel mounted

Frame size	Power loss
5	
6	
7	
8	

3.10 External EMC filter

The external EMC filter details for each drive rating are provided in the table below.

Model	CT part number	Weight	
		kg	lb
200 V			
05200250	4200-0312	5.5	12.13
06200330 to 06200440	4200-2300	6.5	14.3
07200610 to 07200830	4200-1132		
08201160 to 08201320	4200-1672		
400 V			
05400270 to 05400300	4200-0402	5.5	12.13
06400350 to 06400470	4200-4800	6.7	14.8
07400660 to 07401000	4200-1132		
08401340 to 08401570	4200-1972		
575 V			
05500030 to 05500069	4200-0122		
06500100 to 06500350	4200-3690	7.0	15.4
07500440 to 07500550	4200-0672		
08500630 to 08500860	4200-1662		
690 V			
07600190 to 07600540	4200-0672		
08600630 to 08600860	4200-1662		

Mount the external EMC filter following the guidelines in section 4.8.5 *Compliance with generic emission standards* on page 79.

Figure 3-39 Footprint mounting the EMC filter

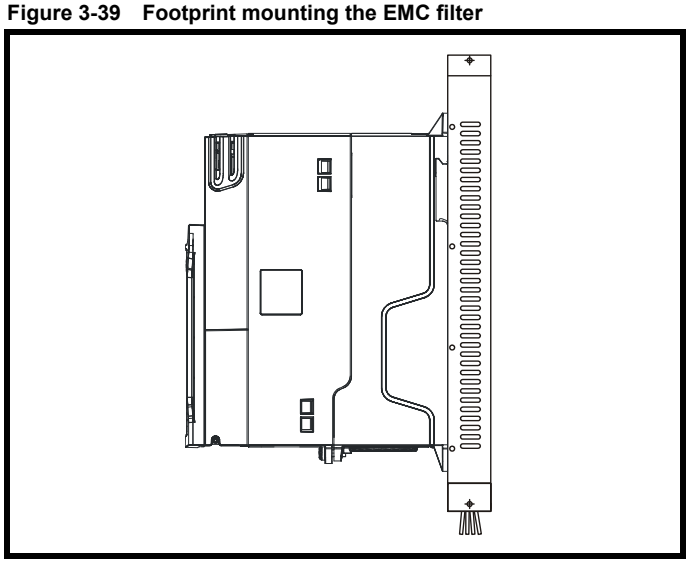


Figure 3-40 Bookcase mounting the EMC filter

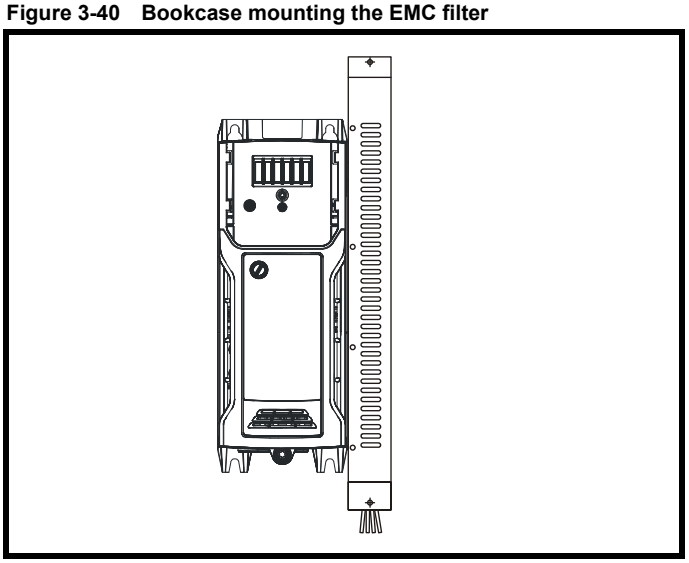
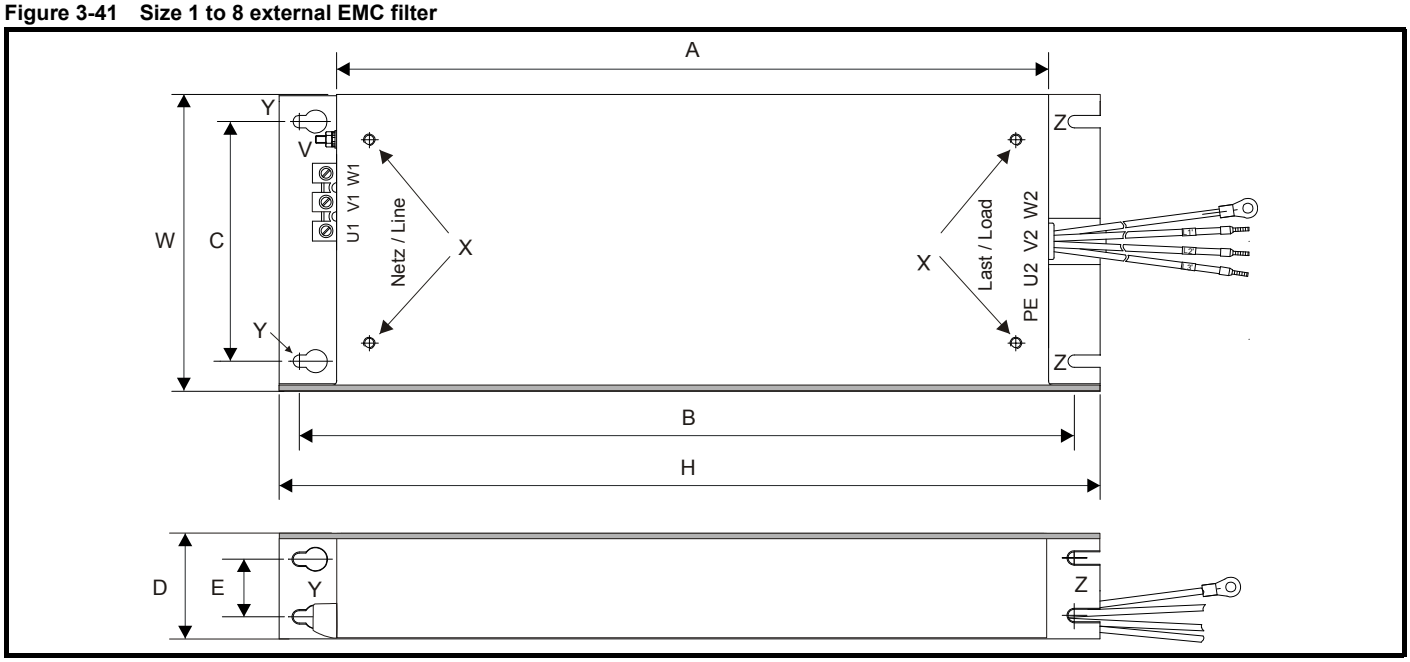


Figure 3-41 Size 1 to 8 external EMC filter



V: Ground stud
X: Threaded holes for footprint mounting of the drive
Y: Footprint mounting hole diameter
Z: Bookcase mounting slot diameter.
CS: Cable size

Table 3-9 Size 1 external EMC filter dimensions

CT part number	A	B	C	D	E	H	W	V	X	Y	Z	CS

Table 3-10 Size 2 external EMC filter dimensions

CT part number	A	B	C	D	E	H	W	V	X	Y	Z	CS

Table 3-11 Size 3 external EMC filter dimensions

CT part number	A	B	C	D	E	H	W	V	X	Y	Z	CS

Table 3-12 Size 4 external EMC filter dimensions

CT part number	A	B	C	D	E	H	W	V	X	Y	Z	CS

Table 3-13 Size 5 external EMC filter dimensions

CT part number	A	B	C	D	E	F	H	W	V	X	Y	Z	CS
4200-0312	395 mm (15.55 in)	425 mm (16.73 in)	106 mm (4.17 in)	60 mm (2.36 in)	33 mm (1.30 in)	11.5 mm (0.45 in)	437 mm (17.2 in)	143 mm (5.63 in)	M6	M6	6.5 mm (0.26 in)	6.5 mm (0.26 in)	10 mm^2 (8 AWG)
4200-0402													
4200-0122													2.5 mm^2 (14 AWG)

Table 3-14 Size 6 external EMC filter dimensions

CT part number	A	B	C	D	E	F	H	W	V	X	Y	Z	CS
4200-2300 4200-4800 4200-3690	392 mm (15.43 in)	420 mm (16.54 in)	180 mm (7.09 in)	60 mm (2.36 in)	33 mm (1.30 in)	11.5 mm (0.45 in)	434 mm (17.09 in)	210 mm (8.27 in)	M6	M6	6.5 mm (0.26 in)	6.5 mm (0.26 in)	16 mm^2 (6 AWG)

Table 3-15 Size 7 external EMC filter dimensions

CT part number	A	B	C	D	E	F	H	W	V	X	Y	Z	CS
4200-1132 4200-0672													

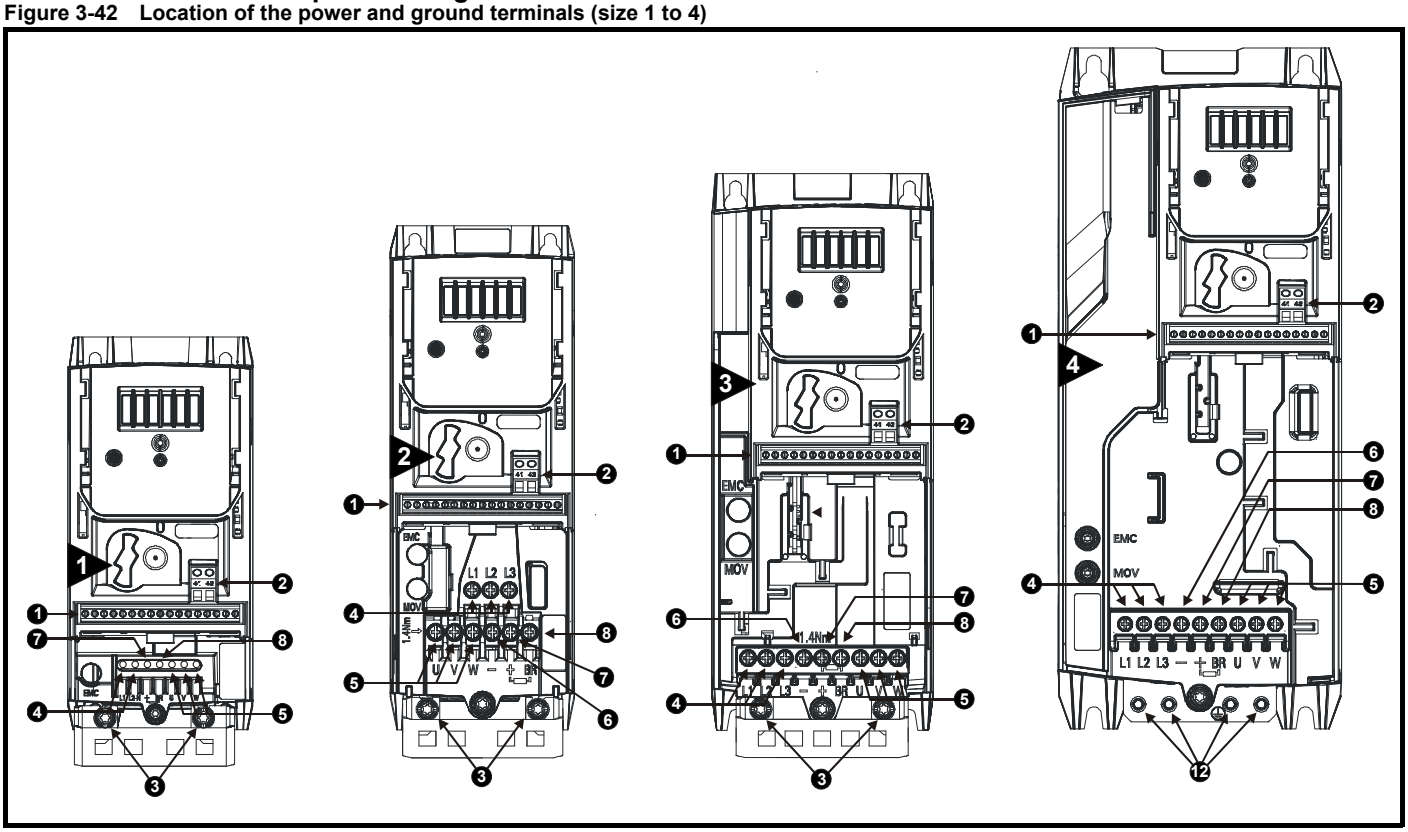
Table 3-16 Size 8 external EMC filter dimensions

CT part number	A	B	C	D	E	F	H	W	V	X	Y	Z	CS
4200-1672 4200-1972 4200-1662													

3.11 Electrical terminals

3.11.1 Location of the power and ground terminals

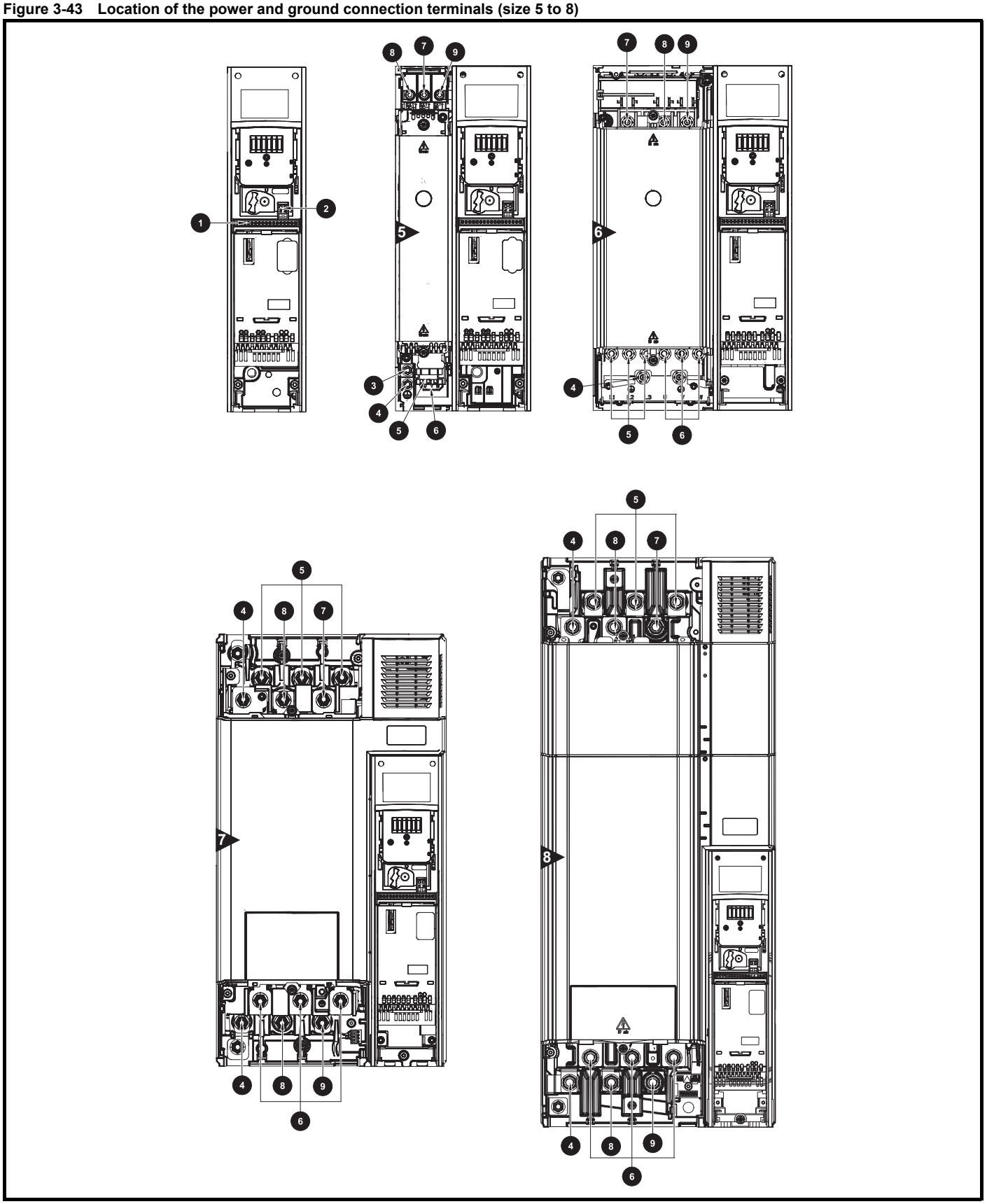
Figure 3-42 Location of the power and ground terminals (size 1 to 4)



Key:

1. Control terminals
2. Relay terminals
3. Ground connections
4. AC power terminals
5. Motor terminals
6. DC bus -
7. DC bus +
8. Brake terminal

Figure 3-43 Location of the power and ground connection terminals (size 5 to 8)



Key

1. Control terminals
2. Relay terminals
3. Additional ground connection
4. Ground connections
5. AC power terminals
6. Motor terminals
7. DC bus -
8. DC bus +
9. Brake terminal

3.11.2 Terminal sizes and torque settings

WARNING

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

Table 3-17 Drive control terminal data

Model	Connection type	Torque setting
All	Screw terminals	0.2 N m (0.15 lb ft)

Table 3-18 Drive relay terminal data

Model	Connection type	Torque setting
All	Screw terminals	0.5 N m (0.4 lb ft)

Table 3-19 Drive power terminal data

Model size	AC and motor terminals		DC and braking		Ground terminal	
	Recommended	Maximum	Recommended	Maximum	Recommended	Maximum
1	0.5 N m (0.4 lb ft)		0.5 N m (0.4 lb ft)		1.5 N m (1.1 lb ft)	
2	1.4 N m (1 lb ft)		1.4 N m (1 lb ft)			
3						
4						
5	Plug-in terminal block		M4 Nut (7 mm AF)		M5 Nut (8 mm AF)	
	1.5 N m (1.1 lb ft)	1.8 N m (1.3 lb ft)	1.5 N m (1.1 lb ft)	2.5 N m (1.8 lb ft)	2.0 N m (1.4 lb ft)	5.0 N m (3.7 lb ft)
6	M6 Nut (10 mm AF)		M6 Nut (10 mm AF)		M6 Nut (10 mm AF)	
	6.0 N m (4.4 lb ft)	8.0 N m (6.0 lb ft)	6.0 N m (4.4 lb ft)	8.0 N m (6.0 lb ft)	6.0 N m (4.4 lb ft)	8.0 N m (6.0 lb ft)
7	M8 Nut (13 mm AF)		M8 Nut (13 mm AF)		M8 Nut (13 mm AF)	
	12 N m (8.8 lb ft)	14 N m (10.0 lb ft)	12 N m (8.8 lb ft)	14 N m (10.0 lb ft)	12 N m (8.8 lb ft)	14 N m (10.0 lb ft)
8	M10 Nut (17 mm AF)		M10 Nut (17 mm AF)		M10 Nut (17 mm AF)	
	15 N m (11.1 lb ft)	20 N m (14.8 lb ft)	15 N m (11.1 lb ft)	20 N m (14.8 lb ft)	15 N m (11.1 lb ft)	20 N m (14.8 lb ft)

Table 3-20 Terminal block maximum cable sizes

Model size	Terminal block description	Max cable size
All	Control connector	1.5 mm^2 (16 AWG)
All	2-way relay connector	2.5 mm^2 (12 AWG)
1 to 4	STO connector	0.5 mm^2 (20 AWG)
	AC input power connector	6 mm^2 (10 AWG)
	AC output power connector	2.5 mm^2 (12 AWG)
5	3-way AC power connector 3-way motor connector	8 mm^2 (8 AWG)
5 to 8	STO connector	2.5 mm^2 (12 AWG)

Table 3-21 External EMC filter terminal data

CT part number	Power connections		Ground connections	
	Max cable size	Max torque	Ground stud size	Max torque
4200-2300	16 mm^2 (6 AWG)	2.3 N m (1.70 lb ft)	M6	4.8 N m (2.8 lb ft)
4200-4800				
4200-3690				

3.12 Routine maintenance

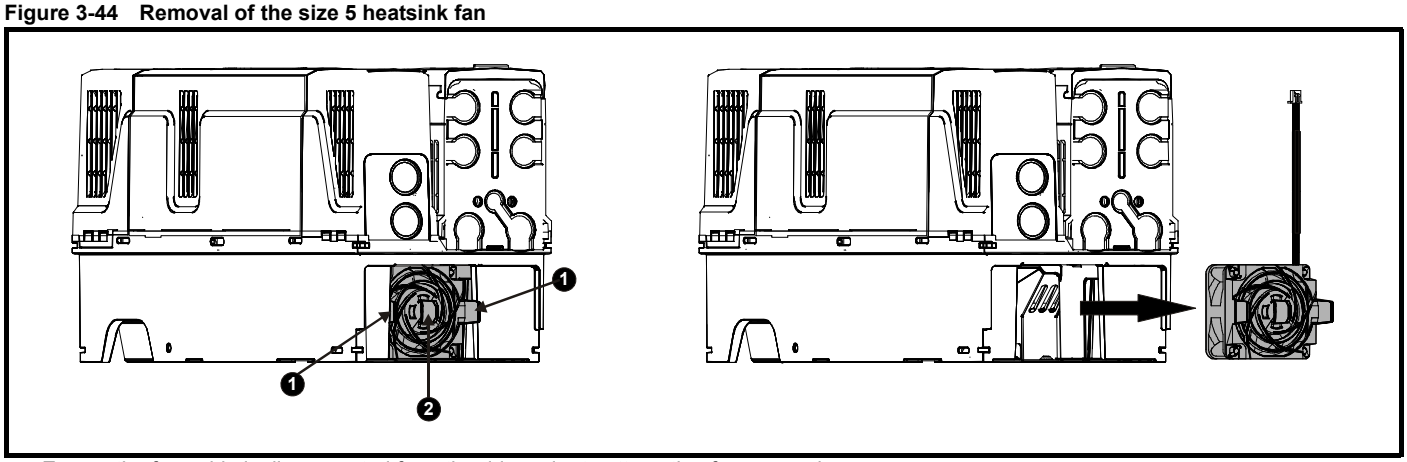
The drive should be installed in a cool, clean, well ventilated location. Contact with moisture and/or dust with the drive should be avoided.

Regular checks of the following should be carried out to ensure drive / installation reliability are maximized:

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

3.12.1 Fan removal procedure

Figure 3-44 Removal of the size 5 heatsink fan



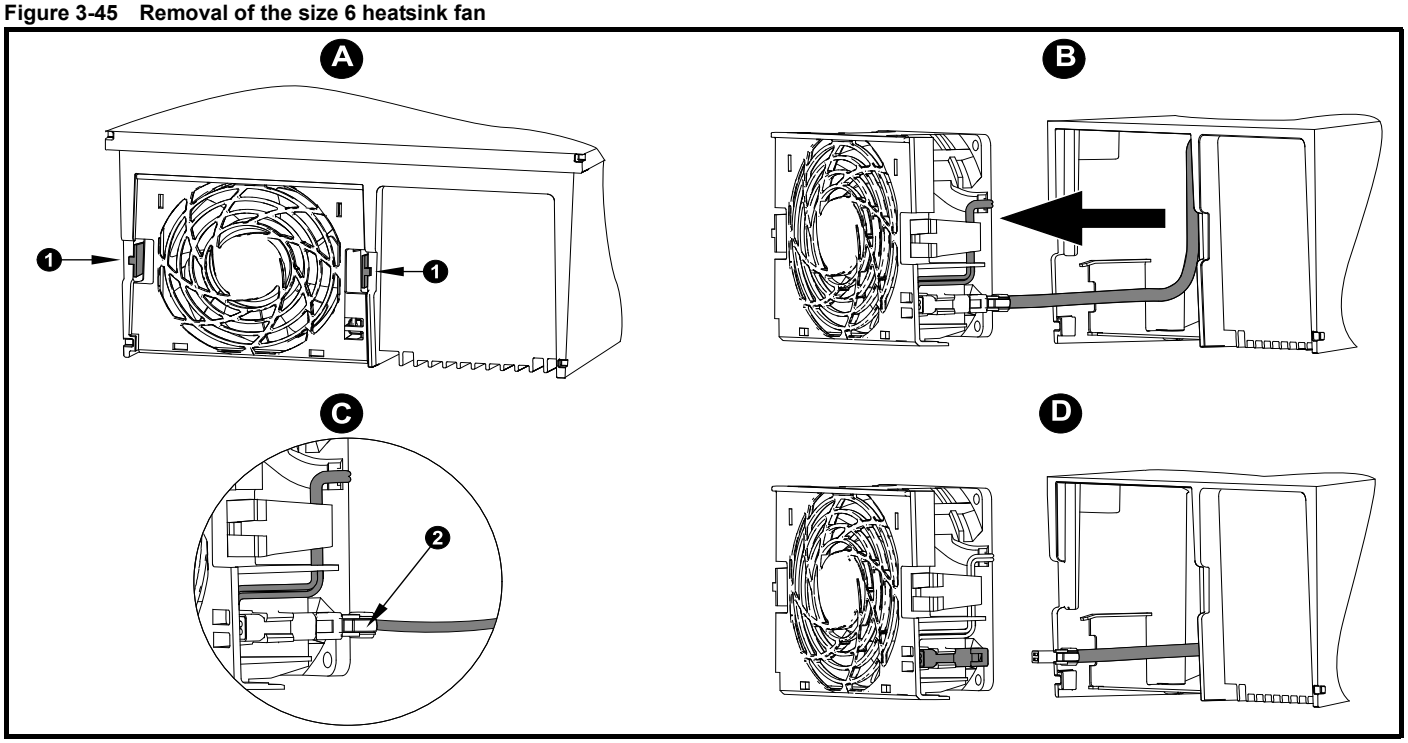
- Ensure the fan cable is disconnected from the drive prior to attempting fan removal.
- Press the two outer tabs (1) inwards to release the fan from the drive frame.
- Using the central fan tab (2), withdraw the fan assembly from the drive housing.

NOTE

Replace the fan by reversing the above instructions.

If the drive is surface mounted using the outer holes on the mounting bracket, then the heatsink fan can be replaced without removing the drive from the backplate.

Figure 3-45 Removal of the size 6 heatsink fan



A: Press the tabs (1) inwards to release the fan assembly from the underside of the drive.

B: Use the tabs (1) to withdraw the fan by pulling it away from the drive.

C: Depress and hold the locking release on the fan cable lead as shown (2).

D: With the locking release depressed (2), take hold of the fan supply cable and carefully pull to separate the connectors.

4 Electrical installation

Many cable management features have been incorporated into the product and accessories, this chapter shows how to optimize them. Key features include:

- SAFE TORQUE OFF function
- Internal EMC filter
- EMC compliance with shielding / grounding accessories
- Product rating, fusing and cabling information
- Brake resistor details (selection / ratings)

WARNING

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

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

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

WARNING

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

WARNING

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

WARNING

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

WARNING

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

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

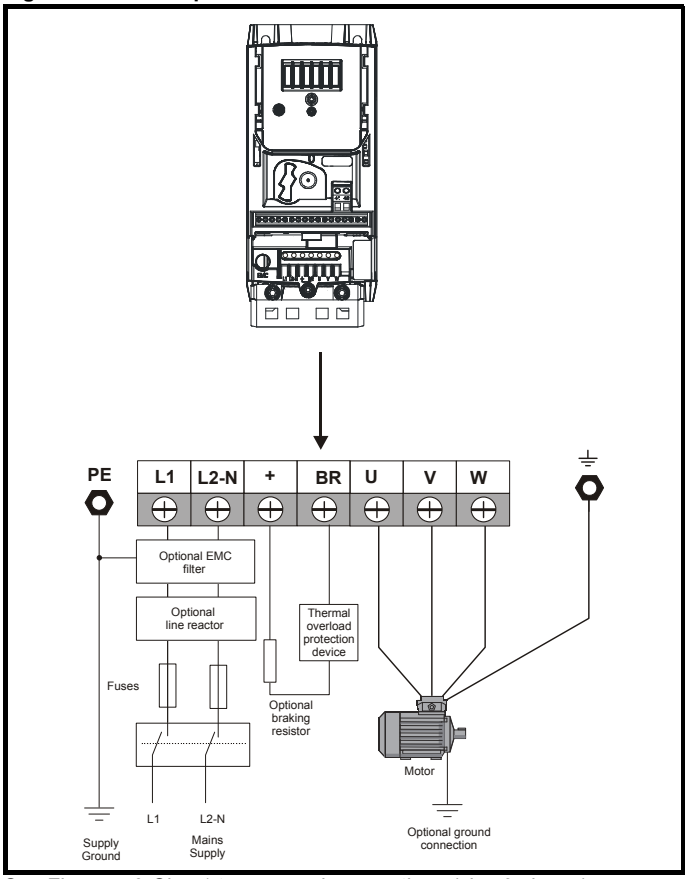
WARNING

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

4.1 Power connections

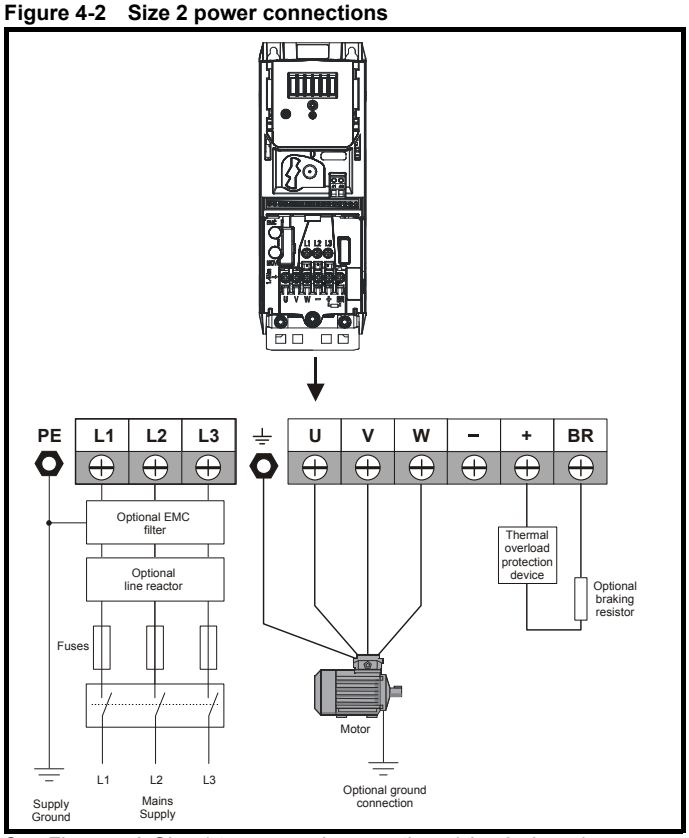
4.1.1 AC and DC connections

Figure 4-1 Size 1 power connections



See Figure 4-8 *Size 1 to 4 ground connections (size 2 shown)* on page 57 for further information on ground connections.

Figure 4-2 Size 2 power connections

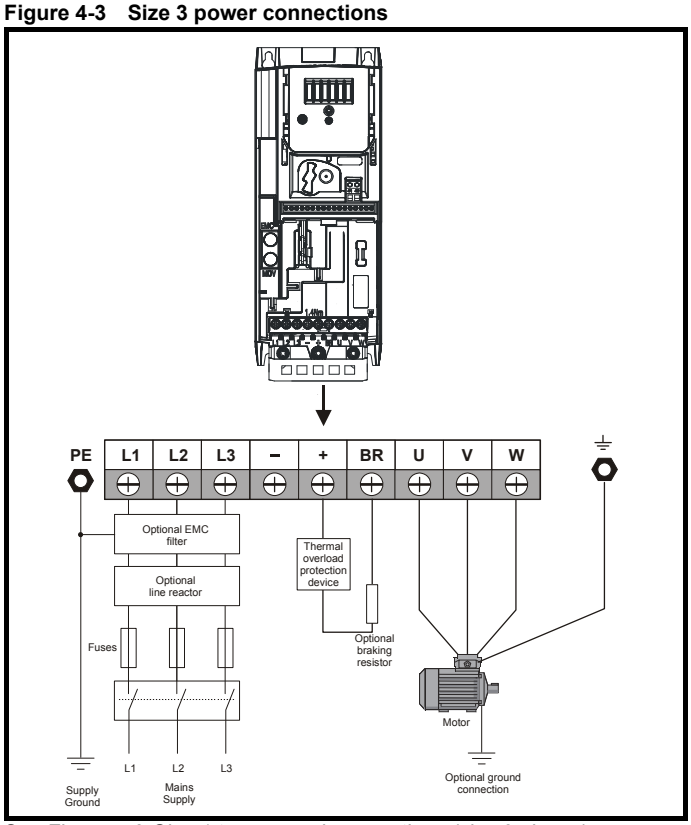


See Figure 4-8 *Size 1 to 4 ground connections (size 2 shown)* on page 57 for further information on ground connections.

NOTE

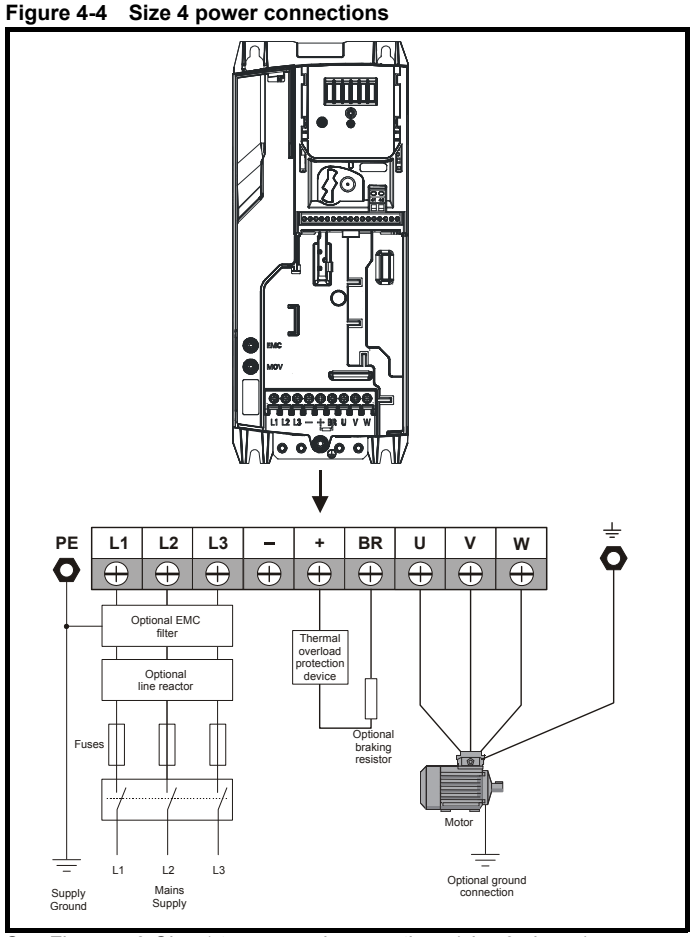
On the size 2 110 V drives, the supply should be connected to L1 and L3. Also the -DC bus (-) terminal has no internal connection.

Figure 4-3 Size 3 power connections



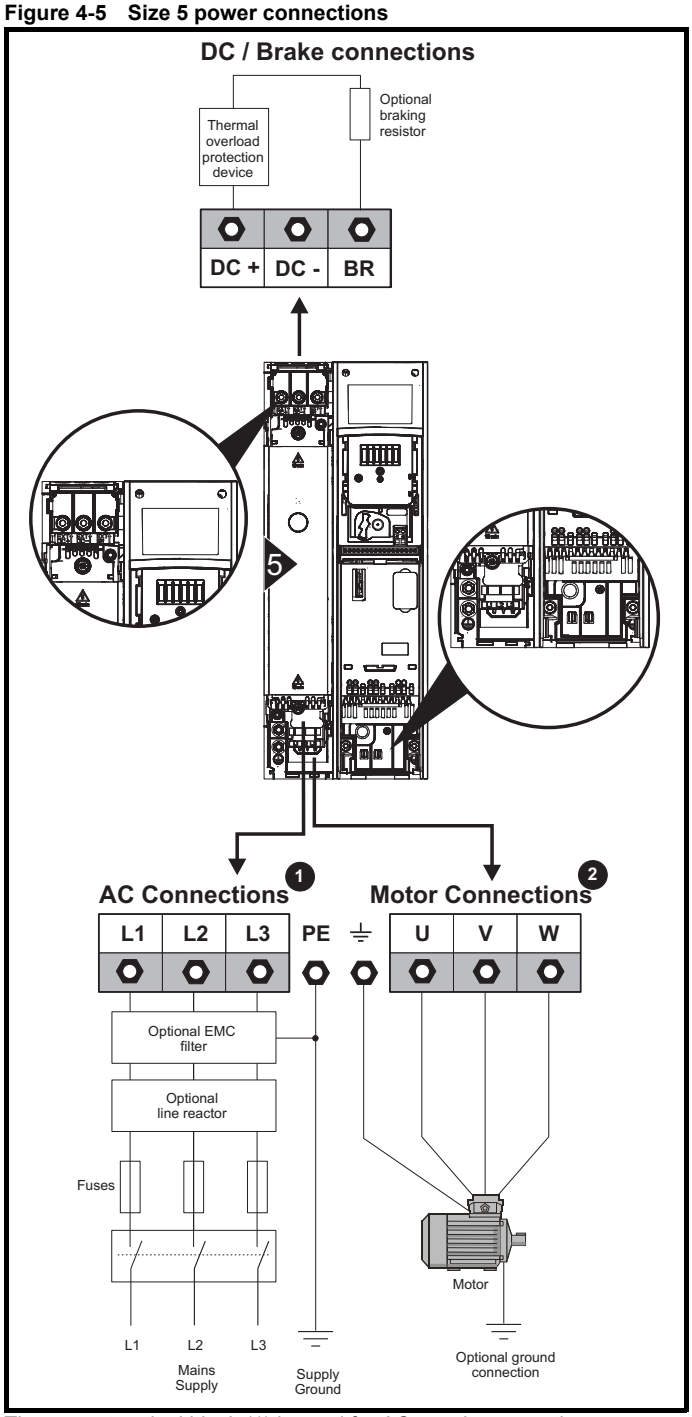
See Figure 4-8 *Size 1 to 4 ground connections (size 2 shown)* on page 57 for further information on ground connections.

Figure 4-4 Size 4 power connections



See Figure 4-8 *Size 1 to 4 ground connections (size 2 shown)* on page 57 for further information on ground connections.

Figure 4-5 Size 5 power connections

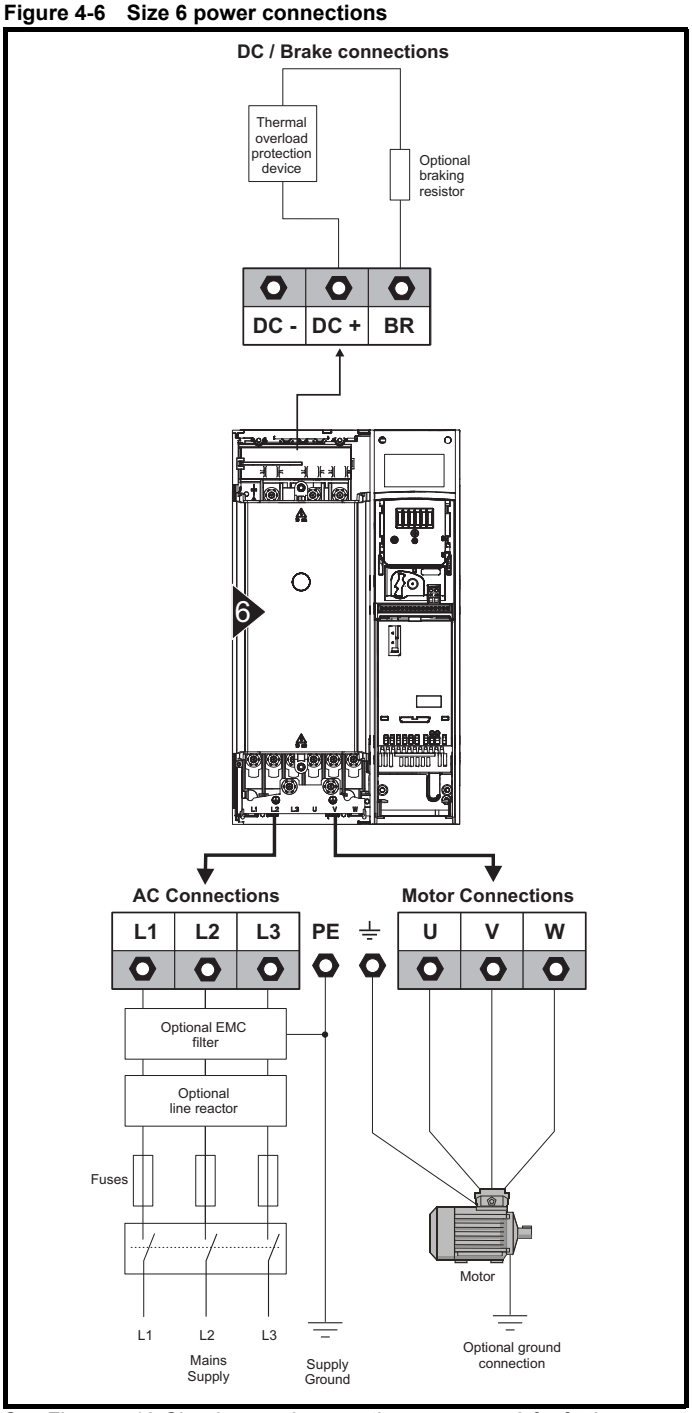


The upper terminal block (1) is used for AC supply connection.

The lower terminal block (2) is used for Motor connection.

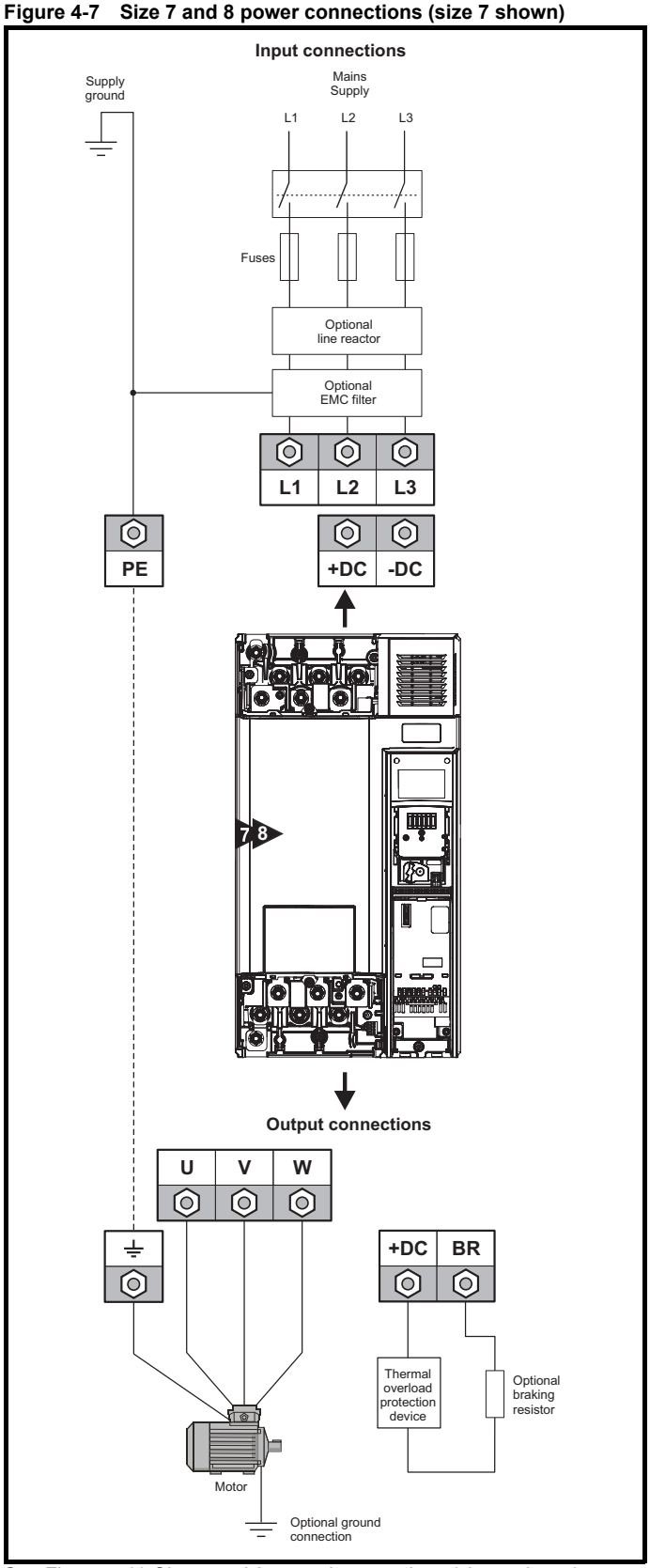
See Figure 4-9 *Size 5 ground connections* on page 57 for further information on ground connections.

Figure 4-6 Size 6 power connections



See Figure 4-10 *Size 6 ground connections* on page 58 for further information on ground connections.

Figure 4-7 Size 7 and 8 power connections (size 7 shown)



See Figure 4-11 *Size 7 and 8 ground connections (size 7 shown)* on page 58 for further information on ground connections.

4.1.2 Ground connections

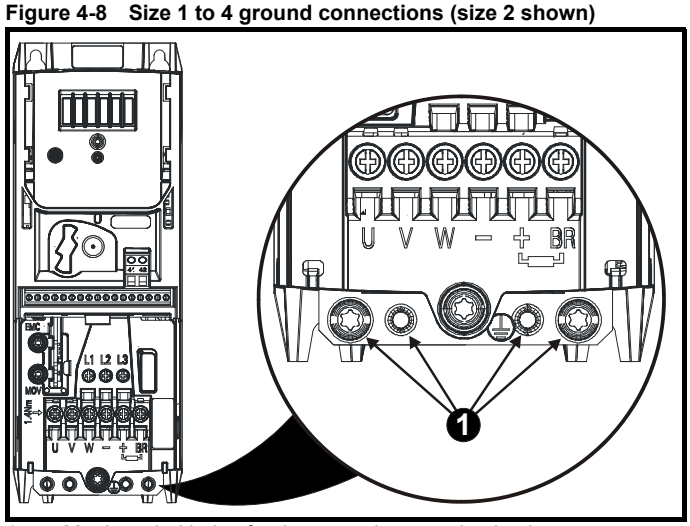
Electrochemical corrosion of grounding terminals
Ensure that grounding terminals are protected against corrosion i.e. as could be caused by condensation.

WARNING

Size 1 to 4

On sizes 1 to 4, the supply and motor ground connections are made using the ground busbar located at the bottom of the drive as shown in Figure 4-8.

Figure 4-8 Size 1 to 4 ground connections (size 2 shown)

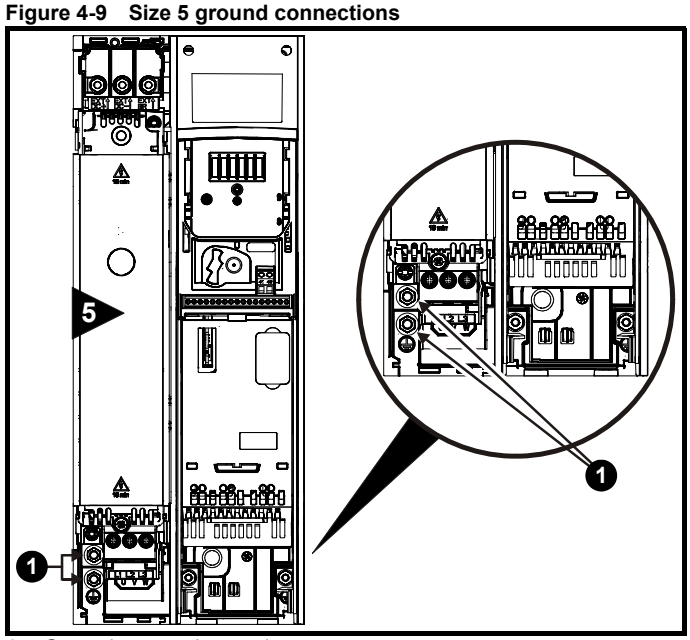


1: 4 x M4 threaded holes for the ground connection busbar

Size 5

On size 5, the supply and motor ground connections are made using the M5 studs located near the plug -in power connector.

Figure 4-9 Size 5 ground connections

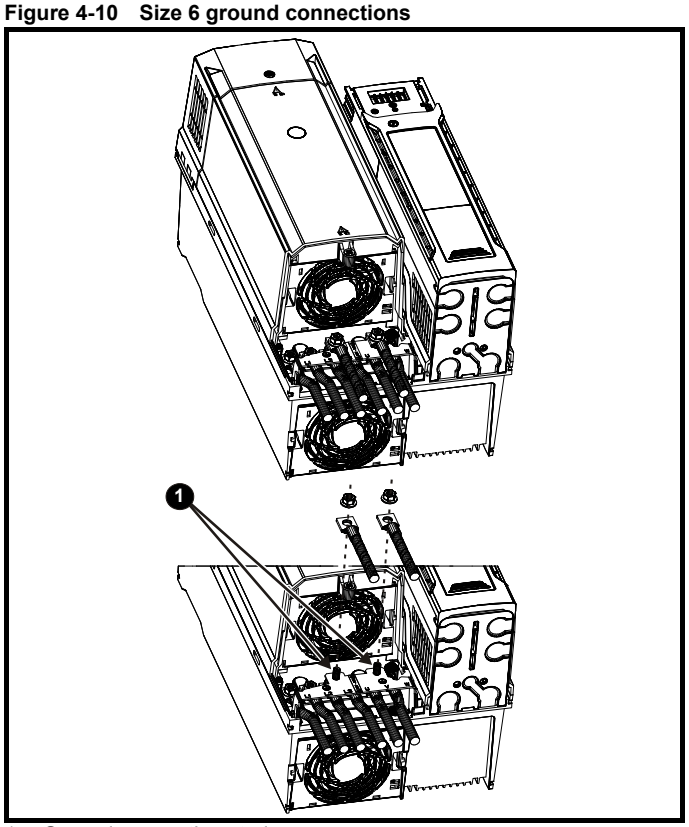


1. Ground connection studs.

Size 6

On a size 6, the supply and motor ground connections are made using the M6 studs located above the supply and motor terminals. Refer to Figure 4-10 below.

Figure 4-10 Size 6 ground connections



1. Ground connection studs

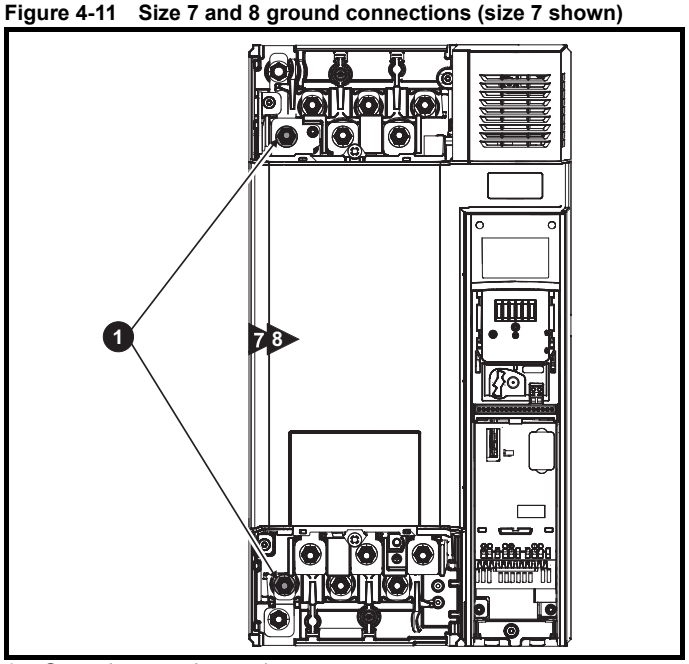
Size 7

On size 7, the supply and motor ground connections are made using the M8 studs located by the supply and motor connection terminals.

Size 8

On size 8, the supply and motor ground connections are made using the M10 studs located by the supply and motor connection terminals.

Figure 4-11 Size 7 and 8 ground connections (size 7 shown)



1. Ground connection studs

WARNING

The ground loop impedance must conform to the requirements of local safety regulations.

The drive must be grounded by a connection capable of carrying the prospective fault current until the protective device (fuse, etc.) disconnects the AC supply.

The ground connections must be inspected and tested at appropriate intervals.

Table 4-1 Protective ground cable ratings

Input phase conductor size	Minimum ground conductor size
≤ 10 mm^2	Either 10 mm^2 **or** two conductors of the same cross-sectional area as the input phase conductor.
> 10 mm^2 and ≤ 16 mm^2	The same cross-sectional area as the first input phase conductor.
> 16 mm^2 and ≤ 35 mm^2	16 mm^2
> 35 mm^2	Half of the cross-sectional area of the input phase conductor.

4.2 AC supply requirements

Voltage:

100 V drive: 100 V to 120 V ±10 %
200 V drive: 200 V to 240 V ±10 %
400 V drive: 380 V to 480 V ±10 %
575 V drive: 500 V to 575 V ±10 %
690 V drive: 500 V to 690 V ±10 %

Number of phases: 3

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

Frequency range: 48 to 62 Hz

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

4.2.1 Supply types

All drives are suitable for use on any supply type i.e TN-S, TN-C-S, TT and IT.

- Supplies with voltage up to 600 V may have grounding at any potential, i.e. neutral, centre or corner (“grounded delta”)
- Supplies with voltage above 600 V may not have corner grounding

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

WARNING

Operation with IT (ungrounded) supplies:
Special attention is required when using internal or external EMC filters with ungrounded supplies, because in the event of a ground (earth) fault in the motor circuit the drive may not trip and the filter could be over-stressed. In this case, either the filter must not be used i.e. removed, or additional independent motor ground fault protection must be provided. For instructions on removal, refer to Figure 4-19 *Installation of grounding bracket (size 1 to 4)* and Figure 4-25 *Removal of the size 3 internal EMC filter* . For details of ground fault protection contact the supplier of the drive.

A ground fault in the supply has no effect in any case. If the motor must continue to run with a ground fault in its own circuit, then an input isolating transformer must be provided, and if an EMC filter is required it must be located in the primary circuit.

Unusual hazards can occur on ungrounded supplies with more than one source, for example on ships. Contact the supplier of the drive for more information.

4.2.2 Supplies requiring line reactors

Input line reactors reduce the risk of damage to the drive resulting from poor phase balance or severe disturbances on the supply network.

Where line reactors are to be used, reactance values of approximately 2 % are recommended. Higher values may be used if necessary, but may result in a loss of drive output (reduced torque at high speed) because of the voltage drop.

For all drive ratings, 2 % line reactors permit drives to be used with a supply unbalance of up to 3.5 % negative phase sequence (equivalent to 5 % voltage imbalance between phases).

Severe disturbances may be caused by the following factors, for example:

- Power factor correction equipment connected close to the drive.
- Large DC drives having no or inadequate line reactors connected to the supply.
- Across the line (DOL) started motor(s) connected to the supply such that when any of these motors are started, the voltage dip exceeds 20 %.

Such disturbances may cause excessive peak currents to flow in the input power circuit of the drive. This may cause nuisance tripping, or in extreme cases, failure of the drive.

Drives of low power rating may also be susceptible to disturbance when connected to supplies with a high rated capacity.

Line reactors are particularly recommended for use with the following drive models when one of the above factors exists, or when the supply capacity exceeds 175 kVA: Size 1 to 3

Model sizes 04200133 to 07600540 have an internal DC choke and 082001160 to 08600860 have internal AC line chokes so they do not require AC line reactors except for cases of excessive phase unbalance or extreme supply conditions.

When required, each drive must have its own reactor(s). Three individual reactors or a single three-phase reactor should be used.

Reactor current ratings

The current rating of the line reactors should be as follows:

Continuous current rating:

Not less than the continuous input current rating of the drive

Repetitive peak current rating:

Not less than twice the continuous input current rating of the drive

4.2.3 Input inductor calculation

To calculate the inductance required (at **Y**%), use the following equation:

$$\mathbf{L} = \frac{\mathbf{Y}}{\mathbf{100}} \times \frac{\mathbf{V}}{\sqrt{\mathbf{3}}} \times \frac{\mathbf{1}}{\mathbf{2\pi f I}}$$

Where:

I = drive rated input current (A)
L = inductance (H)
f = supply frequency (Hz)
V = voltage between lines

4.2.4 Input line reactor specification for size 1 to 7

Table 4-2 AC line reactor values

Drives used with	Reactor part number	Input phases	Inductance	Continuous rms current	Peak current	Weight	Dimensions (mm)		
			mH	A	A	kg	L	D	H
01200017	4402-0224	1	2.25	6.5	13	0.8	72	65	90
01200024									
01200033	4402-0225	1	1.0	15.1	30.2	1.1	82	75	100
01200042									
02200024									
02200033									
02200042									
02200056	4402-0226	1	0.5	26.2	52.4	1.5	82	90	105
02200075									
03200100									
04200133									
02200024	4402-0227	3	2.0	7.9	15.8	3.5	150	90	150
02200033									
02200042									
02400013									
02400018									
02400023									
02400032									
02400041									
02200056	4402-0228	3	1.0	15.4	47.4	3.8	150	90	150
02200075									
03200100									
03400056									
03400073									
03400094									
04200133									
04400135									
05200250	4402-0229	3	0.4	24.6	49.2	3.8	150	90	150
04200176	4402-0232	3	0.6	27.4	54.8	6	180	100	190
04400170									
05400270									
05400300									
06200330	4400-0240**	3	0.45	46	92	11	190	150	225
06400350									
06400420									
06200440	4400-0241**	3	0.3	74	148	15	250	150	275
06400470									
07200610									
07200750									
07400660									

**These input reactors are not stocked by Control Techniques. Contact your local Drive Centre.

The AC line reactors for the 110 V and other size drives should be sourced locally.

NOTE

The reactance values will be higher than 2 % with some of these drives, which may result in a loss of drive output (reduced torque at high speed) because of the voltage drop.

Figure 4-12 Input line reactor 4402-0224, 4402-0225 and 4402-0226

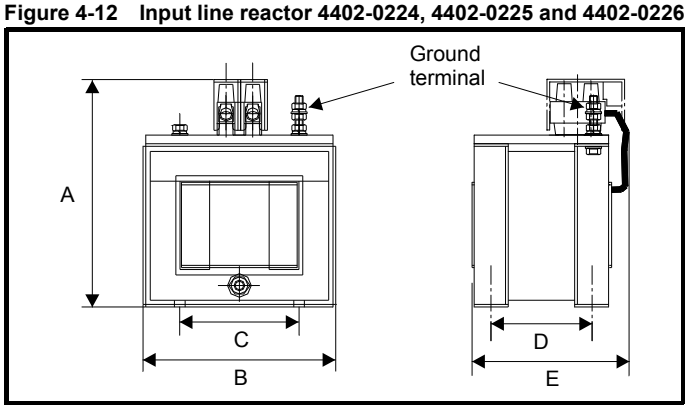


Table 4-3 Dimensions

Part No	Dimensions						Ground terminal
	A	B	C	D	E	Mounting hole	
4402-0224	90 mm (3.54 in)	72 mm (2.84 in)	44.5 mm (1.75in)	35 mm (1.38 in)	65 mm (2.56 in)	8 mm x 4 mm (0.32 in x 0.16 in)	M3
4402-0225	100 mm (3.94 in)	82 mm (3.23 in)	54 mm (2.13in)	40 mm (1.58 in)	75 mm (2.95 in)		
4402-0226	105 mm (4.13 in)			53 mm (2.09 in)	90 mm (3.54 in)		

Figure 4-13 Input line reactor 4402-0227, 4402-0228, 4402-0229

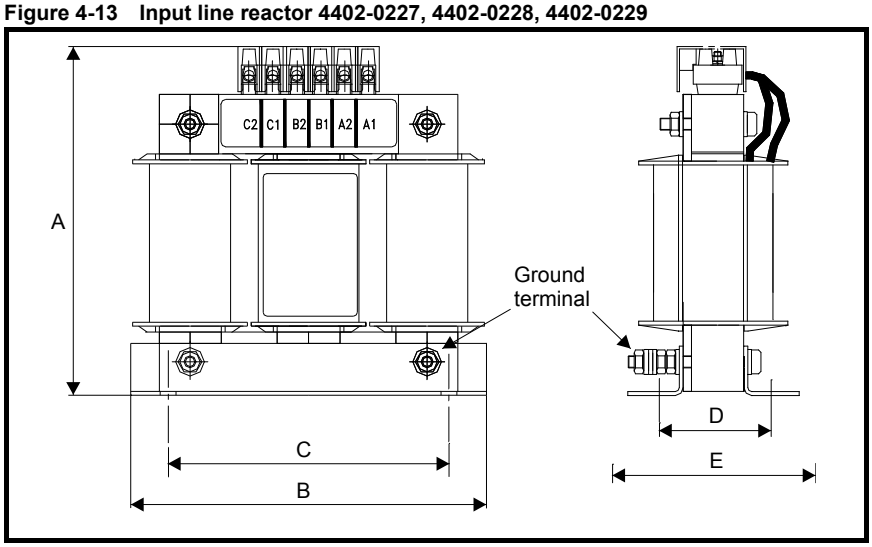


Table 4-4 Dimensions

Part No	Dimensions						Ground terminal
	A	B	C	D	E	Mounting slot	
4402-0227	150 mm (5.91in)	150 mm (5.91in)	120 mm (4.72 in)	47 mm (1.85 in)	90mm (3.54in)	17 mm x 7 mm (0.67 in x 0.28 in)	M5
4402-0228							
4402-0229							

4.3 24 Vdc supply

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

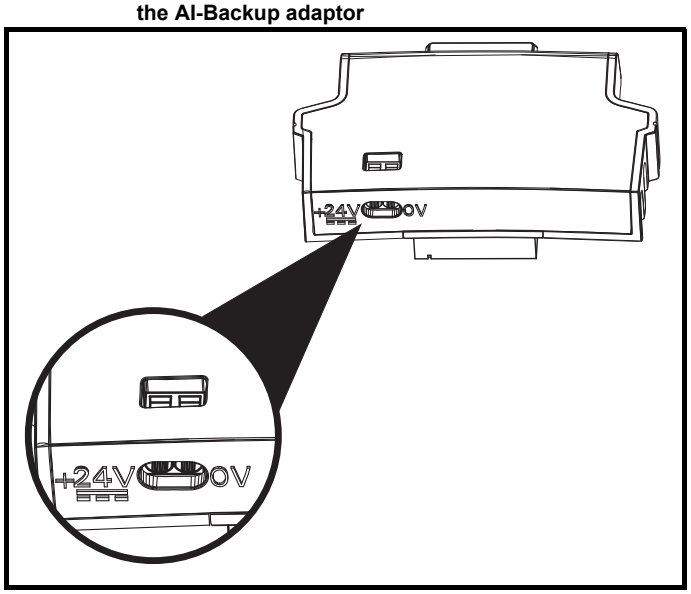
- It can be used as a back-up power supply to keep the control circuits of the drive powered up when the line power supply is removed. This allows any fieldbus modules or serial communications to continue to operate. If the line power supply is re-applied, then the normal operation can carry on after the drive automatically re-initializes the power board parameters.
- It can be used to clone or load parameters and user programs 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:

0 V	**0 V**
+ 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
Recommended fuse	1 A, 50 Vdc

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

Figure 4-14 Location of the 24 Vdc power supply connection on the AI-Backup adaptor



4.4 Ratings

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

Typical input current

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

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

Maximum continuous input current

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

The values of maximum input current are stated for a supply with a 2 % negative phase-sequence imbalance and rated at the supply fault current given in Table 4-5.

Table 4-5 Supply fault current used to calculate maximum input currents

Model	Symmetrical fault level (kA)
All	100

Fuses

The AC supply to the drive must be installed with suitable protection against overload and short-circuits. Table 4-6, Table 4-7, Table 4-8, Table 4-9 and Table 4-10 show the recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

Table 4-6 AC Input current and fuse ratings (100 V)

Model	Typical input current A	Maximum continuous input current A	Maximum overload input current A	Fuse rating	
				IEC gG	Class CC or Class J
				Maximum A	Maximum A
01100017	8.7	8.7		10	10
01100024	11.1	11.1		16	16
02100042	18.8	18.8		20	20
02100056	24.0	24.0		25	25

Table 4-7 AC Input current and fuse ratings (200 V)

Model	Typical input current A	Maximum continuous input current A	Maximum overload input current A	Fuse rating						
				IEC			UL / USA			
				Nominal A	Maximum A		Class	Nominal A	Maximum A		Class
					1ph	3ph			1ph	3ph	
01200017	4.5	4.5			6		gG		5		CC or J
01200024	5.3	5.3							10		
01200033	8.3	8.3			10						
01200042	10.4	10.4			16				16		
02200024	5.3/3.2	5.3/4.1			6		gG		10	5	CC or J
02200033	8.3/4.3	8.3/6.7			10				10		
02200042	10.4/5.4	10.4/7.5			16	10			16	10	
02200056	14.9/7.4	14.9/11.3			20	16			20	16	
02200075	18.1/9.1	18.1/13.5									
03200100	23.9/12.8	23.9/17.7	30/25		25	20	gG		25	20	CC or J
04200133	23.7/13.5	23.7/16.9			25	20	gG		25	20	CC or J
04200176	17.0	21.3				25				25	
05200250	24	31	52	40		40	gG	40		40	CC or J
06200330	42	48	64	63		63	gG	60		60	CC or J
06200440	49	56	85					60			
07200610	58	67	109	80		80	gG	80		80	CC or J
07200750	73	84	135	100		100		100		100	
07200830	91	105	149	125		125		125		125	
08201160	123	137	213	200		200	gR	200		200	HSJ
08201320	149	166	243					225		225	

Table 4-8 AC Input current and fuse ratings (400 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
02400013	2.1	2.4			6	gG		5	CC or J
02400018	2.6	2.9							
02400023	3.1	3.5							
02400032	4.7	5.1						10	
02400041	5.8	6.2			10				
03400056	8.3	8.7	13		10	gG		10	CC or J
03400073	10.2	12.2	18		16			16	
03400094	13.1	14.8	20.7					20	
04400135	14.0	16.3			20	gG		20	CC or J
04400170	18.5	20.7			25			25	
05400270	26	29	52	40	40	gG	35	35	CC or J
05400300	27	30	58						
06400350	32	36	67	63	63	gG	40	60	CC or J
06400420	41	46	80				50		
06400470	54	60	90				60		
07400660	67	74	124	100	100	gG	80	80	CC or J
07400770	80	88	145				100	100	
07401000	96	105	188	125	125		125	125	
08401340	137	155	267	250	250	gR	225	225	HSJ
08401570	164	177	303						

Table 4-9 AC Input current and fuse ratings (575 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
05500030	4	4	7	10	20	gG	10	10	CC or J
05500040	6	7	9					10	
05500069	9	11	15	20			20	20	
06500100	12	13	22	20	40	gG	20	30	CC or J
06500150	17	19	33	32			25		
06500190	22	24	41	40			30		
06500230	26	29	50	50	63		35	50	
06500290	33	37	63				40		
06500350	41	47	76	63			50		
07500440	41	45	75	50	50	gG	50	50	CC or J
07500550	57	62	94	80	80		80	80	
08500630	74	83	121	125	125	gR	100	100	HSJ
08500860	92	104	165	160	160		150	150	

Table 4-10 AC Input current and fuse ratings (690 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
07600190	18	20	32	25	50	gG	25	50	CC or J
07600240	23	26	41	32			30		
07600290	28	31	49	40			35		
07600380	36	39	65	50	80		50	80	
07600440	40	44	75						
07600540	57	62	92	80			80		
08600630	74	83	121	125	125	gR	100	100	HSJ
08600860	92	104	165	160	160		150	150	

NOTE

Ensure cables used suit local wiring regulations.

CAUTION

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

Table 4-11 Cable ratings (100 V)

Model	Cable size (IEC 60364-5-52) mm²				Cable size (UL508C) AWG			
	Input		Output		Input		Output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
01100017	1	6	1	2.5	16	10	16	12
01100024	1.5		1		14			
02100042	2.5	6	1	2.5	12	10	16	12
02100056	4		1		10			

Table 4-12 Cable ratings (200 V)

Model	Cable size (IEC 60364-5-52) mm²				Cable size (UL508C) AWG			
	Input		Output		Input		Output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
01200017	1	6	1	2.5	16	10	16	12
01200024								
01200033								
01200042								
02200024	1	6	1	2.5	16	10	16	12
02200033								
02200042								
02200056	2.5/1.5				12/14			
02200075	2.5				12			
03200100	4	6	1.5	2.5	10/12	10	14	12
04200133	4/2.5	6	2.5	2.5	10	10	12	12
04200176	4							
05200250	10	10	10	10	8	8	8	8
06200330	16	25	16	25	4	3	4	3
06200440	25		25		3		3	
07200610	35	70	35	70	2	1/0	2	1/0
07200750					1		1	
07200830	70		70		1/0		1/0	
08201160	95	2 x 70	95	2 x 70	3/0	2 x 1	3/0	2 x 1
08201320	2 x 70		2 x 70		2 x 1		2 x 1	

Table 4-13 Cable ratings (400 V)

Model	Cable size (IEC 60364-5-52) mm²				Cable size (UL508C) AWG			
	Input		Output		Input		Output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
02400013	1	6	1	2.5	16	10	16	12
02400018								
02400023								
02400032								
02400041								
03400056	1	6	1	2.5	14	10	16	12
03400073	1.5				12			
03400094	2.5		1.5				14	
04400135	2.5	6	2.5	2.5	10	10	12	12
04400170	4							
05400270	6	6	6	6	8	8	8	8
05400300								
06400350	10	25	10	25	6	3	6	3
06400420	16		16		4		4	
06400470	25		25		3		3	
07400660	35	70	35	70	1	1/0	1	1/0
07400770	50		50		2		2	
07401000	70		70		1/0		1/0	
08401340	2 x 50	2 x 70	2 x 50	2 x 70	2 x 1	2 x 1/0	2 x 1	2 x 1/0
08401570	2 x 70		2 x 70		2 x 1/0		2 x 1/0	

Table 4-14 Cable ratings (575 V)

Model	Cable size (IEC 60364-5-52) mm²				Cable size (UL508C) AWG			
	Input		Output		Input		Output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
05500030	0.75	1.5	0.75	1.5	16	16	16	16
05500040	1		1		14		14	
05500069	1.5		1.5					
06500100	2.5	25	2.5	25	14	3	14	3
06500150	4		4		10		10	
06500190	6		6					
06500230	10		10		8		8	
06500290					6		6	
06500350	16							
07500440	16	25	16	25	4	3	4	3
07500550	25		25		3		3	
08500630	35	50	35	50	1	1	1	1
08500860	50		50					

Table 4-15 Cable ratings (690 V)

Model	Cable size (IEC 60364-5-52) mm²				Cable size (UL508C) AWG			
	Input		Output		Input		Output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
07600190	10	25	10	25	8	3	8	3
07600240					6		6	
07600290								
07600380	16		16		4		4	
07600440								
07600540	25		25		3		3	
08600630	50	70	50	70	2	1/0	2	1/0
08600860	70		70		1/0		1/0	

NOTE

PVC insulated cable should be used.

NOTE

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

Installation class (ref: IEC60364-5-52:2001)

B1 - Separate cables in conduit.

B2 - Multicore cable in conduit.

C - Multicore cable in free air.

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

NOTE

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

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

Fuse types

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

MCB

Do not use an MCB instead of the recommended fuses.

Ground connections

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

NOTE

For information on ground cable sizes, refer to Table 4-1 *Protective ground cable ratings* on page 58.

4.4.1 Main AC supply contactor

The recommended AC supply contactor type for size 1 to 8 is AC1.

4.5 Output circuit and motor protection

The output circuit has fast-acting electronic short-circuit protection which limits the fault current to typically no more than 2.5 times the rated output current, and interrupts the current in approximately 20 µs. No additional short-circuit protection devices are required.

The drive provides overload protection for the motor and its cable. For this to be effective, *Rated Current* (**00.006**) must be set to suit the motor.

WARNING

Motor Rated Current (**00.006**) must be set correctly to avoid a risk of fire in the event of motor overload.

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

4.5.1 Cable types and lengths

Since capacitance in the motor cable causes loading on the output of the drive, ensure the cable length does not exceed the values given in Table 4-16 to Table 4-20

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

- AC supply to external EMC filter (when used)
- AC supply (or external EMC filter) to drive
- Drive to motor
- Drive to braking resistor

Table 4-16 Maximum motor cable lengths (100 V drives)

Model	100 V Nominal AC supply voltage								
	Maximum permissible motor cable length for each of the following switching frequencies								
	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
01100017	50 m				37.5 m	25 m	18.75 m	12.5 m	9 m
01100024									
02100042	100 m				75 m	50 m	37.5 m	25 m	18 m
02100056									

Table 4-17 Maximum motor cable lengths (200 V drives)

Model	200 V Nominal AC supply voltage								
	Maximum permissible motor cable length for each of the following switching frequencies								
	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
01200017	50 m (165 ft)				37.5 m (122 ft)	25 m (82.5 ft)	18.75 m (61 ft)	12.5 m (41 ft)	9 m (30 ft)
01200024									
01200033									
01200042									
02200024	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18 m (60 ft)
02200033									
02200042									
02200056									
02200075									
03200100	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18 m (60 ft)
04200133	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18 m (60 ft)
04200176									
05200250			200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
06200330			300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06200440									
07200610			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
07200750									
07200830									
08201160			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
08201320									

Table 4-18 Maximum motor cable lengths (400 V drives)

Model	400 V Nominal AC supply voltage								
	Maximum permissible motor cable length for each of the following switching frequencies								
	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
02400013	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18.25 m (60 ft)
02400018									
02400023									
02400032									
02400041									
03400056	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18.25 m (60 ft)
03400073									
03400094									
04400135	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18.25 m (60 ft)
04400170									
05400270			200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
05400300									
06400350			300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06400420									
06400470									
07400660			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
07400770									
07401000									
08401340			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
08401570									

Table 4-19 Maximum motor cable lengths (575 V drives)

Model	575 V Nominal AC supply voltage								
	Maximum permissible motor cable length for each of the following switching frequencies								
	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
05500030			200 m (660 ft)						
05500040									
05500069									
06500100			300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06500150									
06500190									
06500230									
06500290									
06500350									
07500440			250 m (820 ft)						
07500550									
08500630			250 m (820 ft)						
08500860									

Table 4-20 Maximum motor cable lengths (690 V drives)

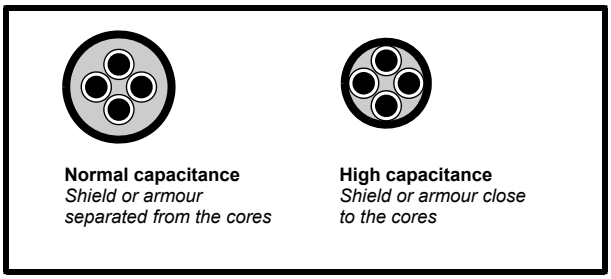
Model	690 V Nominal AC supply voltage								
	Maximum permissible motor cable length for each of the following switching frequencies								
	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
07600190			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
07600240									
07600290									
07600380									
07600440									
07600540									
08600630			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
08600860									

4.5.2 High-capacitance / reduced diameter cables

The maximum cable length is reduced from that shown in section 4.5.1 *Cable types and lengths* on page 68, if high capacitance or reduced diameter motor cables are used.

Most cables have an insulating jacket between the cores and the armor or shield; these cables have a low capacitance and are recommended. Cables that do not have an insulating jacket tend to have high capacitance; if a cable of this type is used, the maximum cable length is half that quoted in the tables, (Figure 4-15 shows how to identify the two types).

Figure 4-15 Cable construction influencing the capacitance



The maximum motor cable lengths specified in section 4.5.1 *Cable types and lengths* on page 68 is shielded and contains four cores. Typical capacitance for this type of cable is 130 pF/m (i.e. from one core to all others and the shield connected together).

4.5.3 Motor winding voltage

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

For normal operation with AC supplies up to 500 Vac and a standard motor with a good quality insulation system, there is no need for any special precautions. In case of doubt the motor supplier should be consulted. Special precautions are recommended under the following conditions, but only if the motor cable length exceeds 10 m:

- AC supply voltage exceeds 500 V
- DC supply voltage exceeds 670 V
- Operation of 400 V drive with continuous or very frequent sustained braking
- Multiple motors connected to a single drive

For multiple motors, the precautions given in section 4.5.4 *Multiple motors* on page 70 should be followed.

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

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

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

4.5.4 Multiple motors

Open-loop only

If the drive is to control more than one motor, one of the fixed V/F modes should be selected (Pr **05.014** = Fixed or Squared). Make the motor connections as shown in Figure 4-16 and Figure 4-17. The maximum cable lengths in Table 4-16 to Table 4-20 apply to the sum of the total cable lengths from the drive to each motor.

It is recommended that each motor is connected through a protection relay since the drive cannot protect each motor individually. For 人 connection, a sinusoidal filter or an output inductor must be connected as shown in Figure 4-17, even when the cable lengths are less than the maximum permissible. For details of inductor sizes refer to the supplier of the drive.

Figure 4-16 Preferred chain connection for multiple motors

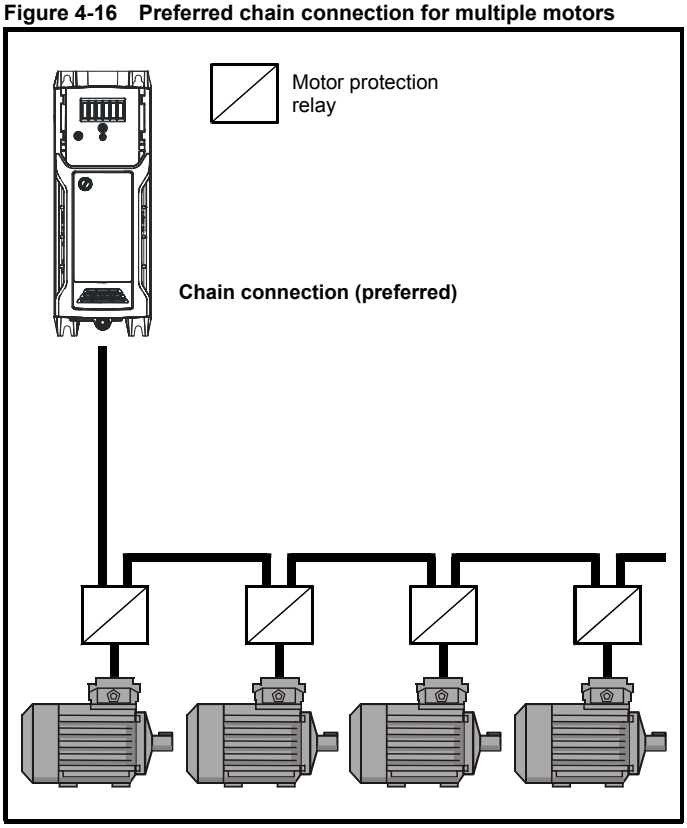
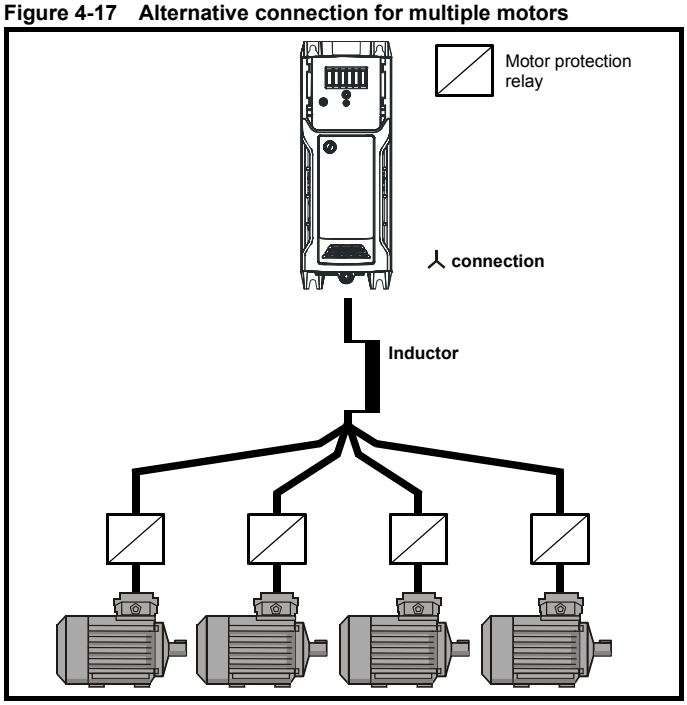


Figure 4-17 Alternative connection for multiple motors



4.5.5 ⅄ / Δ motor operation

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

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

400 V drive 400 V rated voltage
230 V drive 230 V rated voltage

A typical 3 phase motor would be connected in ⅄ for 400 V operation or Δ for 230 V operation, however, variations on this are common e.g. ⅄ 690 V Δ 400 V.

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

4.5.6 Output contactor

WARNING

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

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

The recommended motor contactor is the AC3 type.

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

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

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

The Drive Enable terminal (T31 and T34 frames 1 to 4), (T31 and 35 frames 5 to 6) when opened provides a SAFE TORQUE OFF function. This can in many cases replace output contactors.

For further information see section 4.11 *SAFE TORQUE OFF (STO)* on page 86.

4.6 Braking

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

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

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

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

Table 4-21 shows the default DC voltage level at which the drive turns on the braking transistor. However the braking resistor turn on and the turn off voltages are programmable with *Braking IGBT Lower Threshold* (06.073) and *Braking IGBT Upper Threshold* (06.074).

Table 4-21 Default braking transistor turn on voltage

Drive voltage rating	DC bus voltage level
100 & 200 V	390 V
400 V	780 V
575 V	930 V
690 V	1120 V

NOTE

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

WARNING

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

CAUTION

Braking resistor overload protection parameter settings
Failure to observe the following information may damage the resistor.
The drive software contains an overload protection function for a braking resistor.
For more information on the braking resistor software overload protection, see Pr **10.030,** Pr **10.031** and Pr **10.061** full descriptions in the *Parameter Reference Guide*.

4.6.1 External braking resistor

WARNING

Overload protection
When an external braking resistor is used, it is essential that an overload protection device is incorporated in the braking resistor circuit; this is described in *Figure 4-18 on page 73.*

When a braking resistor is to be mounted outside the enclosure, ensure that it is mounted in a ventilated metal housing that will perform the following functions:

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

When compliance with EMC emission standards is required, external connection requires the cable to be armored or shielded, since it is not fully contained in a metal enclosure. See section 4.8.5 *Compliance with generic emission standards* on page 79 for further details.

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

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

Table 4-22 Braking resistor resistance and power rating (100 V)

Model	Minimum resistance* Ω	Instantaneous power rating kW	Continuous power rating kW
01100017	130	1.2	
01100024			
02100042	68	2.2	
02100056			

Table 4-23 Braking resistor resistance and power rating (200 V)

Model	Minimum resistance* Ω	Instantaneous power rating kW	Continuous power rating kW
01200017	130	1.2	
01200024			
01200033			
01200042			
02200024	68	2.2	
02200033			
02200042			
02200056			
02200075			
03200100	45	3.4	2.2
04200133	22	6.9	
04200176			
05200250	16.5	10.3	8.6
06200330	8.6	19.7	12.6
06200440			16.4
07200610	6.1	27.8	20.5
07200750			24.4
07200830	4.5	37.6	32.5
08201160	2.2	76.9	41
08201320			47.8

Table 4-24 Braking resistor resistance and power rating (400 V)

Model	Minimum resistance* Ω	Instantaneous power rating kW	Continuous power rating kW
02400013	270	2.3	
02400018			
02400023			
02400032			
02400041			
03400056	100	6.1	2.2
03400073			3
03400094			4
04400135	50	12.2	
04400170			
05400270	31.5	21.5	16.2
05400300	18	37.5	19.6
06400350	17	39.8	21.6
06400420			25
06400470			32.7
07400660	9.0	75.2	41.6
07400770			50.6
07401000	7.0	96.6	60.1
08401340	4.8	140.9	81
08401570			98.6

Table 4-25 Braking resistor resistance and power rating (575 V)

Model	Minimum resistance* Ω	Instantaneous power rating kW	Continuous power rating kW
05500030	80	12.1	2.6
05500040			4.6
05500069			6.5
06500100	13	74	8.7
06500150			12.3
06500190			16.3
06500230			19.9
06500290			24.2
06500350			31.7
07500440	8.5	113.1	39.5
07500550			47.1
08500630	5.5	174.8	58.6
08500860			78.1

Table 4-26 Braking resistor resistance and power rating (690 V)

Model	Minimum resistance* Ω	Instantaneous power rating kW	Continuous power rating kW
07600190	11.5	121.2	20.6
07600240			23.9
07600290			32.5
07600380			41.5
07600440			47.8
07600540			60.5
08600630	5.5	253.5	79.7
08600860			95.2

* Resistor tolerance: ±10 %

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

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

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

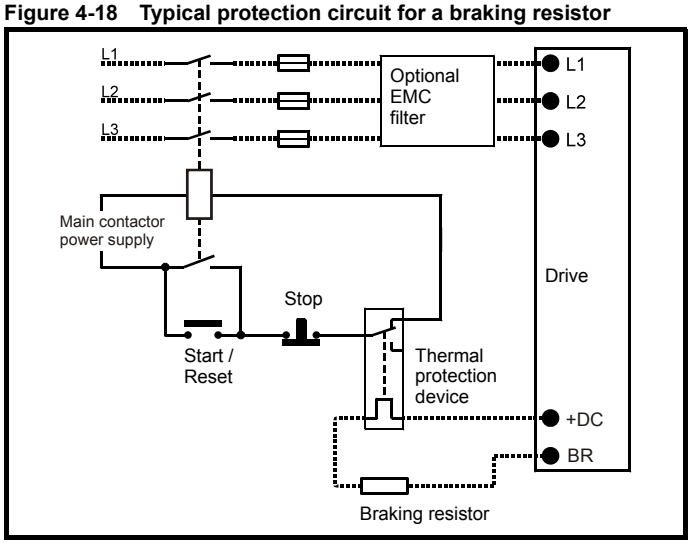
Optimization of the braking resistor requires careful consideration of the braking duty.

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

Thermal protection circuit for the braking resistor

The thermal protection circuit must disconnect the AC supply from the drive if the resistor becomes overloaded due to a fault. Figure 4-18 shows a typical circuit arrangement.

Figure 4-18 Typical protection circuit for a braking resistor



See Figure 4-1 on page 54 and Figure 4-4 on page 55 for the location of the +DC and braking resistor connections.

4.6.2 Braking resistor software overload protection

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

- *Braking Resistor Rated Power* (10.030)
- *Braking Resistor Thermal Time Constant* (10.031)
- *Braking Resistor Resistance* (10.061)

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

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

If Pr **10.037** is equal to 2 or 3, a Brake R Too Hot trip will not occur when Pr **10.039** reaches 100 %, but instead the braking IGBT will be disabled until Pr **10.039** falls below 95 %. This option is intended for applications with parallel connected DC buses where there are several braking resistors, each of which cannot withstand full DC bus voltage continuously. With this type of application it is unlikely the braking energy will be shared equally between the resistors because of voltage measurement tolerances within the individual drives. Therefore with Pr **10.037** set to 2 or 3, then as soon as a resistor has reached its maximum temperature the drive will disable the braking IGBT, and another resistor on another drive will take up the braking energy. Once Pr **10.039** has fallen below 95 % the drive will allow the braking IGBT to operate again.

See the *Parameter Reference Guide* for more information on Pr **10.030**, Pr **10.031**, Pr **10.037** and Pr **10.039**.

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

4.7 Ground leakage

The ground leakage current depends upon whether the internal EMC filter is installed or not. The drive is supplied with the filter installed. Instructions for removing the internal filter are given in section 4.8.2 *Internal EMC filter* on page 76.

With internal filter installed:

Size 1:

2.5 mA* AC at 230 V 50 Hz (line to line supply, star point ground)
9.2 mA* AC at 230 V 50 Hz (line to neutral supply, star point ground)

Size 2:

9.36 mA* AC at 110 V, 50 Hz (2 phase, line to line supply, star point ground)
16.4 mA* AC at 110 V, 50 Hz (1 phase, line to neutral supply, star point ground)
5.3 mA* AC at 230 V, 50 Hz (3 phase supply, star point ground)
15.4 mA* AC at 230 V, 50 Hz (1 phase, line to neutral supply, star point ground)
9.6 mA* AC at 400 V, 50 Hz (3 phase supply, star point ground)

Size 3:

19.7 mA* AC at 400 V 50 Hz (star point ground)
47.4 mA* AC at 400 V 50 Hz (corner ground)

Size 4:

21 mA* AC at 230 V 50 Hz (3 phase, star point ground)
6.8 mA* AC at 230 V 50 Hz (1 phase, line to line supply, star point ground)
30 mA* AC at 230 V 50 Hz (1 phase, line to neutral supply, star point ground)
50 mA* AC at 400 V 50 Hz (3 phase, star point ground)

*Proportional to the supply voltage and frequency.

With internal filter removed:

Size 1: <1.5 mA (line to line supply, star point ground)
<1 mA (line to neutral supply, star point ground)

Size 2: <1.7 mA (line to line supply, star point ground)
<1.9 mA (line to neutral supply, star point ground)

Size 3: <3.3 mA (star point ground)
<4.9 mA (corner ground)

Size 4: < 3.5 mA (star point ground)

NOTE

The above leakage currents are just the leakage currents of the drive with the internal EMC filter connected and do not take into account any leakage currents of the motor or motor cable.

WARNING

When the internal filter is installed the leakage current is high. In this case a permanent fixed ground connection must be provided, or other suitable measures taken to prevent a safety hazard occurring if the connection is lost.

WARNING

When the leakage current exceeds 3.5 mA, a permanent fixed ground connection must be provided using two independent conductors each with a cross-section equal to or exceeding that of the supply conductors. The drive is provided with two ground connections to facilitate this. Both ground connections are necessary to meet EN 61800-5-1: 2007.

4.7.1 Use of residual current device (RCD)

There are three common types of ELCB / RCD:

1. AC - detects AC fault currents
2. A - detects AC and pulsating DC fault currents (provided the DC current reaches zero at least once every half cycle)
3. B - detects AC, pulsating DC and smooth DC fault currents
   - Type AC should never be used with drives.
   - Type A can only be used with single phase drives
   - Type B must be used with three phase drives

WARNING

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

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

4.8 EMC (Electromagnetic compatibility)

The requirements for EMC are divided into three levels in the following three sections:

Section 4.10.3, General requirements for all applications, to ensure reliable operation of the drive and minimise the risk of disturbing nearby equipment. The immunity standards specified in Chapter 12 *Technical data* on page 183 will be met, but no specific emission standards are applied. Note also the special requirements given in *Surge immunity of control circuits - long cables and connections outside a building* on page 82 for increased surge immunity of control circuits where control wiring is extended.

Section 4.8.4, Requirements for meeting the EMC standard for power drive systems, IEC61800-3 (EN 61800-3:2004).

Section 4.8.5, Requirements for meeting the generic emission standards for the industrial environment, IEC61000-6-4, EN 61000-6-4:2007.

The recommendations of section 4.8.3 will usually be sufficient to avoid causing disturbance to adjacent equipment of industrial quality. If particularly sensitive equipment is to be used nearby, or in a non-industrial environment, then the recommendations of section 4.8.4 *Compliance with EN 61800-3:2004 (standard for Power Drive Systems)* on page 79 or section 4.8.5 *Compliance with generic emission standards* on page 79 should be followed to give reduced radio-frequency emission.

In order to ensure the installation meets the various emission standards described in:

- The EMC data sheet available from the supplier of the drive
- The Declaration of Conformity at the front of this manual
- Chapter 12 *Technical data* on page 183

The correct external EMC filter must be used and all of the guidelines in section 4.8.3 *General requirements for EMC* on page 78 and section 4.8.5 *Compliance with generic emission standards* on page 79 must be followed.

Table 4-27 Drive and EMC filter cross reference

Model	CT part number
200 V	
05200250	4200-0312
06200330 to 06200440	4200-2300
07200610 to 07200830	4200-1132
08201160 to 08201320	4200-1672
400 V	
05400270 to 05400300	4200-0402
06400350 to 06400470	4200-4800
07400660 to 07401000	4200-1132
08401340 to 08401570	4200-1972
575 V	
05500030 to 05500069	4200-0122
06500100 to 06500350	4200-3690
07500440 to 07500550	4200-0672
08500630 to 08500860	4200-1662
690 V	
07600190 to 07600540	4200-0672
08600630 to 08600860	4200-1662

WARNING

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

NOTE

The installer of the drive is responsible for ensuring compliance with the EMC regulations that apply in the country in which the drive is to be used.

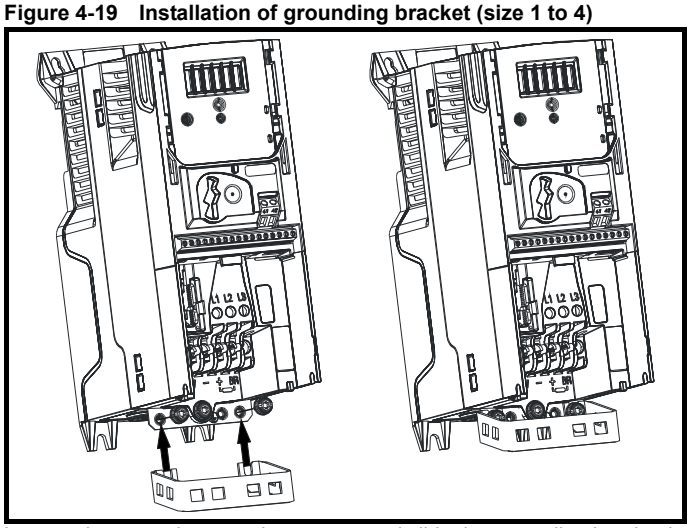
4.8.1 Grounding hardware

The drive is supplied with a grounding bracket / clamp to facilitate EMC compliance. This provides a convenient method for direct grounding of cable shields without the use of "pig-tails". Cable shields can be bared and clamped to the grounding bracket using metal clips or clamps[1] (not supplied) or cable ties. Note that the shield must in all cases be continued through the clamp to the intended terminal on the drive, in accordance with the connection details for the specific signal.

[1] A suitable clamp is the Phoenix DIN rail mounted SK14 cable clamp (for cables with a maximum outer diameter of 14 mm).

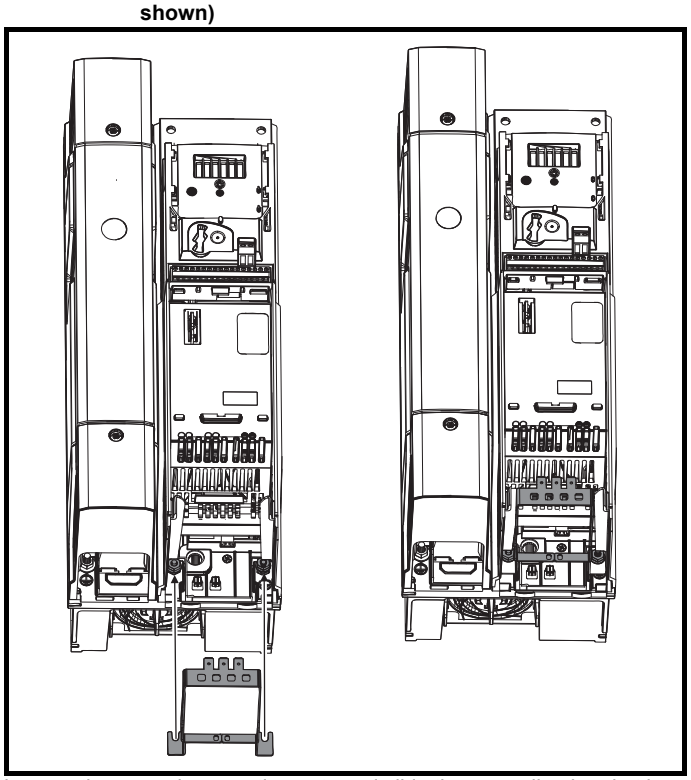
See Figure 4-19 for details regarding the installation of the grounding bracket.

Figure 4-19 Installation of grounding bracket (size 1 to 4)



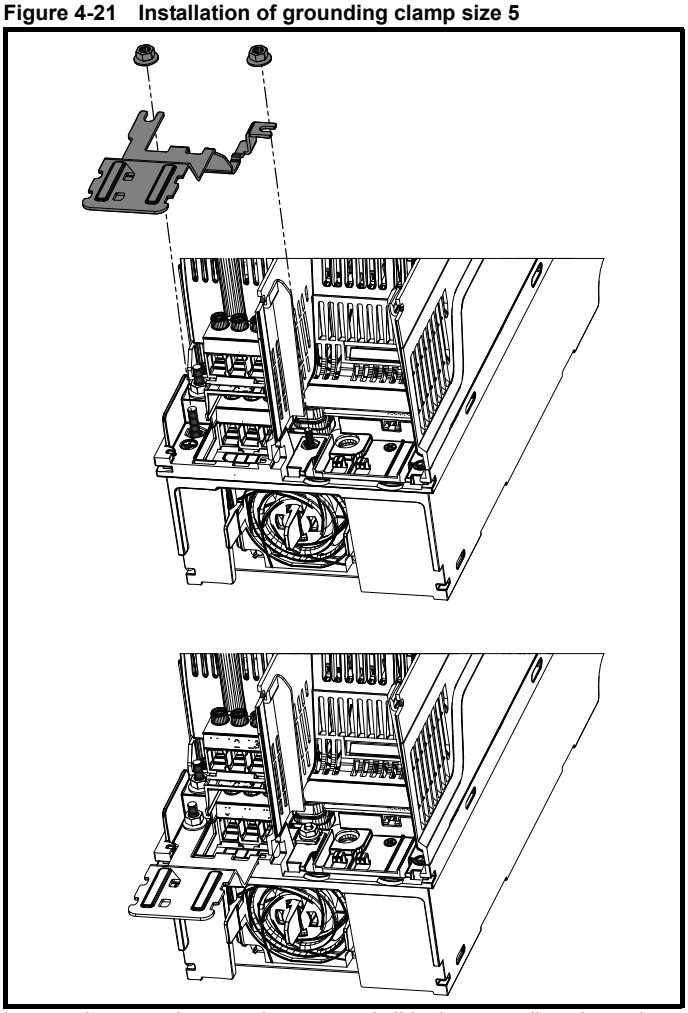
Loosen the ground connection screws and slide the grounding bracket in the direction shown. Once in place, the ground connection screws should be tightened with a maximum torque of 1.5 N m (1.1 lb ft).

Figure 4-20 Installation of grounding bracket (size 5 to 8 - size 5 shown)



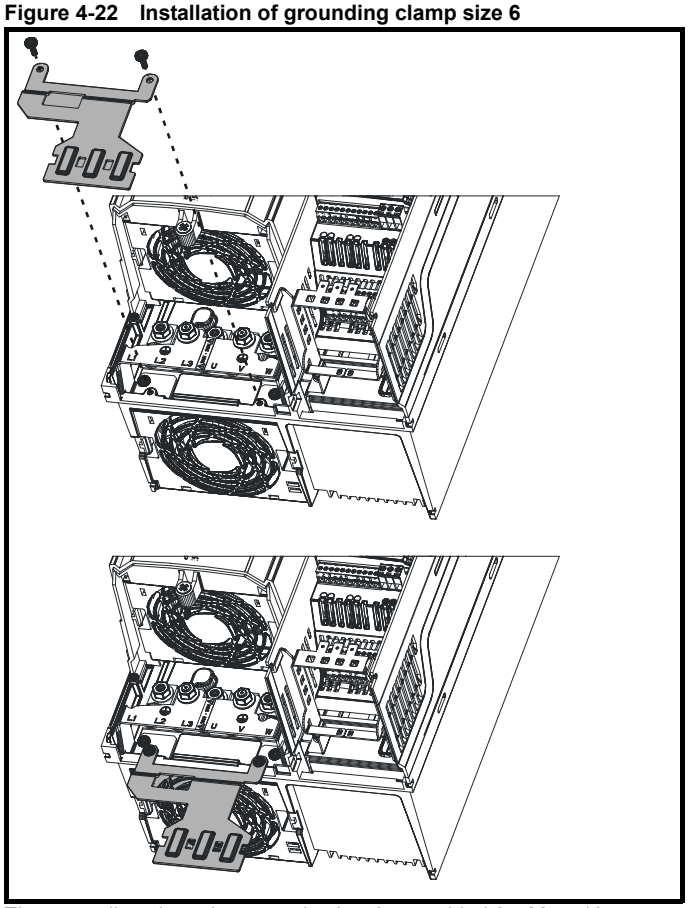
Loosen the ground connection nuts and slide the grounding bracket in the direction shown. Once in place, the ground connection nuts should be tightened with a maximum torque of 2 N m (1.47 lb ft).

Figure 4-21 Installation of grounding clamp size 5



Loosen the ground connection nuts and slide the grounding clamp down onto the pillars in the direction shown. Once in place, the ground connection nuts should be tightened with a maximum torque of 2 N m (1.47 lb ft).

Figure 4-22 Installation of grounding clamp size 6



The grounding clamp is secured using the provided 2 x M4 x 10 mm fasteners. The fasteners should be tightened with the maximum torque of 2 N m (1.47 lb ft).

4.8.2 Internal EMC filter

It is recommended that the internal EMC filter be kept in place unless there is a specific reason for removing it.

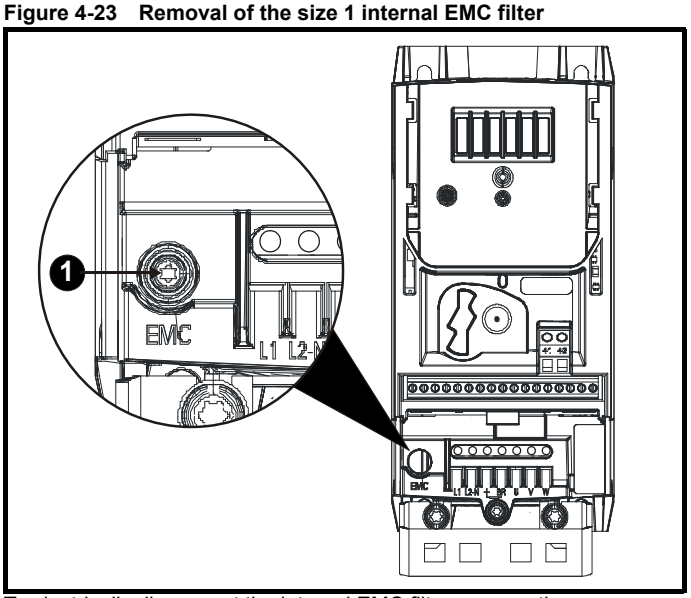
If the drive is used as a motoring drive as part of a regen system, then the internal EMC filter must be removed.

The internal EMC filter reduces radio-frequency emission into the line power supply. Where the motor cable is short, it permits the requirements of EN 61800-3:2004 to be met for the second environment - see section 4.8.4 *Compliance with EN 61800-3:2004 (standard for Power Drive Systems)* on page 79 and section 12.1.26 *Electromagnetic compatibility (EMC)* on page 204. For longer motor cables the filter continues to provide a useful reduction in emission levels, and when used with any length of shielded motor cable up to the limit for the drive, it is unlikely that nearby industrial equipment will be disturbed. It is recommended that the filter be used in all applications unless the instructions given above require it to be removed, or where the ground leakage current of 9.2 mA for size 1 is unacceptable. As shown in Figure 4-23, the size 1 internal EMC filter is removed by removing the screw (1).

WARNING

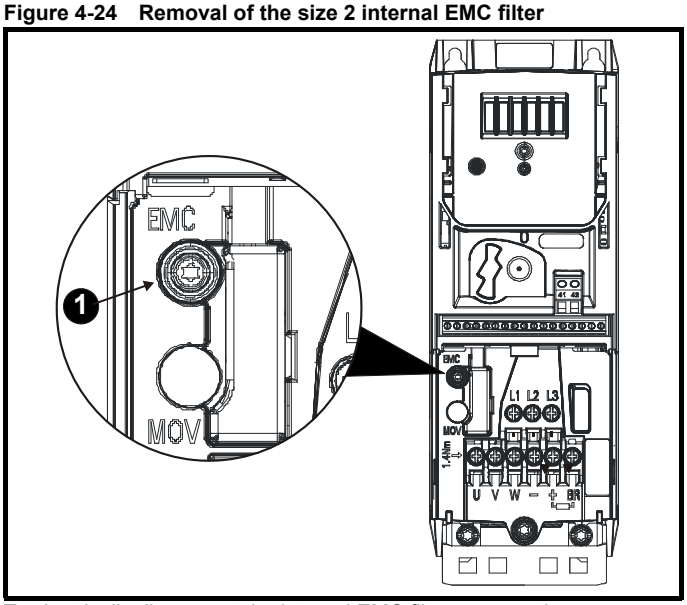
The supply must be disconnected before removing the internal EMC filter.

Figure 4-23 Removal of the size 1 internal EMC filter



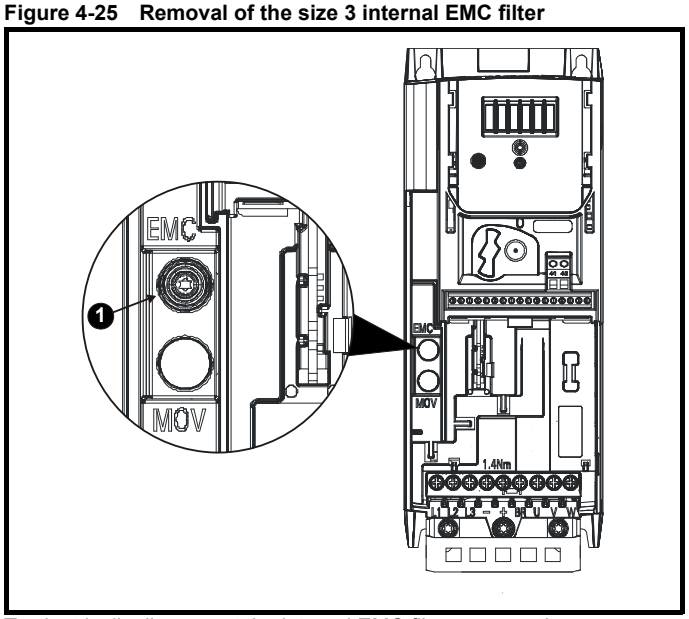
To electrically disconnect the internal EMC filter, remove the screw as shown above (1).

Figure 4-24 Removal of the size 2 internal EMC filter



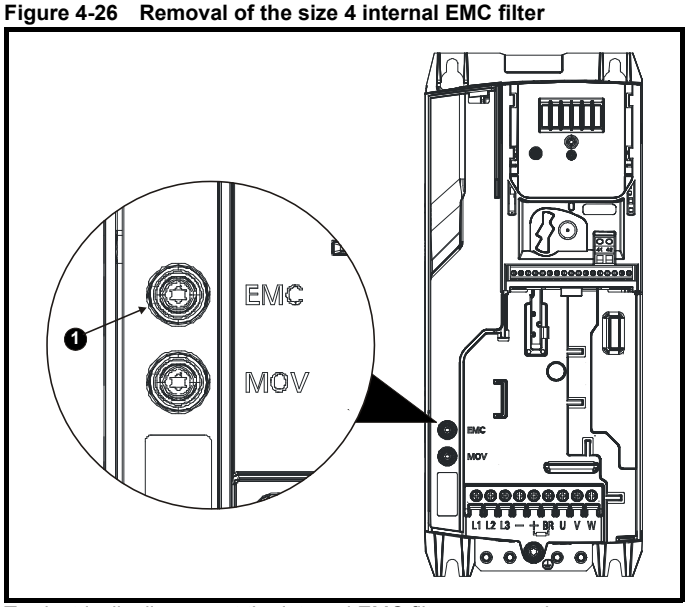
To electrically disconnect the internal EMC filter, remove the screw as shown above (1).

Figure 4-25 Removal of the size 3 internal EMC filter



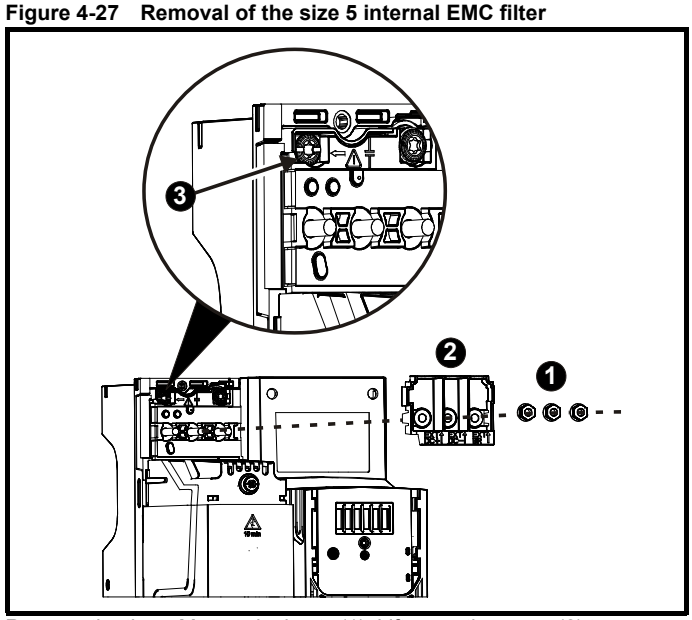
To electrically disconnect the internal EMC filter, remove the screw as shown above (1).

Figure 4-26 Removal of the size 4 internal EMC filter



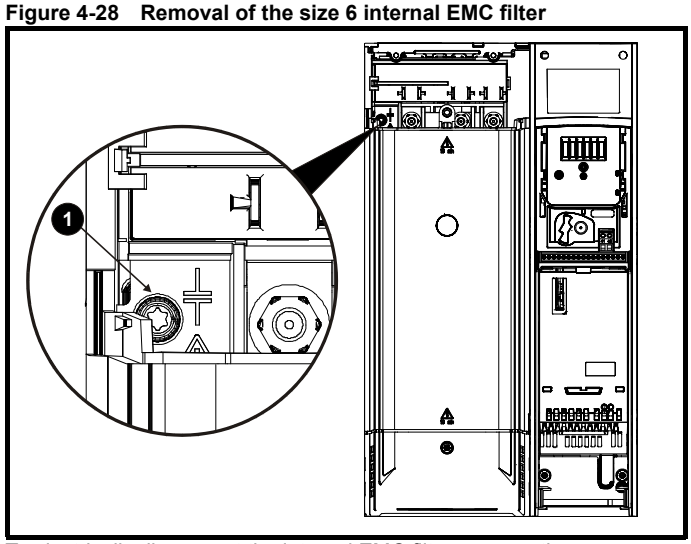
To electrically disconnect the internal EMC filter, remove the screw as shown above (1).

Figure 4-27 Removal of the size 5 internal EMC filter



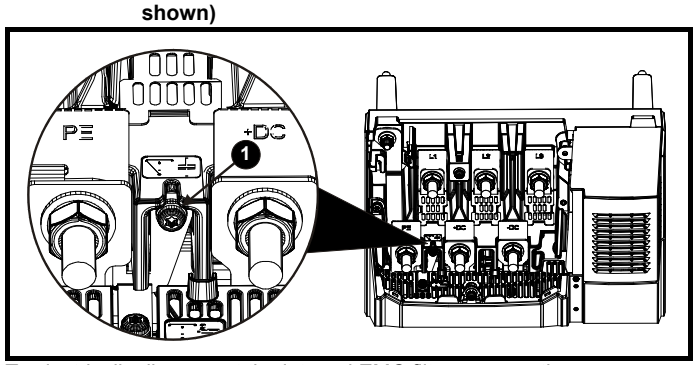
Remove the three M4 terminal nuts (1). Lift away the cover (2) to expose the M4 Torx internal EMC filter removal screw. Finally remove the M4 Torx internal EMC filter removal screw (3) to electrically disconnect the internal EMC filter.

Figure 4-28 Removal of the size 6 internal EMC filter



To electrically disconnect the internal EMC filter, remove the screw as shown above (1).

Figure 4-29 Removal of the size 7 and 8 internal EMC filter (size 7 shown)



To electrically disconnect the internal EMC filter, remove the screw as shown above (1).

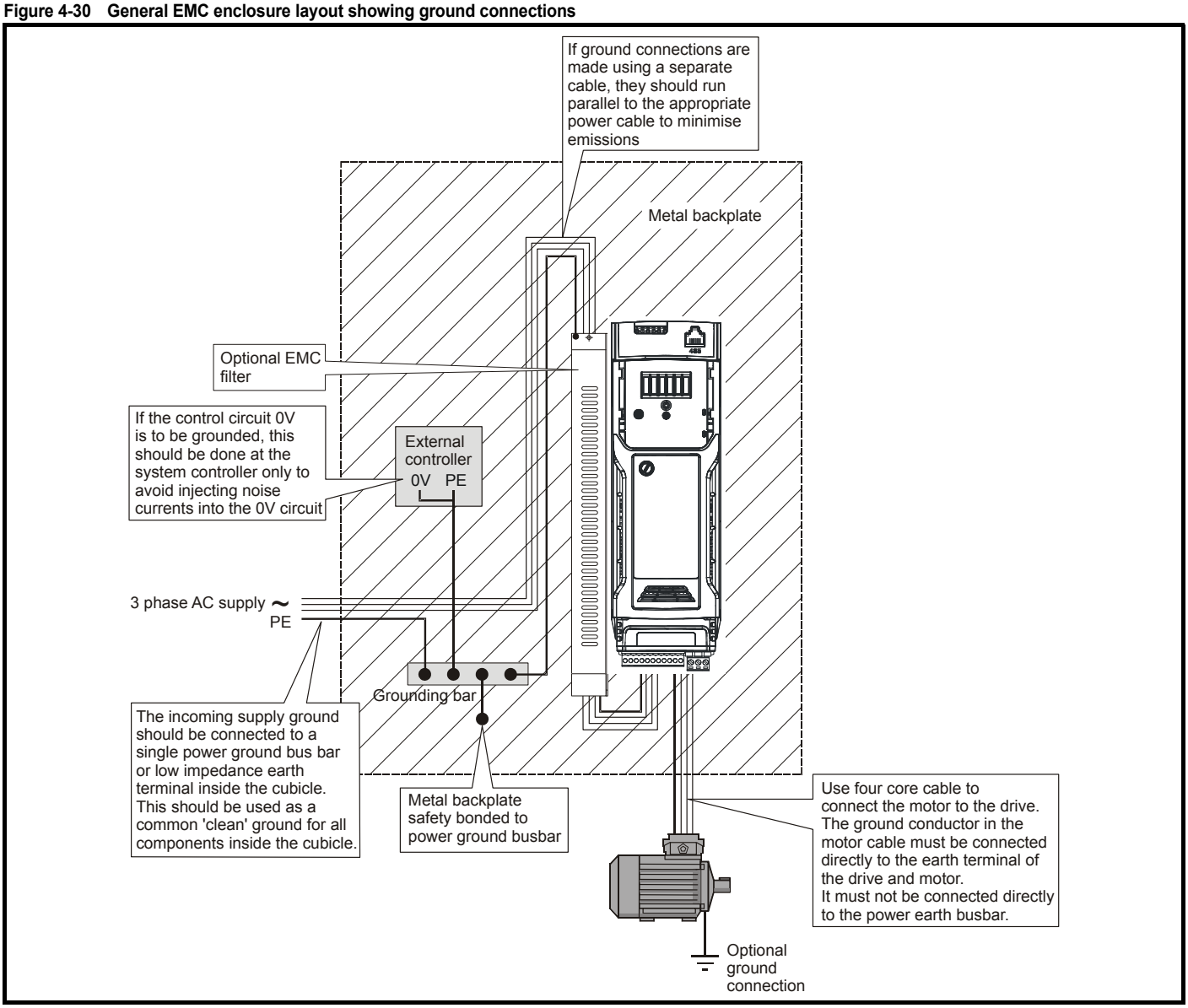
4.8.3 General requirements for EMC

Ground (earth) connections

The grounding arrangements should be in accordance with Figure 4-30, which shows a single drive on a back-plate with or without an additional enclosure.

Figure 4-30 shows how to configure and minimise EMC when using unshielded motor cable. However shielded cable is a better option, in which case it should be installed as shown in section 4.8.5 *Compliance with generic emission standards* on page 79.

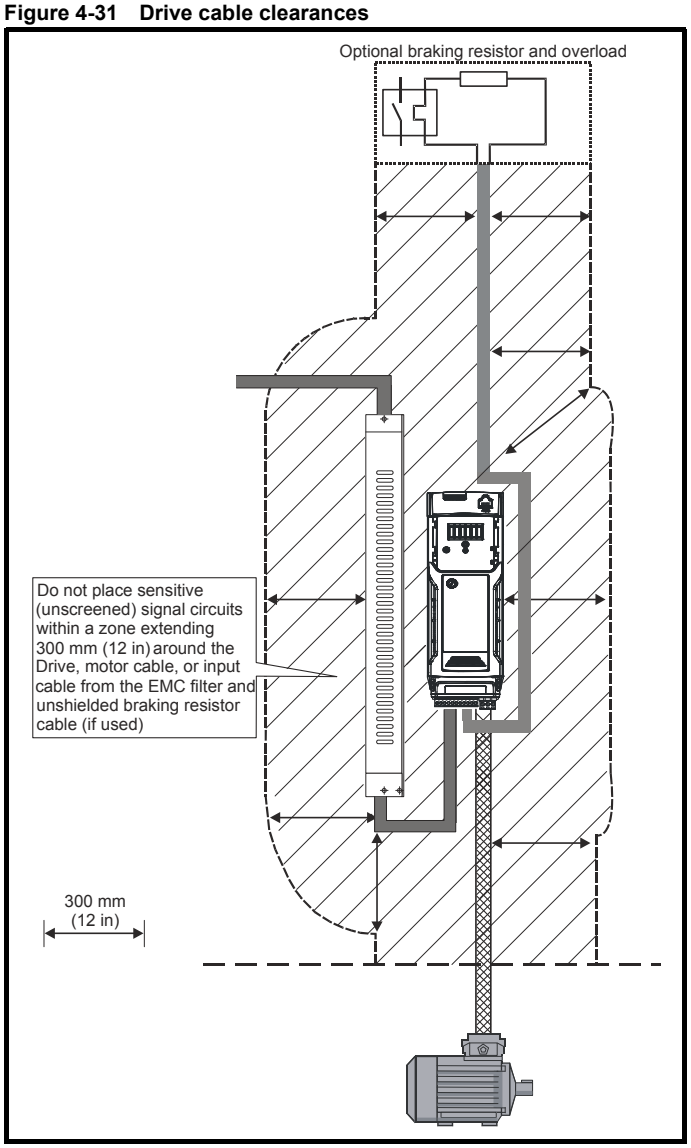
Figure 4-30 General EMC enclosure layout showing ground connections



Cable layout

Figure 4-31 indicates the clearances which should be observed around the drive and related ‘noisy’ power cables by all sensitive control signals / equipment.

Figure 4-31 Drive cable clearances



NOTE

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

4.8.4 Compliance with EN 61800-3:2004 (standard for Power Drive Systems)

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

Operation in the first environment

Observe the guidelines given in section 4.8.5 *Compliance with generic emission standards* on page 79. An external EMC filter will always be required.

CAUTION

This is a product of the restricted distribution class according to IEC 61800-3

In a residential environment this product may cause radio interference in which case the user may be required to take adequate measures.

Operation in the second environment

In all cases a shielded motor cable must be used, and an EMC filter is required for all drives with a rated input current of less than 100 A.

The drive contains an in-built filter for basic emission control. In some cases feeding the motor cables (U, V and W) once through a ferrite ring can maintain compliance for longer cable lengths.

For longer motor cables, an external filter is required. Where a filter is required, follow the guidelines in section 4.8.5 *Compliance with generic emission standards* on page 79.

Where a filter is not required, follow the guidelines given in section 4-27 *Removal of the size 5 internal EMC filter* on page 77.

CAUTION

The second environment typically includes an industrial low-voltage power supply network which does not supply buildings used for residential purposes. Operating the drive in this environment without an external EMC filter may cause interference to nearby electronic equipment whose sensitivity has not been appreciated. The user must take remedial measures if this situation arises. If the consequences of unexpected disturbances are severe, it is recommended that the guidelines in section 4.8.5 *Compliance with generic emission standards* on page 79 be adhered to.

Refer to section 12.1.26 *Electromagnetic compatibility (EMC)* on page 204 for further information on compliance with EMC standards and definitions of environments.

Detailed instructions and EMC information are given in the *EMC Data Sheet* which is available from the supplier of the drive.

4.8.5 Compliance with generic emission standards

The following information applies to frame sizes 1 to 8.

Use the recommended filter and shielded motor cable. Observe the layout rules given in Figure 4-32. Ensure the AC supply and ground cables are at least 100 mm from the power module and motor cable.

Figure 4-32 Supply and ground cable clearance (sizes 1 to 6)

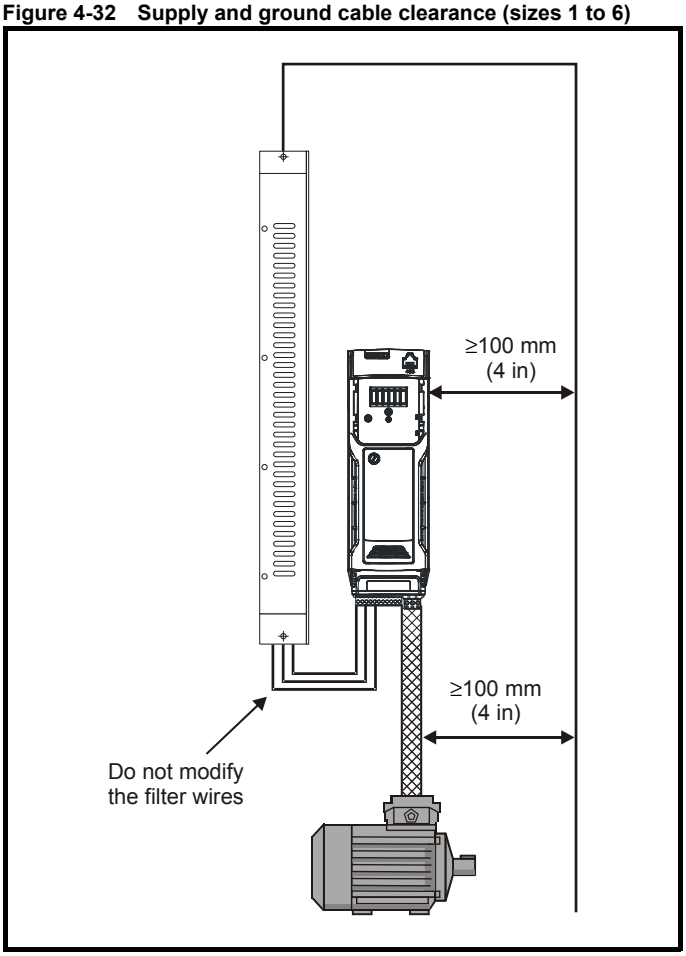
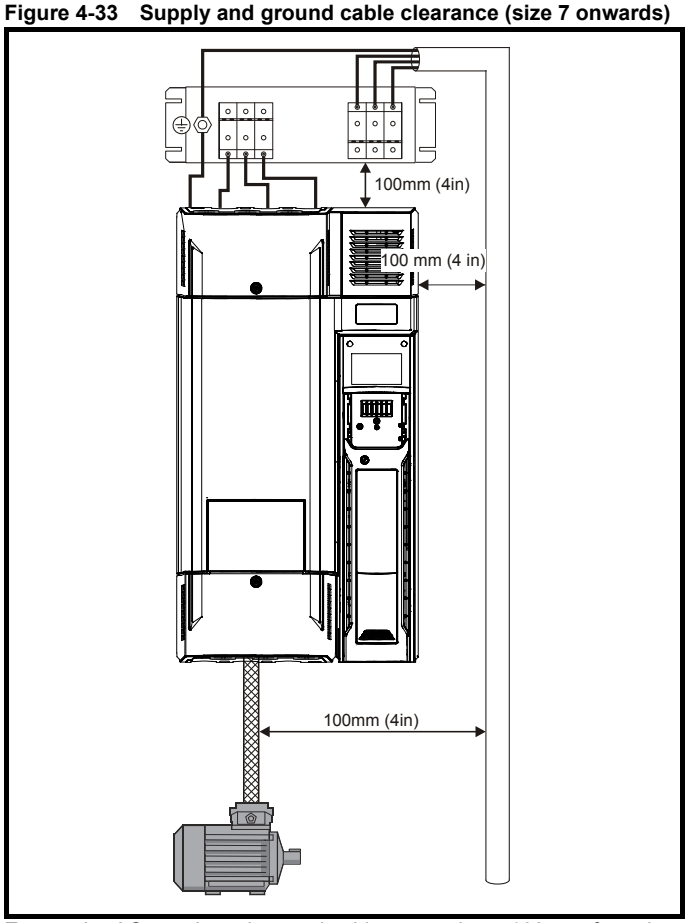


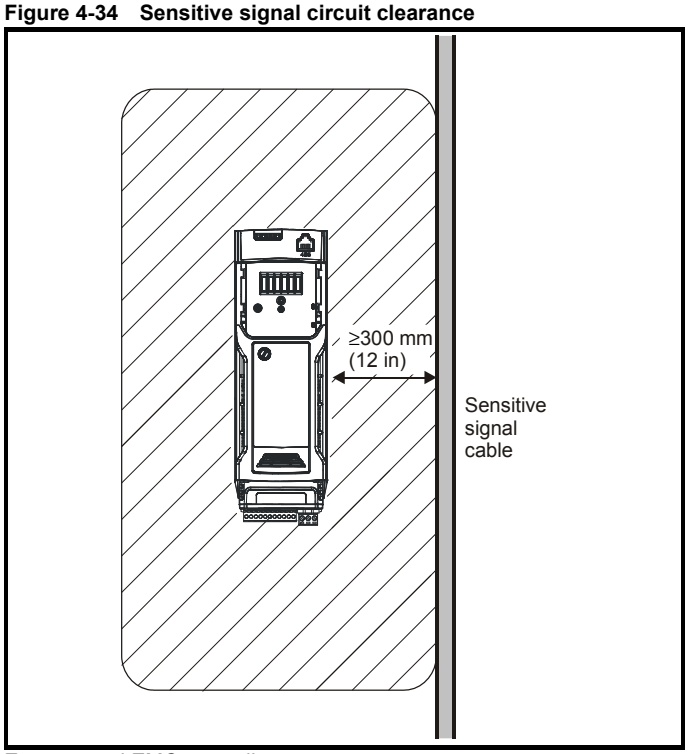
Figure 4-33 Supply and ground cable clearance (size 7 onwards)



Ensure the AC supply and ground cables are at least 100 mm from the power module and motor cable.

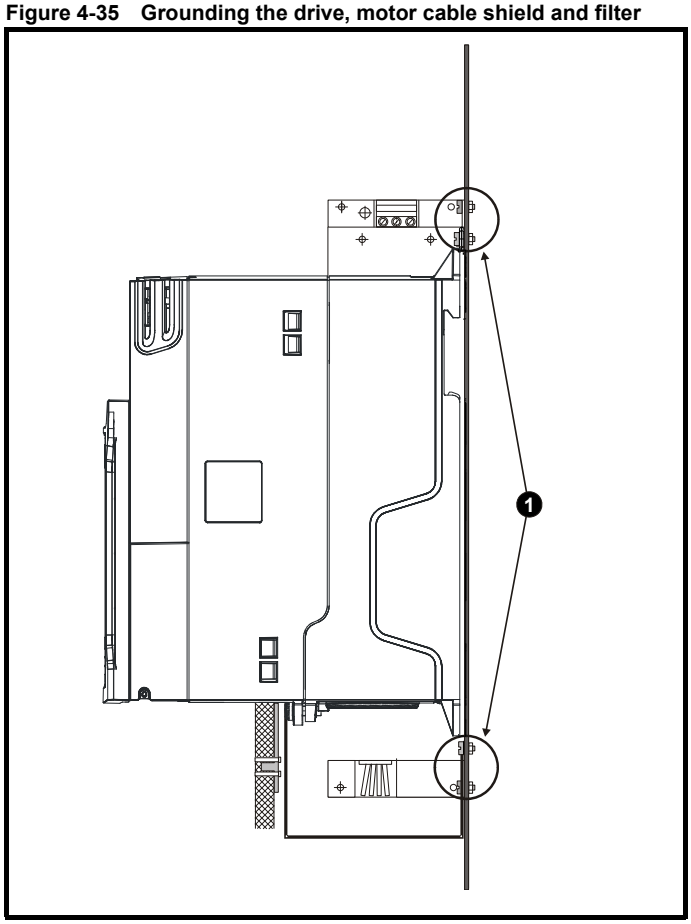
Avoid placing sensitive signal circuits in a zone 300 mm (12 in) in the area immediately surrounding the power module.

Figure 4-34 Sensitive signal circuit clearance



Ensure good EMC grounding.

Figure 4-35 Grounding the drive, motor cable shield and filter



NOTE

1: Ensure direct metal contact at the drive and filter mounting points. Any paint must be removed beforehand.

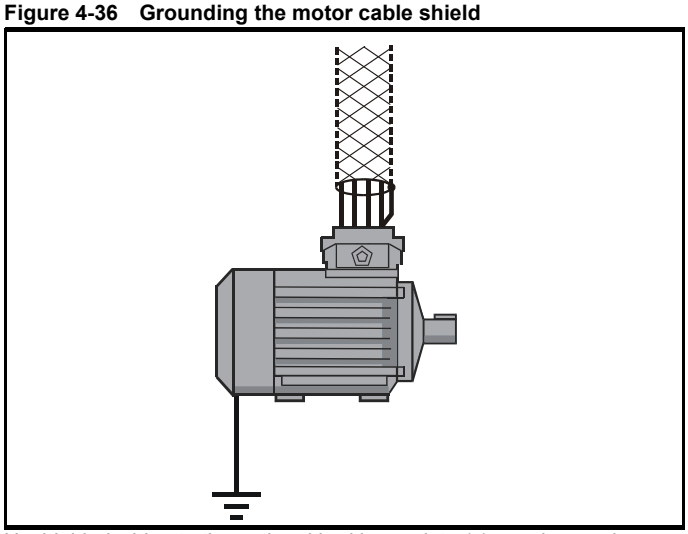
The unbroken motor cable shield (unbroken) electrically connected to and held in place by means of the grounding bracket.

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

A complete 360° termination of the shield to the terminal housing of the motor is beneficial.

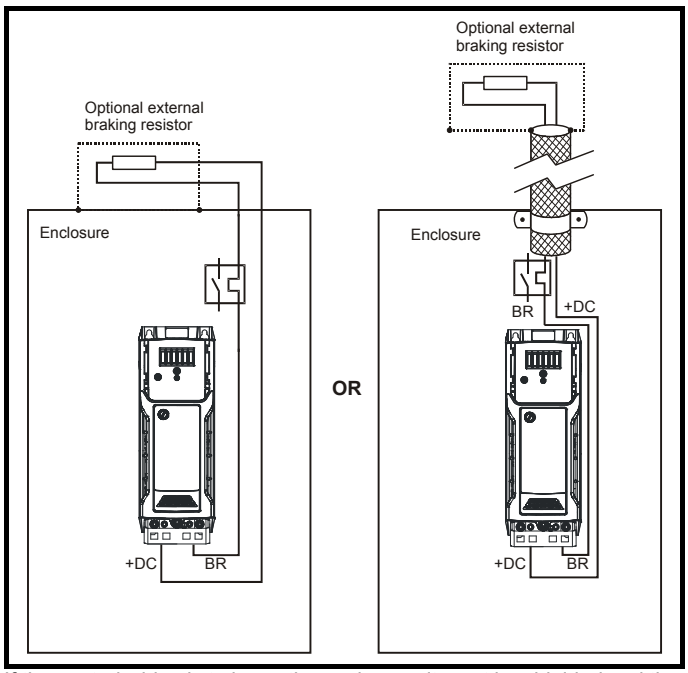
From an EMC consideration it is irrelevant whether the motor cable contains an internal (safety) ground core, or if there is a separate external ground conductor, or where grounding is through the shield alone. An internal ground core will carry a high noise current and therefore it must be terminated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

Figure 4-36 Grounding the motor cable shield



Unshielded wiring to the optional braking resistor(s) may be used provided the wiring runs internally to the enclosure. Ensure a minimum spacing of 300 mm (12 in) from the signal wiring and the AC supply wiring to the external EMC filter. If this condition cannot be met then the wiring must be shielded.

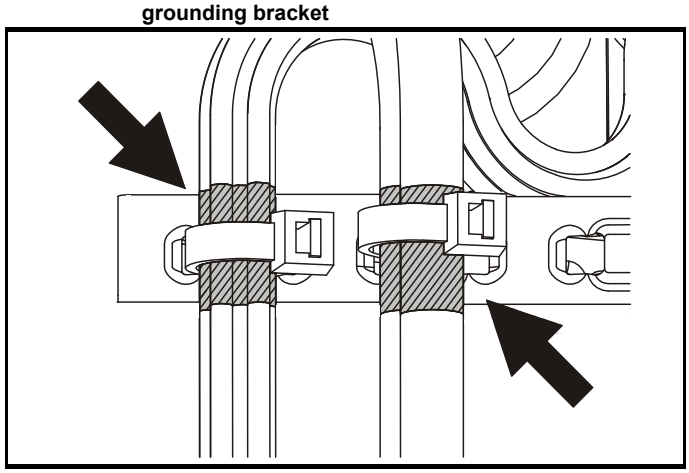
Figure 4-37 Shielding requirements of optional external braking resistor



If the control wiring is to leave the enclosure, it must be shielded and the shield(s) clamped to the drive using the grounding bracket as shown in Figure 4-38. Remove the outer insulating cover of the cable to ensure the shield(s) make direct contact with the bracket, but keep the shield(s) intact until as close as possible to the terminals

Alternatively, wiring may be passed through a ferrite ring, part number 3225-1004.

Figure 4-38 Grounding of signal cable shields using the grounding bracket



4.8.6 Variations in the EMC wiring

Interruptions to the motor cable

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

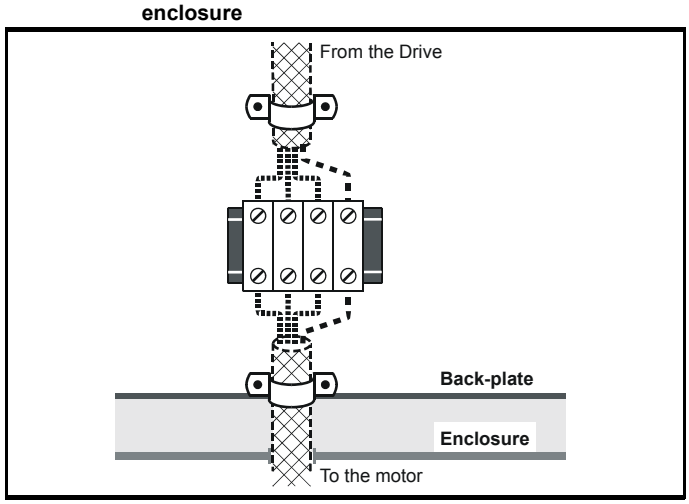
- Connecting the motor cable to a terminal block in the drive enclosure
- Installing a motor isolator / disconnect switch for safety when work is done on the motor

In these cases the following guidelines should be followed.

Terminal block in the enclosure

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

Figure 4-39 Connecting the motor cable to a terminal block in the enclosure



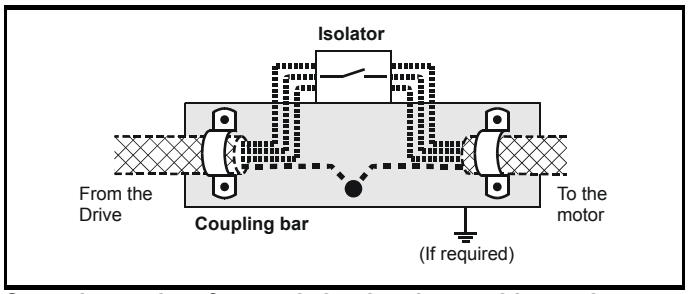
Using a motor isolator / disconnect-switch

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

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

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

Figure 4-40 Connecting the motor cable to an isolator / disconnect switch



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

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

These circuits meet the requirements of EN 61000-6-2:2005 (1 kV surge) provided the 0 V connection is not grounded.

In applications where they may be exposed to high-energy voltage surges, some special measures may be required to prevent malfunction or damage. Surges may be caused by lightning or severe power faults in association with grounding arrangements which permit high transient voltages between nominally grounded points. This is a particular risk where the circuits extend outside the protection of a building.

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

1. Galvanic isolation, i.e. do not connect the control 0 V terminal to ground. Avoid loops in the control wiring, i.e. ensure every control wire is accompanied by its return (0 V) wire.
2. Shielded cable with additional power ground bonding. The cable shield may be connected to ground at both ends, but in addition the ground conductors at both ends of the cable must be bonded together by a power ground cable (equipotential bonding cable) with cross-sectional area of at least 10 mm^2, or 10 times the area of the signal cable shield, or to suit the electrical safety requirements of the plant. This ensures that fault or surge current passes mainly through the ground cable and not in the signal cable shield. If the building or plant has a well-designed common bonded network this precaution is not necessary.
3. Additional over-voltage suppression - for the analog and digital inputs and outputs, a zener diode network or a commercially available surge suppressor may be connected in parallel with the input circuit as shown in Figure 4-41 and Figure 4-42.

If a digital port experiences a severe surge its protective trip may operate (I/O Overload trip). For continued operation after such an event, the trip can be reset automatically by setting Pr **10.034** to 5.

Figure 4-41 Surge suppression for digital and unipolar inputs and outputs

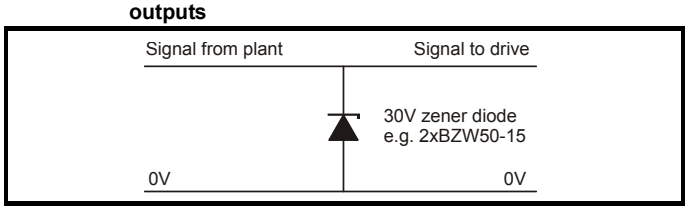
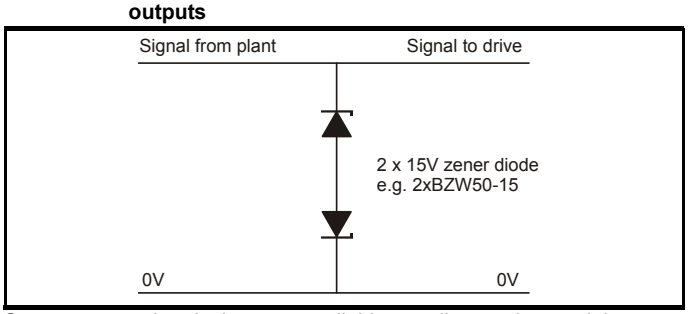


Figure 4-42 Surge suppression for analog and bipolar inputs and outputs



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

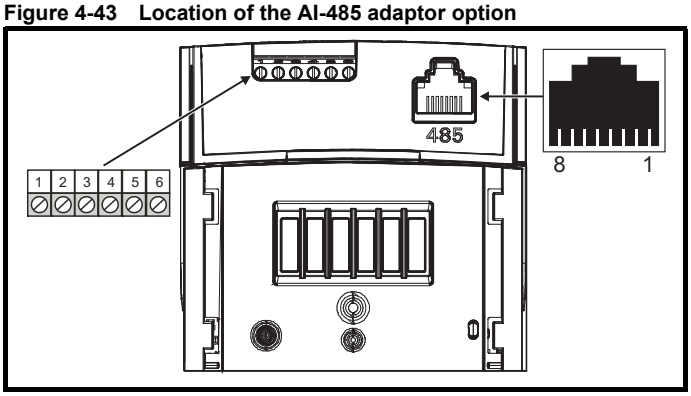
Unipolar TT-UKK5-D/24 DC
Bipolar TT-UKK5-D/24 AC

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

4.9 Communications connections

Installing an AI-485 adaptor provides the drive with a 2 wire 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 4-43 Location of the AI-485 adaptor option



4.9.1 485 serial communications

The drive only supports Modbus RTU protocol. See Table 4-28 for the connection details.

NOTE

Standard Ethernet cables are not recommended for use when connecting drives on a 485 network as they do not have the correct twisted pairs for the pinout of the serial comms port.

Table 4-28 Serial communication port pin-outs (RJ45)

Pin	Function
1	120 Ω Termination resistor
2	RX TX
3	0 V
4	+24 V (100 mA)
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 4-29 Serial communication port pin-outs (screw terminal block)

Pin	Function
1	0 V
2	RX\ TX\
3	RX TX
4	120 Ω Termination resistor
5	TX Enable
6	+24 V (100 mA)

4.9.2 Isolation of the 485 serial communications port

The serial PC communications 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 4-30 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.

4.10 Control connections

4.10.1 General

Table 4-31 The control connections consist of:

Function	Qty	Control parameters available	Terminal number
Single ended analog input	2	Mode, offset, invert, scaling, destination	2, 3, 5
Analog output	2	Source, mode, scaling	7, 8
Digital input	5	Destination, invert, logic select	12, 13, 14, 15, 16
Digital input / output	2	Input / output mode select, destination / source, invert, logic select	10, 11
Relay	1	Source, invert	41, 42
Drive enable (SAFE TORQUE OFF)	2		31, 34 (frame 1- 4) 31, 35 (frame 5 - 6)
+ 10 V User output	1		4
+ 24 V User output	2		9, 17
0V common	2		1, 6
0V SAFE TORQUE OFF	2		32, 33 (frame 1- 4) 32, 36 (frame 5 - 6)

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 on the SAFE TORQUE OFF function on size 5 to 8 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. Ensure the logic sense is correct for the control circuit to be used. Incorrect logic sense could cause the motor to be started unexpectedly. Positive logic is the default state for the drive.

WARNING

Ensure the logic sense is correct for the control circuit to be used. Incorrect logic sense could cause the motor to be started unexpectedly. Positive logic is the default state for 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 4-45 on page 84).

Figure 4-44 Default terminal functions

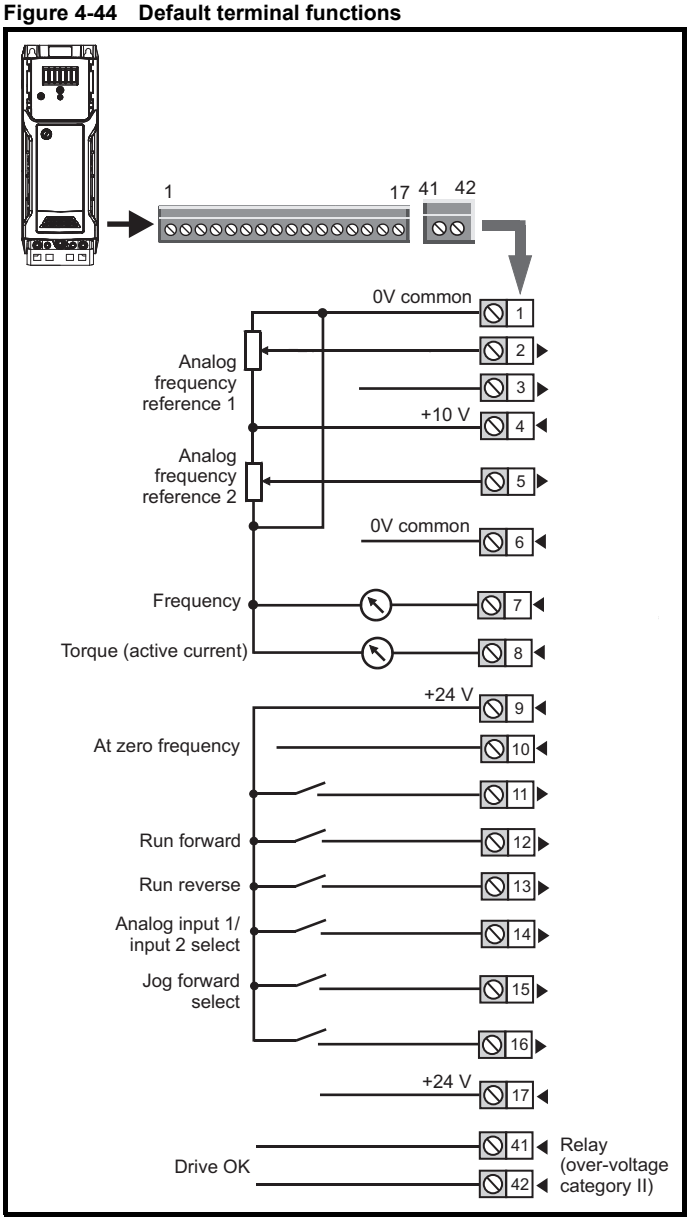


Figure 4-45 SAFE TORQUE OFF inputs (size 1 to 4)

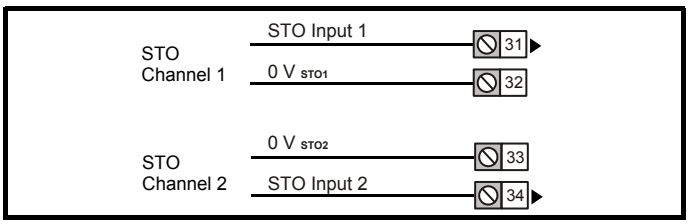
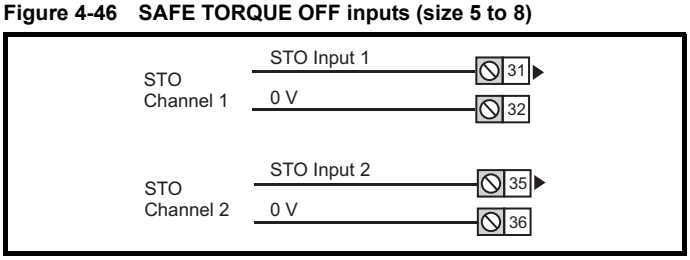


Figure 4-46 SAFE TORQUE OFF inputs (size 5 to 8)



4.10.2 Control terminal specification

1	0V common
Function	Common connection for all external devices.

2	Analog input 1
Default function	Frequency reference.
Type of input	Bipolar single-ended analog voltage or unipolar differential current.
Mode controlled by…	Pr **07.007**
Operating in voltage mode (default)	
Full scale voltage range	±10 V ±3 %
Maximum offset	±30 mV
Absolute maximum voltage range	-18 V to +30 V relative to 0 V
Input resistance	100 k Ω
Resolution	12 bits (11 bits plus sign)
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 0 V
Resolution	11 bits
External fuse rating	80 mA
Common to all modes	
Sample / update	5 ms

WARNING

To avoid damage to the drive, a fuse or other over-current protection should be installed in the analog current input circuit.

3	Analog input 1 return
Function	Return terminal for shunt resistor (current mode)

4	+10 V user output
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, unipolar single-ended current or digital input (positive or negative logic).
Mode controlled by....	Pr **07.011**
Operating in voltage mode (default)	
Full scale voltage range	0 V to +10 V ±3 %
Maximum offset	±30 mV
Absolute maximum voltage range	-18 V to +30 V relative to 0 V
Input resistance	100 k Ω
Resolution	11 bits
Sample / update period	5 ms
Operating in current mode	
Current ranges	0 to 20 mA ±4 %, 20 to 0 mA ±4 %, 4 to 20 mA ±4 %, 20 to 4 mA ±4 %
Maximum offset	250 µA
Absolute maximum applied voltage (reverse bias)	-18 V to +30 V relative to 0 V
Resolution	11 bits
Sample / update period	5 ms
Operating in digital mode	
Logic mode controlled by…	Pr **08.010**
Absolute maximum applied voltage range	-18 V to +30 V relative to 0 V
Impedance	6.8 k Ω
Input threshold	10 V ±0.8 V from IEC 61131-2
Sample / update period	2 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 6 ms.

6	0V common
Function	Common connection for all external devices

7	Analog output 1
8	Analog output 2
Terminal 7 default function	Frequency output
Terminal 8 default function	Motor active current
Type of output	Unipolar single-ended analog voltage, unipolar single-ended current or digital output.
Mode controlled by…	Pr 07.021, Pr 07.024
Operating in voltage mode (default)	
Voltage range	0 to +10 V ±5 %
Maximum offset	15 mV
Minimum load resistance	500 Ω
Protection	Short circuit relative to 0 V
Operating in current mode	
Current ranges	0 to 20 mA ±4 %, 4 to 20 mA ±4 %
Maximum load resistance	500 Ω
Operating in digital output mode	
Nominal maximum output current	50 mA
Voltage range	0 V to +24 V
Common to all modes	
Resolution	0.1 %
Sample / update period	5 ms

9	+24 V user output
Function	Supply for external digital devices
Voltage tolerance	±20 %
Maximum output current	200 mA (total including all Digital Outputs)
Protection	Current limit and trip

10	Digital I/O 1
11	Digital I/O 2
Terminal 10 default function	AT ZERO FREQUENCY output
Terminal 11 default function	None
Type	Positive or negative logic digital inputs, positive logic voltage source outputs. PWM or frequency output modes can be selected on output 1.
Input / output mode controlled by …	Pr **08.031,** Pr **08.032**
Operating as in input	
Logic mode controlled by…	Pr **08.010**
Absolute maximum applied voltage range	-8 V to +30 V relative to 0 V
Impedance	6.8 kΩ
Input threshold	10 V ±0.8 V from IEC 61131-2
Operating as an output	
Nominal maximum output current	50 mA
Maximum output current	200 mA (total including +24 Vout)
Common to all modes	
Voltage range	0 V to +24 V
Sample / update period	2 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 6 ms.

12	Digital Input 3
13	Digital Input 4
Terminal 12 default function	RUN FORWARD input
Terminal 13 default function	RUN REVERSE input
Type	Negative or positive logic digital inputs
Logic mode controlled by…	Pr **08.010**
Voltage range	0 V to +24 V
Absolute maximum applied voltage range	-18 V to +30 V relative to 0 V
Impedance	6.8 kΩ
Input threshold	10 V ±0.8 V from IEC 61131-2
Sample / update period	2 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 6 ms.

14	Digital Input 5
Terminal 14 default function	Analog INPUT 1 / INPUT 2 select
Type	Negative or positive logic digital input or motor thermistor input (bias for DIN44081 ptc, KTY84, PT1000, PT2000 and other types) mode can be selected.
Input mode controlled by…	Pr **08.035**
Operating as digital input	
Logic mode controlled by…	Pr **08.010**
Voltage range	0 V to +24 V
Absolute maximum applied voltage range	-18 V to +30 V relative to 0 V
Impedance	6.8 kΩ
Input threshold	10 V ±0.8 V from IEC 61131-2
Sample / update period	2 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 6 ms.

15	Digital Input 6
16	Digital Input 7
Terminal 15 default function	JOG SELECT input
Terminal 16 default function	None
Type	Negative or positive logic digital inputs, frequency input (digital input 6) or AB encoder input (digital input 6 and 7).
Input mode controlled by...	Pr **08.036**
Operating as digital input	
Logic mode controlled by…	Pr **08.010**
Operating as frequency or AB encoder input	
Maximum input frequency	100 kHz
Common to all modes	
Voltage range	0 V to +24 V
Absolute maximum applied voltage range	-18 V to +30 V relative to 0 V
Impedance	6.8 kΩ
Input threshold	10 V ±0.8 V from IEC 61131-2
Sample / update period	2 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 6 ms.

17	+24 V user output
Function	Supply for external digital devices.
Voltage tolerance	±20 %
Maximum output current	200 mA (total including all Digital Outputs)
Protection	Current limit trip.

31 34	SAFE TORQUE OFF function (drive enable) (frame size 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 from IEC 61131-2, type 1
Low state maximum current for disable to SIL3 and PL e	0.5 mA
Response time	Nominal: 12 ms 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.

31 35	SAFE TORQUE OFF function (drive enable) (frame size 5 to 6)
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, from 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: 8 ms 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 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 4 A DC 30 V resistive load
Contact minimum recommended rating	12 V 100 mA
Contact type	Normally open
Default contact condition	Closed when power applied and drive OK
Update period	4 ms

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.

4.11 SAFE TORQUE OFF (STO)

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 either one or both STO inputs are 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 behavior 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.

According to EN ISO 13849-1:

PL = e

Category = 4

$MTTF_D$ = High

DC_{av} = High

Mission Time and Proof Test Interval = 20 years

The calculated PFD_{AVG} for the complete STO function is:

Frame 1 to 4: 8.4×10^{-6}

Frame 5 to 6: 3.64×10^{-6}

According to EN 61800-5-2:

SIL = 3

Frame 1 to 4: PFH = 9.61×10^{-11} h^{-1}

Frame 5 to 6: PFH = 4.16×10^{-11} h^{-1}

SAFE TORQUE OFF can be used to eliminate electro-mechanical contactors, including special safety contactors, which would otherwise be required for safety applications.

The function can be used in safety-related machines or systems which have been designed according to IEC 62061 or IEC 61508, or other standards which are compatible with IEC 61508, since the analysis and the integrity metrics used in EN 61800-5-2 are the same.

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 1ms.

Two-channel SAFE TORQUE OFF

Two fully independent input channels are provided for the SAFE TORQUE OFF function.Each input separately meets the requirements of the standards as defined above, regardless of the state of the other input. 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 in order for the drive 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. Consequently, 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 of approximately +24 V would 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.

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. Because of the risk of human error, the installation must not provide any facility to override the function. 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.

With SAFE TORQUE OFF there are no single faults in the drive which can permit the motor to be driven. Therefore it is not necessary to have a second channel to interrupt the power connection, nor a fault detection circuit. 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 0 V wiring cannot exceed this value under any loading condition. It is strongly recommended that the SAFE TORQUE OFF circuits be provided with a dedicated 0 V conductors which should be connected to terminals 32 and 33 at the drive.

WARNING

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

WARNING

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.

WARNING

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 0 V wiring cannot exceed this value under any loading condition. It is strongly recommended that the SAFE TORQUE OFF circuits be provided with a dedicated 0 V conductors which should be connected to terminals 32 and 33 at the drive.

For more information regarding the SAFE TORQUE OFF input, please see the *Control Techniques Safe Torque Off Engineering Guide* available for download from www.controltechniques.com.

5 Getting started

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

5.1 Understanding the display

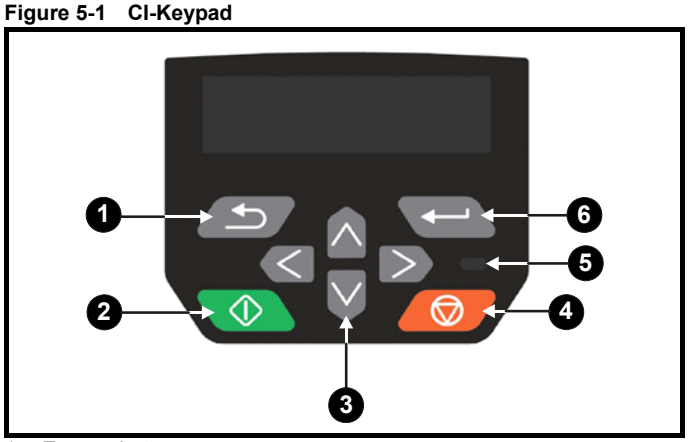
The keypad can only be mounted on the drive.

5.1.1 CI-Keypad

The CI-Keypad display consists of up to four rows of text. The upper two rows show the drive status or the menu and parameter number currently being viewed. When in status mode, an area one character wide and four lines high on the right-hand side of the display, is reserved for displaying actions that are active on the drive. The possible active actions are given in Table 5-2.

When the drive is powered up, the lower two rows will show the status mode parameters defined by *Status Mode Parameter 1* (11.018) and *Status Mode Parameter 2* (11.019).

Figure 5-1 CI-Keypad



1. Escape button
2. Start button
3. Navigation keys (x4)
4. Stop / Reset button (red)
5. Status LED
6. Enter button

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 the below table.

Table 5-1 Keypad display formats

Display formats	Value
IP Address	127. 0. 0. 0
MAC Address	01ABCDEF2345
Time	12:34:56
Date	31-12-13 or 12-31-13
Version number	01.02.00.00
Character	ABCD
32 bit number with decimal point	21474836.47
16 bit binary number	0100001011100101

Table 5-2 Active action icon

Active action icon	Description
	Alarm active
	NV media card being accessed
	Drive security active
	User security unlocked
	Motor map 2 active
	User program running
	Keypad reference active

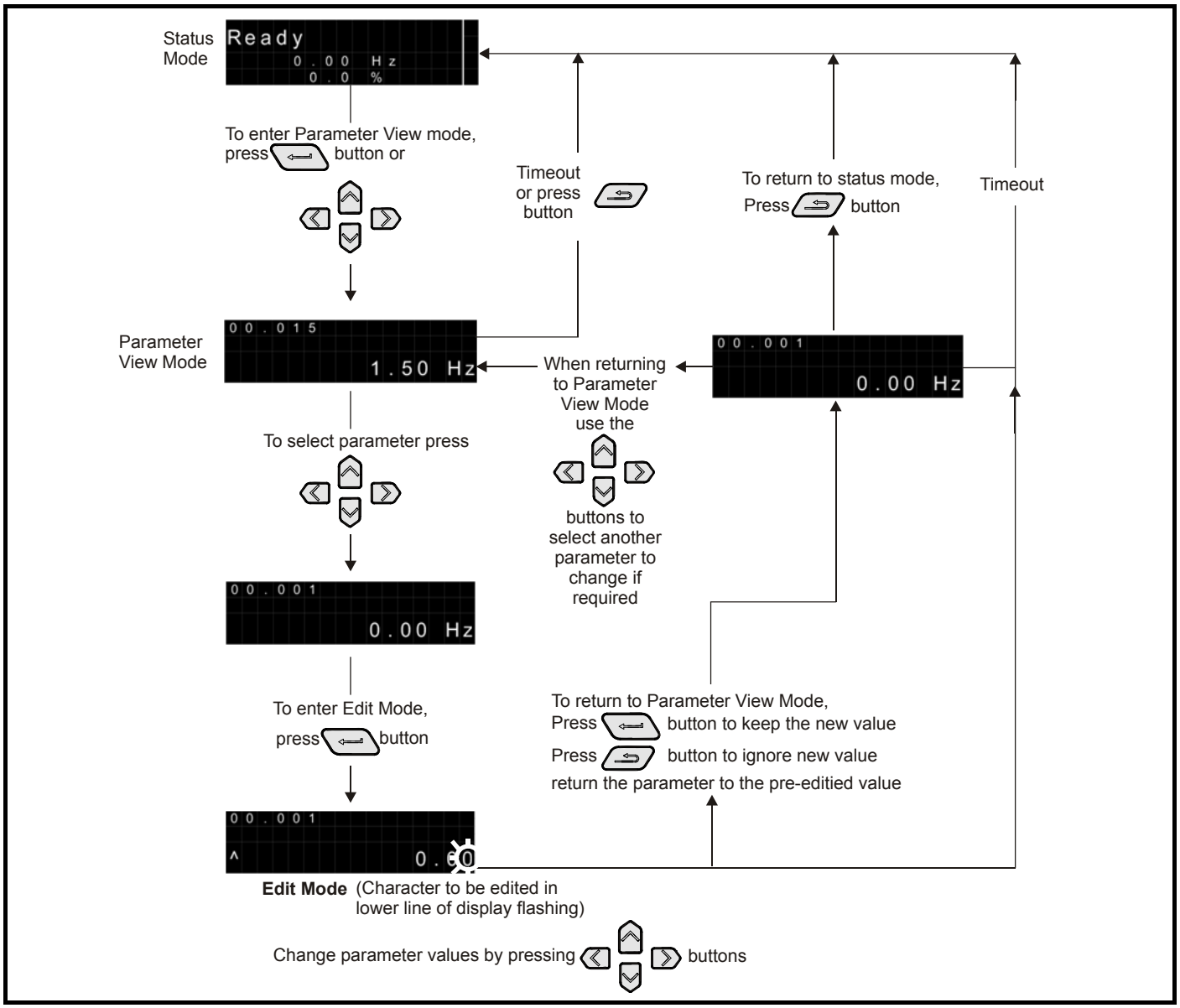
5.2 Keypad operation

5.2.1 Control buttons

The keypad consists of:

- Navigation keys - Used to navigate the parameter structure and change parameter values.
- Enter / Mode button Used to toggle between parameter edit and view mode.
- Escape / Exit button Used to exit from parameter edit or view mode. In parameter edit mode, if parameter values are edited and the exit 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 navigation buttons can only be used to move between menus if Pr **00.010** has been set to show 'All Menus'. Refer to section section 5.8 *Parameter access level and security* on page 92.

NOTE

If the Escape button is held down for 1 second, the display returns to status mode.

5.2.2 Quick access mode

The quick access mode allows direct access to any parameter without scrolling through menus and parameters.

To enter the quick access mode, press and hold the Enter button on the keypad while in 'parameter view mode'.

Figure 5-3 Quick access mode

5.2.3 Keypad shortcuts

In 'parameter view mode':

If the up and down keypad buttons are pressed together, then the keypad display will jump to the start of the parameter menu being viewed, i.e. Pr **05.005** being viewed, when the above buttons pressed together will jump to Pr **05.000**.

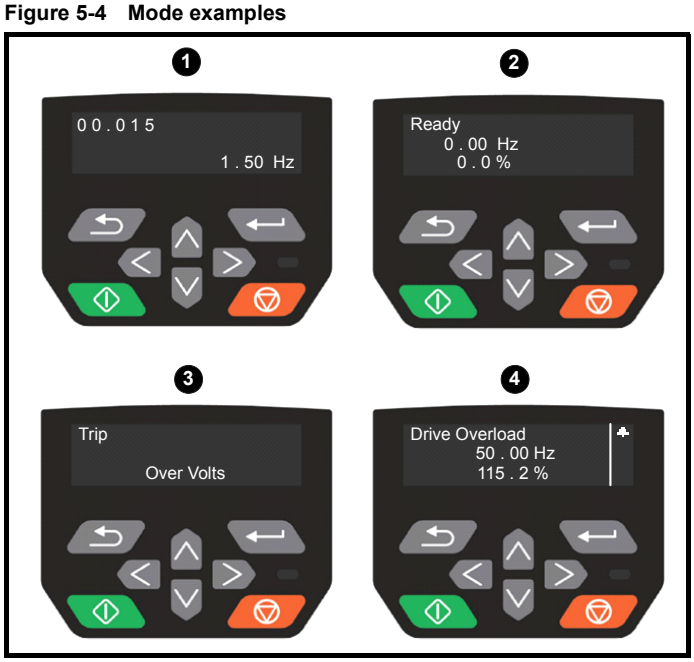
If the left and right keypad buttons are pressed together, then the keypad display will jump to the last viewed parameter in Menu 0.

In 'parameter edit mode':

If the up and down keypad buttons are pressed together, then the parameter value of the parameter being edited will be set to 0.

If the left and right keypad buttons are pressed together, the least significant digit (furthest right) will be selected on the keypad display for editing.

Figure 5-4 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 upper row of the display will show one of the following:

- Inhibit', 'Ready' or 'Run'.

3. **Status mode: trip status**

When the drive is in trip condition, the upper row of the display will indicate that the drive has tripped and the lower row of the display will show the trip code. For further information regarding trip codes, refer to Table 13-2 *Trip indications* on page 209.

4. **Status mode: Alarm status**

During an 'alarm' condition the upper row of the display alternates between the drive status (Inhibit, Ready or Run, depending on what is displayed) 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

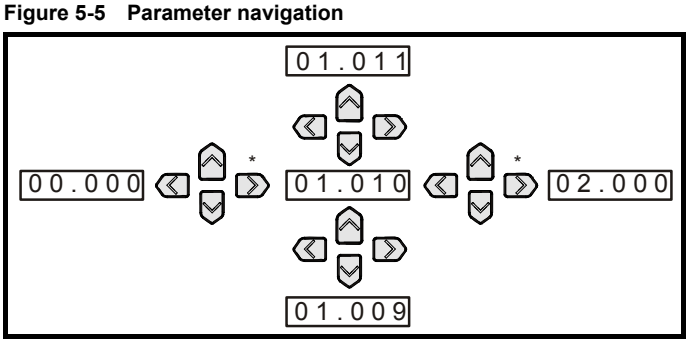
For new parameter values to apply after the line power supply to the drive is interrupted, new values must be saved. Refer to section 5.6 *Saving parameters* on page 92.

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 **00.010** has been set to 'All Menus', the left and right buttons are used to navigate between menus. For further information, refer to section 5.8 *Parameter access level and security* on page 92.

Figure 5-5 Parameter navigation



* Can only be used to move between menus if all menus have been enabled (Pr **00.010**). Refer to section section 5.8 *Parameter access level and security* on page 92.

The menus and parameters roll over 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.

5.3.1 CI-Keypad set-up menu

To enter the keypad set-up menu, press and hold the Escape button on the keypad from status mode. All the keypad parameters are saved to the keypad non-volatile memory when exiting from the keypad set-up menu. To exit from the keypad set-up menu, press the Escape or or button. Below are the keypad set-up parameters.

Table 5-3 CI-Keypad set-up parameters

Parameters		Range	Type
Keypad.00	Language	Classic English or English	RW
Keypad.01	Show Units	Off or On	RW
Keypad.02	Backlight Level	0 to 100 %	RW
Keypad.05	Show Raw Text Parameter Values	Off or On	RW
Keypad.06	Software Version	00.00.00.00 to 99.99.99.99	RO

NOTE

It is not possible to access the keypad parameters via any communications channel.

5.4 Advanced menus

The advanced menus consist of groups or parameters appropriate to a specific function or feature of the drive. Menus 0 to 22 can be viewed on the Keypad.

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.

Table 5-4 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 and scope
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
Slot 1	Slot 1 option menus*

* Only displayed when the option module is installed.

5.4.1 Display messages

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

Table 5-5 Status indications

Upper row string	Description	Drive output stage
Inhibit	The drive is inhibited and cannot be run. The SAFE TORQUE OFF signals are not applied to the 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
Ready	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 frequency.	Enabled
Run	The drive is active and running.	Enabled
Supply Loss	Supply loss condition has been detected	Enabled
Deceleration	The motor is being decelerated to zero frequency because the final drive run has been deactivated.	Enabled
dc Injection	The drive is applying dc injection braking.	Enabled
Trip	The drive has tripped and no longer controlling the motor. The trip code appears in the lower display.	Disabled
Under Voltage	The drive is in the under voltage state either in low voltage or high voltage mode.	Disabled

5.4.2 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 5-6 Alarm indications

Alarm string	Description
Brake Resistor	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.
Motor Overload	*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 %.
Drive overload	Drive over temperature. *Percentage Of Drive Thermal Trip Level* (07.036) in the drive is greater than 90 %.
Auto Tune	The autotune procedure has been initialized and an autotune in progress.
Limit Switch	Limit switch active. Indicates that a limit switch is active and that is causing the motor to be stopped.
Option Slot 1	Option slot alarm.
Low AC	Low voltage mode. See *Low AC Alarm* (10.107).
Current Limit	Current limit active. See *Current Limit Active* (10.009).

5.5 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. terminal 31 & 34 are open or Pr **06.015** is OFF (0)
2. Change the setting of Pr **00.079** as follows:

Pr **00.079** setting		Operating mode
00.079 ^ Open-loop	1	Open-loop
00.079 v RFC-A	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 (ensure that Pr **mm.000** returns to 0)

5.6 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 parameters'* in Pr **mm.000** (alternatively enter a value of 1000* in 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

* If the drive is in the under voltage state (i.e. when the AI-Backup adaptor terminals are being supplied from a +24 Vdc supply) a value of 1001 must be entered into Pr **mm.000** to perform a save function.

5.7 Restoring parameter defaults

Restoring parameter defaults by this method saves the default values in the drives memory. *User security status* (00.010) and *User security code* (00.025) are not affected by this procedure).

Procedure

1. Ensure the drive is not enabled, i.e. terminal 31 & 34 is open or Pr **06.015** is OFF (0)
2. Select 'Reset 50 Hz Defs' or 'Reset 60 Hz Defs' in Pr **mm.000**. (alternatively, enter 1233 (50 Hz settings) or 1244 (60 Hz settings) in 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

5.8 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 22) 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 Table 5-7.

Table 5-7 Parameter access level and security

User security status (11.044)	Access level	User security	Menu 0 status	Advanced menu status
0	Menu 0	Open	RW	Not visible
		Closed	RO	Not visible
1	All Menus	Open	RW	RW
		Closed	RO	RO
2	Read-only Menu 0	Open	RO	Not visible
		Closed	RO	Not visible
3	Read-only	Open	RO	RO
		Closed	RO	RO
4	Status only	Open	Not visible	Not visible
		Closed	Not visible	Not visible
5	No access	Open	Not visible	Not visible
		Closed	Not visible	Not visible

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

5.8.1 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* (11.044); these are shown in the table below.

User Security Status (Pr 11.044)	Description
Menu 0 (0)	All writable parameters are available to be edited but only parameters in Menu 0 are visible
All menus (1)	All parameters are visible and all writable parameters are available to be edited
Read- only Menu 0 (2)	Access is limited to Menu 0 parameters only. All parameters are read-only
Read-only (3)	All parameters are read-only however all menus and parameters are visible
Status only (4)	The keypad remains in status mode and no parameters can be viewed or edited
No access (5)	The keypad remains in status mode and no parameters can be viewed or edited. Drive parameters cannot be accessed via a comms/ fieldbus interface in the drive or any option module

5.8.2 Changing the User Security Level /Access Level

The security level is determined by the setting of Pr **00.010** or Pr **11.044**. The Security Level can be changed through the keypad even if the User Security Code has been set.

5.8.3 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 **00.025** 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 **00.010**. When the drive is reset, the security code will have been activated and the drive returns to Menu 0 and the symbol is displayed in the right hand corner of the keypad display. The value of Pr **00.025** 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 'security code'. 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 'incorrect security code' 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 **00.025** 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.

5.9 Displaying parameters with non-default values only

By selecting 'Show non-default' in Pr **mm.000** (Alternatively, enter 12000 in Pr **mm.000**), 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 **mm.000** and select 'No action' (alternatively enter a value of 0). Please note that this function can be affected by the access level enabled, refer to section 5.8 *Parameter access level and security* on page 92 for further information regarding access level.

5.10 Displaying destination parameters only

By selecting 'Destinations' in Pr **mm.000** (Alternatively enter 12001 in Pr **mm.000**), 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 **mm.000** and select 'No action' (alternatively enter a value of 0).

Please note that this function can be affected by the access level enabled, refer to section 5.8 *Parameter access level and security* on page 92 for further information regarding access level.

5.11 Communications

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

5.11.1 485 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 $^1/_4$ 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 one of the above converters 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), 8 1 NP (1), 8 1 EP (2), 8 1 OP (3), 8 2 NP M (4), 8 1 NP M (5), 8 1 EP M (6), 8 1 OP M (7), 7 1 EP (8), 7 1 OP (9), 7 1 EP M (10), 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 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 (11.025)	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600(8), 76800(9), 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 (11.023)	1 to 247	This parameter defines the serial address and an addresses between 1 and 247 are permitted.

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 {…}). Menus 22 can be used to configure the parameters in Menu 0.

6.1 Menu 0: Basic parameters

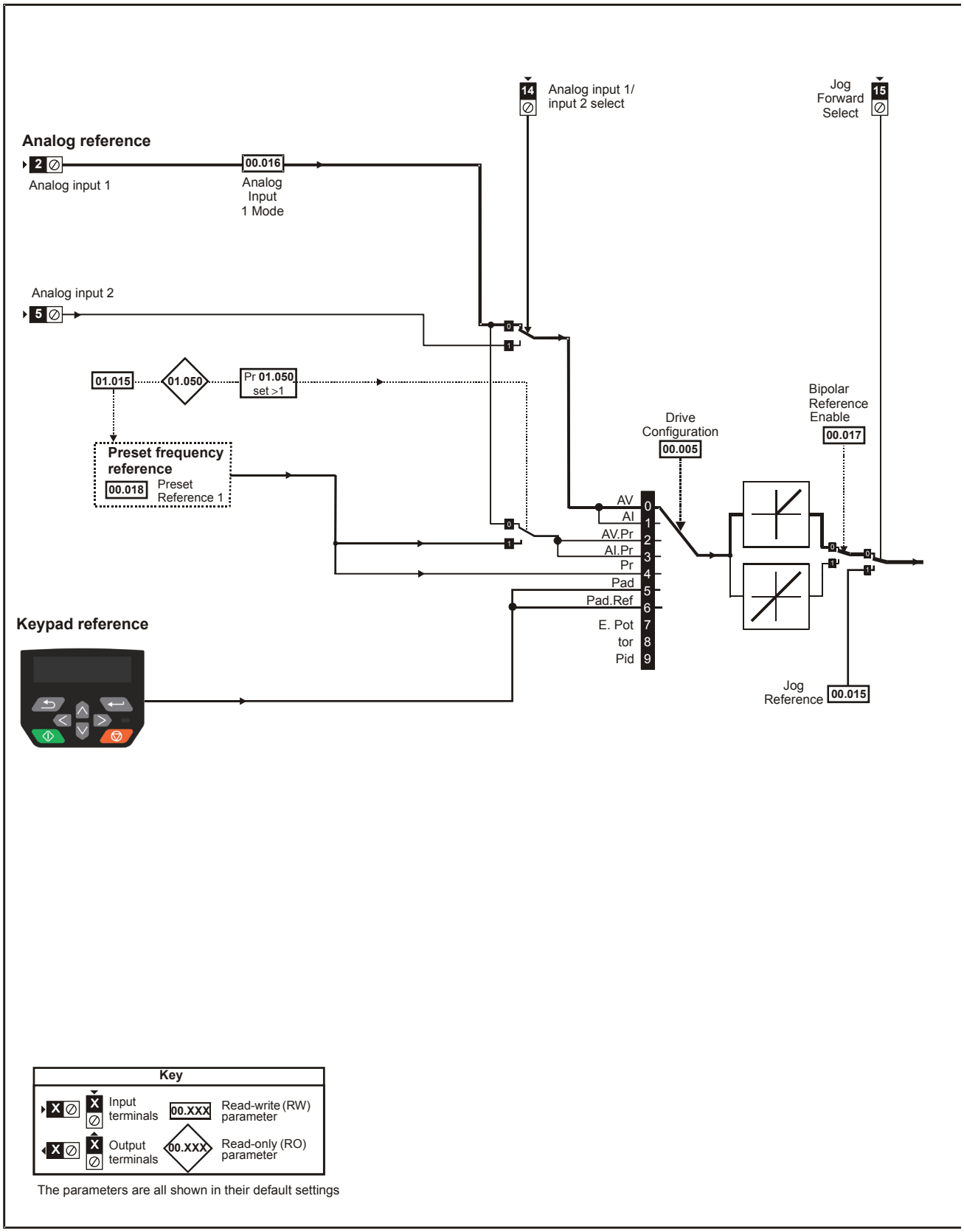
Parameter		Range(⇳)		Default(⇨)		Type					
		OL	RFC-A	OL	RFC-A						
00.001	Minimum Reference Clamp	±VM_NEGATIVE_REF_CLAMP1 Hz		0.00 Hz		RW	Num				US
00.002	Maximum Reference Clamp	±VM_POSITIVE_REF_CLAMP Hz		50 Hz default: 50.00 Hz 60 Hz default: 60.00 Hz		RW	Num				US
00.003	Acceleration Rate 1	±VM_ACCEL_RATE s		5.0 s		RW	Num				US
00.004	Deceleration Rate 1	±VM_ACCEL_RATE s		10.0 s		RW	Num				US
00.005	Drive Configuration	AV (0), AI (1), AV Preset (2), AI Preset (3), Preset (4), Keypad (5), Keypad Ref (6), Electronic Pot (7), Torque Control (8), Pid Control (9)		AV (0)		RW	Txt			PT	US
00.006	Motor Rated Current	±VM_RATED_CURRENT A		Maximum Heavy Duty Rating (11.032) A		RW	Num		RA		US
00.007	Motor Rated Speed	0.0 to 80000.0 rpm		50 Hz default: 1500.0 rpm 60 Hz default: 1800.0 rpm	50 Hz default: 1450.0 rpm 60 Hz default: 1750.0 rpm	RW	Num				US
00.008	Motor Rated Voltage	±VM_AC_VOLTAGE_SET V		110 V drive: 230 V 200 V drive: 230 V 400 V drive 50 Hz: 400 V 400 V drive 60 Hz: 460 V 575 V drive: 575 V 690 V drive: 690 V		RW	Num		RA		US
00.009	Motor Rated Power Factor	0.00 to 1.00		0.85		RW	Num		RA		US
00.010	User Security Status	Menu 0 (0), All Menus (1), Read only Menu 0 (2), Read only (3), Status Only (4), No Access (5)		Menu 0 (0)		RW	Txt	ND	NC	PT	
00.012	Input Logic Polarity	Negative Logic (0) or Positive Logic (1)		Positive Logic (1)		RW	Txt				US
00.015	Jog Reference	0.00 to 300.00 Hz		1.50 Hz		RW	Num				US
00.016	Analog Input 1 Mode	4-20 mA Stop (-6), 20-4 mA Stop (-5), 4-20 mA Low (-4), 20-4 mA Low (-3), 4-20 mA Hold (-2), 20-4 mA Hold (-1), 0-20 mA (0), 20-0 mA (1), 4-20 mA Trp (2), 20-4 mA Trp (3), 4-20 mA (4), 20-4 mA (5), Voltage (6)		Voltage (6)		RW	Txt				US
00.017	Bipolar Reference Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
00.018	Preset Reference 1	±VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
00.025	User Security Code	0 to 9999		0		RW	Num	ND	NC	PT	US
00.027	Power-up Keypad Control Mode Reference	Reset (0), Last (1), Preset (2)		Reset (0)		RW	Txt				US
00.028	Ramp Mode Select	Fast (0), Standard (1), Std boost (2), Fast boost (3)		Standard (1)		RW	Txt				US
00.029	Ramp Enable		Off (0) or On (1)		On (1)	RW	Bit				US
00.030	Parameter Cloning	None (0), Read (1), Program (2), Auto (3), Boot (4)		None (0)		RW	Txt		NC		US
00.031	Stop Mode	Coast (0), Ramp (1), Ramp dc I (2), dc I (3), Timed dc I (4), Disable (5), No Ramp (6)		Ramp (1)		RW	Txt				US
00.032	Dynamic V to F Select / Flux Optimization Select	0 to 1		0		RW	Num				US
00.033	Catch A Spinning Motor	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)		Disable (0)		RW	Txt				US
00.034	Digital Input 5 Select	Input (0), Therm Short Cct (1), Thermistor (2), Therm No Trip (3)		Input (0)		RW	Txt				US
00.035	Digital Output 1 Control	0 to 21		0		RW					US
00.036	Analog Output 1 Control	0 to 15		0		RW					US
00.037	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)	3 (3) kHz		RW	Txt				US

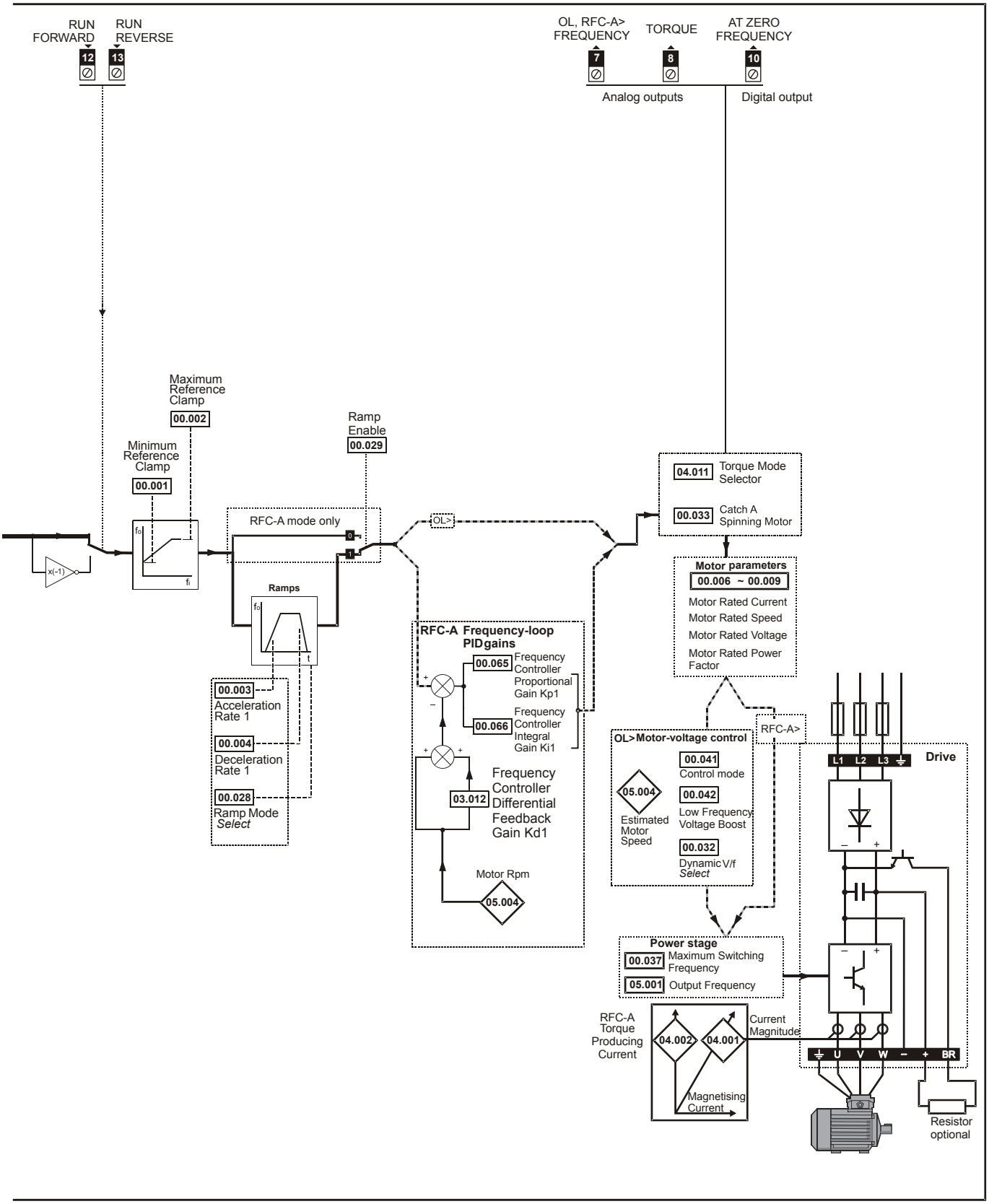
Parameter		Range(⇳)		Default(⇨)		Type					
		OL	RFC-A	OL	RFC-A						
00.038	Auto-tune	0 to 2	0 to 3	0		RW	Num		NC		US
00.039	Motor Rated Frequency	0.00 to VM_SPEED_FREQ_REF_UNIPOLAR Hz		50Hz: 50.00 Hz 60Hz: 60.00 Hz		RW	Num		RA		US
00.040	Number of Motor Poles*	Automatic (0) to 32 (16) Poles		Automatic (0) Poles		RW	Txt				US
00.041	Control Mode	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5)		Ur I (4)		RW	Txt				US
00.042	Low Frequency Voltage Boost	0.0 to 25.0 %		3.0 %		RW	Num				US
00.043	Serial Baud Rate	300 (0), 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
00.044	Serial Address	1 to 247		1		RW	Num				US
00.045	Reset Serial Communications	Off (0) or On (1)		Off (0)		RW	Bit	ND	NC		
00.046	Brake Release Current Threshold	0 to 200 %		50 %		RW	Num				US
00.047	Brake Apply Current Threshold	0 to 200 %		10 %		RW	Num				US
00.048	BC Brake Release Frequency	0.00 to 20.00 Hz		1.00 Hz		RW	Num				US
00.049	BC Brake Apply Frequency	0.00 to 20.00 Hz		2.00 Hz		RW	Num				US
00.050	BC Brake Delay	0.0 to 25.0 s		1.0 s		RW	Num				US
00.051	BC Post-brake Release Delay	0.0 to 25.0 s		1.0 s		RW	Num				US
00.053	BC Initial Direction	Ref (0), Forward (1), Reverse (2)		Ref (0)		RW	Txt				US
00.054	BC Brake Apply Through Zero Threshold	0.00 to 25.00 Hz		0.00 Hz		RW	Num				US
00.055	BC Enable	Disable (0), Relay (1), Digital IO (2), User (3)		Disable (0)		RW	Txt				US
00.059	OUP Enable	Stop (0) or Run (1)		Run (1)		RW	Txt				US
00.065	Frequency Controller Proportional Gain Kp1		0.000 to 200.000 s/rad		0.100 s/rad	RW	Num				US
00.066	Frequency Controller Integral Gain Ki1		0.00 to 655.35 s^2/rad		0.10 s^2/rad	RW	Num				US
00.067	Sensorless Mode Filter		4 (0), 5 (1), 6 (2), 8 (3), 12 (4), 20 (5) ms		4 (0) ms	RW	Txt				US
00.069	Spin Start Boost	0.0 to 10.0		1.0		RW	Num				US
00.076	Action on Trip Detection	00000 to 11111		00000		RW	Bin				US
00.077	Maximum Heavy Duty Current Rating	0.00 to 9999.99 A				RO	Num	ND	NC	PT	
00.078	Software Version	00.00.00.00 to 99.99.99.99				RO	Num	ND	NC	PT	
00.079	User Drive Mode	Open loop (1), RFC A (2)		Open-loop (1)		RW	Txt	ND	NC	PT	US
00.080	User Security Status	Menu 0 (0), All Menus (1), Read only Menu 0 (2), Read only (3), Status Only (4), No Access (5)		Menu 0 (0)		RW	Txt	ND		PT	

* 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

Figure 6-1 Menu 0 logic diagram




RUN FORWARD
12
RUN REVERSE
13
OL, RFC-A> FREQUENCY
7
TORQUE
8
AT ZERO FREQUENCY
10
Analog outputs
Digital output
Maximum Reference Clamp
00.002
Minimum Reference Clamp
00.001
Ramp Enable
00.029
RFC-A mode only
OL>
04.011 Torque Mode Selector
00.033 Catch A Spinning Motor
Motor parameters
00.006 ~ 00.009
Motor Rated Current
Motor Rated Speed
Motor Rated Voltage
Motor Rated Power Factor
Ramps
00.003 Acceleration Rate 1
00.004 Deceleration Rate 1
00.028 Ramp Mode Select
RFC-A Frequency-loop PIDgains
00.065 Frequency Controller Proportional Gain Kp1
00.066 Frequency Controller Integral Gain Ki1
03.012 Frequency Controller Differential Feedback Gain Kd1
Motor Rpm
05.004
OL>Motor-voltage control
05.004 Estimated Motor Speed
00.041 Control mode
00.042 Low Frequency Voltage Boost
00.032 Dynamic V/f Select
RFC-A>
Drive
L1 L2 L3
Power stage
00.037 Maximum Switching Frequency
05.001 Output Frequency
RFC-A Torque Producing Current
04.002
04.001
Current Magnitude
Magnetising Current
U V W BR
Resistor optional

6.2 Parameter descriptions

6.2.1 Pr mm.000

Pr **mm.000** is available in all menus, commonly used functions are provided as text strings in Pr **mm.000** 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 **mm.000**. For example, enter 4001 in Pr **mm.000** to store drive parameters on an NV media card.

Table 6-1 Commonly used functions in xx.000

Value	Equivalent value	String	Action
0	0	**No Action**	No action
1000	1	**Save Parameters**	Save drive parameters to non-volatile memory
6001	2	**Load file 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 to file 1**	Store the drive parameters in file 1 on a non-volatile media card
6002	4	**Load file 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 to file 2**	Store the drive parameters in file 2 on a non-volatile media card
6003	6	**Load file 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 to file 3**	Store the drive parameters in file 3 on a non-volatile media card
12000	8	**Show non-default**	Only display parameters that are different from their default value
12001	9	**Destinations**	Only display parameters that are used to set-up destinations
1233	10	**Reset 50 Hz defs**	Load 50 Hz defaults
1244	11	**Reset 60 Hz defs**	Load 60 Hz defaults
1070	12	**Reset modules**	Reset all option modules

Table 6-2 Functions in Pr mm.000

Value	Action
1000	Save parameters when *Under Voltage Active* (Pr **10.016**) is not active.
1001	Save parameter 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 {Stored 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
6yyy*	NV media card: Load the drive parameters from parameter file yyy or the onboard user program from onboard user program 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: Clear 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.
40yyy	Backup all drive data (parameter differences from defaults, an onboard user program and miscellaneous option data), including the drive name; the store will occur to the </fs/MCDF/driveyyy/> folder; if it does not exist, it will be created. Since the name is stored, this is a backup, rather than a clone. The command code will be cleared when all drive and option data have been saved.
60yyy	Load all drive data (parameter differences from defaults, an onboard user program and miscellaneous option data); the load will come from the </fs/MCDF/driveyyy/> folder. The command code will not be cleared until the drive and all option data have been loaded.

* See Chapter 9 *NV Media Card Operation* on page 114 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.

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 106*.

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 **00.006** *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 104.

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

Drive control method	Requirements
Terminal mode	Drive enable Speed / Torque reference Run forward / Run reverse
Keypad mode	Drive enable
Serial communications	Drive enable Serial communications link

Table 7-2 Minimum control connection requirements for each mode of operation

Operating mode	Requirements
Open loop mode	Induction motor
RFC – A mode (without speed feedback)	Induction motor without speed feedback

7.2 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. terminal 31 & 34 are open or Pr **06.015** is OFF (0)
2. Change the setting of **Pr 00.079** as follows:

Pr **00.079** setting		Operating mode
00.079 ^ Open-loop	1	Open-loop
00.079 v 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 (ensure that Pr **mm.000** returns to 0).

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)

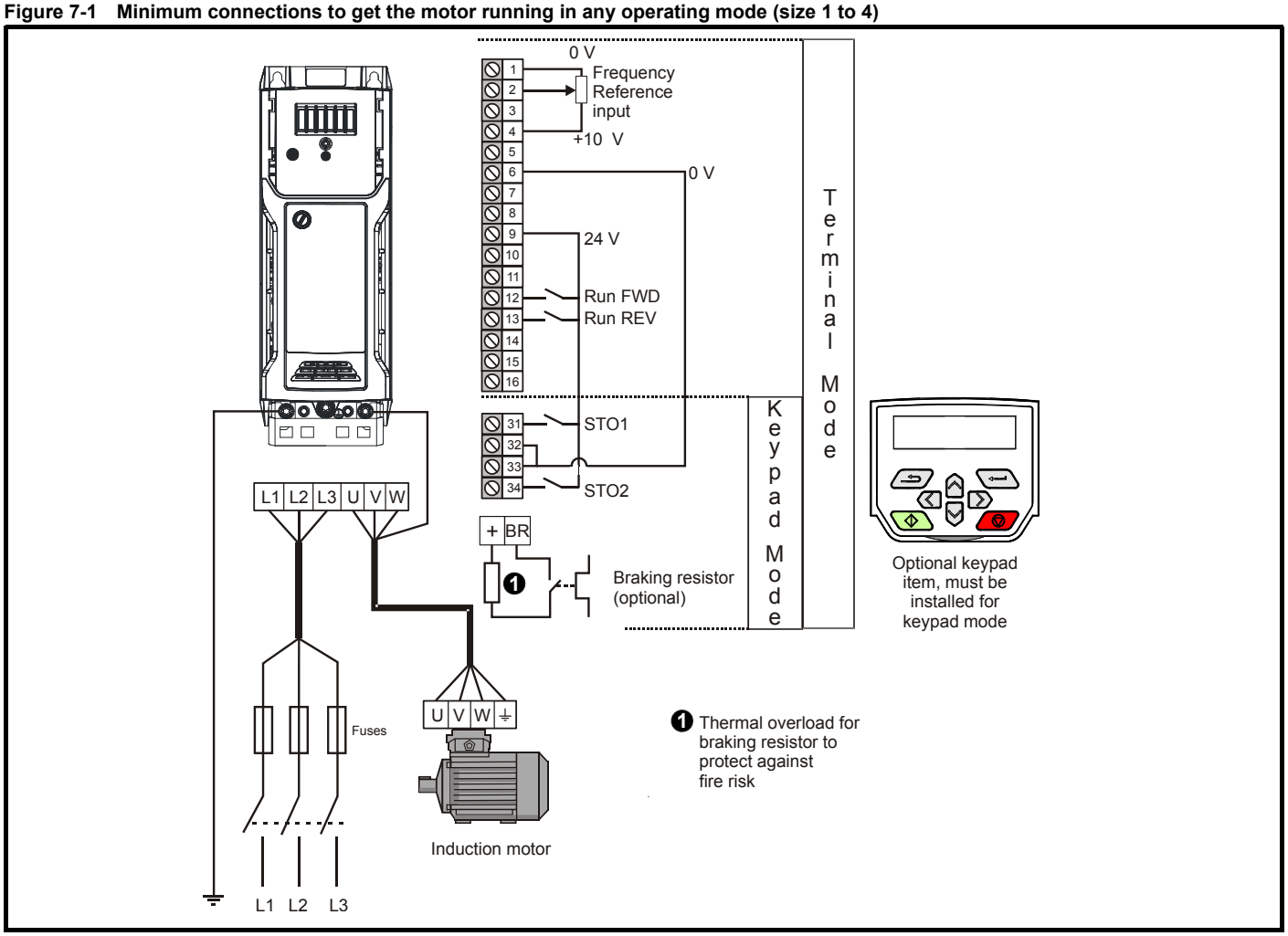


Figure 7-2 Minimum connections required to get the motor running in any mode (size 5)

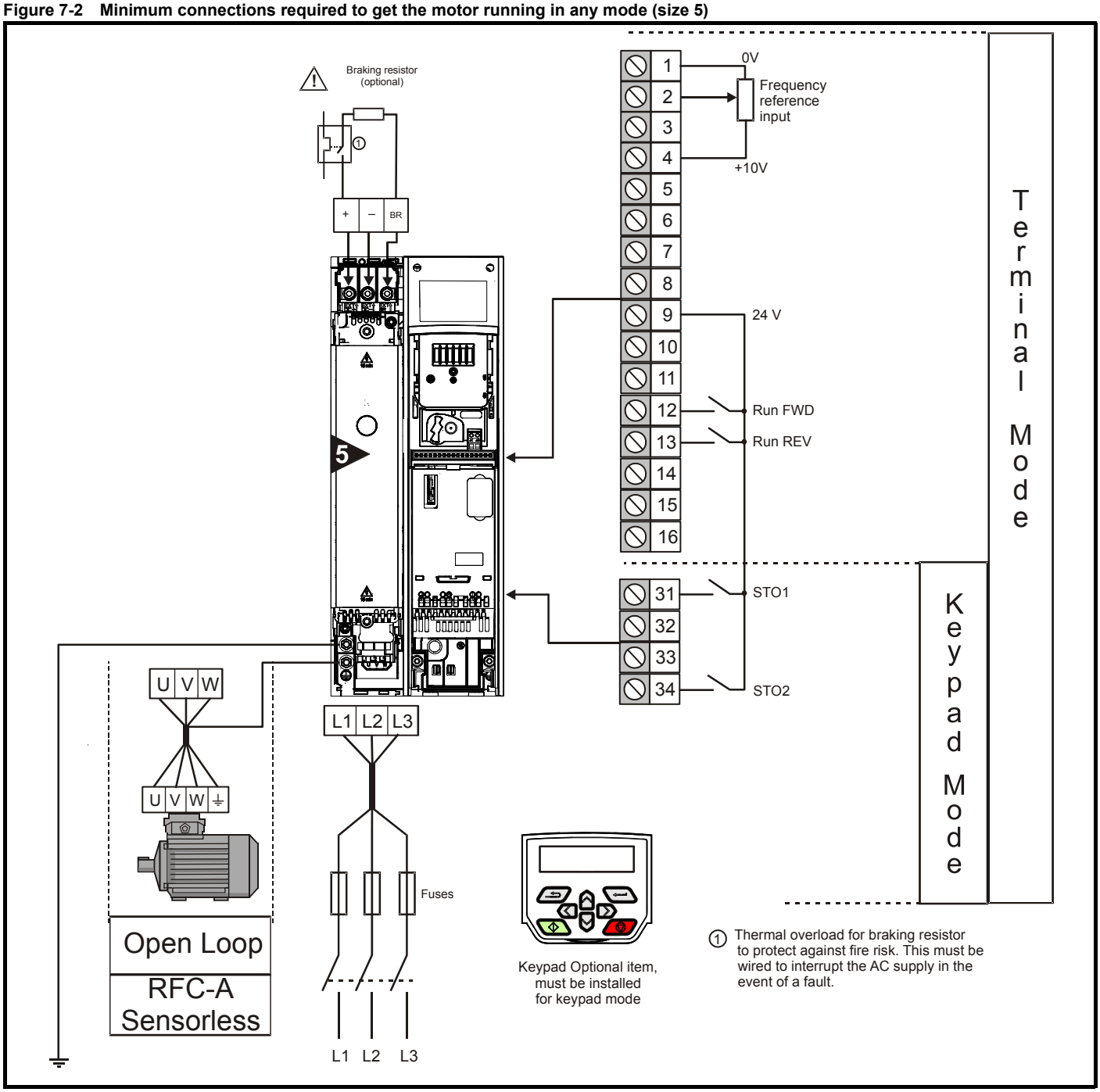


Figure 7-3 Minimum connections required to get the motor running in any operating mode (size 6)

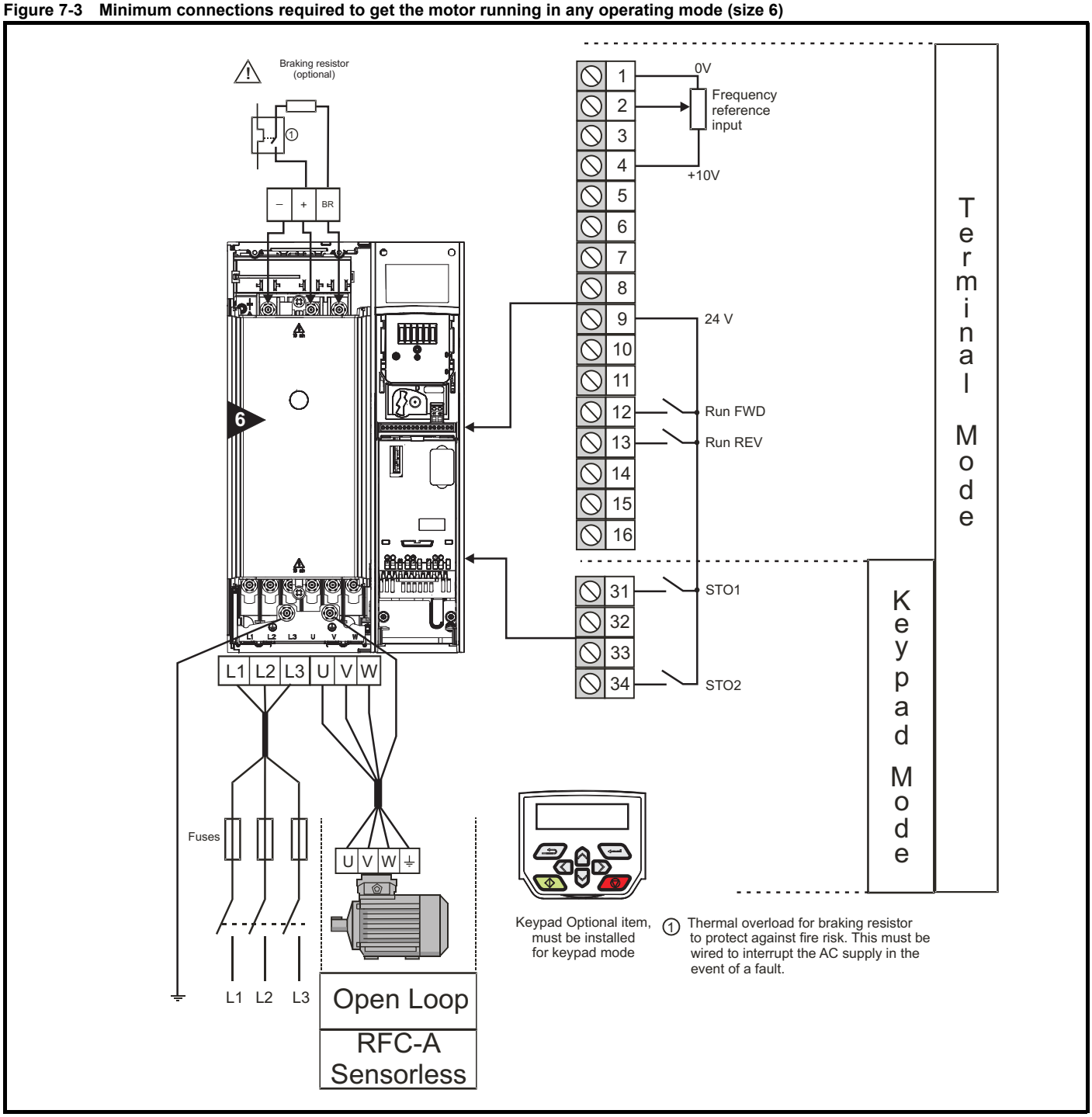
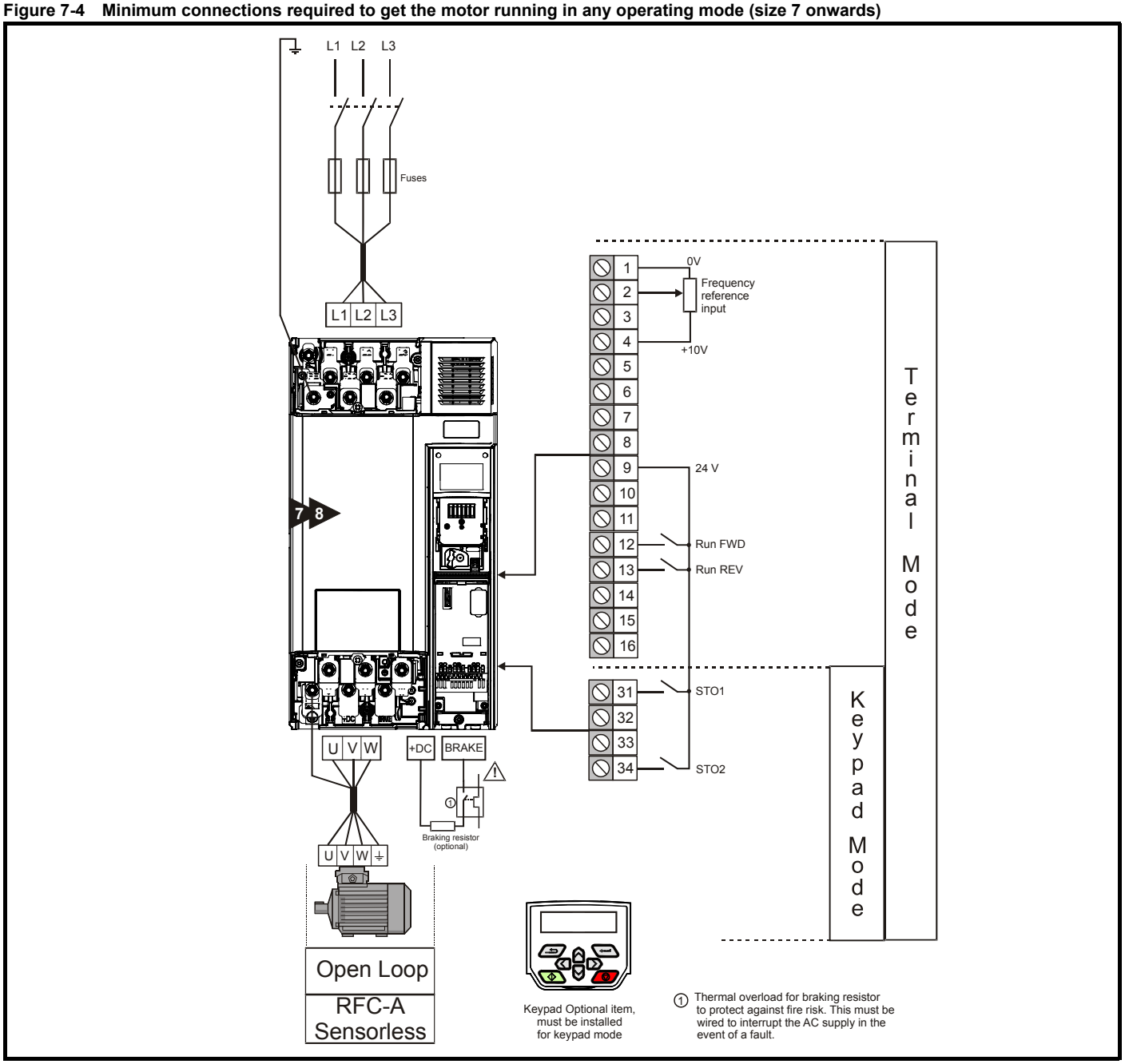
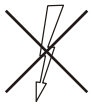
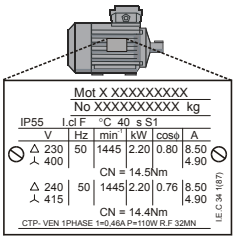
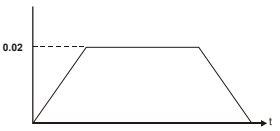
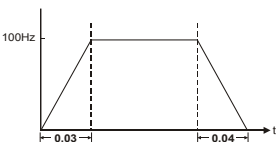
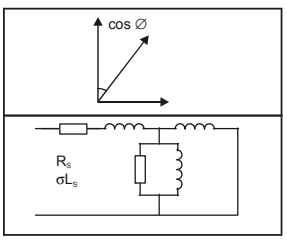


Figure 7-4 Minimum connections required to get the motor running in any operating mode (size 7 onwards)



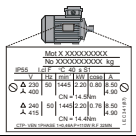
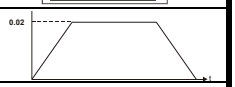
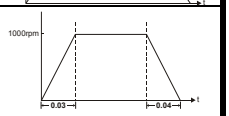
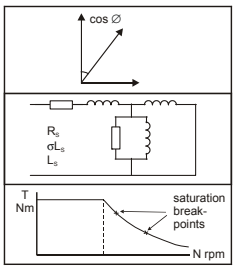
7.3 Quick start commissioning / start-up

7.3.1 Open loop

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminals 31 & 34) • Run signal is not given • Motor is connected	
Power-up the drive	Verify that open loop mode is displayed as the drive powers up. If the mode is incorrect see section 5.5 *Changing the operating mode* on page 92. Ensure: • Drive displays 'Inhibit' If the drive trips, see section 13 *Diagnostics* on page 207.	
Enter motor nameplate details	Enter: • Motor rated frequency in Pr **00.039** (Hz) • Motor rated current in Pr **00.006** (A) • Motor rated speed in Pr **00.007** (rpm) • Motor rated voltage in Pr **00.008** (V) - check if ⅄ or △ connection	
Set maximum frequency	Enter: • Maximum frequency in Pr **00.002** (Hz)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.003** (s/100 Hz) • Deceleration rate in Pr **00.004** (s/100 Hz) (If braking resistor installed, set Pr **00.028** = FAST. Also ensure Pr **10.030** and Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'Brake R Too Hot' 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. **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. • 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 **00.009**. • 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. To perform an autotune: • Set Pr **00.038** = 1 for a stationary autotune or set Pr **00.038** = 2 for a rotating autotune • Close the Drive Enable signal (apply +24 V to terminal 31 & 34). The drive will display 'ready'. • Close the run signal (apply +24 V to terminal 12 or 13). The display will flash 'Auto Tune' while the drive is performing the autotune. • Wait for the drive to display 'inhibit' and for the motor to come to a standstill. If the drive trips, see Chapter 13 *Diagnostics* on page 207. • Remove the drive enable and run signal from the drive.	
Save parameters	Select 'Save parameters' in Pr **mm.000** (alternatively enter a value of 1000 in Pr **mm.000**) and press the red  reset button.	
Run	Drive is now ready to run	

7.3.2 RFC - A mode (without position feedback)

Induction motor without position feedback

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminal 31 & 34) • Run signal is not given	
Power-up the drive	Verify that RFC-A mode is displayed as the drive powers up. If the mode is incorrect see section 5.5 *Changing the operating mode* on page 92. Ensure: • Drive displays 'inhibit' If the drive trips, see Chapter 13 *Diagnostics* on page 207.	
Enter motor nameplate details	Enter: • Motor rated frequency in Pr **00.039** (Hz) • Motor rated current in Pr **00.006** (A) • Motor rated speed in Pr **00.007** (rpm) • Motor rated voltage in Pr **00.008** (V) - check if ⅄ or △ connection	
Set maximum frequency	Enter: • Maximum frequency in Pr **00.002** (Hz)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.003** (s/100 Hz) • Deceleration rate in Pr **00.004** (s/100 Hz) (If braking resistor installed, set Pr **00.028** = FAST. Also ensure Pr **10.030**, Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'Brake R Too Hot' 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. **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. • 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 **00.009**. • 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. To perform an autotune: • Set Pr **00.038** = 1 for a stationary autotune or set Pr **00.038** = 2 for a rotating autotune • Close the drive enable signal (apply +24 V to terminal 31 & 34). The drive will display 'ready'. • Close the run signal (apply +24 V to terminal 12 or 13). The display will flash 'Auto Tune' while the drive is performing the autotune. • Wait for the drive to display 'Inhibit' and for the motor to come to a standstill If the drive trips, see Chapter 13 *Diagnostics* on page 207. • Remove the drive enable and run signal from the drive.	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1000 in Pr **mm.000**) and press red reset button.	
Run	The drive is now ready to run	

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

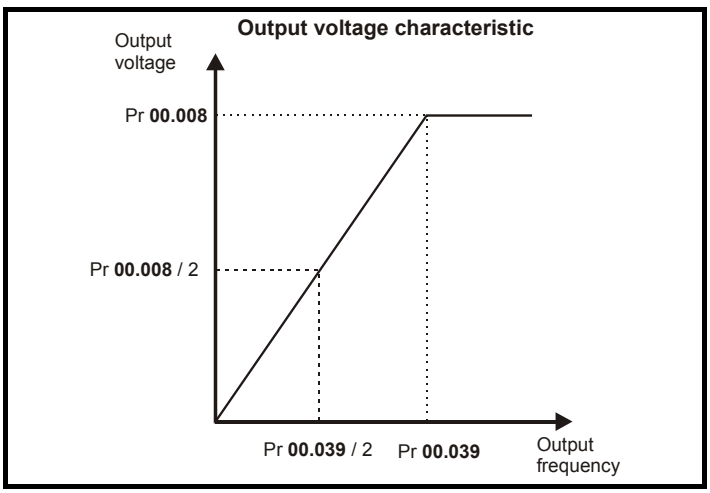
8.1.1 Open loop motor control

Pr 00.006 {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 112, for more information)
- Motor thermal overload protection (see section section 8.4 *Motor thermal protection* on page 112, 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 00.008 {05.009} *Motor Rated Voltage*	**Defines the voltage applied to the motor at rated frequency**
Pr 00.039 {05.006} *Motor Rated Frequency*	**Defines the frequency at which rated voltage is applied**

The *Motor Rated Voltage* (00.008) and the *Motor Rated Frequency* (00.039) 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 00.007 {05.008} *Motor Rated Speed*	**Defines the full load rated speed of the motor**
Pr 00.040 {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]) = **00.039** $= \left(\frac{\mathbf{00.040}}{\mathbf{2}} \times \frac{\mathbf{00.007}}{\mathbf{60}}\right)$

If Pr **00.007** 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 **00.040** is also used in the calculation of the motor speed display by the drive for a given output frequency. When Pr **00.040** is set to 'Automatic', the number of motor poles is automatically calculated from the rated frequency Pr **00.039**, and the motor rated speed Pr **00.007**.

Number of poles = 120 x (*Rated Frequency* (00.039) / *Rated Speed* (00.007)) rounded to the nearest even number.

Pr 00.043 {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* (00.006), 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 **00.038**), below).

Pr 00.038 {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 **00.009**. To perform a Stationary autotune, set Pr **00.038** to 1, and provide the drive with both an enable signal (on terminals 31 & 34) 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* (05.006) 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* (05.010). To perform a Rotating autotune, set Pr **00.038** to 2, and provide the drive with both an enable signal (on terminals 31 & 34) 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, 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 00.041 {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*, *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 **00.038** *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* (00.041) is changed to Ur mode. The *Stator Resistance* (05.017) parameter is written to, and along with the *Control Mode* (00.041), 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

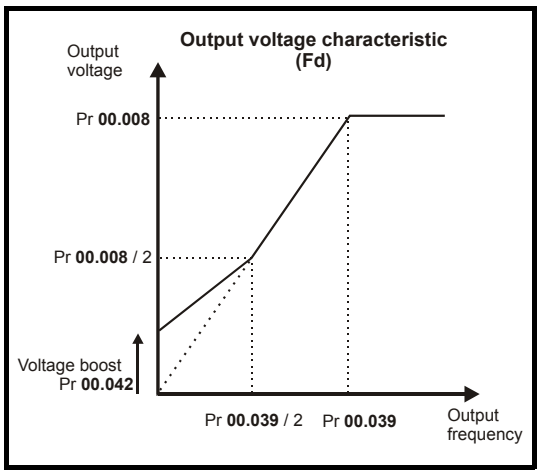
The stator resistance is not used in the control of the motor, instead a fixed characteristic with low frequency voltage boost as defined by Pr **00.042**, is used. Fixed boost mode should be used when the drive is controlling multiple motors. There are two settings of fixed boost available:

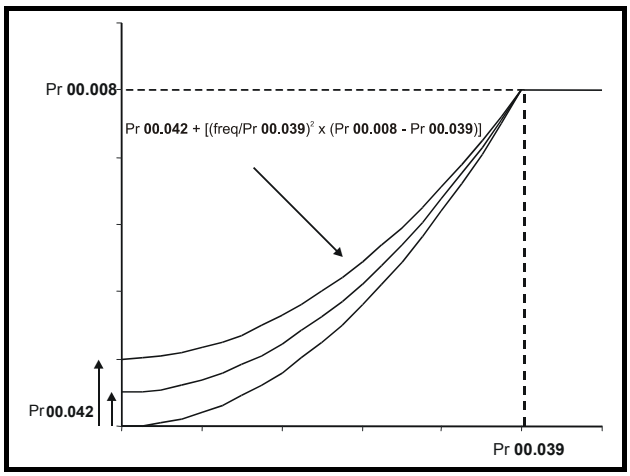
(2) **Fixed =** This mode provides the motor with a linear voltage characteristic from 0 Hz to *Motor Rated Frequency* (00.039), and then a constant voltage above rated frequency.

(5) **Square =** This mode provides the motor with a square law voltage characteristic from 0 Hz to *Motor Rated Frequency* (00.039), 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.

Pr 00.041 {05.014} *Control Mode (cont)*

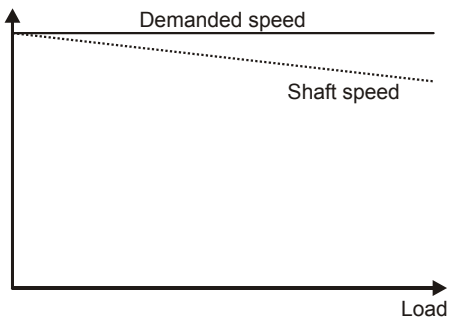
For both these modes, at low frequencies (from 0 Hz to ½ x Pr **00.039**) a voltage boost is applied as defined by Pr **00.042** as shown below:





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 a 1 (this is the default setting), and the motor rated speed must be entered in Pr **00.007** (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 **00.007**, slip compensation will be disabled. If too small a value is entered in Pr **00.007**, 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, 6pole =1000 rpm, 8 pole = 750 rpm

8.1.2 RFC-A mode

Induction motor without Position feedback

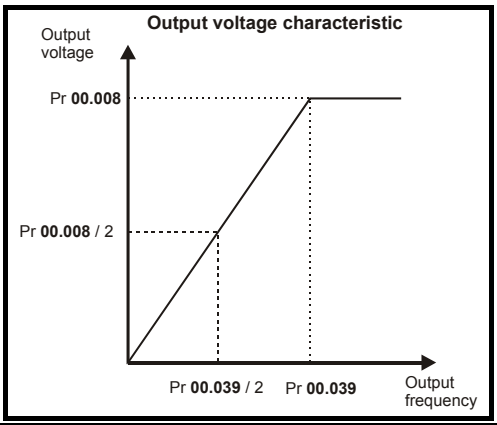
Pr 00.006 {05.007} *Motor Rated Current*	**Defines the maximum motor continuous current**

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 112, for more information).
- Motor thermal overload protection (see section 8.4 *Motor thermal protection* on page 112, for more information)
- Vector control algorithm

Pr 00.008 {05.009} *Motor Rated Voltage*	**Defines the voltage applied to the motor at rated frequency**
Pr 00.039 {05.006} *Motor Rated Frequency*	**Defines the frequency at which rated voltage is applied**

The *Motor Rated Voltage* (00.008) and the *Motor Rated Frequency* (Pr **00.039**) are used to define the voltage to frequency characteristic applied to the motor (see *Control Mode* (00.041), 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 (*00.007), later in this table).



Pr 00.007 {05.008} *Motor Rated Speed*	**Defines the full load rated speed of the motor**
Pr 00.040 {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 **00.040** is set to 'Automatic', the number of motor poles is automatically calculated from the *Motor Rated Frequency* (00.039), and the *Motor Rated Speed* (00.007).

Number of poles = 120 x (Motor *Rated Frequency* (00.039 / Motor *Rated Speed* (00.007) rounded to the nearest even number.

Pr 00.009 {5.10} *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* (00.006) 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 **00.038**), later in this table).

Pr 00.038 {05.012} *Autotune*

There are three autotune tests available in RFC-A mode, a stationary test, a rotating test and an inertia 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 **00.038** 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 **00.009**. To perform a Stationary autotune, set Pr **00.038** 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* (05.006) 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 **00.038** to 2, and provide the drive with both an enable signal (on terminal 31 & 32) and a run signal (on terminal 12 or 13).
- The inertia measurement test can measure the total inertia of the load and the motor. This is used to set the frequency loop gains (see Frequency loop gains) and to provide torque feed-forwards when required during acceleration. During the inertia measurement test motor is accelerated with the currently selected ramps up to a speed of *Motor Rated Speed* (05.008) / 4, and this speed is maintained at this level for 60 seconds. The *Motor And Load Inertia* (03.018) is measured. If the required speed is not achieved on the final attempt the test is aborted and an Autotune trip is initiated. To perform an Inertia measurement autotune, set Pr **00.038** 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 **00.038**, 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 **00.007** {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 **00.008** {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**

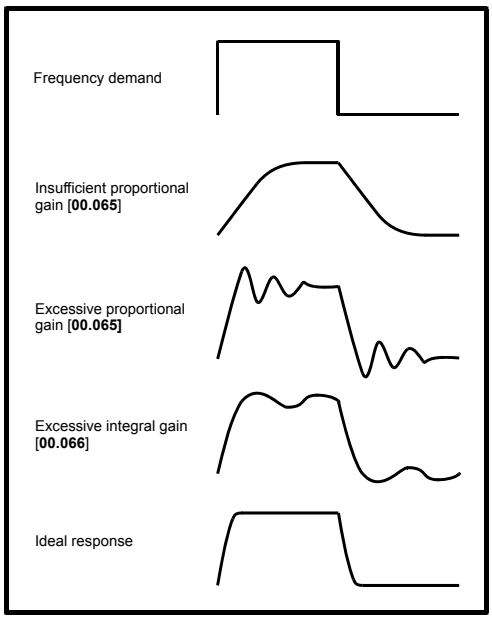
The differential gain is provided in the feedback of the frequency controller to give additional damping. The differential term is implemented in a way that does not introduce excessive noise normally associated with this type of function. Increasing the differential term reduces the overshoot produced 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* (11.032).

The values for the Heavy Duty rating can be found in section 2.2 *Ratings* on page 12.

Size 5 onwards:

The maximum motor rated current allowed by the drive is greater than the *Maximum Heavy Duty Current Rating* (11.032). The ratio between the Normal Duty rating and the *Maximum Heavy Duty Current Rating* (11.032) varies between drive sizes. The values for the Normal and Heavy Duty rating can be found in section 2.2 *Ratings* on page 12. If the *Motor Rated Current* (00.006) is set above the *Maximum Heavy Duty Current Rating* (11.032), 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 current for open loop mode.
- 175 % x motor rated 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 **00.006** / 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 = $I / (K_1 \times I_{Rated})^2$

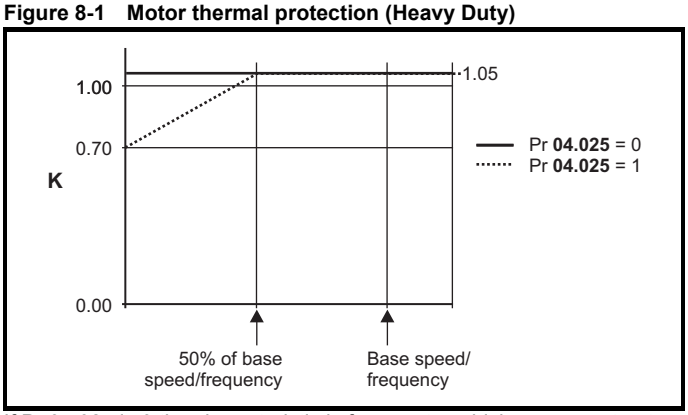
Where:

I = *Current Magnitude* (04.001)

I_{Rated} = *Motor Rated Current* (05.007)

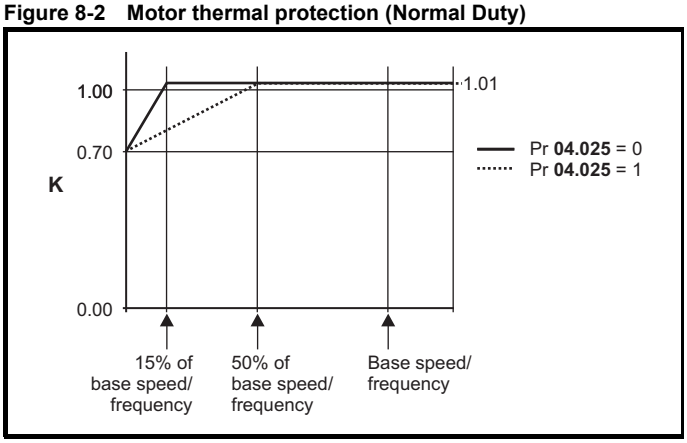
If *Motor Rated Current* (05.007) ≤ *Maximum Heavy Duty Current* (11.032)

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 is reset to zero at power-up and accumulates the temperature of the motor while them drive remains powered-up. If the rated current defined by Pr **05.007** 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 **05.018** (dependent on drive size). The available switching frequencies are shown below.

Table 8-1 Available switching frequencies

Drive size	Model	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
1 to 8	All	✓	✓	✓	✓	✓	✓	✓	✓	✓

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 *section 12.1.1 Power and current ratings (Derating for switching frequency and temperature)* on page 183.
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.

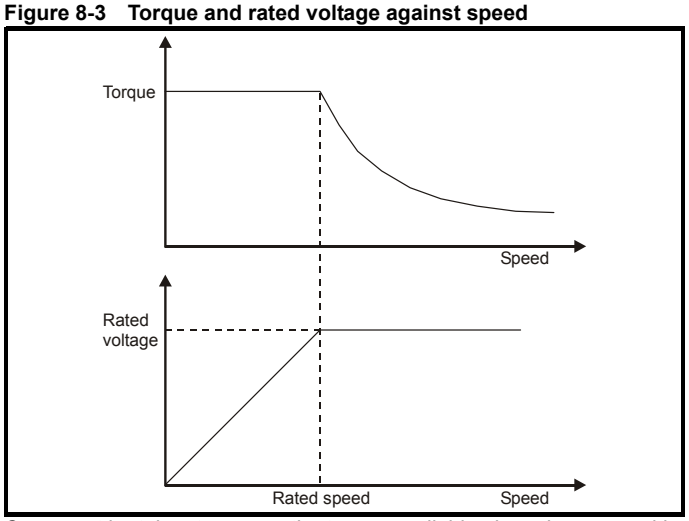
Table 8-2 Sample rates for various control tasks at each switching frequency

	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 4 kHz = 125 µs 8 kHz = 125 µs 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. The modulation depth will increase beyond unity; first producing trapezoidal and then quasi-square waveforms.

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.

9 NV Media Card Operation

9.1 Introduction

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

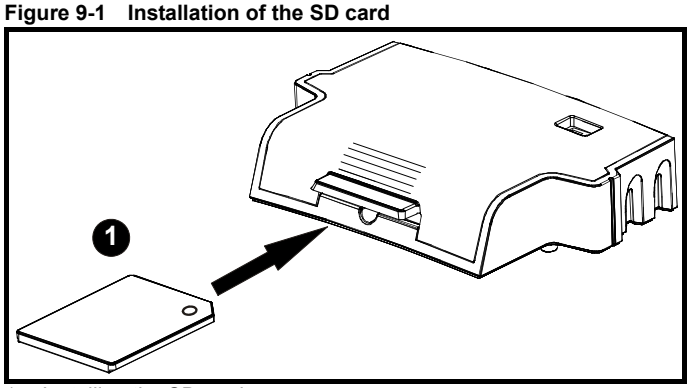
The SD card can be used for:

- Parameter copying between drives
- Saving drive parameter sets
- Saving onboard user program

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

The drive only communicates with the NV Media Card when commanded to read or write, meaning the card may be "hot swapped".

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 / from 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.

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 {Card Product} 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 {Card Drive Mode} 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 {Card Rating} 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 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 the parameters are set to their default values. After the parameters have been transferred and saved to non-volatile memory a {Card Option} trip is given as a warning.

9.2.4 Different current ratings

If any of the current rating parameters (Maximum Heavy Duty Rating (11.032), 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) *Frequency Controller Integral Gain Ki1* (03.011) *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)	[Source *Full Scale Current Kc* (11.061)] / [Target *Full Scale Current Kc* (11.061)]
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)	[Source *Full Scale Current Kc* (11.061)] / [Target *Full Scale Current Kc* (11.061)]

9.2.5 Different variable maximums

It should be noted that if ratings of the source and target drives are different, or the option module installed to 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 **mm.000** for NV media card operations. The yyy represents the file identification number.

Table 9-1 Functions in Pr mm.000

Value	Action
2001	Transfer the drive parameters to parameter file 001 and sets the block as bootable. This will include the parameters from the attached option module.
4yyy	Transfer the drive parameters to parameter file yyy. This will include the parameters from attached option module.
5yyy	Transfer the onboard user program to onboard user program file yyy.
6yyy	Load the drive parameters from parameter file yyy or the onboard user program from onboard user program 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* **mm.000** 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.
40yyy	Backup all drive data (parameter differences from defaults, an onboard user program and miscellaneous option data), including the drive name; the store will occur to the </fs/MCDF/driveyyy/> folder; if it does not exist, it will be created. Since the name is stored, this is a backup, rather than a clone. The command value will be cleared when all drive and option data has been saved.
60yyy	Load all drive data (parameter differences from defaults, an onboard user program and miscellaneous option data); the load will come from the <fs/MCDF/driveyyy/> folder. The command value will not be cleared until the drive and all option data have been loaded.

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** and Pr **11.039**.

11.038	NV Media Card File Type					
RO	Txt	ND	NC	PT		
⇳	0 to 5			⇨	0	

Displays the type of data block selected with Pr **11.037**.

Pr 11.038	String	Type
0	None	No file selected
1	Open-loop	Open-loop mode parameter file
2	RFC-A	RFC-A mode parameter file
3	Reserved	Reserved
4	Reserved	Reserved
5	User Program	Onboard user program 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	Parameter Cloning					
RW	Txt		NC			US*
⇳	None (0), Read (1), Program (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 13 *Diagnostics* on page 207 for more information on NV Media Card trips.

10 Onboard PLC

10.1 Onboard PLC and Machine Control Studio

The drive has the ability to store and execute a 16 kB 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 Unidrive M 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 Unidrive M 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 Unidrive M.

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
- Sequences routines
- Custom control words.

10.3 Features

The Unidrive M 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 16 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. If it is restarted by setting *Onboard User Program: Enable* (11.047) to a non-zero value the background task starts from the beginning.

1 - Run the User Program

The user program will execute.

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 ladder 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 13 *Diagnostics* on page 207 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 and scope
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
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

Feature	Related parameters (Pr)												
Acceleration rates	02.010	02.011 to 02.019		02.032	02.033	02.034	02.002						
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
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	07.028	07.031	07.052	07.065	07.066	07.067	07.068	
Analog output 1	07.019	07.020			07.055	07.099							
Analog output 2	07.022	07.023	07.024	07.056	07.102								
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		05.024	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												
Comms	11.023 to 11.027												
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 I/O T11	08.002	08.012	08.022		08.082	08.122							
Digital I/O 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						
Digital input T15	08.006	08.016	08.026	08.036	08.086	08.126							
Digital input T16	08.007	08.017	08.027	08.036	08.087	08.127							
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	08.039		08.040	06.038								
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								
Frequency reference selection	01.014	01.015											
Frequency slaving	03.001	03.013	03.014	03.015	03.016	03.017	03.018						
Hard speed 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	05.012	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									
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					

Feature	Related parameters (Pr)												
Maximum frequency	01.006												
Menu 0 set-up				Menu 22									
Minimum frequency	01.007	10.004											
Motor map	05.006	05.007	05.008	05.009	05.010	05.011							
Motor map 2	Menu 21		11.45										
Motorized potentiometer	09.021	09.022	09.023	09.024	09.025	09.026	09.027	09.028	09.003				
Offset reference	01.004	01.038	01.009										
Onboard PLC	11.047 to 11.051			11.055									
Open loop vector mode	05.014	05.017											
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												
Positive logic	08.010												
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					
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	10.033			10.034	10.035	10.036	10.001						
RFC mode (encoder less CLV mode)				05.040									
Scope	09.055 to 09.073												
S ramp	02.006	02.007											
Sample rates	05.018												
SAFE TORQUE OFF input			08.039	08.040									
Security code	11.030	11.044											
Serial comms	11.023 to 11.027												
Skip speeds	01.029	01.030	01.031	01.032	01.033	01.034	01.035						
Slip compensation	05.027	05.008											
NV media card	11.036 to 11.039			11.042									
Firmware version	11.029	11.035											
Frequency controller	03.010 to 03.017												
Estimated frequency	03.002	03.003	03.004										
Reference selection	01.014	01.015	01.049	01.050	01.001								
Status word	10.040												
Supply		05.005	06.046										
Switching frequency	05.018	05.035	07.034	07.035									
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			08.035	07.047	07.050								
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							
Time - run log				06.019	06.017	06.018							
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										
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											

11.0.1 Parameter ranges and Variable minimum/maximums:

Some parameters in the drive have a variable range with a variable minimum and a variable maximum values 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 the value listed below
Definition	VM_AC_VOLTAGE[MAX] is drive voltage rating dependent. See Table 11-4 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 the value listed below
Definition	VM_AC_VOLTAGE_SET[MAX] is drive voltage rating dependent. See Table 11-4 VM_AC_VOLTAGE_SET[MIN] = 0

VM_ACCEL_RATE	Maximum applied to the ramp rate parameters
Units	s / 100 Hz
Range of [MIN]	Open-loop: 0.0 RFC-A: 0.0
Range of [MAX]	Open-loop: 0.0 to 3200.0 RFC-A: 0.0 to 3200.0
Definition	If Ramp Rate Units (02.039) = 0: VM_ACCEL_RATE[MAX] = 3200.0 If Ramp Rate Units (02.039) = 1: VM_ACCEL_RATE[MAX] = 3200.0 x Pr **01.006** / 100.00 VM_ACCEL_RATE[MIN] = 0.0 If the second motor map is selected (Pr **11.045** = 1) Pr **21.001** is used instead of Pr **01.006**

VM_DC_VOLTAGE	Range applied to parameters showing DC voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to the value listed below
Definition	VM_DC_VOLTAGE[MAX] is the full scale d.c. link voltage feedback (over voltage trip level) for the drive. This level is drive voltage rating dependent. See Table 11-4 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 the value listed below
Definition	VM_DC_VOLTAGE_SET[MAX] is drive voltage rating dependent. See Table 11-4 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). VM_DRIVE_CURRENT[MIN] = - VM_DRIVE_CURRENT[MAX]

VM_DRIVE_CURRENT_UNIPOLAR	Unipolar version of VM_DRIVE_CURRENT
Units	A
Range of [MIN]	0.00
Range of [MAX]	0.00 to 9999.99
Definition	VM_DRIVE_CURRENT_UNIPOLAR[MAX] = VM_DRIVE_CURRENT[MAX] VM_DRIVE_CURRENT_UNIPOLAR[MIN] = 0.00

VM_HIGH_DC_VOLTAGE	Range applied to parameters showing high DC voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 1500
Definition	VM_HIGH_DC_VOLTAGE[MAX] is the full scale d.c. link voltage feedback for the high d.c. link voltage measurement which can measure the voltage if it goes above the normal full scale value. This level is drive voltage rating dependent. See Table 11-4 VM_HIGH_DC_VOLTAGE[MIN] = 0

VM_MOTOR1_CURRENT_LIMIT VM_MOTOR2_CURRENT_LIMIT	Range applied to current limit parameters
Units	%
Range of [MIN]	0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_MOTOR1_CURRENT_LIMIT[MIN] = 0.0 **Open-loop** VM_MOTOR1_CURRENT_LIMIT[MAX] = $(I_{Tlimit} / I_{Trated}) \times 100$ % Where: $I_{Tlimit} = I_{MaxRef} \times \cos(\sin^{-1}(I_{Mrated} / I_{MaxRef}))$ I_{Mrated} = Pr **05.007** $\sin \phi$ I_{Trated} = Pr **05.007** $\times \cos \phi$ $\cos \phi$ = Pr **05.010** 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). **RFC-A** VM_MOTOR1_CURRENT_LIMIT[MAX] = $(I_{Tlimit} / I_{Trated}) \times 100$ % Where: $I_{Tlimit} = I_{MaxRef} \times \cos(\sin^{-1}(I_{Mrated} / I_{MaxRef}))$ I_{Mrated} = Pr **05.007** $\times \cos \phi_1$ ITrated = Pr 05.007 x $\sin \phi_1$ ϕ_1 = cos-1 (Pr **05.010**) + ϕ_2. ϕ_1 is calculated during an autotune. See the variable minimum / maximum calculations in the *Parameter Reference Guide* for more information regarding ϕ_2. 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). 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 **VM_NEGATIVE_REF_CLAMP2**	Limits applied to the negative frequency or speed clamp
Units	Hz
Range of [MIN]	Open-loop: -550.00 to 0.00 RFC-A: -550.00 to 0.00
Range of [MAX]	Open-loop: 0.00 to 550.00 RFC-A: 0.00 to 550.00
Definition	See table below VM_NEGATIVE_REF_CLAMP2 is defined in the same way except that Pr **21.001** is used instead of Pr **01.006**

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_POSITIVE_REF_CLAMP	Limits applied to the positive frequency or speed reference clamp
Units	Hz
Range of [MIN]	Open-loop: 0.00 RFC-A: 0.00
Range of [MAX]	Open-loop: 550.00 RFC-A: 550.00
Definition	In all modes VM_POSITIVE_REF_CLAMP[MAX] is fixed at 550.00 In all modes VM_POSITIVE_REF_CLAMP[MIN] is fixed at 0.0

VM_POWER	Range applied to parameters that either set or display power
Units	kW
Range of [MIN]	-999.99 to 0.00
Range of [MAX]	0.00 to 999.99
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 a.c. output voltage, at maximum controlled current and unity power factor. VM_POWER[MAX] = √3 x VM_AC_VOLTAGE[MAX] x VM_DRIVE_CURRENT[MAX] / 1000 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. VM_RATED_CURRENT [MIN] = 0.00

VM_FREQ	Range applied to parameters showing frequency
Units	Hz
Range of [MIN]	Open-loop, RFC-A: -550.00 to 0.00
Range of [MAX]	Open-loop, RFC-A: 0.00 to 550.00
Definition	This variable minimum/maximum defines the range of frequency monitoring parameters. To allow headroom for overshoot the range is set to twice the range of the frequency references. VM_FREQ[MAX] = 2 x VM_SPEED_FREQ_REF[MAX] VM_FREQ[MIN] = 2 x VM_SPEED_FREQ_REF[MIN]

VM_FREQ_UNIPOLAR	Unipolar version of VM_FREQ
Units	Hz
Range of [MIN]	Open-loop, RFC-A: 0.00
Range of [MAX]	Open-loop, RFC-A: 0.00 to 550.00
Definition	VM_FREQ_UNIPOLAR[MAX] = VM_FREQ[MAX] VM_FREQ_UNIPOLAR[MIN] = 0.00

VM_SPEED_FREQ_REF	Range applied to the frequency or speed reference parameters
Units	Hz
Range of [MIN]	Open-loop: -550.00 to 0.00 RFC-A: -550.00.0 to 0.00
Range of [MAX]	Open-loop: 0.00 to 550.00 RFC-A: 0.00 to 550.00
Definition	If Pr **01.008** = 0: VM_SPEED_FREQ_REF[MAX] = Pr **01.006** If Pr **01.008** = 1: VM_SPEED_FREQ_REF[MAX] = Pr **01.006** or |Pr **01.007**|, whichever is larger. If the second motor map is selected (Pr **11.045** = 1) Pr **21.001** is used instead of Pr **01.006** and Pr **21.002** instead of Pr **01.007**. 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]	Open-loop: 0.00 RFC-A: 0.00
Range of [MAX]	Open-loop: 0.00 to 550.00 RFC-A: 0.00 to 550.00
Definition	VM_SPEED_FREQ_REF_UNIPOLAR[MAX] = VM_SPEED_FREQ_REF[MAX] VM_SPEED_FREQ_REF_UNIPOLAR[MIN] = 0.00

VM_SPEED_FREQ_USER_REFS	Range applied to some Menu 1 reference parameters
Units	Hz
Range of [MIN]	Open-loop: -550.00 to 0.00 RFC-A: -550.00 to 0.00
Range of [MAX]	Open-loop: 0.00 to 550.00 RFC-A: 0.00 to 550.00
Definition	VM_SPEED_FREQ_USER_REFS[MAX] = VM_SPEED_FREQ_REF[MAX]

***Negative Reference Clamp Enable* (01.008)**	***Bipolar Reference Enable* (01.010)**	**VM_SPEED_FREQ_USER_REFS [MIN]**
0	0	Pr **01.007**
0	1	-VM_SPEED_FREQ_REF[MAX]
1	0	0.00
1	1	-VM_SPEED_FREQ_REF[MAX]

If the second motor map is selected (Pr **11.045** = 1) Pr **21.002** is used instead of Pr **01.007**.

VM_STD_UNDER_VOLTS	Range applied the standard under-voltage threshold
Units	V
Range of [MIN]	0 to 1150
Range of [MAX]	0 to 1150
Definition	VM_STD_UNDER_VOLTS[MAX] = VM_DC_VOLTAGE_SET VM_STD_UNDER_VOLTS[MIN] is voltage rating dependent. See Table 11-4

VM_SUPPLY_LOSS_LEVEL	Range applied to the supply loss threshold
Units	V
Range of [MIN]	Open-loop: 0 to 1150 RFC-A: 0 to 1150
Range of [MAX]	Open-loop: 0 to 1150 RFC-A: 0 to 1150
Definition	VM_SUPPLY_LOSS_LEVEL[MAX] = VM_DC_VOLTAGE_SET[MAX] 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
Definition	*Select Motor 2 Parameters* (11.045) / VM_TORQUE_CURRENT [MAX] 0 / VM_MOTOR1_CURRENT_LIMIT[MAX] 1 / VM_MOTOR2_CURRENT_LIMIT[MAX] 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] VM_TORQUE_CURRENT_UNIPOLAR[MIN] =0.0

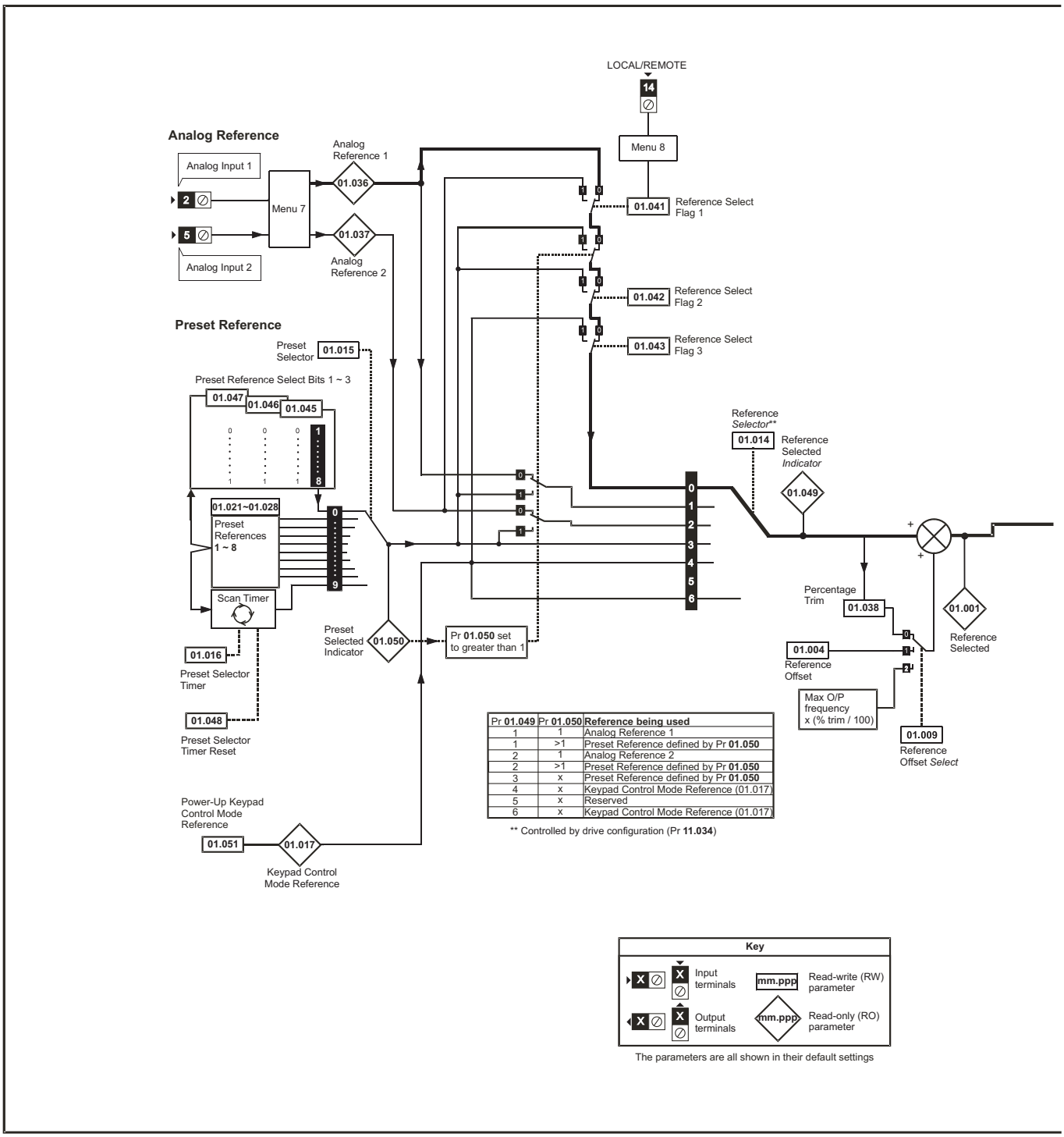
VM_USER_CURRENT	Range applied to torque reference and percentage load parameters with one decimal place
Units	%
Range of [MIN]	-1000.0 to 0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_USER_CURRENT[MAX] = *User Current Maximum Scaling* (04.024) VM_USER_CURRENT[MIN] = -VM_USER_CURRENT[MAX]

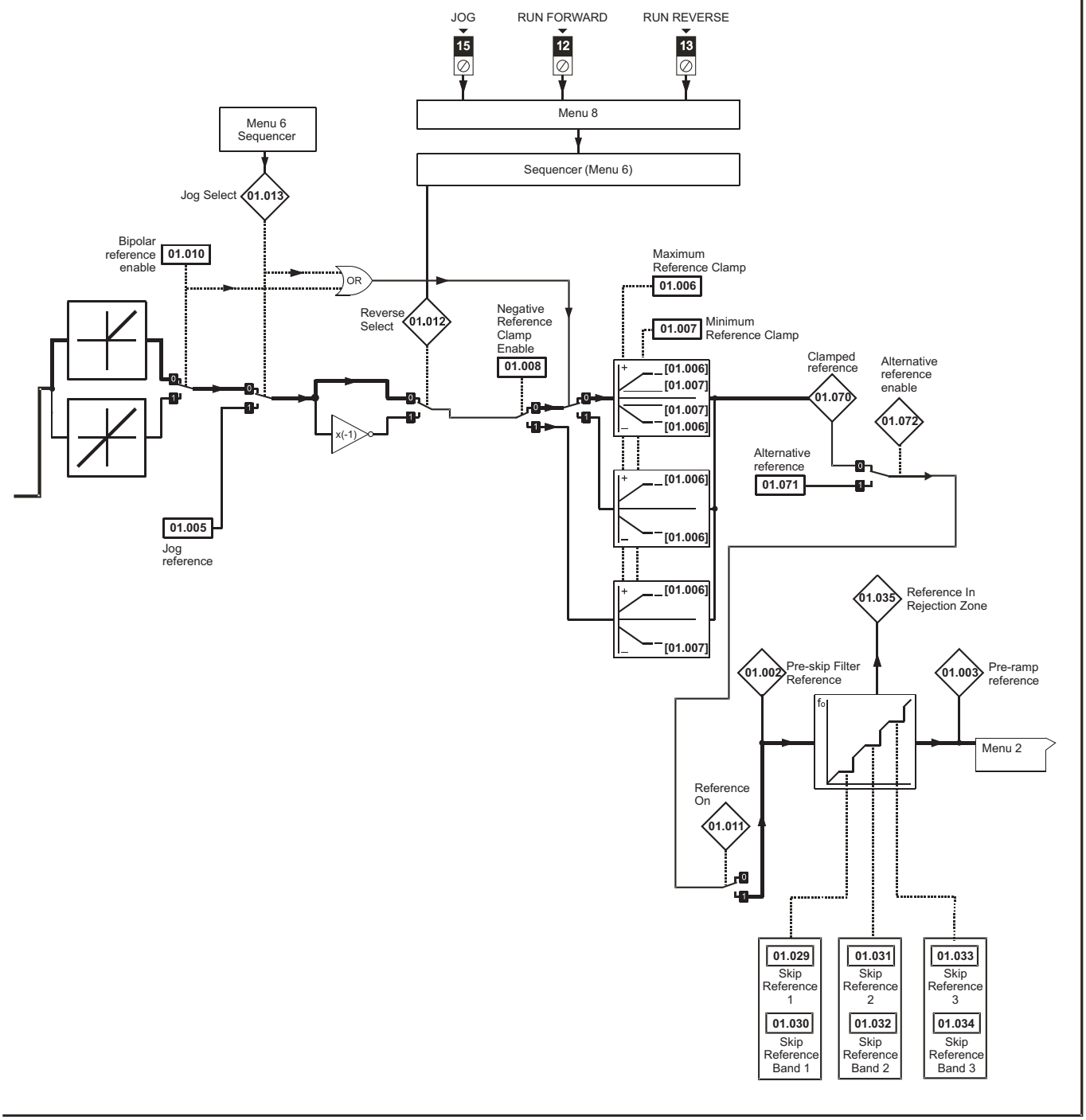
Table 11-4 Voltage ratings dependant values

Variable min/max	Voltage level				
	100 V	**200 V**	**400 V**	**575 V**	**690 V**
VM_DC_VOLTAGE_SET(MAX]	410		800	955	1150
VM_DC_VOLTAGE(MAX]	415		830	990	1190
VM_AC_VOLTAGE_SET(MAX]	240		480	575	690
VM_AC_VOLTAGE[MAX]	325		650	780	930
VM_STD_UNDER_VOLTS[MIN]	175		330	435	435
VM_SUPPLY_LOSS_LEVEL{MIN]	205		410	540	540
VM_HIGH_DC_VOLTAGE	1500				

11.1 Menu 1: Frequency reference

Figure 11-1 Menu 1 logic diagram



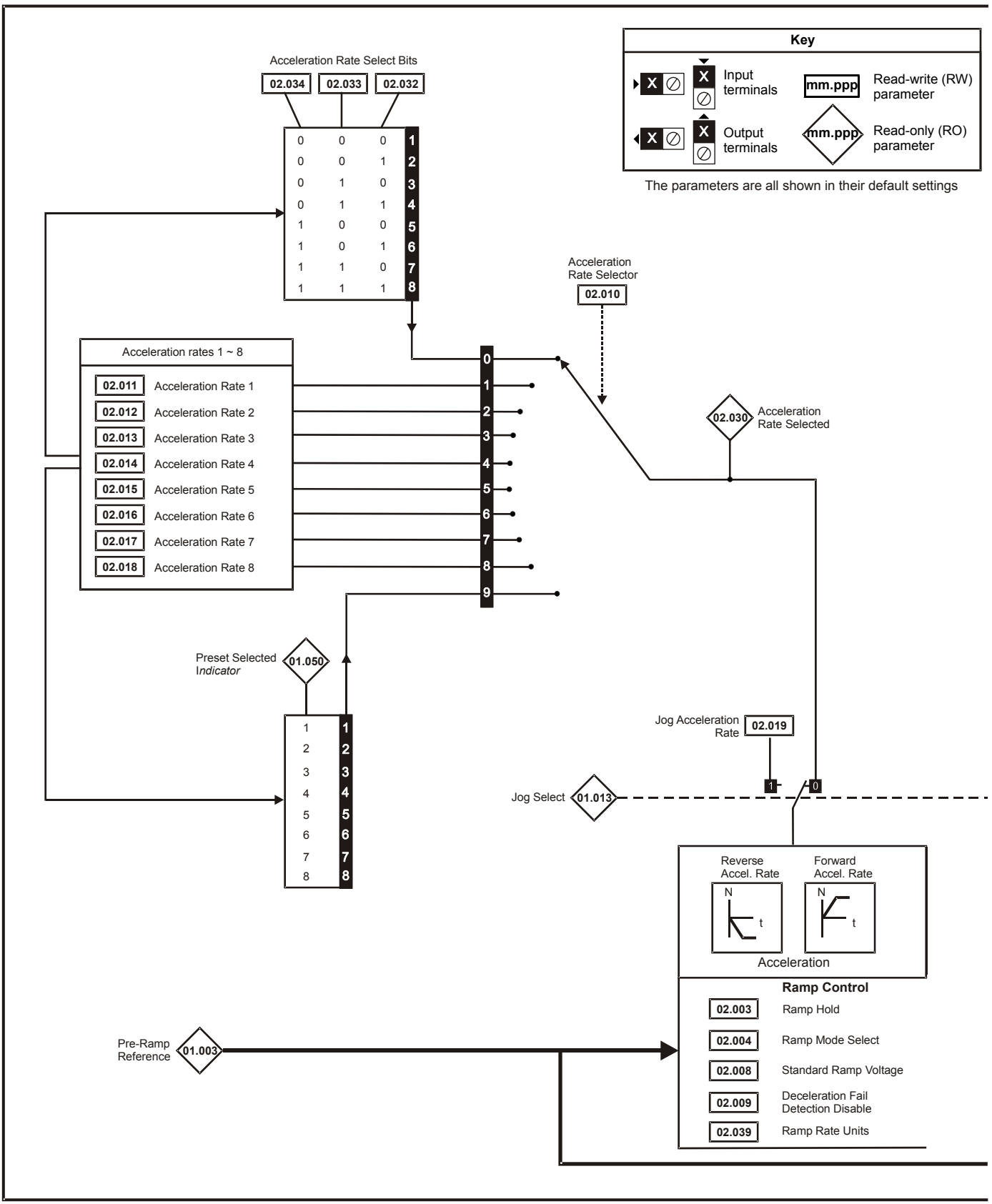

JOG
RUN FORWARD
RUN REVERSE
15
12
13
Menu 8
Sequencer (Menu 6)
Menu 6 Sequencer
Jog Select 01.013
Bipolar reference enable 01.010
OR
Reverse Select 01.012
Negative Reference Clamp Enable 01.008
Maximum Reference Clamp 01.006
01.007 Minimum Reference Clamp
[01.006]
[01.007]
[01.007]
[01.006]
Clamped reference 01.070
Alternative reference enable 01.072
Alternative reference 01.071
x(-1)
01.005 Jog reference
01.035 Reference In Rejection Zone
01.002 Pre-skip Filter Reference
01.003 Pre-ramp reference
fo
Menu 2
Reference On 01.011
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

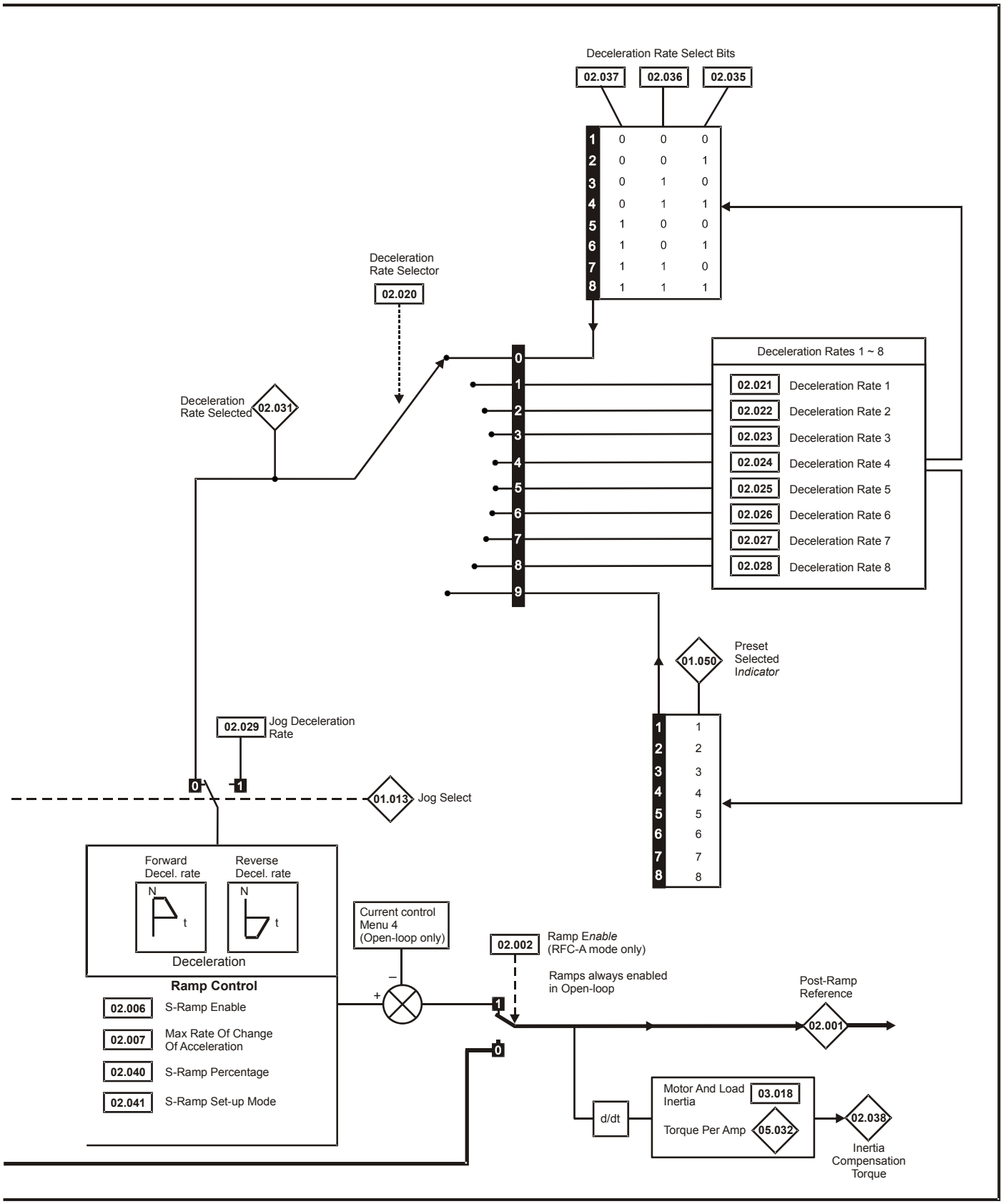
Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
01.001	Reference Selected	±VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	
01.002	Pre-skip Filter Reference	±VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	
01.003	Pre-ramp Reference	±VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	
01.004	Reference Offset	±VM_SPEED_FREQ_REF 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 Reference Clamp	±VM_POSITIVE_REF_CLAMP Hz		50Hz: 50.00 Hz 60Hz: 60.00 Hz		RW	Num				US
01.007	Minimum Reference Clamp	±VM_NEGATIVE_REF_CLAMP1 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 Preset (1), A2 Preset (2), Preset (3), Keypad (4), Reserved (5), Keypad Ref (6)		A1 A2 (0)		RW	Txt				US
01.015	Preset Selector	0 to 9		0		RW	Num				US
01.016	Preset Selector Timer	0.0 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	±VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.022	Preset Reference 2	±VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.023	Preset Reference 3	±VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.024	Preset Reference 4	±VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.025	Preset Reference 5	±VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.026	Preset Reference 6	±VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.027	Preset Reference 7	±VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.028	Preset Reference 8	±VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.029	Skip Reference 1	0.00 to VM_SPEED_FREQ_REF_UNIPOLAR 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 VM_SPEED_FREQ_REF_UNIPOLAR 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 VM_SPEED_FREQ_REF_UNIPOLAR 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), Forward (1), Reverse (2)		None (0)		RW	Txt				
01.069	Reference in rpm	±VM_SPEED_FREQ_REF rpm				RO	Num	ND	NC	PT	
01.070	Clamped Reference	±VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	
01.071	Alternative Reference	±VM_SPEED_FREQ_REF Hz		0.00 Hz		RO	Num		NC		
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

11.2 Menu 2: Ramps

Figure 11-2 Menu 2 logic diagram




Deceleration Rate Select Bits
02.037
02.036
02.035
1 0 0 0
2 0 0 1
3 0 1 0
4 0 1 1
5 1 0 0
6 1 0 1
7 1 1 0
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 1
2 2
3 3
4 4
5 5
6 6
7 7
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
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	±VM_SPEED_FREQ_REF 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), Standard (1), Std boost (2), Fast boost (3)		Standard (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 s²/100Hz		RW	Num				US
02.008	Standard Ramp Voltage	±VM_DC_VOLTAGE_SET V		110V drive: 375 V, 200V drive: 375 V 400V drive 50Hz: 750 V, 400V drive 60Hz: 775 V 575V drive: 895 V, 690V drive: 1075 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	±VM_ACCEL_RATE s		5.0 s		RW	Num				US
02.012	Acceleration Rate 2	±VM_ACCEL_RATE s		5.0 s		RW	Num				US
02.013	Acceleration Rate 3	±VM_ACCEL_RATE s		5.0 s		RW	Num				US
02.014	Acceleration Rate 4	±VM_ACCEL_RATE s		5.0 s		RW	Num				US
02.015	Acceleration Rate 5	±VM_ACCEL_RATE s		5.0 s		RW	Num				US
02.016	Acceleration Rate 6	±VM_ACCEL_RATE s		5.0 s		RW	Num				US
02.017	Acceleration Rate 7	±VM_ACCEL_RATE s		5.0 s		RW	Num				US
02.018	Acceleration Rate 8	±VM_ACCEL_RATE s		5.0 s		RW	Num				US
02.019	Jog Acceleration Rate	±VM_ACCEL_RATE s		0.2 s		RW	Num				US
02.020	Deceleration Rate Selector	0 to 9		0		RW	Num				US
02.021	Deceleration Rate 1	±VM_ACCEL_RATE s		10.0 s		RW	Num				US
02.022	Deceleration Rate 2	±VM_ACCEL_RATE s		10.0 s		RW	Num				US
02.023	Deceleration Rate 3	±VM_ACCEL_RATE s		10.0 s		RW	Num				US
02.024	Deceleration Rate 4	±VM_ACCEL_RATE s		10.0 s		RW	Num				US
02.025	Deceleration Rate 5	±VM_ACCEL_RATE s		10.0 s		RW	Num				US
02.026	Deceleration Rate 6	±VM_ACCEL_RATE s		10.0 s		RW	Num				US
02.027	Deceleration Rate 7	±VM_ACCEL_RATE s		10.0 s		RW	Num				US
02.028	Deceleration Rate 8	±VM_ACCEL_RATE s		10.0 s		RW	Num				US
02.029	Jog Deceleration Rate	±VM_ACCEL_RATE s		0.2 s		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 to 1		0		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 s²/100Hz		0.0 s²/100Hz		RW	Num				US
02.043	Maximum Rate Of Change Of Acceleration 2	0.0 to 300.0 s²/100Hz		0.0 s²/100Hz		RW	Num				US
02.044	Maximum Rate Of Change Of Acceleration 3	0.0 to 300.0 s²/100Hz		0.0 s²/100Hz		RW	Num				US
02.045	Maximum Rate Of Change Of Acceleration 4	0.0 to 300.0 s²/100Hz		0.0 s²/100Hz		RW	Num				US
02.048	Start Frequency	±VM_SPEED_FREQ_REF Hz		0.00 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

11.3 Menu 3: Frequency control

Figure 11-3 Menu 3 Open-loop logic diagram

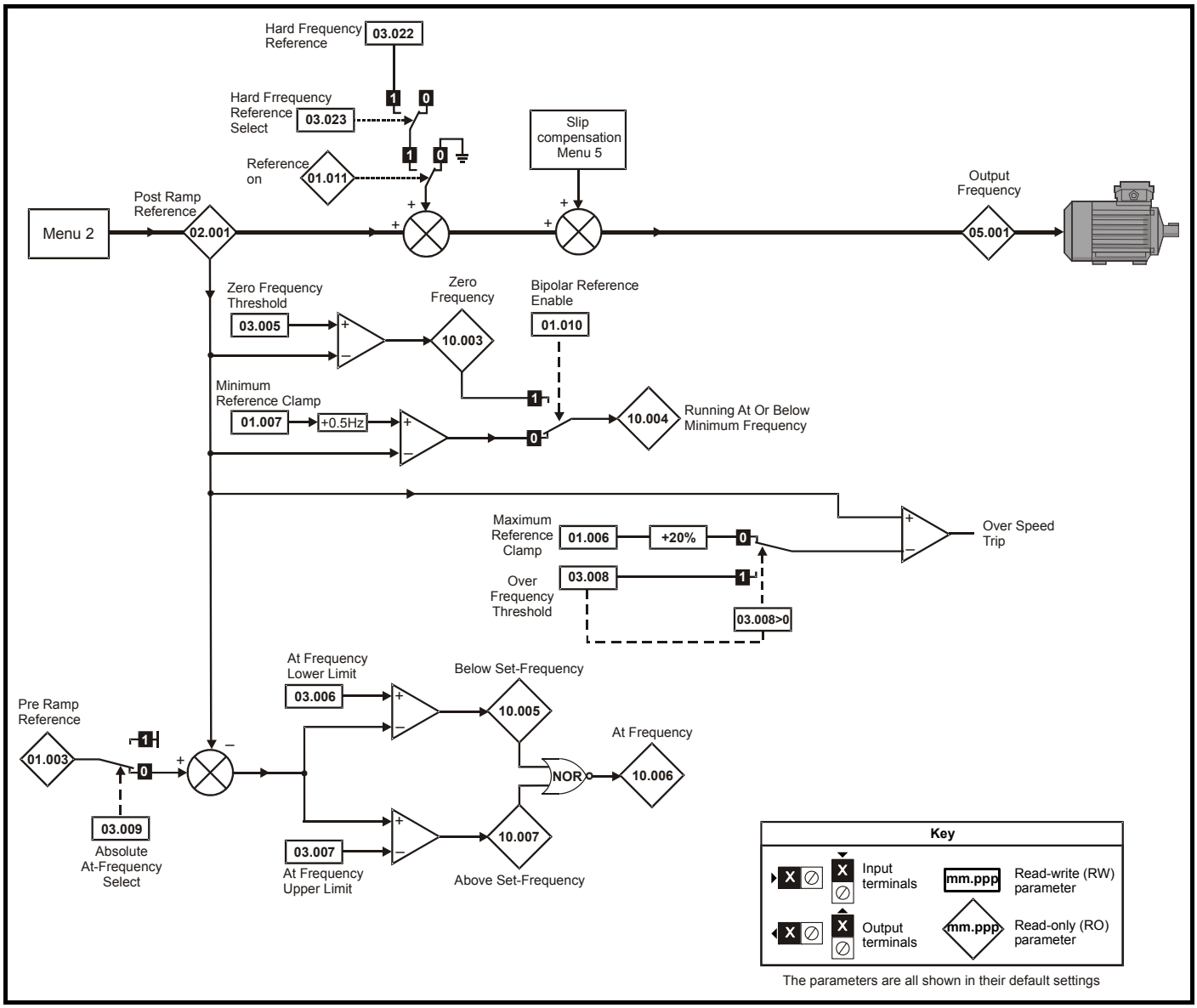
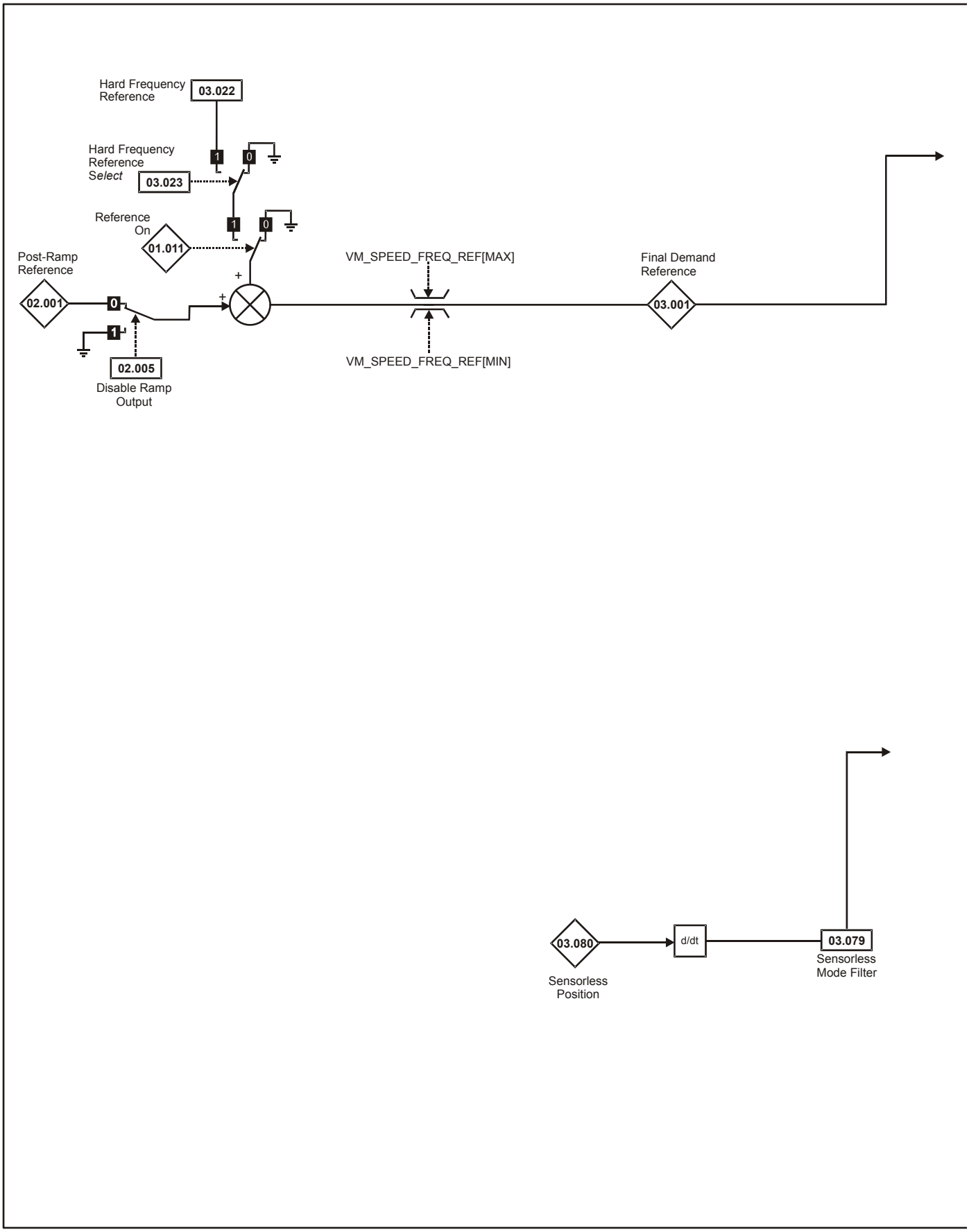
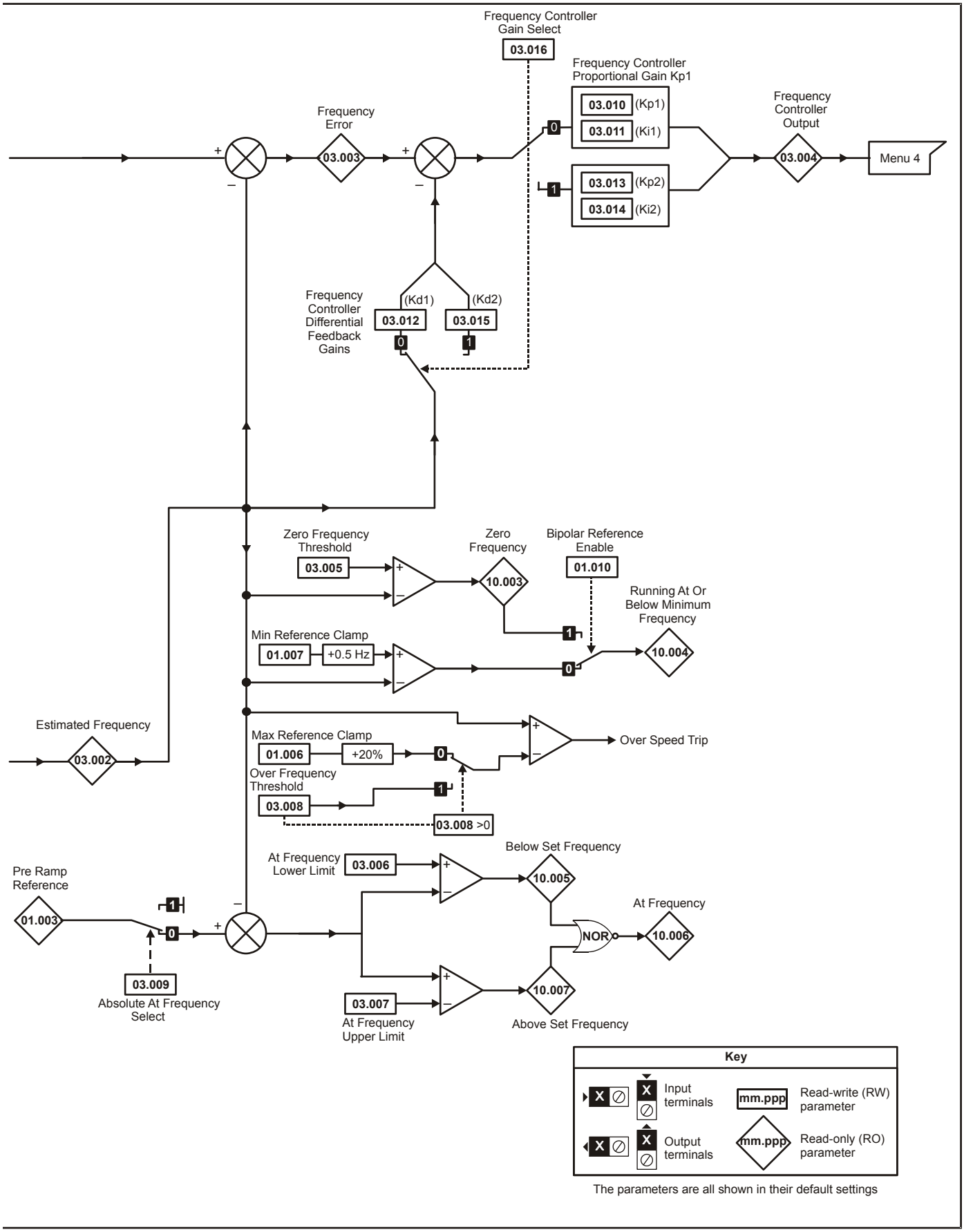


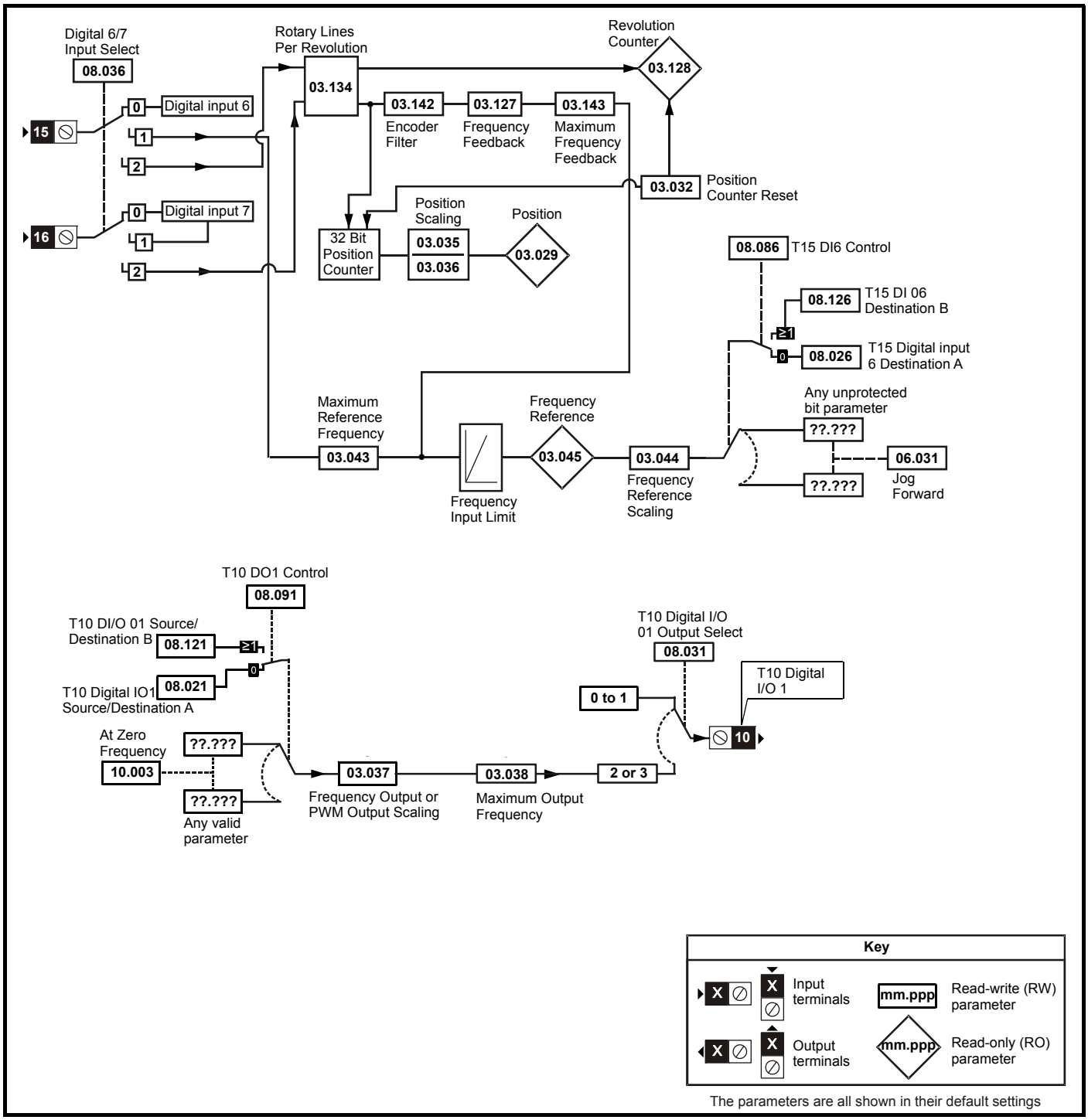
Figure 11-4 Menu 3 RFC-A logic diagram





The parameters are all shown in their default settings

Figure 11-5 Menu 3 Logic Diagram



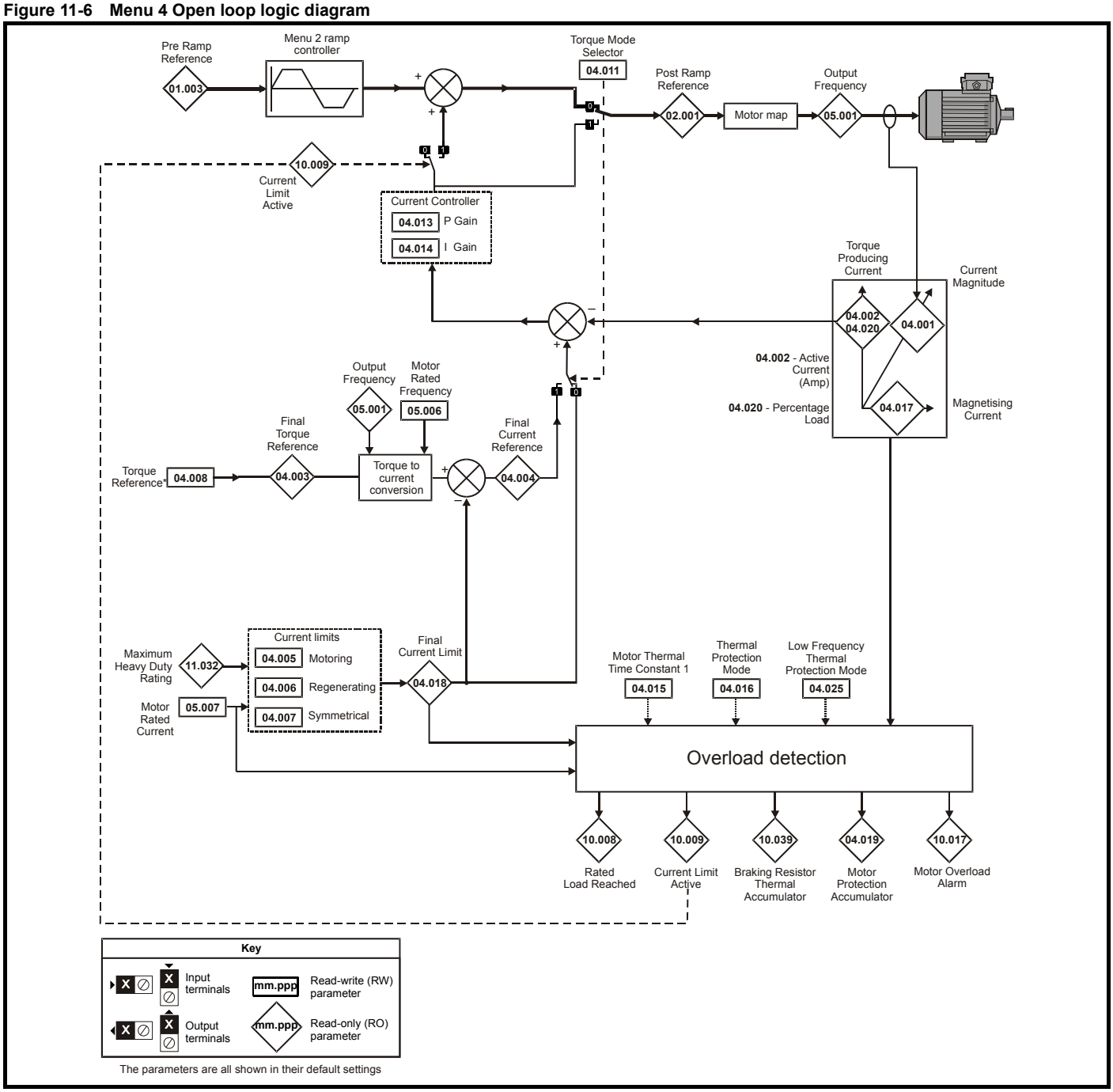
The parameters are all shown in their default settings

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
03.001	Final Demand Reference	±VM_FREQ Hz				RO	Num	ND	NC	PT	FI
03.002	Estimated Frequency		±VM_FREQ Hz			RO	Num	ND	NC	PT	FI
03.003	Frequency Error		±VM_FREQ 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 VM_SPEED_FREQ_REF_UNIPOLAR Hz		1.00 Hz		RW	Num				US
03.007	At Frequency Upper Limit	0.00 to VM_SPEED_FREQ_REF_UNIPOLAR Hz		1.00 Hz		RW	Num				US
03.008	Over Frequency Threshold	0.00 to VM_SPEED_FREQ_REF_UNIPOLAR 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 VM_FREQ_ UNIPOLAR Hz		0.00 Hz	RW	Num				US
03.018	Motor and Load Inertia		0.00 to 1000.00 kgm²		0.00 kgm²	RW	Num				US
03.022	Hard Frequency Reference	±VM_SPEED_FREQ_REF 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 (T15/16)	0 to 65535				RO	Num	ND	NC	PT	FI
03.032	Position Counter Reset (T15/16)	Off (0) or On (1)		Off (0)		RW	Bit		NC		
03.035	Position Scaling Numerator (T15/16)	0.000 to 1.000		1.000		RW	Num				US
03.036	Position Scaling Denominator (T15/16)	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)		5 (2)		RW	Txt				US
03.043	Maximum Reference Frequency (T15)	0.00 to 100.00 kHz		10.00 kHz		RW	Num				US
03.044	Frequency Reference Scaling (T15/16)	0.000 to 4.000		1.000		RW	Num				US
03.045	Frequency Reference (T15/16)	±100.00 %				RO	Num	ND	NC	PT	FI
03.047	Two Point Minimum Frequency (T15/16)	±100.00 %		-100.00 %		RW	Num				US
03.048	Drive Reference at Minimum Frequency (T15/16)	±100.00 %		-100.00 %		RW	Num				US
03.049	Two Point Maximum Frequency (T15/16)	0.00 to 100.00 %		100.00 %		RW	Num				US
03.050	Drive Reference at Maximum Frequency (T15/16)	0.00 to 100.00 %		100.00 %		RW	Num				US
03.072	Motor speed percent	±150.0 %				RO	Num	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	
03.127	Frequency Feedback	0.00 to VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	
03.128	Revolution Counter	0 to 65535				RO	Num	ND	NC	PT	FI
03.134	Rotary Lines Per Revolution	512 (0), 1024 (1), 2048 (2),4096 (3)		1024 (1)		RW	Txt				US
03.142	Encoder Filter	1 to 31 ms		3 ms		RW					US
03.143	Maximum Frequency Feedback	±VM_SPEED_FREQ_REF Hz		50 Hz: 50 Hz: 60 Hz: 60 Hz		RW					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

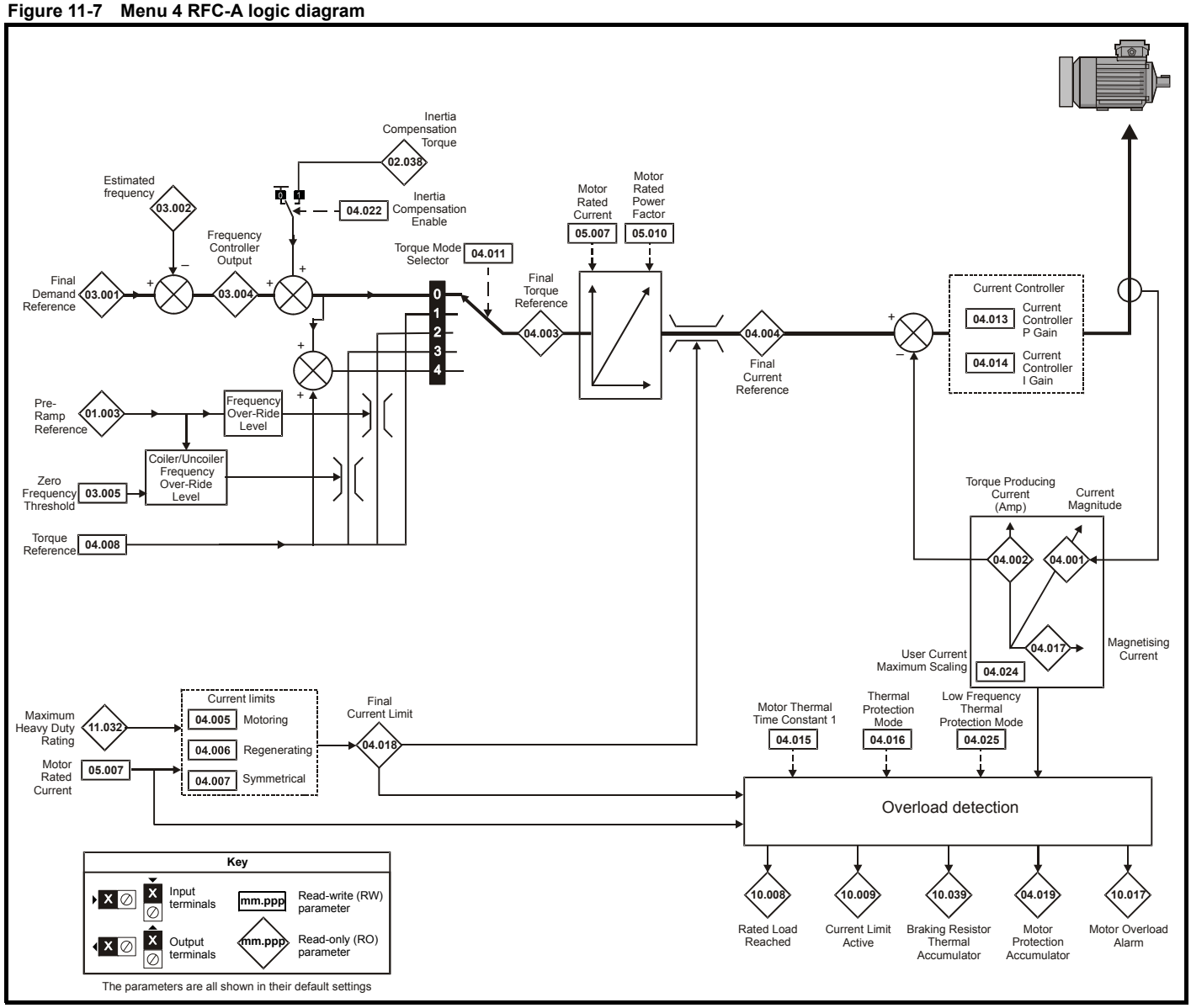
11.4 Menu 4: Torque and current control

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



The parameters are all shown in their default settings

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
04.001	Current Magnitude	±VM_DRIVE_CURRENT A				RO	Num	ND	NC	PT	FI
04.002	Torque Producing Current	±VM_DRIVE_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	±VM_MOTOR1_CURRENT_LIMIT %		165.0 %	175.0 %	RW	Num		RA		US
04.006	Regenerating Current Limit	±VM_MOTOR1_CURRENT_LIMIT %		165.0 %	175.0 %	RW	Num		RA		US
04.007	Symmetrical Current Limit	±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	00 to 11		00		RW	Bin				US
04.017	Magnetising Current	±VM_DRIVE_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	±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	Power down (0), Zero (1), Real time (2)		Power down (0)		RW	Txt				US
04.041	User Over Current Trip Level	0 to 100 %		100 %		RW	Num		RA		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

11.5 Menu 5: Motor control

Figure 11-8 Menu 5 Open-loop logic diagram

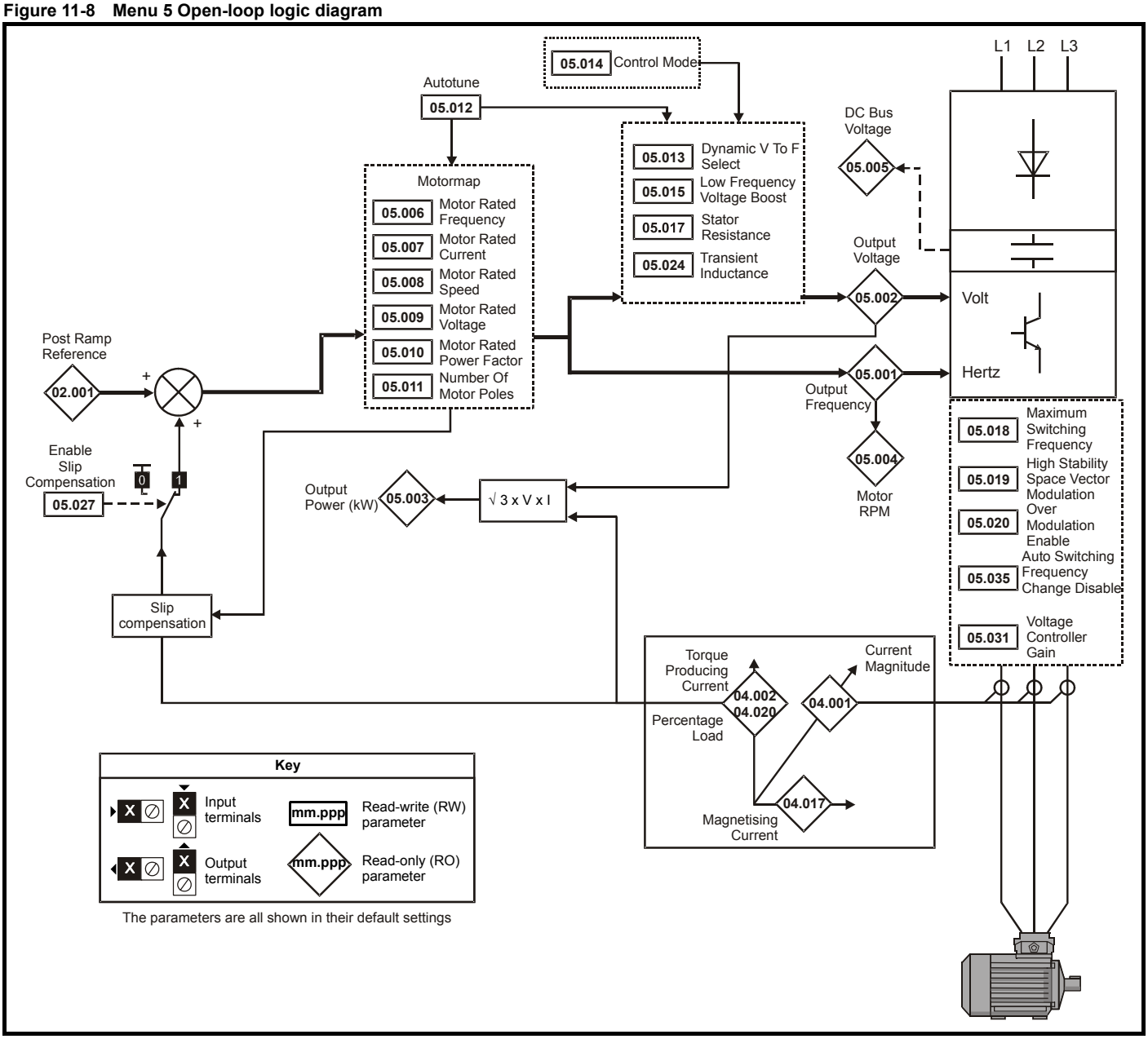
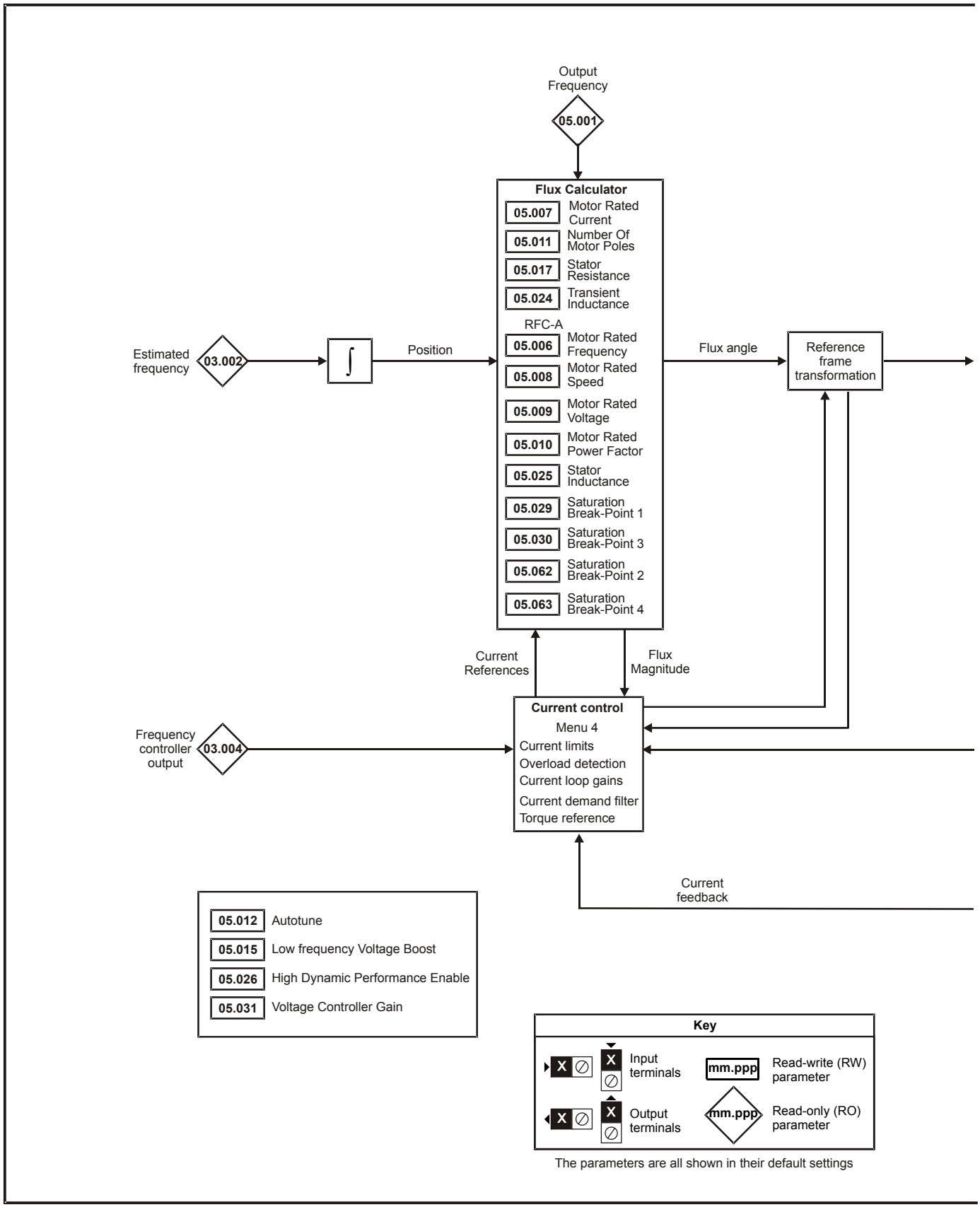
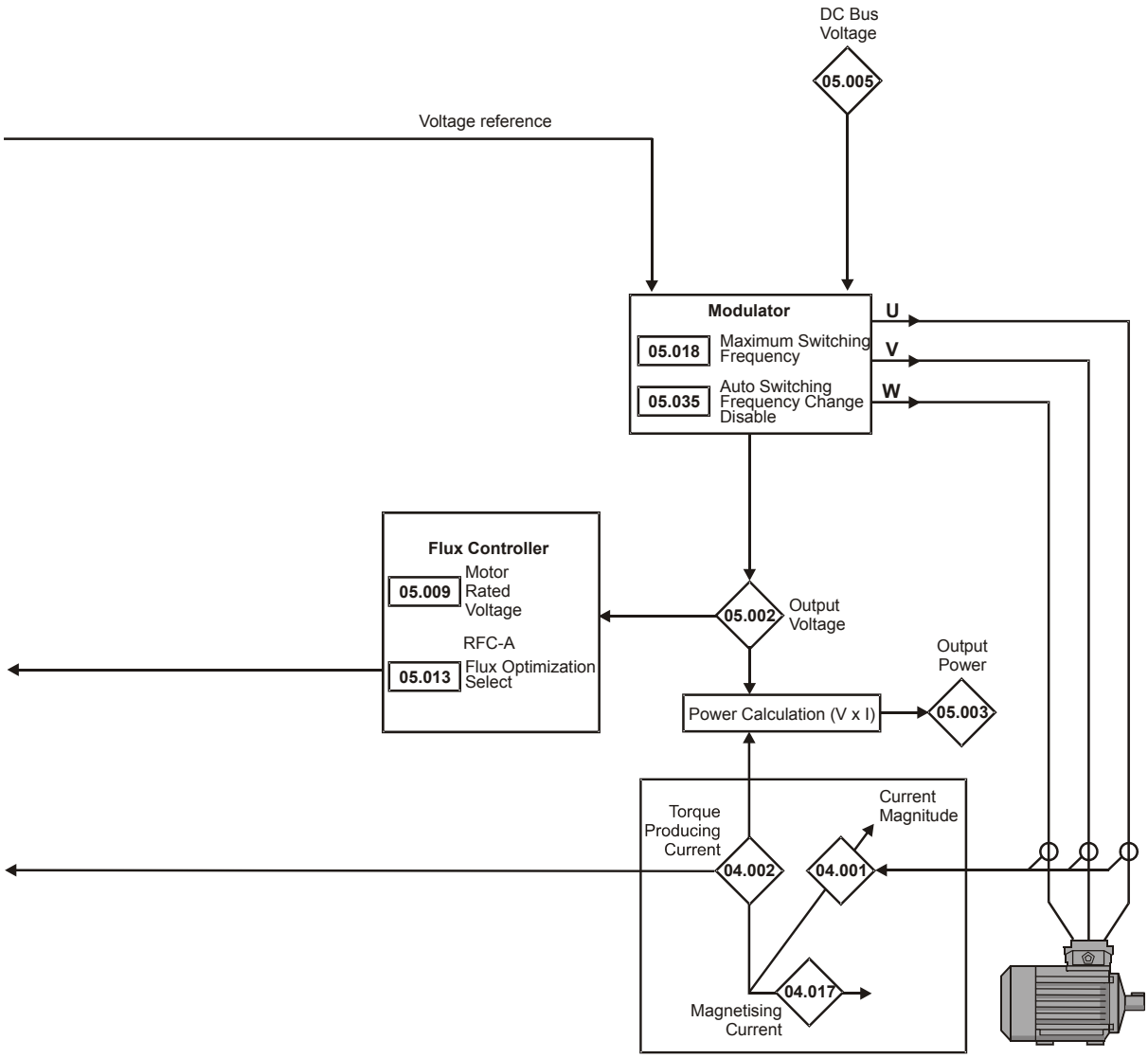


Figure 11-9 Menu 5 RFC-A, logic diagram




DC Bus Voltage
05.005
Voltage reference
Modulator
05.018
Maximum Switching Frequency
05.035
Auto Switching Frequency Change Disable
U
V
W
Flux Controller
05.009
Motor Rated Voltage
RFC-A
05.013
Flux Optimization Select
05.002
Output Voltage
Output Power
Power Calculation (V x I)
05.003
Torque Producing Current
04.002
Current Magnitude
04.001
04.017
Magnetising Current

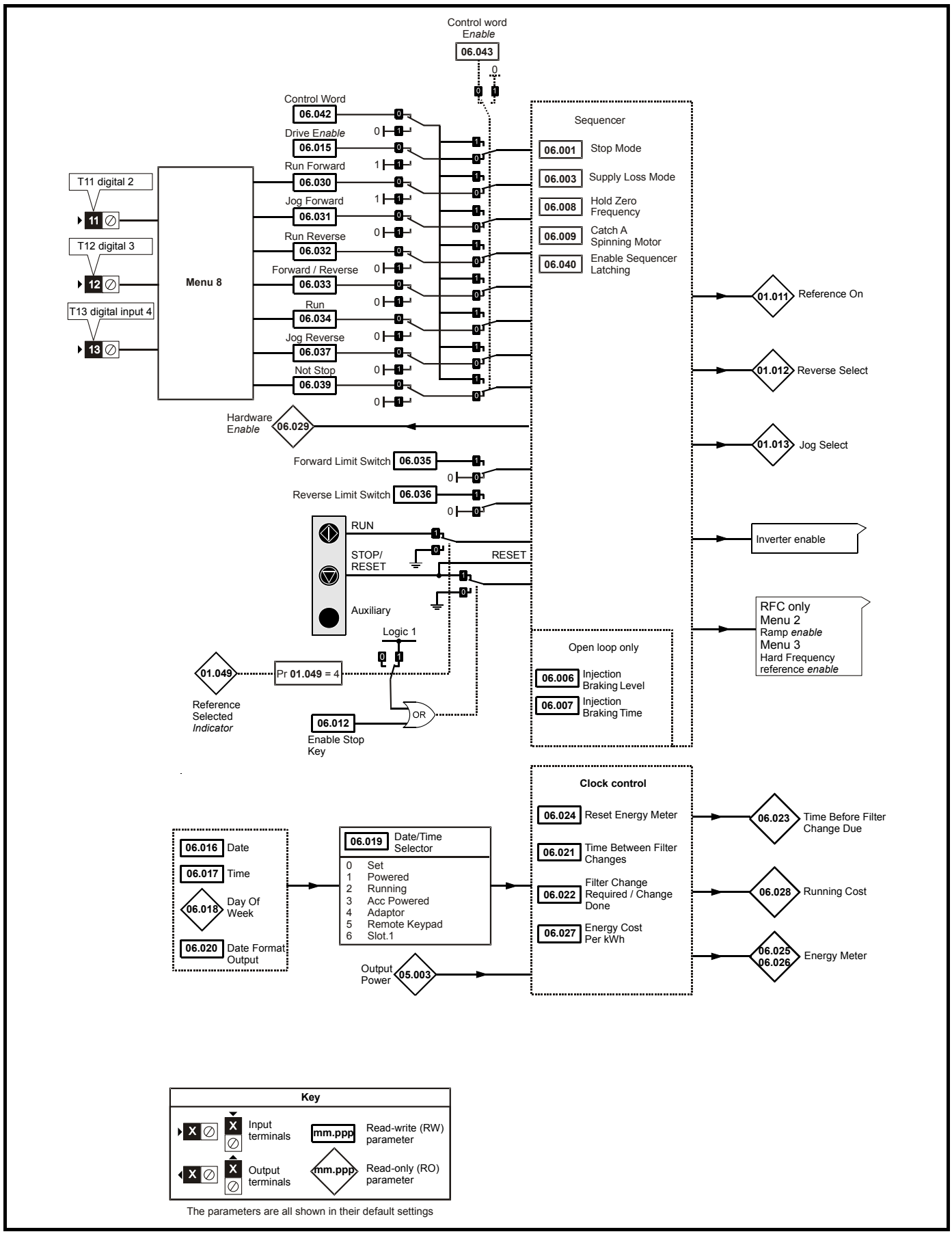
Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
05.001	Output Frequency	±VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	FI
05.002	Output Voltage	±VM_AC_VOLTAGE V				RO	Num	ND	NC	PT	FI
05.003	Output Power	±VM_POWER kW				RO	Num	ND	NC	PT	FI
05.004	Motor Rpm	±80000.0 rpm				RO	Num	ND	NC	PT	FI
05.005	D.C. Bus Voltage	±VM_DC_VOLTAGE V				RO	Num	ND	NC	PT	FI
05.006	Motor Rated Frequency	0.00 to VM_SPEED_FREQ_REF_ UNIPOLAR Hz		50Hz: 50.00 Hz 60Hz: 60.00 Hz		RW	Num				US
05.007	Motor Rated Current	±VM_RATED_CURRENT A		Maximum Heavy Duty Rating (11.032)		RW	Num		RA		US
05.008	Motor Rated Speed	0.0 to 80000.0 rpm		50 Hz: 1500.0 rpm 60 Hz: 1800.0 rpm	50 Hz: 1450.0 rpm 60 Hz: 1750.0 rpm	RW	Num				US
05.009	Motor Rated Voltage	±VM_AC_VOLTAGE_SET V		110 V drive: 230 V, 200 V drive: 230 V 400 V drive 50 Hz: 400 V 400 V drive 60 Hz: 460 V 575 V drive: 575 V 690 V drive: 690 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	Automatic (0) to 32 (16) Poles		Automatic (0) Poles		RW	Txt				US
05.012	Auto-tune	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), Fixed (2), Ur Auto (3), Ur I (4), Square (5)		Ur I (4)		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
05.024	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		5.00 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 2		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	
05.040	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		0.000 µs		RO	Num		NC	PT	US
05.060	Current At Maximum Deadtime Compensation	0.00 to 100.00 %		0.00 %		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
05.081	Change to maximum drive switching frequency at low output current	Off (0) or On (1)		Off (0)		RW	Bit				US
05.082	Motor Rated Power	±VM_POWER kW		0.00 kW		RW	Num		RA		
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

* 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

11.6 Menu 6: Sequencer and clock

Figure 11-10 Menu 6 logic diagram



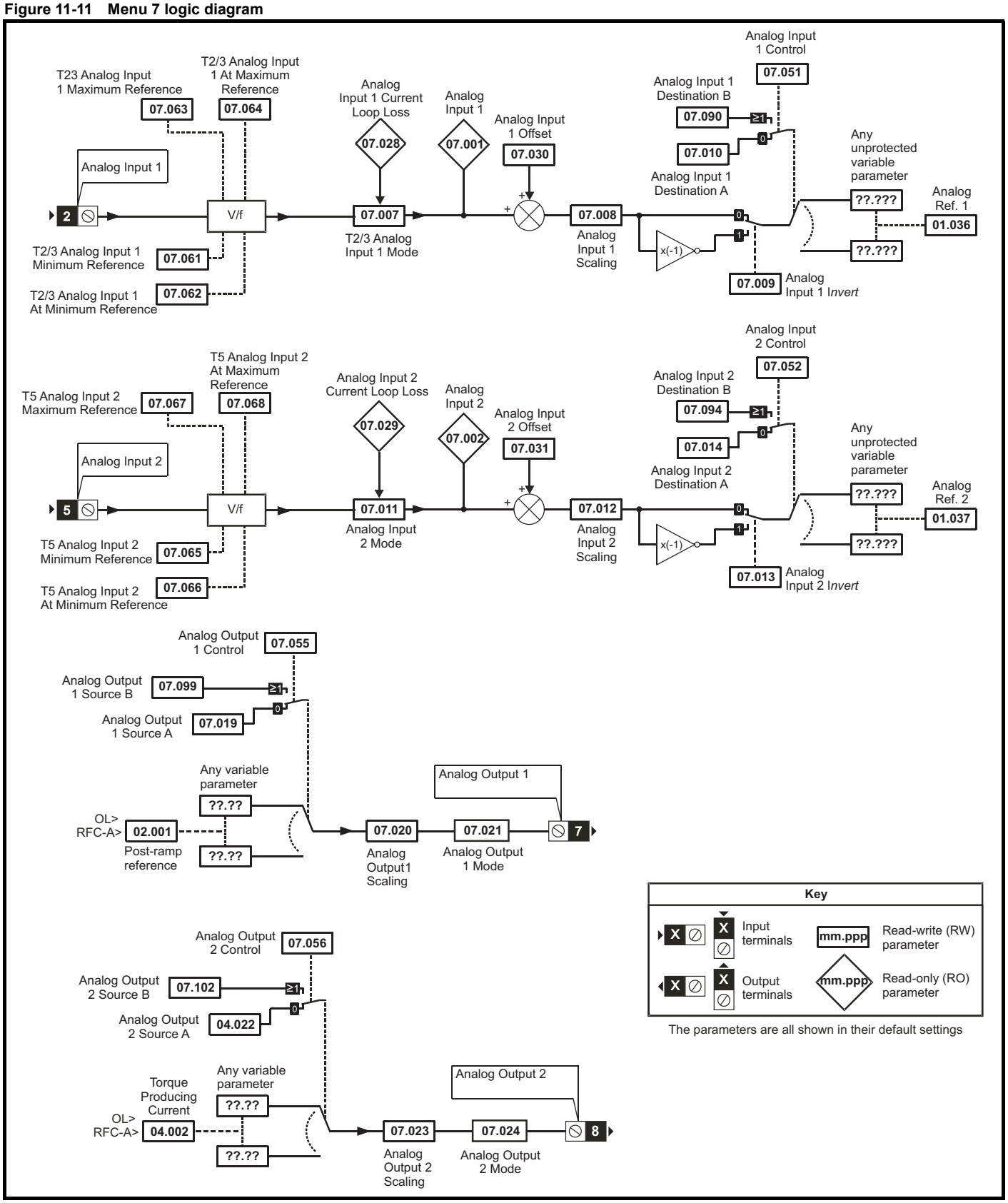
The parameters are all shown in their default settings

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
06.001	Stop Mode	Coast (0), Ramp (1), Ramp dc I (2), dc I (3), Timed dc I (4), Disable (5), No Ramp (6)		Ramp (1)		RW	Txt				US
06.002	Limit Switch Stop Mode	Stop (0), Ramp (1)		Ramp (1)		RW	Txt				US
06.003	Supply Loss Mode	Disable (0), Ramp Stop (1), Ride Thru (2), Limit Stop (3)		Disable (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 25.0 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	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)		Disable (0)		RW	Txt				US
06.010	Enable Conditions	000000000000 to 111111110111				RO	Bin	ND	NC	PT	
06.011	Sequencer State Machine Inputs	0000000 to 1111111				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	Disabled (0), Forward/Reverse (1), Run Reverse (2)		Disabled (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	Sunday (0), Monday (1), Tuesday (2), Wednesday (3), Thursday (4), Friday (5), Saturday (6)				RO	Txt	ND	NC	PT	
06.019	Date/Time Selector	Set (0), Powered (1), Running (2), Acc Powered (3), Adaptor Int. (4), Remote Keypad (5), Slot 1 (6)		Powered (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)		On (1)		RO	Bit		NC		
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	00 to 11		00		RW	Bin		NC		
06.042	Control Word	000000000000000 to 111111111111111		000000000000000		RW	Bin		NC		
06.043	Control Word Enable	0 to 1		0		RW	Num		NC		US
06.045	Cooling Fan control	0 to 5		2		RW	Num				US
06.046	Supply Loss Hold Disable	Off (0) or On (1)		Off (0)		RW	Bit				US
06.047	Input Phase Loss Detection Mode	Full (0), Ripple Only (1), Disabled (2)		Full (0)		RW	Txt				US
06.048	Supply Loss Detection Level	0 to VM_SUPPLY_LOSS_LEVEL V		110V drive: 205 V, 200V drive: 205 V 400V drive: 410 V, 575V drive: 540 V 690V drive: 540 V		RW	Num		RA		US
06.051	Allow Motoring Load	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.052	Motor Pre-heat Current Magnitude	0 to 100 %		0 %		RW	Num				US
06.059	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	0000 to 1111		0000		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		110V drive: 390 V, 200V drive: 390 V 400V drive: 780 V, 575V drive: 930 V 690V drive: 1120 V		RW	Num				US
06.074	Braking IGBT Upper Threshold	0 to VM_DC_VOLTAGE_SET V		110V drive: 390 V, 200V drive: 390 V 400V drive: 780 V, 575V drive: 930 V 690V drive: 1120 V		RW	Num				US
06.075	Low Voltage Braking IGBT Threshold	0 to VM_DC_VOLTAGE_SET V		0 V		RW	Num				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
06.089	DC Injection Active	Off (0) or On (1)		Off (0)		RO	Bit		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

11.7 Menu 7: Analog I/O

Figure 11-11 Menu 7 logic diagram

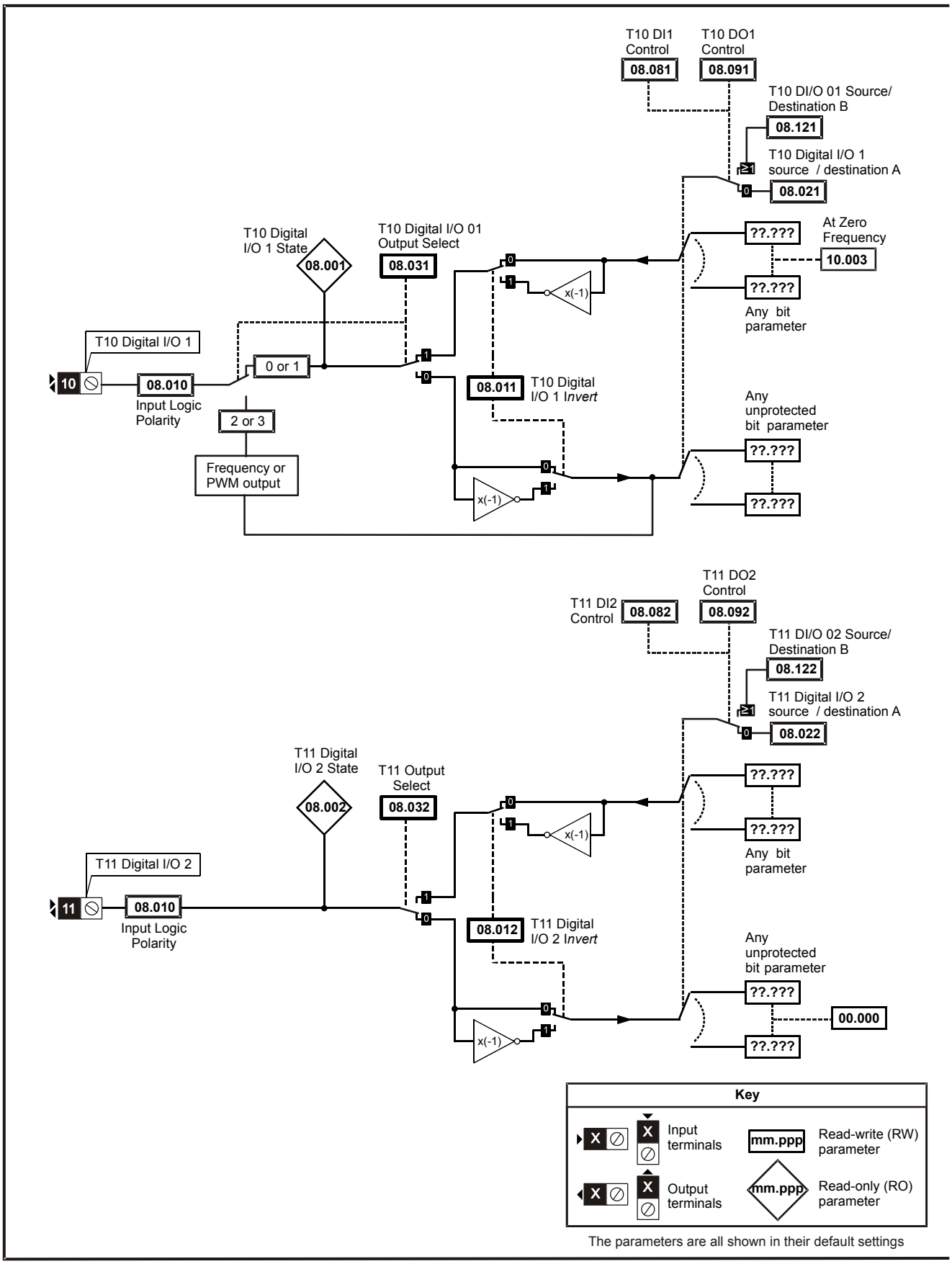


Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
07.001	Analog Input 1 (T2/3)	±100.00 %				RO	Num	ND	NC	PT	FI
07.002	Analog Input 2 (T5)	0.00 to 100.00 %				RO	Num	ND	NC	PT	FI
07.004	Stack Temperature	±250 °C				RO	Num	ND	NC	PT	
07.005	Auxiliary Temperature	±250 °C				RO	Num	ND	NC	PT	
07.007	Analog Input 1 Mode (T2/3)	4-20mA Stop (-6), 20-4mA Stop (-5), 4-20mA Low (-4), 20-4mA Low (-3), 4-20mA Hold (-2), 20-4mA Hold (-1), 0-20mA (0), 20-0mA (1), 4-20mA Trp (2), 20-4mA Trp (3), 4-20mA (4), 20-4mA (5), Voltage (6)		Voltage (6)		RW	Txt				US
07.008	Analog Input 1 Scaling (T2/3)	0.000 to 10.000		1.000		RW	Num				US
07.009	Analog Input 1 Invert (T2/3)	Off (0) or On (1)		Off (0)		RW	Bit				US
07.010	Analog Input 1 Destination A (T2/3)	0.000 to 30.999		1.036		RW	Num	DE		PT	US
07.011	Analog Input 2 Mode (T5)	4-20mA Stop (-6), 20-4mA Stop (-5), 4-20mA Low (-4), 20-4mA Low (-3), 4-20mA Hold (-2), 20-4mA Hold (-1), 0-20mA (0), 20-0mA (1), 4-20mA Trp (2), 20-4mA Trp (3), 4-20mA (4), 20-4mA (5), Voltage (6), Digital (7)		Voltage (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
07.021	Analog Output 1 Mode (T7)	Voltage (0), 0-20mA (1), 4-20mA (2), Digital (3)		Voltage (0)		RW	Txt				US
07.022	Analog Output 2 Source A (T8)	0.000 to 30.999		4.002		RW	Num			PT	US
07.023	Analog Output 2 Scaling (T8)	0.000 to 40.000		1.000		RW	Num				US
07.024	Analog Output 2 Mode (T8)	Voltage (0), 0-20mA (1), 4-20mA (2), Digital (3)		Voltage (0)		RW	Txt				US
07.026	Analog Input 1 Preset on Current Loss (T2/3)	4.00 to 20.00		4.00		RW	Num				US
07.027	Analog Input 2 Preset on Current Loss (T5)	4.00 to 20.00		4.00		RW	Num				US
07.028	Analog Input 1 Current Loop Loss (T2/3)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
07.029	Analog Input 2 Current Loop Loss (T5)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
07.030	Analog Input 1 Offset (T2/3)	±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 29999				RO	Num	ND	NC	PT	
07.046	Thermistor Type	DIN44081 (0), KTY84 (1), PT1000 (2), PT2000 (3), Other (4)		DIN44081 (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 (T2/3)	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
07.056	Analog Output 2 Control (T8)	0 to 15		0		RW	Num				US
07.061	Analog Input 1 Minimum Reference (T2/3)	±100.00 %		-100.00 %		RW	Num				US
07.062	Analog Input 1 At Minimum Reference (T2/3)	±100.00 %		-100.00 %		RW	Num				US
07.063	Analog Input 1 Maximum Reference (T2/3)	±100.00 %		100.00 %		RW	Num				US
07.064	Analog Input 1 At Maximum Reference (T2/3)	±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 (T2/3)	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
07.102	Analog Output 2 Source B (T8)	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

11.8 Menu 8: Digital I/O

Figure 11-12 Menu 8 logic diagram



The parameters are all shown in their default settings

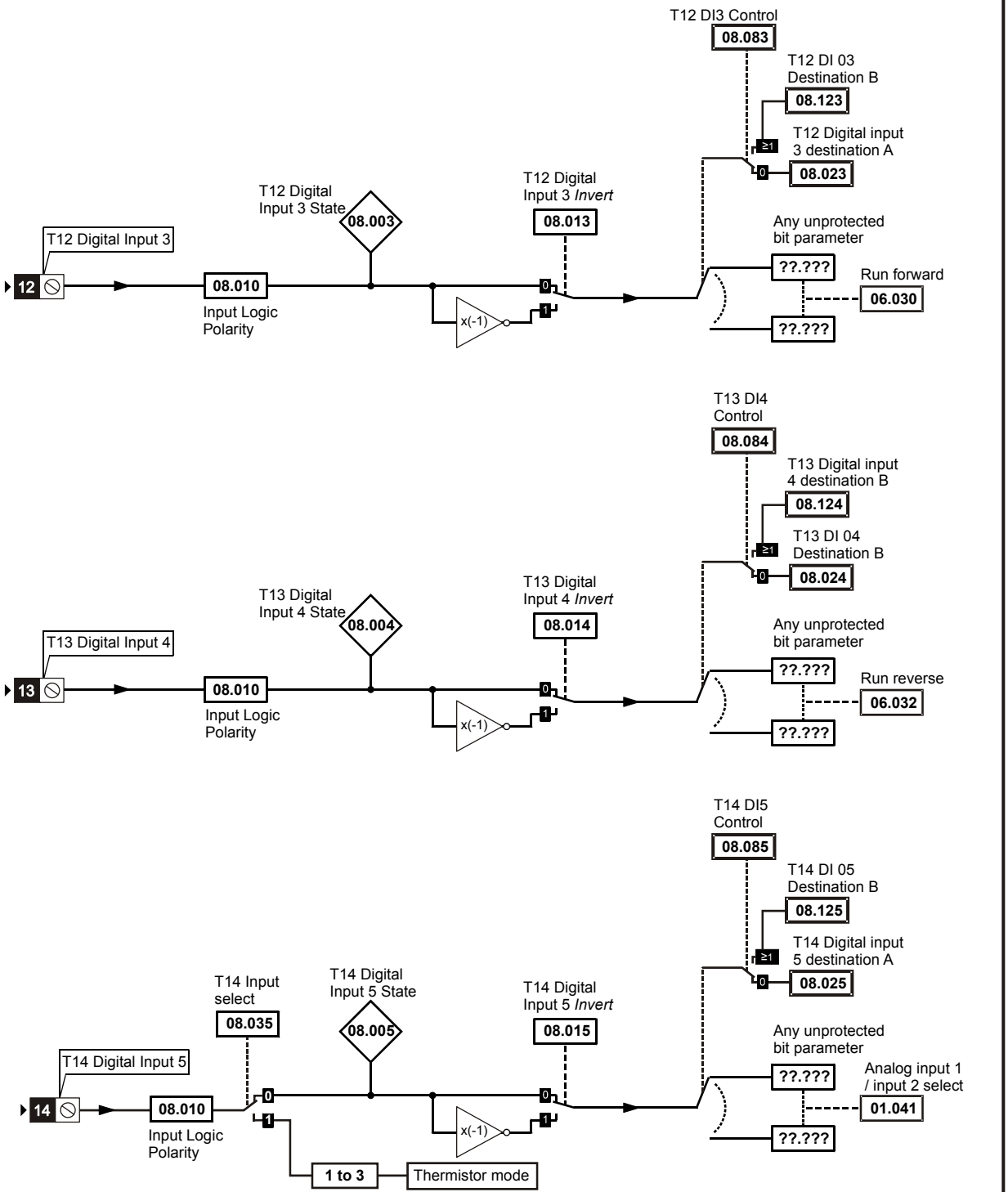

T12 DI3 Control
08.083
T12 DI 03 Destination B
08.123
T12 Digital input 3 destination A
08.023
T12 Digital Input 3 State
08.003
T12 Digital Input 3 Invert
08.013
T12 Digital Input 3
12
08.010
Input Logic Polarity
x(-1)
Any unprotected bit parameter
??.???
??.???
Run forward
06.030
T13 DI4 Control
08.084
T13 Digital input 4 destination B
08.124
T13 DI 04 Destination B
08.024
T13 Digital Input 4 State
08.004
T13 Digital Input 4 Invert
08.014
T13 Digital Input 4
13
08.010
Input Logic Polarity
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 Input select
08.035
T14 Digital Input 5 State
08.005
T14 Digital Input 5 Invert
08.015
T14 Digital Input 5
14
08.010
Input Logic Polarity
1 to 3
Thermistor mode
x(-1)
Any unprotected bit parameter
??.???
??.???
Analog input 1 / input 2 select
01.041

Figure 11-13 Menu 8 logic diagram (cont)

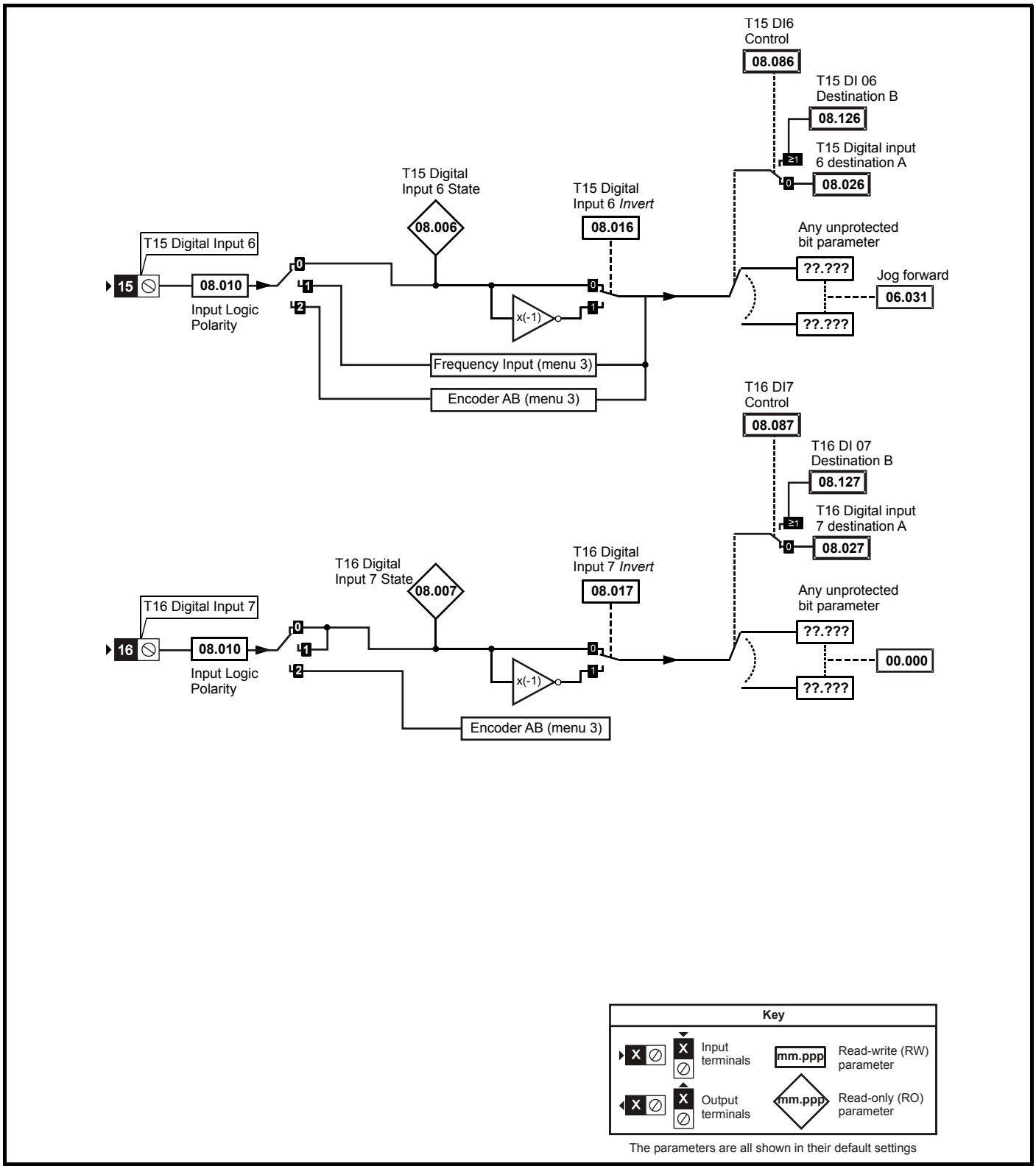


Figure 11-14 Menu 8 logic (cont)

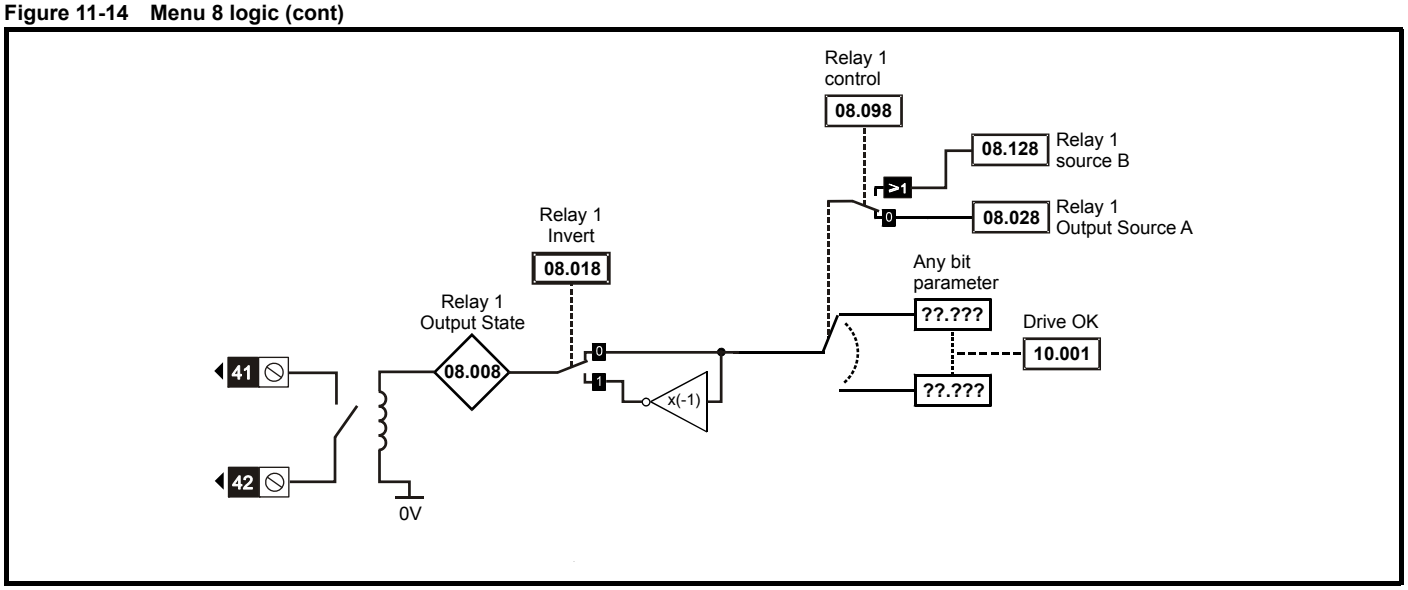


Figure 11-15 SAFE TORQUE OFF logic diagram (frame 1 to 4)

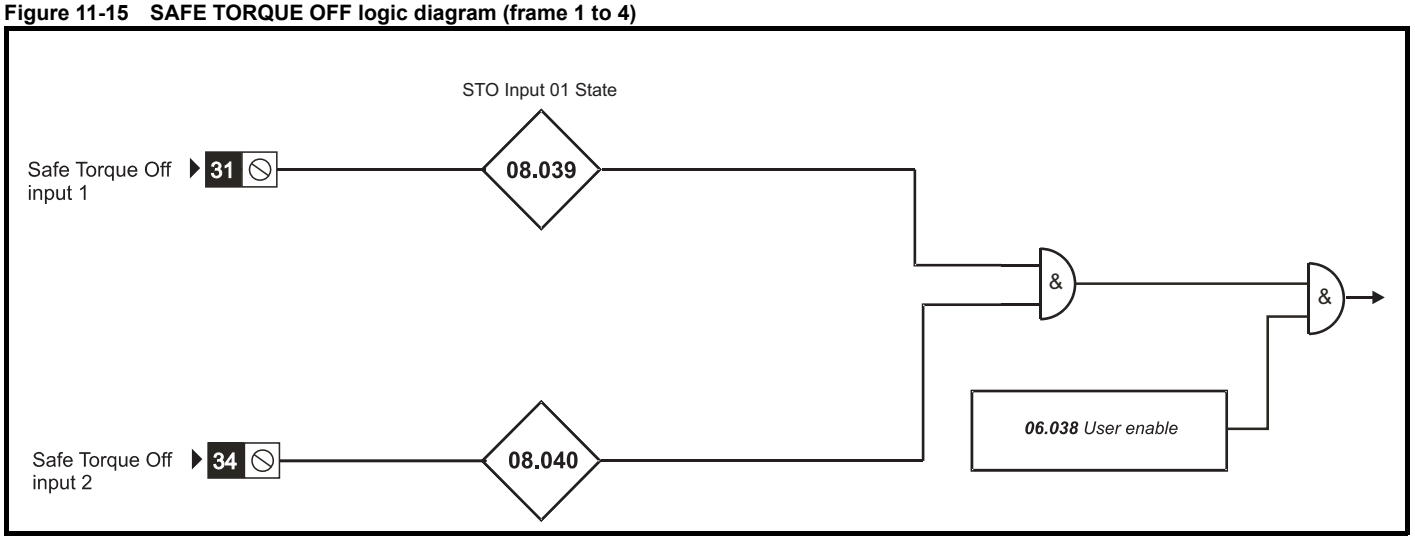


Figure 11-16 SAFE TORQUE OFF logic diagram (frame 5 to 6)

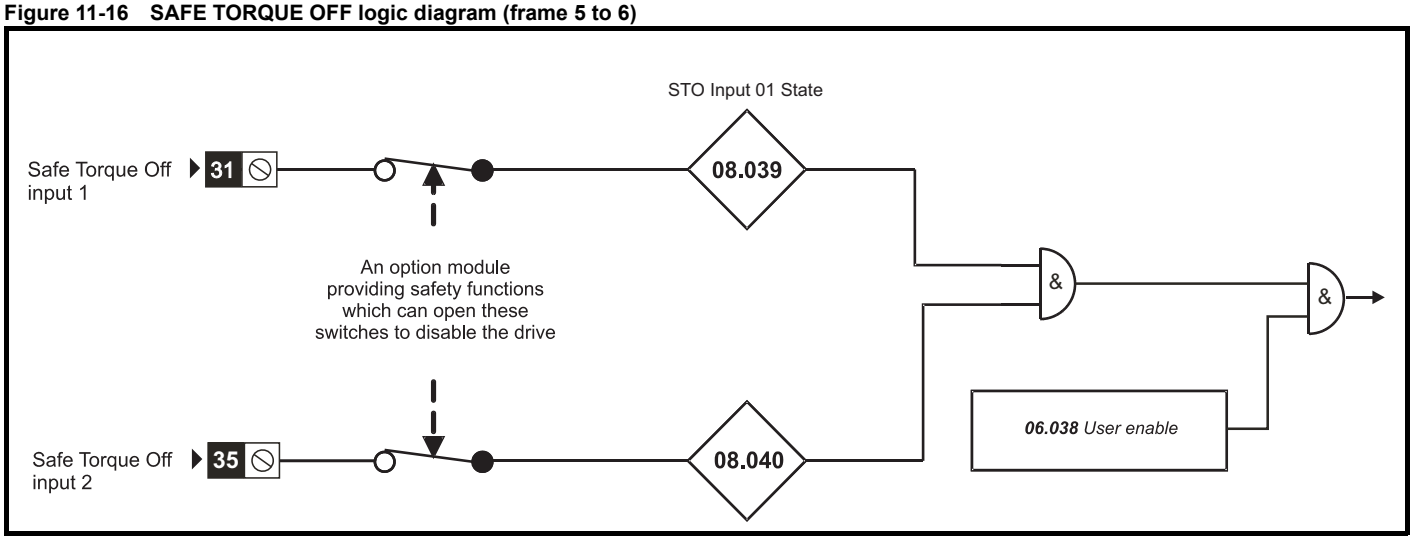
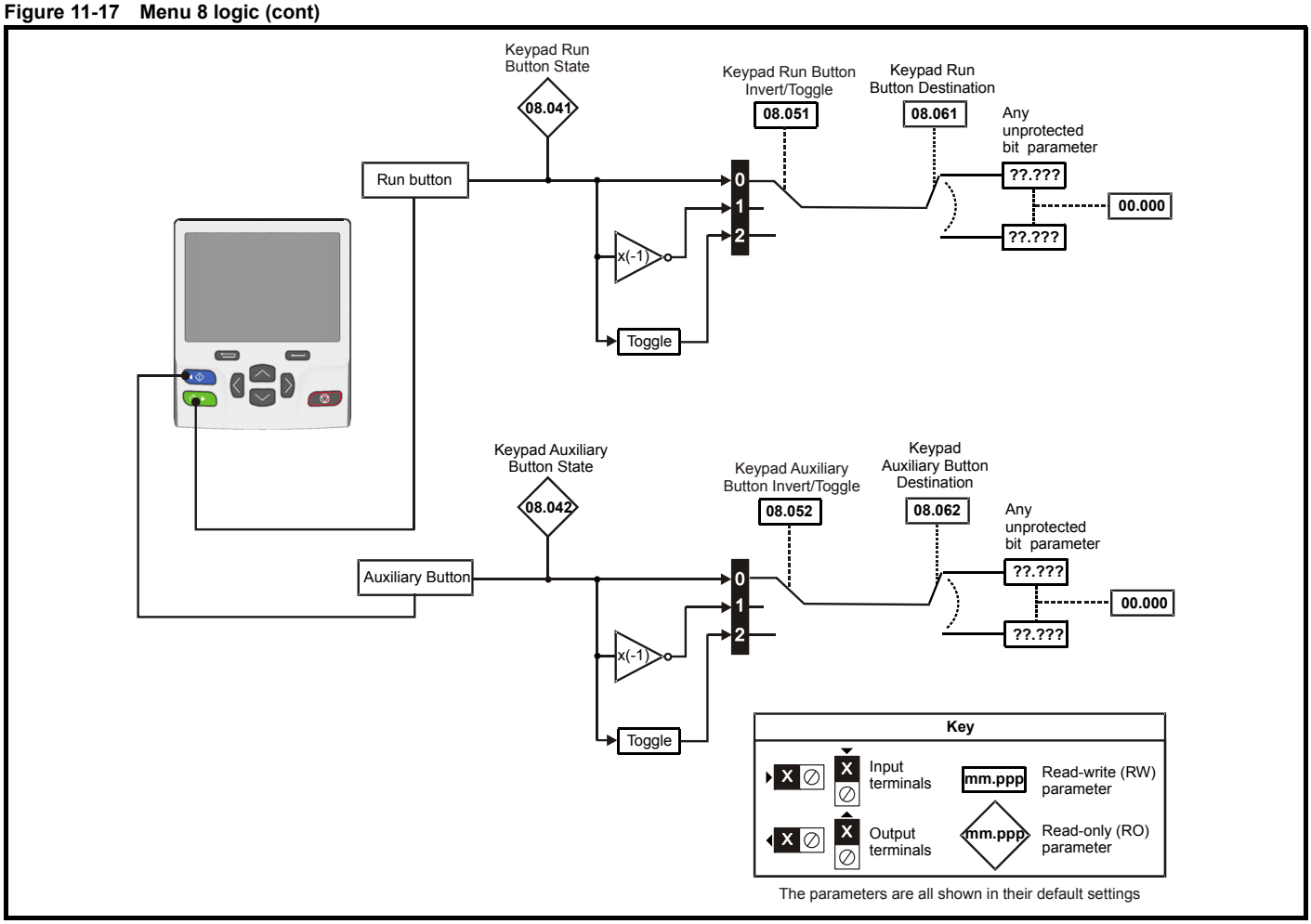


Figure 11-17 Menu 8 logic (cont)

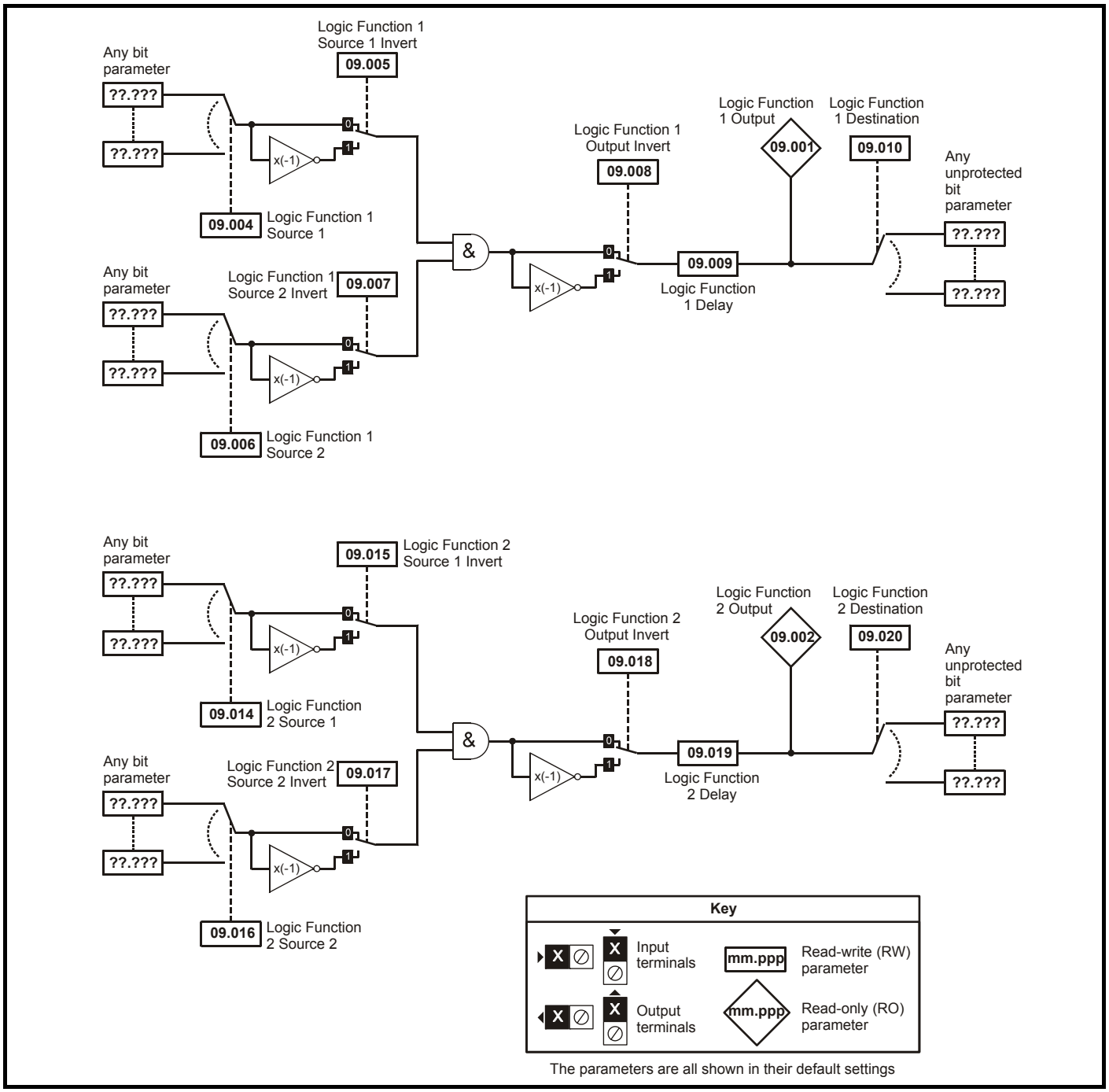


Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
08.001	Digital I/O 1 State (T10)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.002	Digital I/O 2 State (T11)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.003	Digital Input 3 State (T12)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.004	Digital 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	
08.006	Digital Input 6 State (T15)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.007	Digital Input 7 State (T16)	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	
08.010	Input Logic Polarity	Negative Logic (0), Positive Logic (1)		Positive Logic (1)		RW	Txt				US
08.011	Digital I/O 1 Invert (T10)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.012	Digital I/O 2 Invert (T11)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.013	Digital Input 3 Invert (T12)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.014	Digital Input 4 Invert (T13)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.015	Digital Input 5 Invert (T14)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.016	Digital Input 6 Invert (T15)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.017	Digital Input 7 Invert (T16)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.018	Relay 1 Invert	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.020	Digital I/O Read Word	000000000000 to 111111111111				RO	Bin	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 IO2 Source/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
08.026	Digital Input 06 Destination A (T15)	0.000 to 30.999		6.031		RW	Num	DE		PT	US
08.027	Digital Input 07 Destination A (T16)	0.000 to 30.999		0.000		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 Select (T10)	Input (0), Output (1), Frequency output (2), PWM output (3)		Output (1)		RW	Txt				US
08.032	Digital I/O 02 Output Select (T11)	Input (0), Output (1)		Input (0)		RW	Txt				US
08.035	Digital 5 Input Select (T14)	Input (0), Therm Short Cct (1), Thermistor (2), Therm No Trip (3)		Input (0)		RW	Txt				US
08.036	Digital 6/7 Input Select (T15/16)	Digital Input (0), Frequency (1), Encoder AB (2)		Digital Input (0)		RW	Txt				US
08.039	STO Input 01 State (T31)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.040	STO Input 02 State (T34)	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	24V 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 Invert (0), Invert (1), Toggle (2)		Not Invert (0)		RW	Txt				US
08.052	Keypad Auxiliary Button Invert/Toggle	Not Invert (0), Invert (1), Toggle (2)		Not Invert (0)		RW	Txt				US
08.053	24V Supply Input Invert	Not Invert (0), Invert (1)		Not Invert (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	24V 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
08.086	DI6 Control (T15)	0 to 26		0		RW	Num				US
08.087	DI7 Control (T16)	0 to 26		0		RW	Num				US
08.091	DO1 Control (T10)	0 to 21		0		RW	Num				US
08.092	DO2 Control (T11)	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		PT	US
08.122	DI/O 02 Source/Destination B (T11)	0.000 to 30.999				RO	Num	DE		PT	US
08.123	DI 03 Destination B (T12)	0.000 to 30.999				RO	Num	DE		PT	US
08.124	DI 04 Destination B (T13)	0.000 to 30.999				RO	Num	DE		PT	US
08.125	DI 05 Destination B (T14)	0.000 to 30.999				RO	Num	DE		PT	US
08.126	DI 06 Destination B (T15)	0.000 to 30.999				RO	Num	DE		PT	US
08.127	DI 07 Destination B (T16)	0.000 to 30.999				RO	Num	DE		PT	US
08.128	Relay 01 Source B	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

11.9 Menu 9: Programmable logic, motorized pot, binary sum and timers

Figure 11-18 Menu 9 logic diagram: Programmable logic



The parameters are all shown in their default settings

Figure 11-19 Menu 9 logic diagram: Motorized pot and binary sum

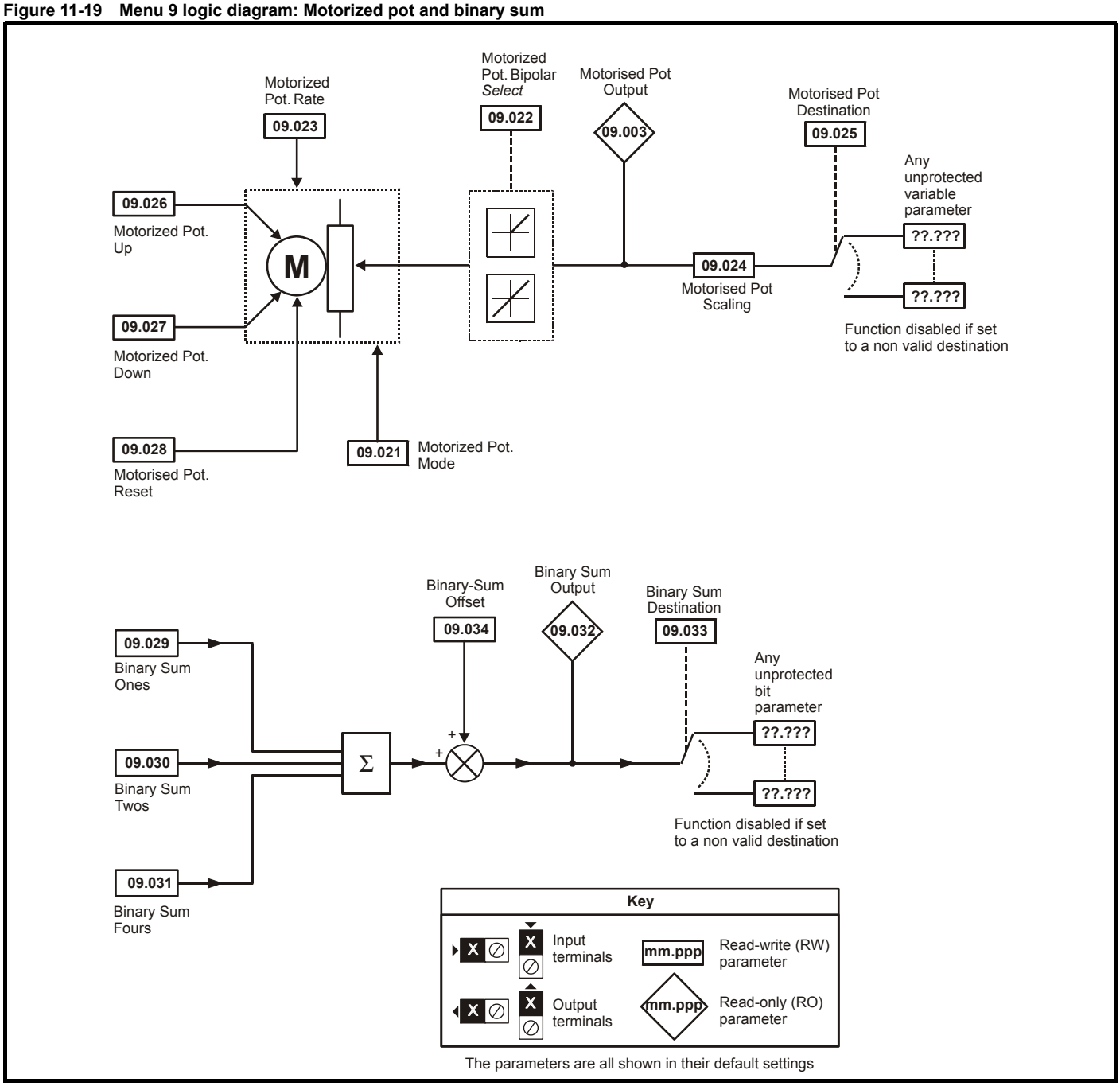
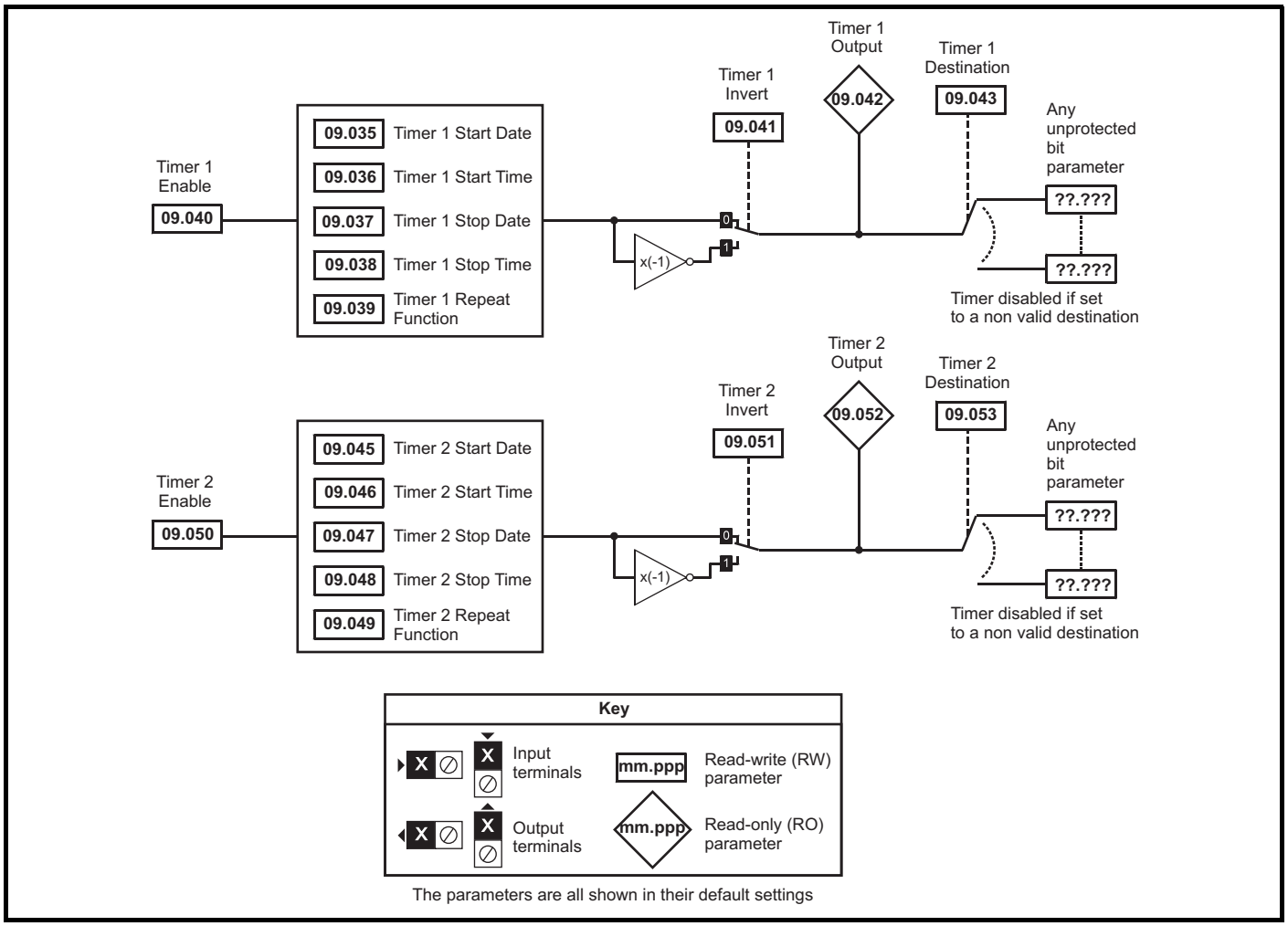
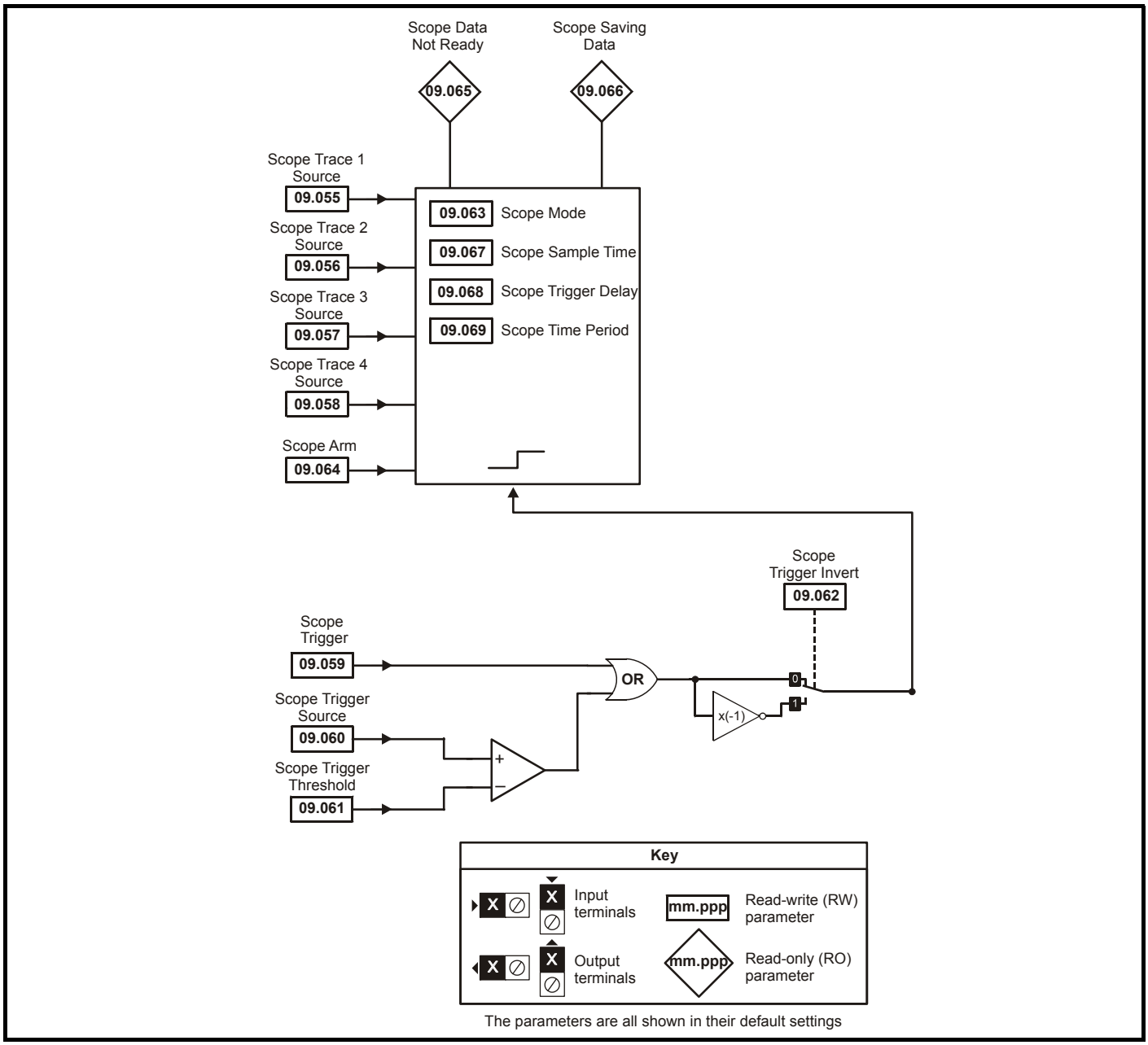


Figure 11-20 Menu 9 logic diagram



The parameters are all shown in their default settings

Figure 11-21 Scope function



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	Motorised 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	Motorised Pot Mode	0 to 4		0		RW	Num				US
09.022	Motorised Pot Bipolar Select	Off (0) or On (1)		Off (0)		RW	Bit				US
09.023	Motorised Pot Rate	0 to 250 s		20 s		RW	Num				US
09.024	Motorised Pot Scaling	0.000 to 4.000		1.000		RW	Num				US
09.025	Motorised Pot Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
09.026	Motorised Pot Up	Off (0) or On (1)		Off (0)		RW	Bit		NC		
09.027	Motorised Pot Down	Off (0) or On (1)		Off (0)		RW	Bit		NC		
09.028	Motorised 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), Hour (1), Day (2), Week (3), Month (4), Year (5), One off (6), Minute (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), Hour (1), Day (2), Week (3), Month (4), Year (5), One off (6), Minute (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
09.055	Scope Trace 1 Source	0.000 to 30.999		0.000		RW	Num			PT	US
09.056	Scope Trace 2 Source	0.000 to 30.999		0.000		RW	Num			PT	US
09.057	Scope Trace 3 Source	0.000 to 30.999		0.000		RW	Num			PT	US
09.058	Scope Trace 4 Source	0.000 to 30.999		0.000		RW	Num			PT	US
09.059	Scope Trigger	Off (0) or On (1)		Off (0)		RW	Bit				
09.060	Scope Trigger Source	0.000 to 30.999		0.000		RW	Num			PT	US
09.061	Scope Trigger Threshold	-2147483648 to 2147483647		0		RW	Num				US
09.062	Scope Trigger Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
09.063	Scope Mode	Single (0), Normal (1), Auto (2)		Single (0)		RW	Txt				US
09.064	Scope Arm	Off (0) or On (1)		Off (0)		RW	Bit		NC		
09.065	Scope Data Not Ready	Off (0) or On (1)				RO	Bit	ND	NC	PT	
09.066	Scope Saving Data	Off (0) or On (1)				RO	Bit	ND	NC	PT	
09.067	Scope Sample Time	1 to 200		1		RW	Num				US
09.068	Scope Trigger Delay	0 to 100 %		0 %		RW	Num				US

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
09.069	Scope Time Period	0.00 to 200000.00 ms				RO	Bit	ND	NC	PT	
09.070	Scope Auto-save Mode	Disabled (0), Overwrite (1), Keep (2)		Disabled (0)		RW	Txt				US
09.071	Scope Auto-save File Number	0 to 99		0		RO	Num				PS
09.072	Scope Auto-save Reset	Off (0) or On (1)		Off (0)		RW	Bit				
09.073	Scope Auto-save Status	Disabled (0), Active (1), Stopped (2), Failed (3)		Disabled (0)		RO	Txt				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
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter	SMP	Slot,menu,parameter	Chr	Character parameter	Ver	Version number

11.10 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), Infinite (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	00000 to 11111		00000		RW	Bin				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	000000000000000 to 111111111111111				RO	Bin	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	Auto-tune 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	

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
10.069	Additional Status Bits	00000000000 to 11111111111				RO	Bin	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	Inhibit (0), Ready (1), Stop (2), Reserved (3), Run (4), Supply Loss (5), Deceleration (6), dc Injection (7), Reserved (8), Trip (9), Active (10), Heat (14), Under Voltage (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), Brake Resistor (1), Motor Overload (2), Reserved (3), Drive Overload (4), Auto Tune (5), Limit Switch (6), Reserved (8), Option Slot 1 (9), Reserved (10), Reserved (11), Reserved (12), Low AC (13), Current limit (14)				RO	Txt	ND	NC	PT	
10.107	Low AC Alarm	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.106	Potential Drive Damage Conditions	00 to 11		00		RO	Bin	ND	NC	PT	
10.108	Reversed cooling fan detected	Off (0) or On (1)				RO	Bit	ND		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

11.11 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 0.080		0.010		RW	Num			PT	US
11.023	Serial Address	1 to 247		1		RW	Num				US
11.024	Serial Mode	8 2 NP (0), 8 1 NP (1), 8 1 EP (2), 8 1 OP (3), 8 2 NP M (4), 8 1 NP M (5), 8 1 EP M (6), 8 1 OP M (7), 7 1 EP (8), 7 1 OP (9), 7 1 EP M (10), 7 1 OP M (11)		8 2 NP (0)		RW	Txt				US
11.025	Serial Baud Rate	300 (0), 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	00.00.00.00 to 99.99.99.99				RO	Ver	ND	NC	PT	
11.030	User Security Code	0 to 9999				RW	Num	ND	NC	PT	US
11.031	User Drive Mode	Open-loop (1), RFC-A (2)				RW	Txt	ND	NC	PT	
11.032	Maximum Heavy Duty Rating	0.00 to 9999.99 A				RO	Num	ND	NC	PT	
11.033	Drive Rated Voltage	110V (0), 200V (1), 400V (2), 575V (3), 690V (4)				RO	Txt	ND	NC	PT	
11.034	Drive Configuration	AV (0), AI (1), AV Preset (2), AI Preset (3), Preset (4), Keypad (5), Keypad Ref (6), Electronic Pot (7), Torque Control (8), Pid Control (9)		AV (0)		RW	Txt			PT	US
11.035	Power Software Version	00.00.00.00 to 99.99.99.99				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-loop (1), RFC-A (2), User Program (5)				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), Program (2), Auto (3), Boot (4)		None (0)		RW	Txt		NC		US
11.043	Load Defaults	None (0), Standard (1), US (2)		None (0)		RW	Txt		NC		
11.044	User Security Status	Menu 0 (0), All Menus (1), Read-only Menu 0 (2), Read-only (3), Status Only (4), No Access (5)				RW	Txt	ND		PT	
11.045	Select Motor 2 Parameters	Motor 1 (0), Motor 2 (1)		Motor 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	000000 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	0000 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	0.000 to 999.999 A				RO	Num	ND	NC	PT	
11.061	Full Scale Current Kc	0.000 to 999.999 A				RO	Num	ND	NC	PT	
11.063	Product Type	0 to 255				RO	Num	ND	NC	PT	
11.064	Product Identifier Characters	M400 (1295265840) to □□□□ (2147483647)				RO	Chr	ND	NC	PT	
11.065	Frame size and voltage code	000 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	00000 to 32767				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), Reserved (1), SD Card (2)				RO	Txt	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-loop (1), RFC-A (2)				RO	Txt	ND	NC	PT	US
11.085	Security Status	None (0), Read-only (1), Status-only (2), No Access (3)				RO	Txt	ND	NC	PT	PS
11.086	Menu Access Status	Menu 0 (0), All Menus (1)				RO	Txt	ND	NC	PT	PS

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
11.090	Keypad Port Serial Address	1 to 16		1		RW	Num				US
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	
11.097	AI ID Code	None (0), SD Card (1), RS-485 (2), boot (3), RS-485 (4)				RO	Txt	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 12: Threshold detectors, variable selectors and brake control function

Figure 11-22 Menu 12 logic diagram

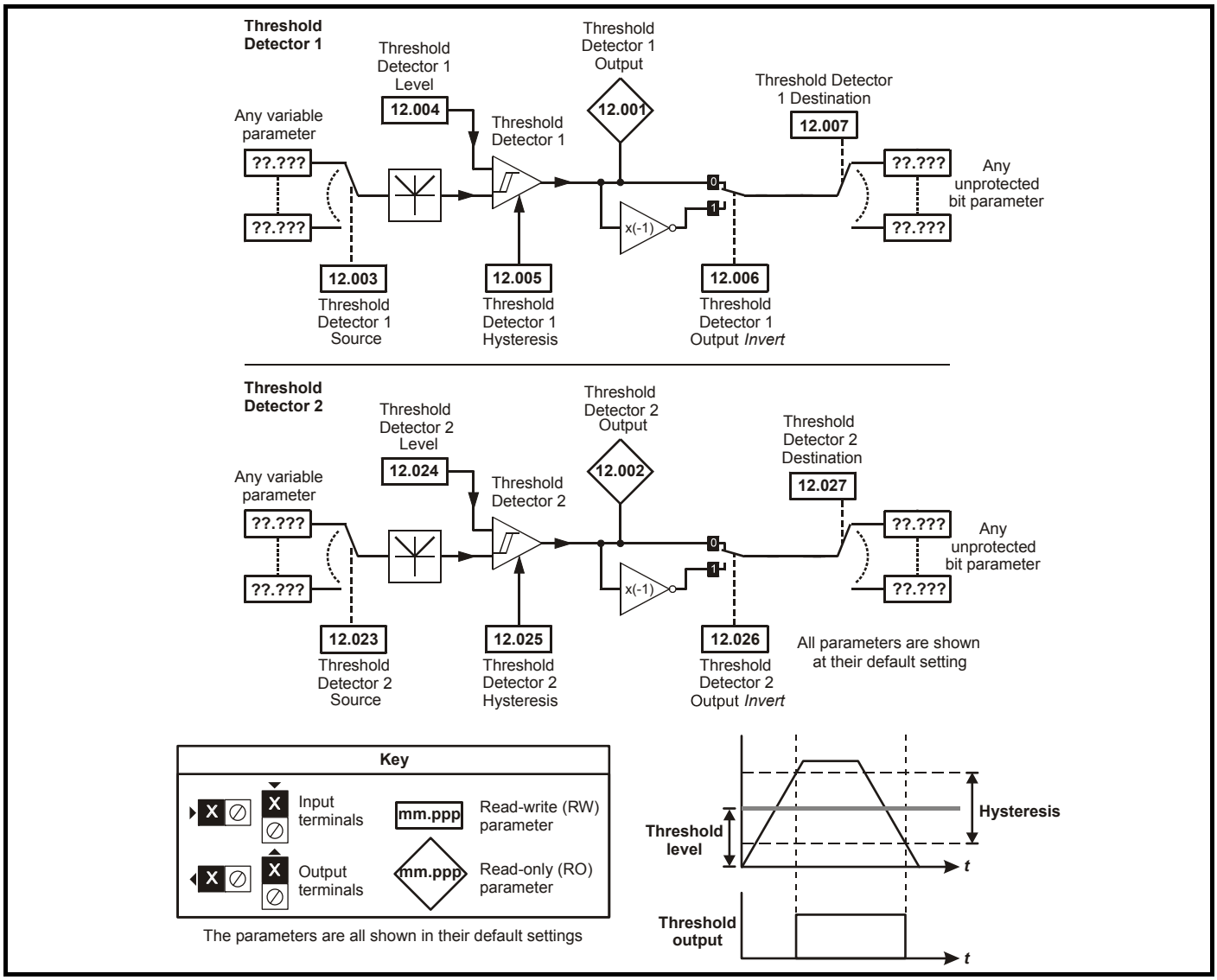
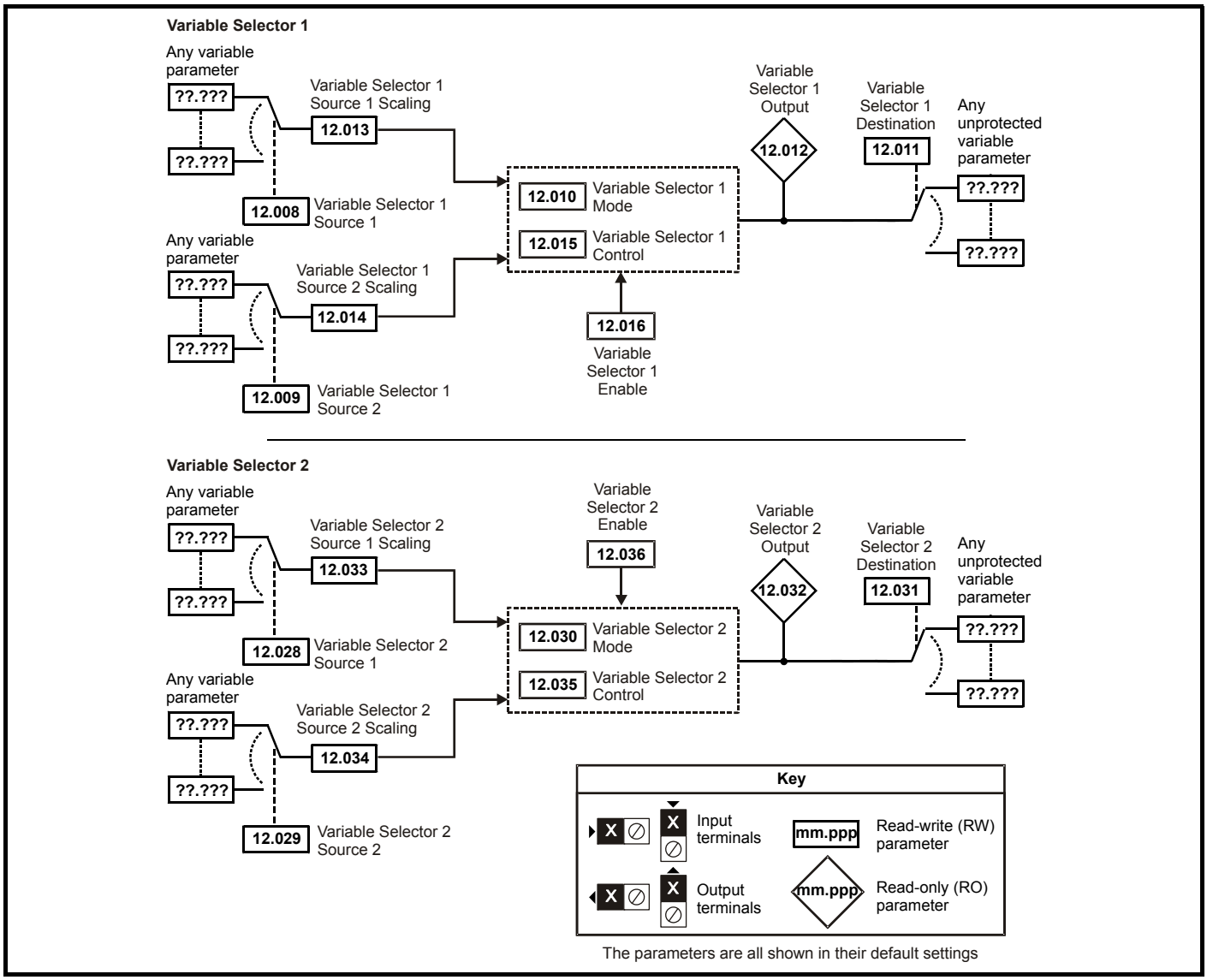


Figure 11-23 Menu 12 logic diagram (continued)



The parameters are all shown in their default settings

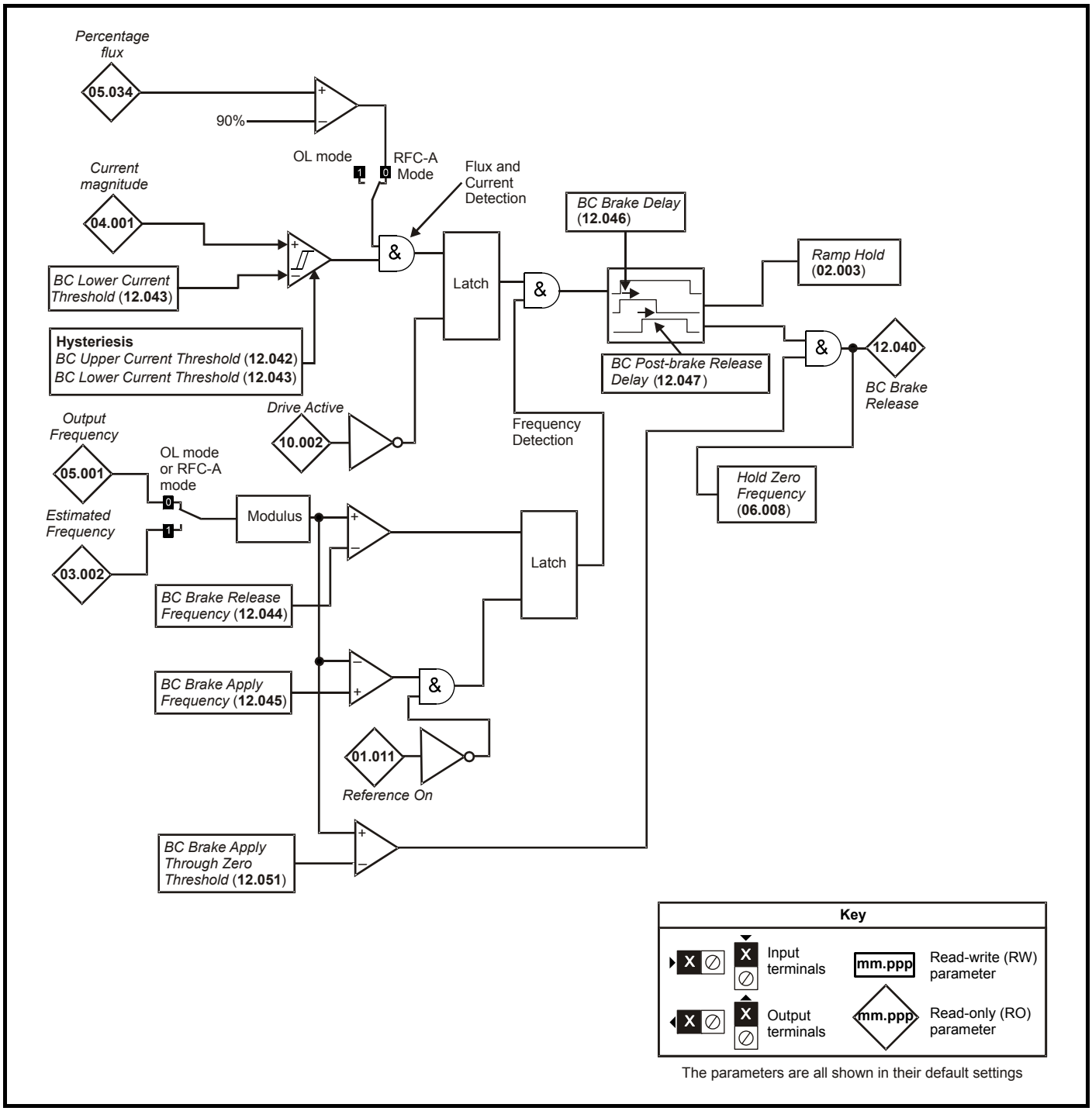
WARNING

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

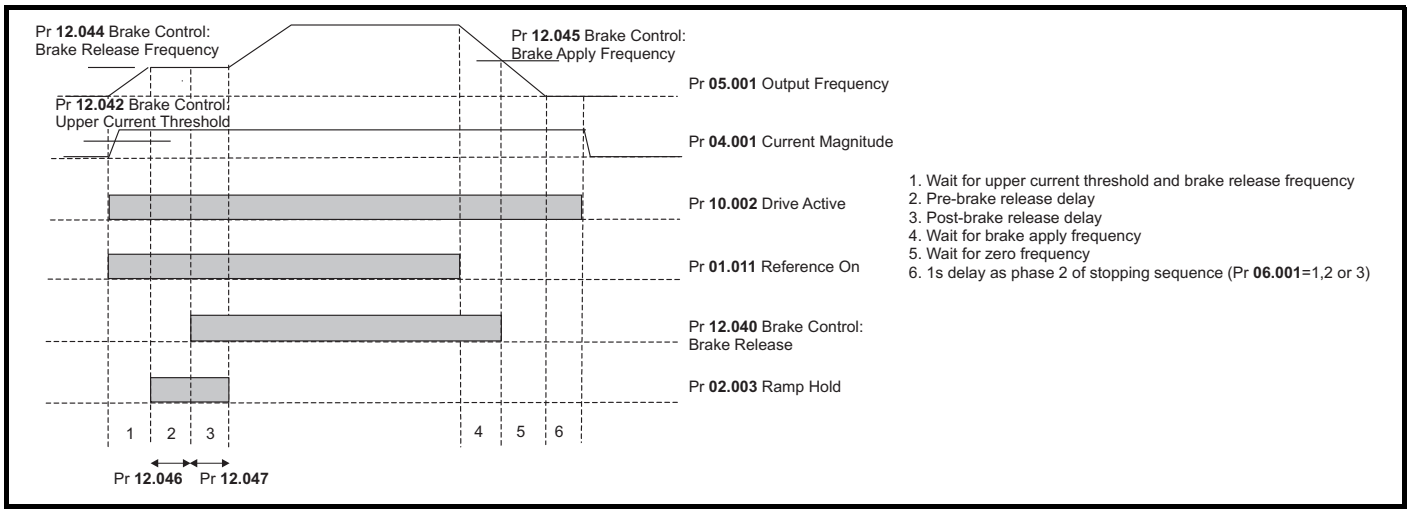
The control terminal relay can be selected as an output to release a brake. If a drive is set up in this manner and a drive replacement takes place, prior to programming the drive on initial power up, the brake may be released.
When drive terminals are programmed to non default settings the result of 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 11-24 Brake function



The parameters are all shown in their default settings

Figure 11-25 Brake sequence

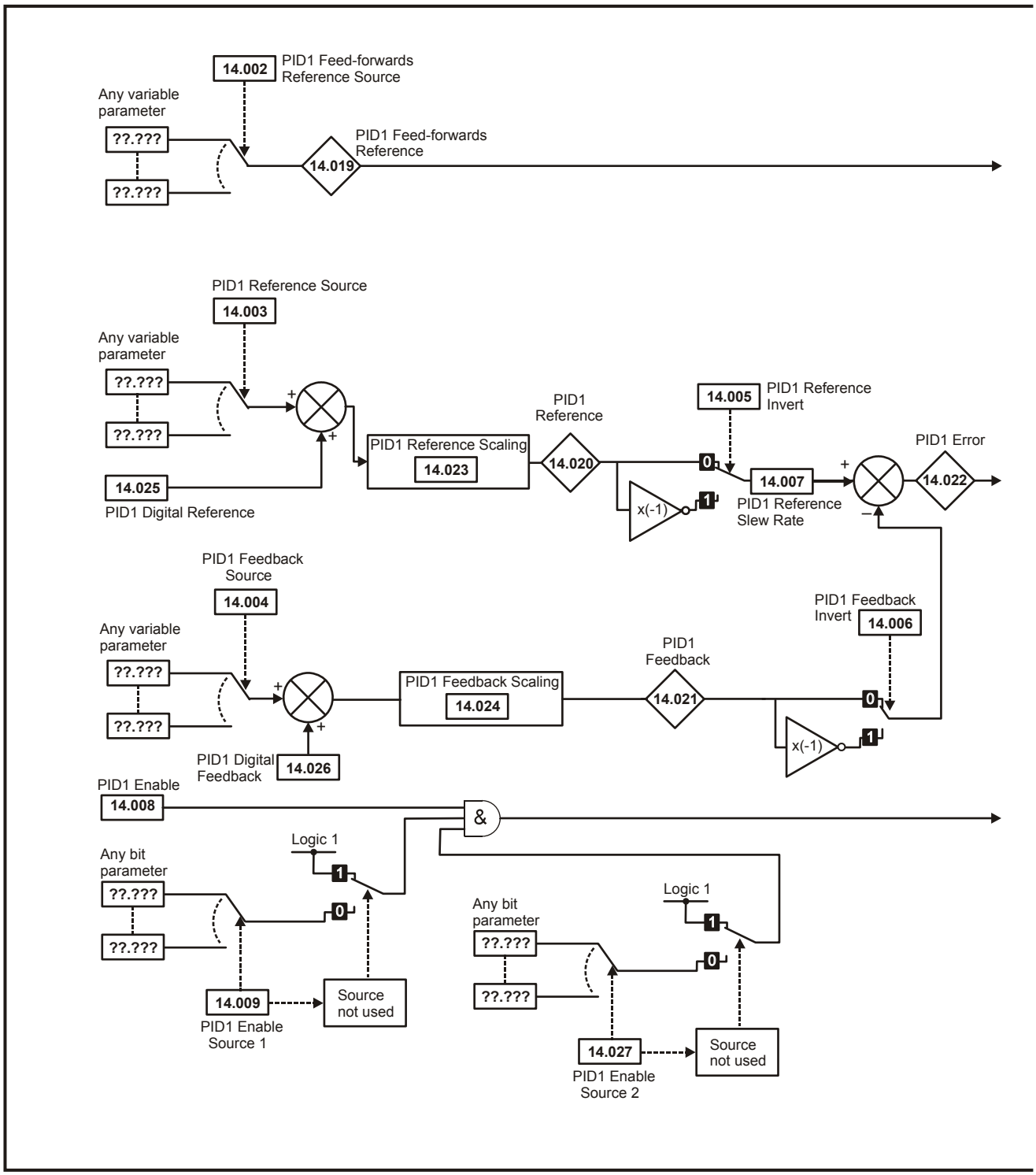


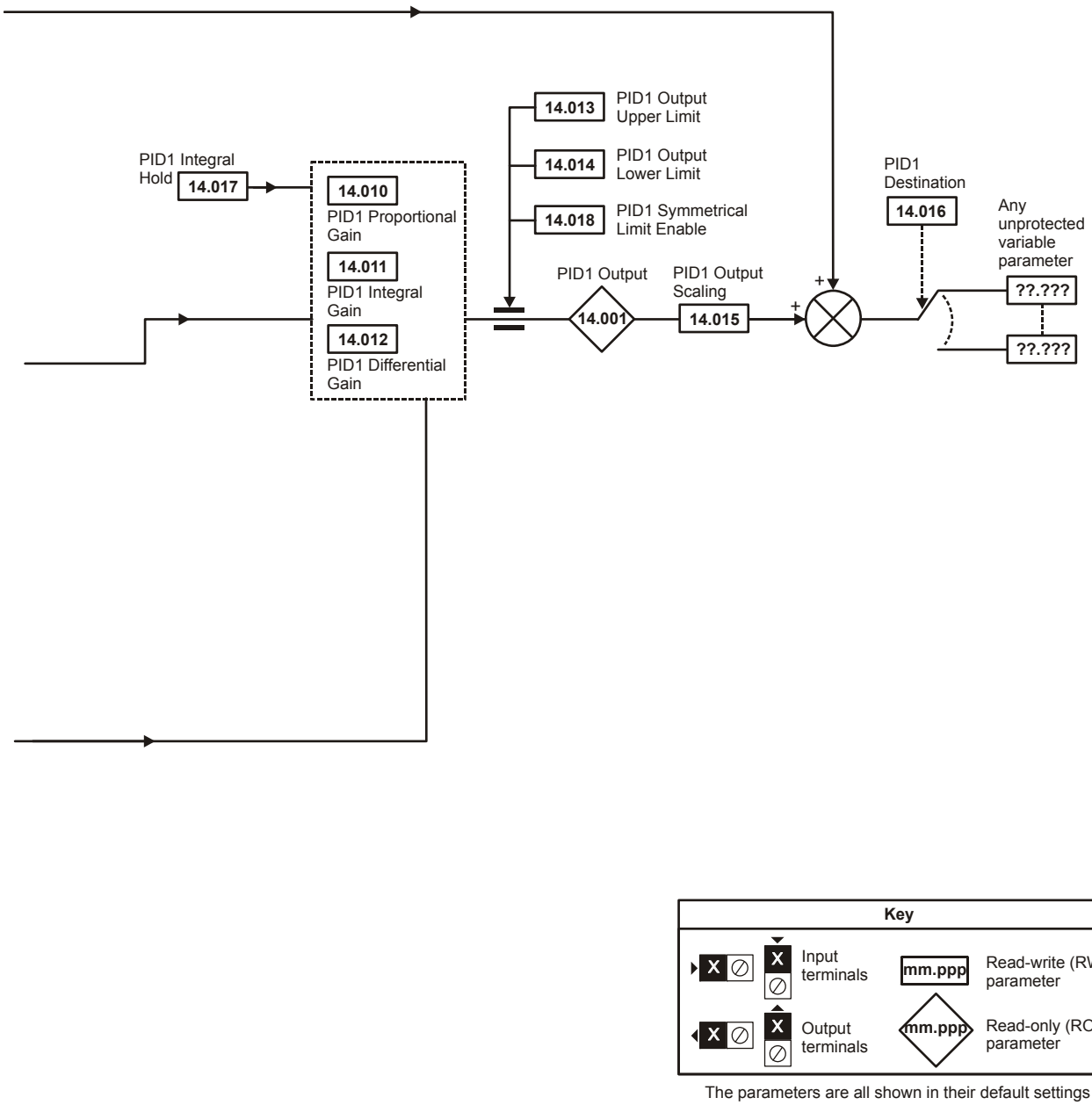
Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
12.001	Threshold Detector 1 Output	Off (0) or On (1)				RO	Bit	ND	NC	PT	
12.002	Threshold Detector 2 Output	Off (0) or On (1)				RO	Bit	ND	NC	PT	
12.003	Threshold Detector 1 Source	0.000 to 30.999		0.000		RW	Num			PT	US
12.004	Threshold 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	Input 1 (0), Input 2 (1), Add (2), Subtract (3), Multiply (4), Divide (5), Time Const (6), Ramp (7), Modulus (8), Powers (9)		Input 1 (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	Input 1 (0), Input 2 (1), Add (2), Subtract (3), Multiply (4), Divide (5), Time Const (6), Ramp (7), Modulus (8), Powers (9)		Input 1 (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	Disable (0), Relay (1), Digital IO (2), User (3)		Disable (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), Forward (1), Reverse (2)		Ref (0)		RW	Txt				US
12.051	BC Brake Apply Through Zero Threshold	0.00 to 25.00 Hz		0.00 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
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 14: User PID controller

Figure 11-26 Menu 14 Logic diagram





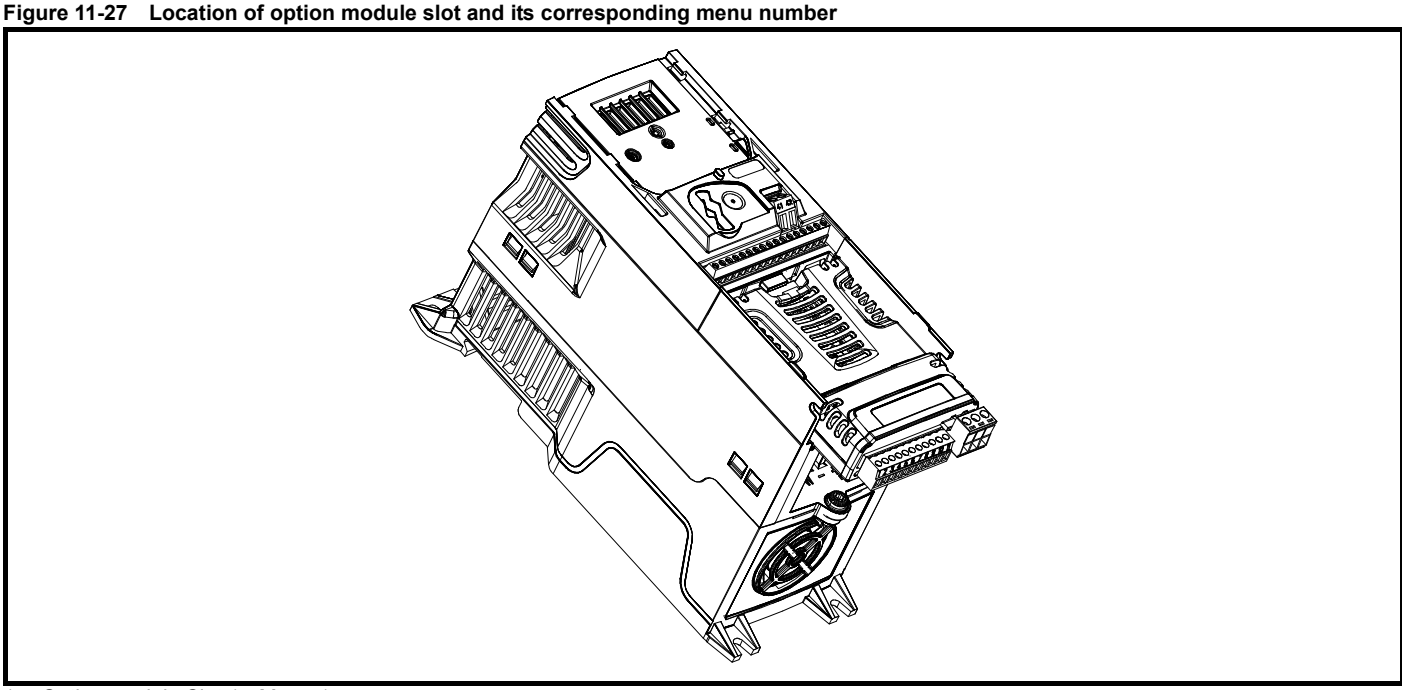
The parameters are all shown in their default settings

Parameter		Range (⇳)		Default (⇨)		Type					
		Open-Loop	RFC-A	Open-Loop	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
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter	SMP	Slot,menu,parameter	Chr	Character parameter	Ver	Version number

11.14 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

11.14.1 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 to 99.99		RO	Num	ND	NC	PT	
15.003	Hardware Version	0.00 to 99.99		RO	Num	ND	NC	PT	
15.004	Serial Number LS	0 to 99999999		RO	Num	ND	NC	PT	
15.005	Serial Number MS			RO	Num	ND	NC	PT	
15.051	Software Sub-version	0 to 99		RO	Num	ND	NC	PT	

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)
443	SI-PROFIBUS	Fieldbus
447	SI-DeviceNet	Fieldbus
448	SI-CANopen	Fieldbus

11.15 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	-32768 to 32767				RO	Num	ND	NC		
18.003	Application Menu 1 Read-only Integer 3	-32768 to 32767				RO	Num	ND	NC		
18.004	Application Menu 1 Read-only Integer 4	-32768 to 32767				RO	Num	ND	NC		
18.005	Application Menu 1 Read-only Integer 5	-32768 to 32767				RO	Num	ND	NC		
18.006	Application Menu 1 Read-only Integer 6	-32768 to 32767				RO	Num	ND	NC		
18.007	Application Menu 1 Read-only Integer 7	-32768 to 32767				RO	Num	ND	NC		
18.008	Application Menu 1 Read-only Integer 8	-32768 to 32767				RO	Num	ND	NC		
18.009	Application Menu 1 Read-only Integer 9	-32768 to 32767				RO	Num	ND	NC		
18.010	Application Menu 1 Read-only Integer 10	-32768 to 32767				RO	Num	ND	NC		
18.011	Application Menu 1 Read-write Integer 11	-32768 to 32767		0		RW	Num				US
18.012	Application Menu 1 Read-write Integer 12	-32768 to 32767		0		RW	Num				US
18.013	Application Menu 1 Read-write Integer 13	-32768 to 32767		0		RW	Num				US
18.014	Application Menu 1 Read-write Integer 14	-32768 to 32767		0		RW	Num				US
18.015	Application Menu 1 Read-write Integer 15	-32768 to 32767		0		RW	Num				US
18.016	Application Menu 1 Read-write Integer 16	-32768 to 32767		0		RW	Num				US
18.017	Application Menu 1 Read-write Integer 17	-32768 to 32767		0		RW	Num				US
18.018	Application Menu 1 Read-write Integer 18	-32768 to 32767		0		RW	Num				US
18.019	Application Menu 1 Read-write Integer 19	-32768 to 32767		0		RW	Num				US
18.020	Application Menu 1 Read-write Integer 20	-32768 to 32767		0		RW	Num				US
18.021	Application Menu 1 Read-write Integer 21	-32768 to 32767		0		RW	Num				US
18.022	Application Menu 1 Read-write Integer 22	-32768 to 32767		0		RW	Num				US
18.023	Application Menu 1 Read-write Integer 23	-32768 to 32767		0		RW	Num				US
18.024	Application Menu 1 Read-write Integer 24	-32768 to 32767		0		RW	Num				US
18.025	Application Menu 1 Read-write Integer 25	-32768 to 32767		0		RW	Num				US
18.026	Application Menu 1 Read-write Integer 26	-32768 to 32767		0		RW	Num				US
18.027	Application Menu 1 Read-write Integer 27	-32768 to 32767		0		RW	Num				US
18.028	Application Menu 1 Read-write Integer 28	-32768 to 32767		0		RW	Num				US
18.029	Application Menu 1 Read-write Integer 29	-32768 to 32767		0		RW	Num				US
18.030	Application Menu 1 Read-write Integer 30	-32768 to 32767		0		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	Off (0) or On (1)		Off (0)		RW	Bit				US
18.033	Application Menu 1 Read-write bit 33	Off (0) or On (1)		Off (0)		RW	Bit				US
18.034	Application Menu 1 Read-write bit 34	Off (0) or On (1)		Off (0)		RW	Bit				US
18.035	Application Menu 1 Read-write bit 35	Off (0) or On (1)		Off (0)		RW	Bit				US
18.036	Application Menu 1 Read-write bit 36	Off (0) or On (1)		Off (0)		RW	Bit				US
18.037	Application Menu 1 Read-write bit 37	Off (0) or On (1)		Off (0)		RW	Bit				US
18.038	Application Menu 1 Read-write bit 38	Off (0) or On (1)		Off (0)		RW	Bit				US
18.039	Application Menu 1 Read-write bit 39	Off (0) or On (1)		Off (0)		RW	Bit				US
18.040	Application Menu 1 Read-write bit 40	Off (0) or On (1)		Off (0)		RW	Bit				US
18.041	Application Menu 1 Read-write bit 41	Off (0) or On (1)		Off (0)		RW	Bit				US
18.042	Application Menu 1 Read-write bit 42	Off (0) or On (1)		Off (0)		RW	Bit				US
18.043	Application Menu 1 Read-write bit 43	Off (0) or On (1)		Off (0)		RW	Bit				US
18.044	Application Menu 1 Read-write bit 44	Off (0) or On (1)		Off (0)		RW	Bit				US
18.045	Application Menu 1 Read-write bit 45	Off (0) or On (1)		Off (0)		RW	Bit				US
18.046	Application Menu 1 Read-write bit 46	Off (0) or On (1)		Off (0)		RW	Bit				US
18.047	Application Menu 1 Read-write bit 47	Off (0) or On (1)		Off (0)		RW	Bit				US
18.048	Application Menu 1 Read-write bit 48	Off (0) or On (1)		Off (0)		RW	Bit				US
18.049	Application Menu 1 Read-write bit 49	Off (0) or On (1)		Off (0)		RW	Bit				US
18.050	Application Menu 1 Read-write bit 50	Off (0) or On (1)		Off (0)		RW	Bit				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

11.16 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	-2147483648 to 2147483647		0		RW	Num				
20.023	Application Menu 2 Read-write Long Integer 23	-2147483648 to 2147483647		0		RW	Num				
20.024	Application Menu 2 Read-write Long Integer 24	-2147483648 to 2147483647		0		RW	Num				
20.025	Application Menu 2 Read-write Long Integer 25	-2147483648 to 2147483647		0		RW	Num				
20.026	Application Menu 2 Read-write Long Integer 26	-2147483648 to 2147483647		0		RW	Num				
20.027	Application Menu 2 Read-write Long Integer 27	-2147483648 to 2147483647		0		RW	Num				
20.028	Application Menu 2 Read-write Long Integer 28	-2147483648 to 2147483647		0		RW	Num				
20.029	Application Menu 2 Read-write Long Integer 29	-2147483648 to 2147483647		0		RW	Num				
20.030	Application Menu 2 Read-write Long Integer 30	-2147483648 to 2147483647		0		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

11.17 Menu 21: Second motor parameters

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
21.001	M2 Maximum Reference Clamp	±VM_POSITIVE_REF_CLAMP Hz		50 Hz: 50.00 Hz 60 Hz: 60.00 Hz		RW	Num				US
21.002	M2 Minimum Reference Clamp	±VM_NEGATIVE_REF_CLAMP2 Hz		0.00 Hz		RW	Num				US
21.003	M2 Reference Selector	A1 A2 (0), A1 Preset (1), A2 Preset (2), Preset (3), Keypad (4), Reserved (5), Keypad Ref (6)		A1 A2 (0)		RW	Txt				US
21.004	M2 Acceleration Rate 1	±VM_ACCEL_RATE		5.0		RW	Num				US
21.005	M2 Deceleration Rate 1	±VM_ACCEL_RATE		10.0		RW	Num				US
21.006	M2 Motor Rated Frequency	0.00 to VM_SPEED_FREQ_REF _UNIPOLAR Hz		50 Hz: 50.00 Hz 60 Hz: 60.00 Hz		RW	Num				US
21.007	M2 Motor Rated Current	±VM_RATED_CURRENT A		Maximum Heavy Duty Rating (11.032)		RW	Num		RA		US
21.008	M2 Motor Rated Speed	0.0 to 80000.0 rpm		50 Hz: 1500.0 rpm 60 Hz: 1800.0 rpm	50 Hz: 1450.0 rpm 60 Hz: 1750.0 rpm	RW	Num				US
21.009	M2 Motor Rated Voltage	±VM_AC_VOLTAGE_SET V		110V drive: 230 V, 200V drive: 230 V 400V drive 50 Hz: 400 V, 400V drive 60 Hz: 460 V 575 V drive: 575 V, 690V drive: 690 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	Automatic (0) to 32 (16) Poles		Automatic (0) Poles		RW	Txt				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		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	±VM_MOTOR2_CURRENT_LIMIT %		165.0 %	175.0 %	RW	Num		RA		US
21.028	M2 Regenerating Current Limit	±VM_MOTOR2_CURRENT_LIMIT %		165.0 %	175.0 %	RW	Num		RA		US
21.029	M2 Symmetrical Current Limit	±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.

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 22: Additional Menu 0 set-up

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
22.001	Parameter 00.001 Set-up	0.000 to 30.999		1.007		RW	Num			PT	US
22.002	Parameter 00.002 Set-up	0.000 to 30.999		1.006		RW	Num			PT	US
22.003	Parameter 00.003 Set-up	0.000 to 30.999		2.011		RW	Num			PT	US
22.004	Parameter 00.004 Set-up	0.000 to 30.999		2.021		RW	Num			PT	US
22.005	Parameter 00.005 Set-up	0.000 to 30.999		11.034		RW	Num			PT	US
22.006	Parameter 00.006 Set-up	0.000 to 30.999		5.007		RW	Num			PT	US
22.007	Parameter 00.007 Set-up	0.000 to 30.999		5.008		RW	Num			PT	US
22.008	Parameter 00.008 Set-up	0.000 to 30.999		5.009		RW	Num			PT	US
22.009	Parameter 00.009 Set-up	0.000 to 30.999		5.010		RW	Num			PT	US
22.010	Parameter 00.010 Set-up	0.000 to 30.999		11.044		RW	Num			PT	US
22.011	Parameter 00.011 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.012	Parameter 00.012 Set-up	0.000 to 30.999		8.010		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		0.000		RW	Num			PT	US
22.020	Parameter 00.020 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.021	Parameter 00.021 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.022	Parameter 00.022 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.023	Parameter 00.023 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.024	Parameter 00.024 Set-up	0.000 to 30.999		0.000		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		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		12.048		RW	Num			PT	US
22.053	Parameter 00.053 Set-up	0.000 to 30.999		12.050		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		0.000		RW	Num			PT	US
22.057	Parameter 00.057 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.058	Parameter 00.058 Set-up	0.000 to 30.999		0.000		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		0.000		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		0.000		RW	Num			PT	US
22.065	Parameter 00.065 Set-up	0.000 to 30.999		3.010		RW	Num			PT	US

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
22.066	Parameter 00.066 Set-up	0.000 to 30.999		3.011		RW	Num			PT	US
22.067	Parameter 00.067 Set-up	0.000 to 30.999		3.079		RW	Num			PT	US
22.068	Parameter 00.068 Set-up	0.000 to 30.999		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		0.000		RW	Num			PT	US
22.071	Parameter 00.071 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.072	Parameter 00.072 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.073	Parameter 00.073 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.074	Parameter 00.074 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.075	Parameter 00.075 Set-up	0.000 to 30.999		0.000		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		11.044		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

12 Technical data

12.1 Drive technical data

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

For a full explanation of 'Normal Duty' and 'Heavy Duty' refer to section 2.2 *Ratings* on page 12.

Table 12-1 Maximum permissible continuous output current @ 40 °C (104 °F) ambient (size 1 to 4)

Model	Heavy Duty										
	Nominal rating		Maximum permissible continuous output current (A) for the following switching frequencies								
	kW	hp	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
100 V											
01100017	0.25	0.33	1.7								
01100024	0.37	0.5	2.4								
02100042	0.75	1.0	4.2								
02100056	1.1	1.5	5.6								
200 V											
01200017	0.25	0.33	1.7								
01200024	0.37	0.5	2.4								
01200033	0.55	0.75	3.3								
01200042	0.75	1.0	4.2								
02200024	0.37	0.5				2.4					
02200033	0.55	0.75				3.3					
02200042	0.75	1.0				4.2					
02200056	1.1	1.5	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
02200075	1.5	2.0	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.0
03200100	2.2	3.0	10	10	10	10	10	10	10	9	7.3
04200133	3.0	3.0	13.3								
04200176	4.0	5.0	17.6								
400 V											
02400013	0.37	0.5	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
02400018	0.55	0.75	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	
02400023	0.75	1.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.0	
02400032	1.1	1.5	3.2	3.2	3.2	3.2	3.2	3.2	3.2	2.0	
02400041	1.5	2.0	4.1	4.1	4.1	4.1	4.1	4.1	3.8	2.0	
03400056	2.2	3.0	5.6	5.6	5.6	5.6	5.6	5.6	5.1	3.7	2.4
03400073	3.0	3.0	7.3	7.3	7.3	7.3	7.3	7.1	5.6	3.8	
03400094	4.0	5.0	9.4	9.4	9.4	9.4	9.4	8.5	7	4.6	
04400135	5.5	7.5	13.5								
04400170	7.5	10.0	17								

Table 12-2 Maximum permissible continuous output current @ 40 °C (104 °F) ambient (size 5 to 8)

Model	Normal Duty									Heavy Duty							
	Nominal rating		Maximum permissible continuous output current (A) for the following switching frequencies							Nominal rating		Maximum permissible continuous output current (A) for the following switching frequencies					
	kW	hp	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz	kW	hp	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V																		
05200250	7.5	10	30					27.6	23.7	5.5	7.5	25				24.8	21.5	18.8
06200330	11	15	50					42.3	24.5	7.5	10	33.0					32	27
06200440	15	20	58				53	42.3	32.5	11	15	44.0				40	33	27.3
07200610	18.5	25	75					74.3	59.7	15	20	61						53.1
07200750	22	30	94					74.3	59.7	18.5	25	75					65.3	53.1
07200830	30	40	117			114	96	74.3	59.7	22	30	83				80.5	65.6	53.1
08201160	37	50	149				146	125.2	93	30	40	116			113.7	103	89.3	80.5
08201320	45	60	180			160.2	148.8	126	93	37	50	132		126.7	114	103	89.8	80.5
400 V																		
05400270	15	20	30			25.8	22.2	17.1	13.5	11	20	27	25.4	23.7	20.3	17.6	13.8	11.1
05400300	15	20	31			30.7	26.4	18.3	14.1	15	20	30		27.9	24	21	14.9	12.2
06400350	18.5	25	38					31	24.3	15	25	35				30	23	18.5
06400420	22	30	48				41	31	24.5	18.5	30	42			35	30	23	18.5
06400470	30	40	63	57	48		41	31	24.5	22	30	47	46	42	35	30	23	18.5
07400660	37	50	79					63	53.6	30	50	66			57	48	41	34
07400770	45	60	94				80.6	63	53.6	37	60	77		70	59	51	44	37
07401000	55	75	112			95.2	80.6	63	53.8	45	75	100		88	73	61	48	41
08401340	75	100	155				132	98	77	55	100	134		130	109	91	72	57
08401570	90	125	184			169	142	106.7	77	75	125	157		143	121	104	80.1	65
575 V																		
05500030	2.2	3.0	3.9							1.5	2.0	3.0						
05500040	4.0	5.0	6.1							2.2	3.0	4.0						
05500069	5.5	7.5	10							4.0	5.0	6.9						
06500100	7.5	10.0	12							5.5	7.5	10						
06500150	11.0	15.0	17						14.8	7.5	10	15						11.6
06500190	15.0	20.0	22					20.5	15	11	15	19					15.4	11.6
06500230	18.5	25.0	27				26.2	20	16	15	20	23				20	15.4	12.8
06500290	22.0	30.0	34			31	26.2	20	16.8	18.5	25	29			23.8	20	15.4	12.8
06500350	30.0	40.0	43	39.6		31	26.2	20	16.8	22	30	35	34	29.8	23.8	20	15.4	13
07500440	45	50	53			51.8	40.2	27.7	21.2	30	40	44			39.2	30.8	21.6	16.7
07500550	55	60	73	71.5		51.8	40.2	27.7	21.2	37	50	55		52.8	39.2	30.8	21.6	17.1
08500630	75	75	86				73.1	49.7	37.8	45	60	63				53.3	37.2	28.4
08500860	90	100	108			91.8	73.1	49.7	37.8	55	75	86			67.1	53.3	37.8	28.4
690 V																		
07600190	18.5	25	23						21.2	15	20	19						16.7
07600240	22	30	30					27.9	21.2	18.5	25	24					21.8	16.6
07600290	30	40	36					28.1	21.2	22	30	29					21.8	16.5
07600380	37	50	46				40.5	28.1	21.2	30	40	38				30.8	21.7	16.7
07600440	45	60	52			51.5	40.6	28.1	21.2	37	50	44			38.7	30.8	21.6	16.7
07600540	55	75	73	71.5		51.8	40.2	27.7	21.2	45	60	54		52.9	39	31	21.6	16.7
08600630	75	100	86				72.2	49.7	37.8	55	75	63				53.3	37	28.4
08600860	90	125	108			91.8	72.4	49.7	37.8	75	100	86			67.1	53.3	37	28.4

Table 12-3 Maximum permissible continuous output current @ 40 °C (104 °F) ambient with high IP insert installed (size 5 only)

Model	Normal Duty							Heavy Duty						
	Maximum permissible continuous output current (A) for the following switching frequencies							Maximum permissible continuous output current (A) for the following switching frequencies						
	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V														
05200250	25.5	25.2	24.9	24.3	23.7	22.5	21.6	25		24.8	24.3	23.8	22.5	20
400 V														
05400270	17.1	15.6	14.4	12.6	11.4	9.6	8.7	17.3	15.7	14.6	12.7	11.3	9.7	8.6
05400300	19.8	19.5	18.9	17.7	16.4	14	11.8	19.8	19.5	18.9	17.7	16.2	13.8	11.7
575 V														
05500030	3.9							3.0						
05500040	6.1							4.0						
05500069	10							6.9						

Table 12-4 Maximum permissible continuous output current @ 50 °C (122 °F) (size 1 to 4)

Model	Heavy Duty								
	Maximum permissible continuous output current (A) for the following switching frequencies								
	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
100 V									
01100017*	1.7								
01100024*	2.4								
02100042	4.2								
02100056	5.6					5.5	5.3	5.1	4.9
200 V									
01200017*	1.7								
01200024*	2.4								
01200033*	3.3								
01200042*	4.2								
02200024				2.4					
02200033				3.3					
02200042				4.2					
02200056	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.4
02200075	7.5	7.5	7.4	7.2	6.8	6.6	6.3	5.8	5.4
03200100	10	10	10	10	9.5	8.6	7.5	6.1	5
04200133									
04200176									
400 V									
02400013	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.1	
02400018	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.1	
02400023	2.3	2.3	2.3	2.3	2.3	2.3	2.3	1.1	
02400032	3.2	3.2	3.2	3.2	3.2	3.2	2.5	1.1	
02400041	4.1	4.1	4.1	4.1	3.7	3.2	2.5	1.1	
03400056	5.6	5.6	5.6	5.6	5	3.5	2.8	1.9	
03400073	7.3	7.3	7.3	7.3	6.2	4.5	3.4		
03400094	9.4	9.4	9.4	9.4	7.9	6.2	4.7		
04400135									
04400170									

* CI-Keypad not installed.

Table 12-5 Maximum permissible continuous output current @ 50 °C (122 °F) (size 5 to 8)

Model	Normal Duty							Heavy Duty						
	Maximum permissible continuous output current (A) for the following switching frequencies							Maximum permissible continuous output current (A) for the following switching frequencies						
	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V														
05200250	30.0			29.7	25.2	21.6		25.0			23.0	19.8	17.3	
06200330	50.0			49.0	38.0	30.0		33.0				29.0	24.6	
06200440	58.0		56.0	49.0	38.0	30.2		44.0		41.0	36.0	29.0	24.6	
07200610	75				60.8	48.8		61				53.7	43.3	
07200750	94		92.1	80	59.7	48.9		75			69.8	53.3	43.5	
07200830	117	112	92.4	80	59.7	49.1		83		81.3	69.7	53.1	43.2	
08201160	149		147	133	113	84		116		104	95.1	81.8	72	
08201320	180	167	148	133	113	84		132	125	117	104	95.1	81.8	72
400 V														
05400270	25.5		23.6	20.4	15.6	12.3		24.0	23.5	21.6	18.6	16.2	12.7	10.0
05400300	25.5		23.6		15.9	12.3		24.0			21.9	19.2	13.8	10.5
06400350	38.0			37.0	28.0	21.4		35.0			32.0	27.0	21.0	16.5
06400420	48.0		43.0	36.5	27.4	21.4		42.0	42.0	38.0	32.0	27.0	21.0	16.5
06400470	63.0	58.0	52.0	43.0	37.0	28.0	21.4	47.0	42.0	38.0	32.0	27.0	21.0	16.5
07400660	79			73.5	57.7	49		66			55	45	38	30
07400770	94		86.5	73.3	58.3	49		77		70	57	48	41	34
07401000	112	109	87.4	72.8	58.3	49.3		100	91	80	65	55	44	37
08401340	155		146	122	93	69		134		120	99	85	69	55
08401570	184	180	145	123	93.8	69		157	146	132	110	94.2	73.8	58
575 V														
05500030	3.9							3.0						
05500040	6.1							4.0						
05500069	10.0							6.9						
06500100	12.0							10.0						
06500150	17.0					13.4		15.0				14.0	10.3	
06500190	22.0				17.8	13.4		19.0				14.0	10.3	
06500230	27.0			23.5	17.8	15.0		23.0			21.6	19.0	14.0	11.5
06500290	34.0		28.2	23.5	18.0	15.0		29.0		27.3	22.0	19.0	14.0	11.6
06500350	43.0	41.7	36.1	28.0	23.7	18.0	15.0	35.0	31.2	27.3	21.8	19.0	14.0	11.6
07500440	53		46.7	35.8	24.8	19		44			35.2	28.1	19.3	15
07500550	73	65	46.7	35.8	24.8	19		55		48.4	35.2	28.1	19.3	15
08500630	86		76.7	64.5	44.3	31.3		63			61.1	48.5	33.4	24.9
08500860	104	97.2	90.7	76.7	64.8	44.3	31.3	86		80.8	61.1	49	33.4	24.9
690 V														
07600190	23					19		19						14.5
07600240	30				24.8	19		24					19.4	14.5
07600290	36			35.8	24.8	19		29				27.7	19.4	14.5
07600380	46			35.8	24.8	19		38			35.3	27.7	19.4	14.5
07600440	52		46.7	35.8	25	19		44			35.6	27.7	19.4	14.5
07600540	73	65	46.7	35.8	25	19		54		48.1	35.6	27.7	19.4	14.6
08600630	86		76.7	64.5	44.3	31.3		63			61.1	48.2	33.4	24.9
08600860	104	97.2	90.7	76.7	64.8	44.3	31.3	86		80.8	61.1	48.2	33.5	24.9

12.1.2 Power dissipation

Table 12-6 Losses @ 40°C (104°F) ambient (size 1 to 4)

Model	Heavy Duty										
	Nominal rating		Drive losses (W) taking into account any current derating for the given conditions								
	kW	hp	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
100 V											
01100017	0.25	0.33									
01100024	0.37	0.5									
02100042	0.75	1.0	34	34	35	36	37	39	41	46	50
02100056	1.1	1.5	42	43	44	46	47	50	53	59	65
200 V											
01200017	0.25	0.33									
01200024	0.37	0.5									
01200033	0.55	0.75									
01200042	0.75	1.0									
02200024	0.37	0.5	24	24	24	25	25	26	27	30	32
02200033	0.55	0.75	31	31	32	33	34	35	37	40	43
02200042	0.75	1.0	37	37	38	39	40	42	44	49	53
02200056	1.1	1.5	45	46	47	48	50	53	56	62	68
02200075	1.5	2.0	58	59	61	63	65	69	74	82	84
03200100	2.2	3.0	85	87	91	96	101	110	117	121	117
04200133	3.0	3.0									
04200176	4.0	5.0									
400 V											
02400013	0.37	0.5	25	26	30	33	36	42	48	60	
02400018	0.55	0.75	29	30	34	37	40	47	53	67	
02400023	0.75	1.0	33	34	38	41	45	52	59	69	
02400032	1.1	1.5	41	42	46	50	54	63	71	70	
02400041	1.5	2.0	49	50	55	60	64	74	78	70	
03400056	2.2	3.0	55	57	62	68	75	86	90	86	77
03400073	3.0	3.0	72	74	82	90	98	113	101	92	
03400094	4.0	5.0	95	99	108	116	129	128	125	113	
04400135	5.5	7.5									
04400170	7.5	10.0									

Table 12-7 Losses @ 40°C (104°F) ambient (size 5 to 8)

Model	Normal Duty									Heavy Duty								
	Nominal rating		Drive losses (W) taking into account any current derating for the given conditions							Nominal rating		Drive losses (W) taking into account any current derating for the given conditions						
	kW	hp	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz	kW	hp	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V																		
05200250	7.5	10		291	302	324	344	356	342	5.5	7.5		245	254	272	288	284	282
06200330	11	15		394	413	452	490	480		7.5	10		277	290	316	342	382	
06200440	15	20		463	484	528	522	481		11	15		366	382	417	410	388	
07200610	18.5	25		570	597	650	703			15	20		466	488	532	575		
07200750	22	30		718	751	815	881			18.5	25		570	597	650	703		
07200830	30	40		911	951	1004	911			22	30		634	663	720	755		
08201160	37	50		1433	1536	1765	1943			30	40		1105	1193	1343	1373		
08201320	45	60		1753	1894	1914	1985			37	50		1269	1306	1349	1372		
400 V																		
05400270	15	20		324	353	356	355	359	362	11	20		276	282	285	290	301	310
05400300	15	20		332	367	434	441	417	424	15	20		322	333	352	374	372	439
06400350	18.5	25		417	456	532	613	652	645	15	25		389	424	498	496	502	513
06400420	22	30		515	561	657	651	646	650	18.5	30		455	497	487	486	495	513
06400470	30	40		656	659	650	646	643		22	30		500	496	487	486	495	
07400660	37	50		830	907	1062	1218			30	50		692	758	773	763		
07400770	45	60		999	1088	1264	1241			37	60		812	802	800	811		
07401000	55	75		1152	1247	1218	1170			45	75		1017	968	936	907		
08401340	75	100		1652	1817	2154	2121			55	100		1374	1509	1521	1510		
08401570	90	125		2004	2191	2333	2279			75	125		1541	1670	1674	1673		
575 V																		
05500030	2.2	3		92	102	121	142			1.5	2		82	91	108	126		
05500040	4	5		135	150	180	209			2.2	3		94	104	124	145		
05500069	5.5	7.5		194	215	260	302			4	5		153	170	204	236		
06500100	7.5	10		215	239	287	334			5.5	7.5		187	208	249	291		
06500150	11	15		284	315	376	438			7.5	10		265	294	351	410		
06500190	15	20		362	399	484	569			11	15		317	350	418	496		
06500230	18.5	25		448	505	596	682			15	20		382	421	508	523		
06500290	22	30		623	712	810	822			18.5	25		533	610	628	635		
06500350	30	40		798	836	813	823			22	30		546	624	622	627		
07500440	45	50		1004	1139	1358	1262			30	40		817	929	1028	967		
07500550	55	60		1248	1375	1209	1122			37	50		886	1002	914	863		
08500630	75	75		1861	2180	2814	2982			45	60		1345	1585	2136	2284		
08500860	90	100		2374	2753	2947	2963			55	75		1813	2174	2212	2218		
690 V																		
07600190	18.5	25		428	491	617	743			15	20		360	413	519	625		
07600240	22	30		551	631	791	952			18.5	25		446	513	644	776		
07600290	30	40		660	754	941	1129			22	30		533	610	765	920		

Model	Normal Duty									Heavy Duty								
	Nominal rating		Drive losses (W) taking into account any current derating for the given conditions							Nominal rating		Drive losses (W) taking into account any current derating for the given conditions						
	kW	hp	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz	kW	hp	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
07600380	37	50		854	971	1206	1271			30	40		697	796	993	966		
07600440	45	60		985	1117	1350	1275			37	50		817	929	1015	967		
07600540	55	75		1248	1375	1209	1122			45	60		888	1004	909	869		
08600630	75	100		1861	2180	2814	2945			55	75		1345	1585	2136	2284		
08600860	90	125		2374	2753	2947	2935			75	100		1813	2174	2212	2218		

Table 12-8 Losses @ 40°C (104°F) ambient with high IP insert installed (size 5 only)

Model	Normal Duty							Heavy Duty						
	Drive losses (W) taking into consideration any current derating for the given conditions							Drive losses (W) taking into consideration any current derating for the given conditions						
	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V														
05200250		244	249	262	274	298	328		245	251	264	278	301	306
400 V														
05400270		170	173	182	194	223	268		172	177	184	194	225	265
05400300		218	240	284	329	432	564		218	240	284	325	425	560
575 V														
05500030														
05500040														
05500069														

Table 12-9 Losses @ 50°C (122°F) ambient (size 1 to 4)

Model	Heavy Duty										
	Nominal rating		Drive losses (W) taking into account any current derating for the given conditions								
	kW	hp	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
100 V											
01100017	0.25	0.33									
01100024	0.37	0.5									
02100042	0.75	1.0	34	34	35	36	37	39	41	46	50
02100056	1.1	1.5	42	43	44	46	47	49	47	47	57
200 V											
01200017	0.25	0.33									
01200024	0.37	0.5									
01200033	0.55	0.75									
01200042	0.75	1.0									
02200024	0.37	0.5	24	24	24	25	25	26	27	30	32
02200033	0.55	0.75	31	31	32	33	34	35	37	40	43
02200042	0.75	1.0	37	37	38	39	39	40	42	45	46
02200056	1.1	1.5	44	44	46	46	47	48	44	46	50
02200075	1.5	2.0	44	44	45	46	47	48	44	46	50
03200100	2.2	3.0	86	88	92	96	96	97	93	90	86
04200133	3.0	3.0									
04200176	4.0	5.0									
400 V											
02400013	0.37	0.5	25	26	30	33	36	42	48	58	
02400018	0.55	0.75	29	30	34	37	40	47	53	58	
02400023	0.75	1.0	33	34	38	41	45	52	59	58	
02400032	1.1	1.5	41	42	46	50	54	63	62	70	
02400041	1.5	2.0	49	50	55	60	60	63	62	58	
03400056	2.2	3.0	57	58	64	70	73	63	60	60	
03400073	3.0	3.0	73	75	82	91	87	77	71		
03400094	4.0	5.0	96	98	109	122	111	104	97		
04400135	5.5	7.5									
04400170	7.5	10.0									

Table 12-10 Losses @ 50°C (122°F) ambient (size 5 to 8)

Model	Normal Duty							Heavy Duty						
	Drive losses (W) taking into account any current derating for the given conditions							Drive losses (W) taking into account any current derating for the given conditions						
	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz	0.667, 1 and 2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V														
05200250		292	306	331	357	357	357		247	258	279	278	283	288
06200330		394	413	452	481	434			277	290	316	342	346	
06200440		463	484	509	483	437			366	382	389	369	342	
07200610		570	597	650	703				466	488	532	575		
07200750		718	751	799	750				570	597	650	654		
07200830		898	898	805	751				634	663	705	653		
08201160		1433	1536	1741	1770				1105	1193	1228	1277		
08201320		1737	1740	1759	1771				1202	1206	1228	1278		
400 V														
05400270		288	323	368	384	417			267	274	290	305	340	373
05400300		280	316	366	452	453	511		264	297	383	420	463	523
06400350		417	456	536	607	609	597		389	424	459	452	468	472
06400420		515	561	597	595	601	614		455	449	450	445	468	491
06400470		613	600	593	601	613			455	449	450	446	464	
07400660		830	907	1062	1141				692	758	751	725		
07400770		999	1087	1163	1138				808	804	779	773		
07401000		1136	1200	1118	1074				922	878	838	828		
08401340		1652	1815	2016	1970				1410	1392	1391	1432		
08401570		1957	2114	1998	1979				1564	1539	1518	1531		
575 V														
05500030		92	102	121	142				82	91	108	126		
05500040		135	150	180	209				94	104	124	145		
05500069		194	215	260	302				153	170	204	236		
06500100		215	239	287	334				187	208	249	291		
06500150		284	315	376	443				265	294	351	410		
06500190		362	399	482	575				317	350	421	504		
06500230		445	490	592	614				382	422	477	504		
06500290		623	712	739	751				533	574	580	555		
06500350		774	758	734	757				572	572	572	607		
07500440		988	1115	1225	1144				817	923	923	898		
07500550		1225	1228	1098	1030				923	914	828	809		
08500630		1850	2172	2540	2672				1345	1585	2292	2242		
08500860		2090	2291	2540	2684				1845	2029	2039	2047		
690 V														
07600190		428	491	617	743				360	413	519	625		
07600240		551	631	791	958				446	513	644	776		
07600290		660	754	944	1144				533	610	765	809		
07600380		854	965	1206	1144				697	796	926	885		
07600440		969	1094	1225	1144				817	923	933	885		
07600540		1225	1228	1098	1030				906	908	837	797		
08600630		1850	2172	2540	2672				1345	1585	2292	2229		
08600860		2090	2291	2540	2684				1845	2029	2039	2014		

Table 12-11 Power losses from the front of the drive when through-panel mounted

Frame size	Power loss
5	
6	
7	
8	

12.1.3 Supply requirements

AC supply voltage:

100 V drive: 100 V to 120 V ±10 %
200 V drive: 200 V to 240 V ±10 %
400 V drive: 380 V to 480 V ±10 %
575 V drive: 500 V to 575 V ±10 %
690 V drive: 500 V to 690 V ±10 %

Number of phases: 3

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

Frequency range: 48 to 62 Hz

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

12.1.4 Line reactors

Input line reactors reduce the risk of damage to the drive resulting from poor phase balance or severe disturbances on the supply network.

Where line reactors are to be used, reactance values of approximately 2 % are recommended. Higher values may be used if necessary, but may result in a loss of drive output (reduced torque at high speed) because of the voltage drop.

For all drive ratings, 2 % line reactors permit drives to be used with a supply unbalance of up to 3.5 % negative phase sequence (equivalent to 5 % voltage imbalance between phases).

Severe disturbances may be caused by the following factors, for example:

- Power factor correction equipment connected close to the drive.
- Large DC drives having no or inadequate line reactors connected to the supply.
- Across the line (DOL) started motor(s) connected to the supply such that when any of these motors are started, the voltage dip exceeds 20 %

Such disturbances may cause excessive peak currents to flow in the input power circuit of the drive. This may cause nuisance tripping, or in extreme cases, failure of the drive.

Drives of low power rating may also be susceptible to disturbance when connected to supplies with a high rated capacity.

Line reactors are particularly recommended for use with the following drive models when one of the above factors exists, or when the supply capacity exceeds 175 kVA:
Model sizes 04200133 to 07600540 have an internal DC choke and 082001160 to 08600860 have internal AC line chokes so they do not require AC line reactors except for cases of excessive phase unbalance or extreme supply conditions.

When required each drive must have its own reactor(s). Three individual reactors or a single three-phase reactor should be used.

Reactor current ratings

The current rating of the line reactors should be as follows:

Continuous current rating:

Not less than the continuous input current rating of the drive

Repetitive peak current rating:

Not less than twice the continuous input current rating of the drive

12.1.5 Motor requirements

No. of phases: 3

Maximum voltage:

200 V drive: 240 V
400 V drive: 480 V
575 V drive: 575 V
690 V drive: 690 V

12.1.6 Temperature, humidity and cooling method

Size 1 to 4:

Ambient temperature operating range:

- 20 °C to 40 °C (- 4 °F to 104 °F).

Output current derating must be applied at ambient temperatures >40 °C (104 °F).

Size 5 onwards:

Ambient temperature operating range:

- 20 °C to 50 °C (- 4 °F to 122 °F).

Output current derating must be applied at ambient temperatures >40 °C (104 °F).

Cooling method: Forced convection

Maximum humidity: 95 % non-condensing at 40 °C (104 °F)

12.1.7 Storage

Size 1 to 4:

-40 °C (-40 °F) to +60 °C (140 °F) for long term storage.

Size 5 onwards:

-40 °C (-40 °F) to +50 °C (122 °F) for long term storage, or to +70 °C (158 °F) for short term storage

Storage time is 2 years.

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

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

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

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

It is therefore recommended that drives are powered up for a minimum of 1 hour after every 2 years of storage.

This process allows the drive to be stored for a further 2 years.

12.1.8 Altitude

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

1,000 m to 3,000 m (3,300 ft to 9,900 ft) above sea level: de-rate the maximum output current from the specified figure by 1% per 100 m (330 ft) above 1,000 m (3,300 ft)

For example at 3,000 m (9,900 ft) the output current of the drive would have to be de-rated by 20 %.

12.1.9 IP / UL Rating

The drive is rated to IP20 pollution degree 2 (non-conductive contamination only).

In addition to this, drive sizes 2 and 3 are rated to IP21 standard (without an Adaptor Interface module installed).

It is possible to configure drive size 5 and above to achieve IP65 rating (NEMA 12) at the rear of the heatsink for through-panel mounting (some current derating is required).

In order to achieve the high IP rating at the rear of the heatsink with drive size 5 it is necessary to seal a heatsink vent by installing the high IP insert.

The IP rating of a product is a measure of protection against ingress and contact to foreign bodies and water. It is stated as IP XX, where the two digits (XX) indicate the degree of protection provided as shown in Table 12-12.

Table 12-12 IP Rating degrees of protection

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

Table 12-13 UL enclosure ratings

UL rating	Description
Type 1	Enclosures are intended for indoor use, primarily to provide a degree of protection against limited amounts of falling dirt.
Type 12	Enclosures are intended for indoor use, primarily to provide a degree of protection against dust, falling dirt and dripping non-corrosive liquids.

12.1.10 Corrosive gasses

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

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

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

12.1.11 RoHS compliance

The drive meets EU directive 2002-95-EC for RoHS compliance.

12.1.12 Vibration

Size 1 to 4:

Bump Test

Testing in each of three mutually perpendicular axes in turn.
Referenced standard: IEC 60068-2-27: Test Ea:
Severity: 15 g peak, 11 ms pulse duration, half sine.
No. of Bumps: 18 (3 in each direction of each axis).

Referenced standard: IEC 60068-2-29: Test Eb:
Severity: 18 g peak, 6 ms pulse duration, half sine.
No. of Bumps: 600 (100 in each direction of each axis).

Random Vibration Test

Testing in each of three mutually perpendicular axes in turn.
Referenced standard: IEC 60068-2-64: Test Fh:
Severity: 1.0 m^2/s^3 (0.01 g^2/Hz) ASD from 5 to 20 Hz
-3 db/octave from 20 to 200 Hz
Duration: 30 minutes in each of 3 mutually perpendicular axes.

Sinusoidal Vibration Test

Testing in each of three mutually perpendicular axes in turn.
Referenced standard: IEC 60068-2-6: Test Fc:
Frequency range: 5 to 500 Hz
Severity: 3.5 mm peak displacement from 5 to 9 Hz
10 m/s^2 peak acceleration from 9 to 200 Hz
15 m/s^2 peak acceleration from 200 to 500 Hz
Sweep rate:1 octave/minute
Duration: 15 minutes in each of 3 mutually perpendicular axes.

Referenced standard: EN 61800-5-1: 2007, Section 5.2.6.4. referring to IEC 60068-2-6:
Frequency range: 10 to 150 Hz
Severity: 0.075 mm amplitude from 10 to 57 Hz
1g peak acceleration from 57 to 150 Hz
Sweep rate:1 octave/minute
Duration:10 sweep cycles per axis in each of 3 mutually perpendicular axes.

Testing to Environmental Category ENV3

Subjected to resonance search in the range listed. If no natural frequencies found then subjected only to endurance test.
Referenced standard: Environment Category ENV3:
Frequency range: 5 to 13.2 Hz ± 1.0 mm
13.2 to 100 Hz ± 0.7g (6.9 ms -2)

For more information, please refer to section 12 *Vibration Test 1* of the Lloyds Register Test Specification Number 1.

12.1.13 Starts per hour

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

12.1.14 Start up time

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

Size 1 to 4: 1.5 s

12.1.15 Output frequency / speed range

In all operating modes (Open loop, RFC-A) the maximum output frequency is limited to 550 Hz.

12.1.16 Accuracy and resolution

Frequency:

The absolute frequency accuracy depends on the accuracy of the oscillator used with the drive microprocessor. The accuracy of the oscillator is ± 2 % , and so the absolute frequency accuracy is ± 2 % of the reference, when a preset frequency is used. If an analog input is used, the absolute accuracy is further limited by the absolute accuracy of the analog input.

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

Open & closed loop resolution:

Preset frequency reference: 0.01 Hz

Analog input 1: 11 bit plus sign

Analog input 2: 11 bit plus sign

Current:

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

Accuracy: typical 2 %

worst case 5 %

12.1.17 Acoustic noise

The heatsink fan generates the majority of the sound pressure level at 1 m produced by the drive. The heatsink fan on all drives is a variable speed fan. The drive controls the speed at which the fan runs based on the temperature of the heatsink and the drive's thermal model system.

Table 12-14 gives the sound pressure level at 1 m produced by the drive for the heatsink fan running at the maximum and minimum speeds.

Table 12-14 Acoustic noise data

Size	Max speed dBA	Min speed dBA
1	46.7	
2	45	
3	58.6	49
4	60.8	
5	57	
6	57	40
7	57	
8	57	

12.1.18 Overall dimensions

H Height including surface mounting brackets
W Width
D Projection forward of panel when surface mounted
F Projection forward of panel when through-panel mounted
R Projection rear of panel when through-panel mounted

Table 12-15 Overall drive dimensions

Size	Dimension				
	H	W	D	F	R
1	160 mm (6.3 in)	75 mm (2.95 in)	130 mm (5.1 in)		
2	205 mm (8.07 in)		150 mm (5.9 in)		
3	226 mm (8.9 in)	90 mm (3.54 in)	160 mm (6.3 in)		
4	277 mm (10.9 in)	115 mm (4.5 in)	175 mm (6.9 in)		
5	391 mm (15.39 in)	143 mm (5.63 in)	192 mm (7.60 in)		
6	391 mm (15.39 in)	210 mm (8.27 in)	221 mm (8.70 in)		
7	557 mm (21.93 in)	270 mm (10.63 in)	280 mm (11.0 in)		
8	803 mm (31.61 in)	310 mm (12.21 in)	290 mm (11.42 in)		

12.1.19 Weights

Table 12-16 Overall drive weights

Size	Model	kg	lb
1	All	0.75	1.65
2		1.0	2.2
3		1.5	3.3
4		3.13	6.9
5		7.4	16.3
6		14	30.9
7		28	61.7
8		50	110.2

12.1.20 SAFE TORQUE OFF data

According to EN ISO 13849-1:

PL = e

Category = 4

$MTTF_D$ = High

DC_{av} = High

Mission Time and Proof Test Interval = 20 years

The calculated PFD_{AVG} for the complete STO function is:

Frame 1 to 4: 8.4×10^{-6}

Frame 5 to 6: 3.64×10^{-6}

According to EN 61800-5-2:

SIL = 3

Frame 1 to 4: PFH = 9.61×10^{-11} h^{-1}

Frame 5 to 6: PFH = 4.16×10^{-11} h^{-1}

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.

12.1.21 Input current, fuse and cable size ratings

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

Typical input current

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

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

Maximum continuous input current

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

The values of maximum input current are stated for a supply with a 2 % negative phase-sequence imbalance and rated at the maximum supply fault current given in Table 12-17.

Table 12-17 Supply fault current used to calculate maximum input currents

Model	Symmetrical fault level (kA)
All	100

Fuses

The AC supply to the drive must be installed with suitable protection against overload and short-circuits. Table 12-18, Table 12-19, Table 12-20, Table 12-21 and Table 12-22 show the recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

WARNING

Table 12-18 AC Input current and fuse ratings (100 V)

Model	Typical input current A	Maximum continuous input current A	Maximum overload input current A	Fuse rating	
				IEC gG	Class CC or Class J
				Maximum A	Maximum A
01100017	8.7	8.7		10	10
01100024	11.1	11.1		16	16
02100042	18.8	18.8		20	20
02100056	24.0	24.0		25	25

Table 12-19 AC Input current and fuse ratings (200 V)

Model	Typical input current A	Maximum continuous input current A	Maximum overload input current A	Fuse rating						
				IEC			UL / USA			
				Nominal A	Maximum A		Class	Nominal A	Maximum A		Class
					1ph	3ph			1ph	3ph	
01200017	4.5	4.5			6		gG		5		CC or J
01200024	5.3	5.3							10		
01200033	8.3	8.3			10						
01200042	10.4	10.4			16				16		
02200024	5.3/3.2	5.3/4.1			6		gG		10	5	CC or J
02200033	8.3/4.3	8.3/6.7			10				10		
02200042	10.4/5.4	10.4/7.5			16	10			16	10	
02200056	14.9/7.4	14.9/11.3			20	16			20	16	
02200075	18.1/9.1	18.1/13.5									
03200100	23.9/12.8	23.9/17.7	30/25		25	20	gG		25	20	CC or J
04200133	23.7/13.5	23.7/16.9			25	20	gG		25	20	CC or J
04200176	17.0	21.3				25				25	
05200250	24	31	52	40		40	gG	40		40	CC or J
06200330	42	48	64	63		63	gG	60		60	CC or J
06200440	49	56	85					60			
07200610	58	67	109	80		80	gG	80		80	CC or J
07200750	73	84	135	100		100		100		100	
07200830	91	105	149	125		125		125		125	
08201160	123	137	213	200		200	gR	200		200	HSJ
08201320	149	166	243					225		225	

Table 12-20 AC Input current and fuse ratings (400 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
02400013	2.1	2.4			6	gG		5	CC or J
02400018	2.6	2.9							
02400023	3.1	3.5							
02400032	4.7	5.1						10	
02400041	5.8	6.2			10				
03400056	8.3	8.7	13		10	gG		10	CC or J
03400073	10.2	12.2	18		16			16	
03400094	13.1	14.8	20.7					20	
04400135	14.0	16.3			20	gG		20	CC or J
04400170	18.5	20.7			25			25	
05400270	26	29	52	40	40	gG	35	35	CC or J
05400300	27	30	58						
06400350	32	36	67	63	63	gG	40	60	CC or J
06400420	41	46	80				50		
06400470	54	60	90				60		
07400660	67	74	124	100	100	gG	80	80	CC or J
07400770	80	88	145				100	100	
07401000	96	105	188	125	125		125	125	
08401340	137	155	267	250	250	gR	225	225	HSJ
08401570	164	177	303						

Table 12-21 AC Input current and fuse ratings (575 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
05500030	4	4	7	10	20	gG	10	10	CC or J
05500040	6	7	9					10	
05500069	9	11	15	20			20	20	
06500100	12	13	22	20	40	gG	20	30	CC or J
06500150	17	19	33	32			25		
06500190	22	24	41	40			30		
06500230	26	29	50	50	63		35	50	
06500290	33	37	63				40		
06500350	41	47	76	63			50		
07500440	41	45	75	50	50	gG	50	50	CC or J
07500550	57	62	94	80	80		80	80	
08500630	74	83	121	125	125	gR	100	100	HSJ
08500860	92	104	165	160	160		150	150	

Table 12-22 AC Input current and fuse ratings (690 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
07600190	18	20	32	25	50	gG	25	50	CC or J
07600240	23	26	41	32			30		
07600290	28	31	49	40			35		
07600380	36	39	65	50			50		
07600440	40	44	75		80			80	
07600540	57	62	92	80			80		
08600630	74	83	121	125	125	gR	100	100	HSJ
08600860	92	104	165	160	160		150	150	

NOTE

Ensure cables used suit local wiring regulations.

CAUTION

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

Table 12-23 Cable ratings (100 V)

Model	Cable size (IEC 60364-5-52) mm²				Cable size (UL508C) AWG			
	Input		Output		Input		Output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
01100017	1	6	1	2.5	16	10	16	12
01100024	1.5		1		14			
02100042	2.5	6	1	2.5	12	10	16	12
02100056	4		1		10			

Table 12-24 Cable ratings (200 V)

Model	Cable size (IEC 60364-5-52) mm²				Cable size (UL508C) AWG			
	Input		Output		Input		Output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
01200017	1	6	1	2.5	16	10	16	12
01200024								
01200033								
01200042								
02200024	1	6	1	2.5	16	10	16	12
02200033								
02200042								
02200056	2.5/1.5				12/14			
02200075	2.5				12			
03200100	4	6	1.5	2.5	10/12	10	14	12
04200133	4/2.5	6	2.5	2.5	10	10	12	12
04200176	4							
05200250	10	10	10	10	8	8	8	8
06200330	16	25	16	25	4	3	4	3
06200440	25		25		3		3	
07200610	35	70	35	70	2	1/0	2	1/0
07200750					1		1	
07200830	70		70		1/0		1/0	
08201160	95	2 x 70	95	2 x 70	3/0	2 x 1	3/0	2 x 1
08201320	2 x 70		2 x 70		2 x 1		2 x 1	

Table 12-25 Cable ratings (400 V)

Model	Cable size (IEC 60364-5-52) mm²				Cable size (UL508C) AWG			
	Input		Output		Input		Output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
02400013	1	6	1	2.5	16	10	16	12
02400018								
02400023								
02400032								
02400041								
03400056	1	6	1	2.5	14	10	16	12
03400073	1.5				12			
03400094	2.5		1.5				14	
04400135	2.5	6	2.5	2.5	10	10	12	12
04400170	4							
05400270	6	6	6	6	8	8	8	8
05400300								
06400350	10	25	10	25	6	3	6	3
06400420	16		16		4		4	
06400470	25		25		3		3	
07400660	35	70	35	70	1	1/0	1	1/0
07400770	50		50		2		2	
07401000	70		70		1/0		1/0	
08401340	2 x 50	2 x 70	2 x 50	2 x 70	2 x 1	2 x 1/0	2 x 1	2 x 1/0
08401570	2 x 70		2 x 70		2 x 1/0		2 x 1/0	

Table 12-26 Cable ratings (575 V)

Model	Cable size (IEC 60364-5-52) mm²				Cable size (UL508C) AWG			
	Input		Output		Input		Output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
05500030	0.75	1.5	0.75	1.5	16	16	16	16
05500040	1		1		14		14	
05500069	1.5		1.5					
06500100	2.5	25	2.5	25	14	3	14	3
06500150	4		4		10		10	
06500190	6		6					
06500230	10		10		8		8	
06500290					6		6	
06500350	16							
07500440	16	25	16	25	4	3	4	3
07500550	25		25		3		3	
08500630	35	50	35	50	1	1	1	1
08500860	50		50					

Table 12-27 Cable ratings (690 V)

Model	Cable size (IEC 60364-5-52) mm²				Cable size (UL508C) AWG			
	Input		Output		Input		Output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
07600190	10	25	10	25	8	3	8	3
07600240					6		6	
07600290								
07600380	16		16		4		4	
07600440								
07600540	25		25		3		3	
08600630	50	70	50	70	2	1/0	2	1/0
08600860	70		70		1/0		1/0	

12.1.22 Protective ground cable ratings

Table 12-28 Protective ground cable ratings

Input phase conductor size	Minimum ground conductor size
≤ 10 mm²	Either 10 mm² **or** two conductors of the same cross-sectional area as the input phase conductor.
> 10 mm² and ≤ 16 mm²	The same cross-sectional area as the first input phase conductor.
> 16 mm² and ≤ 35 mm²	16 mm²
> 35 mm²	Half of the cross-sectional area of the input phase conductor.

12.1.23 Maximum motor cable lengths

Table 12-29 Maximum motor cable lengths (100 V drives)

Model	100 V Nominal AC supply voltage								
	Maximum permissible motor cable length for each of the following switching frequencies								
	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
01100017	50 m				37.5 m	25 m	18.75 m	12.5 m	9 m
01100024									
02100042	100 m				75 m	50 m	37.5 m	25 m	18 m
02100056									

Table 12-30 Maximum motor cable lengths (200 V drives)

Model	200 V Nominal AC supply voltage								
	Maximum permissible motor cable length for each of the following switching frequencies								
	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
01200017	50 m (165 ft)				37.5 m (122 ft)	25 m (82.5 ft)	18.75 m (61 ft)	12.5 m (41 ft)	9 m (30 ft)
01200024									
01200033									
01200042									
02200024	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18 m (60 ft)
02200033									
02200042									
02200056									
02200075									
03200100	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18 m (60 ft)
04200133	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18 m (60 ft)
04200176									
05200250			200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
06200330			300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06200440									
07200610			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
07200750									
07200830									
08201160			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
08201320									

Table 12-31 Maximum motor cable lengths (400 V drives)

Model	400 V Nominal AC supply voltage								
	Maximum permissible motor cable length for each of the following switching frequencies								
	0.667 kHz	1 kHz	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
02400013	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18.25 m (60 ft)
02400018									
02400023									
02400032									
02400041									
03400056	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18.25 m (60 ft)
03400073									
03400094									
04400135	100 m (330 ft)				75 m (245 ft)	50 m (165 ft)	37.5 m (122 ft)	25 m (82.5 ft)	18.25 m (60 ft)
04400170									
05400270			200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
05400300									
06400350			300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06400420									
06400470									
07400660			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
07400770									
07401000									
08401340			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
08401570									

Table 12-32 Maximum motor cable lengths (575 V drives)

575 V Nominal AC supply voltage									
Model	**Maximum permissible motor cable length for each of the following switching frequencies**								
	0.667 kHz	**1 kHz**	**2 kHz**	**3 kHz**	**4 kHz**	**6 kHz**	**8 kHz**	**12 kHz**	**16 kHz**
05500030			200 m (660 ft)						
05500040									
05500069									
06500100			300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06500150									
06500190									
06500230									
06500290									
06500350									
07500440			250 m (820 ft)						
07500550									
08500630			250 m (820 ft)						
08500860									

Table 12-33 Maximum motor cable lengths (690 V drives)

690 V Nominal AC supply voltage									
Model	**Maximum permissible motor cable length for each of the following switching frequencies**								
	0.667 kHz	**1 kHz**	**2 kHz**	**3 kHz**	**4 kHz**	**6 kHz**	**8 kHz**	**12 kHz**	**16 kHz**
07600190			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
07600240									
07600290									
07600380									
07600440									
07600540									
08600630			250 m (820 ft)		185 m (607 ft)	125 m (410 ft)	90 m (295 ft)		
08600860									

- Cable lengths in excess of the specified values may be used only when special techniques are adopted; refer to the supplier of the drive.
- The default switching frequency is 3 kHz for Open-loop and RFC-A.

The maximum cable length is reduced from that shown in Table 12-29, Table 12-30, Table 12-31, Table 12-32 and Table 12-33 if high capacitance motor cables are used. For further information, refer to section 4.5.2 *High-capacitance / reduced diameter cables* on page 70.

12.1.24 Minimum resistance values and peak power rating for the braking resistor at 40 °C (104 °F)

Table 12-34 Braking resistor resistance and power rating (100 V)

Model	Minimum resistance* Ω	Instantaneous power rating kW	Continuous power rating kW
01100017	130	1.2	
01100024			
02100042	68	2.2	
02100056			

Table 12-35 Braking resistor resistance and power rating (200 V)

Model	Minimum resistance* Ω	Instantaneous power rating kW	Continuous power rating kW
01200017	130	1.2	
01200024			
01200033			
01200042			
02200024	68	2.2	
02200033			
02200042			
02200056			
02200075			
03200100	45	3.4	2.2
04200133	22	6.9	
04200176			
05200250	16.5	10.3	8.6
06200330	8.6	19.7	12.6
06200440			16.4
07200610	6.1	27.8	20.5
07200750			24.4
07200830	4.5	37.6	32.5
08201160	2.2	76.9	41
08201320			47.8

Table 12-36 Braking resistor resistance and power rating (400 V)

Model	Minimum resistance* Ω	Instantaneous power rating kW	Continuous power rating kW
02400013	270	2.3	
02400018			
02400023			
02400032			
02400041			
03400056	100	6.1	2.2
03400073			3
03400094			4
04400135	50	12.2	
04400170			
05400270	31.5	21.5	16.2
05400300	18	37.5	19.6
06400350	17	39.8	21.6
06400420			25
06400470			32.7
07400660	9.0	75.2	41.6
07400770			50.6
07401000	7.0	96.6	60.1
08401340	4.8	140.9	81
08401570			98.6

Table 12-37 Braking resistor resistance and power rating (575 V)

Model	Minimum resistance* Ω	Instantaneous power rating kW	Continuous power rating kW
05500030	80	12.1	2.6
05500040			4.6
05500069			6.5
06500100	13	74	8.7
06500150			12.3
06500190			16.3
06500230			19.9
06500290			24.2
06500350			31.7
07500440	8.5	113.1	39.5
07500550			47.1
08500630	5.5	174.8	58.6
08500860			78.1

Table 12-38 Braking resistor resistance and power rating (690 V)

Model	Minimum resistance* Ω	Instantaneous power rating kW	Continuous power rating kW
07600190	11.5	121.2	20.6
07600240			23.9
07600290			32.5
07600380			41.5
07600440			47.8
07600540			60.5
08600630	5.5	253.5	79.7
08600860			95.2

* Resistor tolerance: ±10 %

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

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

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

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

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

12.1.25 Torque settings

Table 12-39 Drive relay terminal data

Model	Connection type	Torque setting
All	Screw terminals	0.5 N m (0.4 lb ft)

Table 12-40 Drive power terminal data

Model size	AC and motor terminals		DC and braking		Ground terminal	
	Recommended	Maximum	Recommended	Maximum	Recommended	Maximum
1	0.5 N m (0.4 lb ft)		0.5 N m (0.4 lb ft)		1.5 N m (1.1 lb ft)	
2	1.4 N m (1 lb ft)		1.4 N m (1 lb ft)			
3						
4						
5	Plug-in terminal block		M4 Nut (7 mm AF)		M5 Nut (8 mm AF)	
	1.5 N m (1.1 lb ft)	1.8 N m (1.3 lb ft)	1.5 N m (1.1 lb ft)	2.5 N m (1.8 lb ft)	2.0 N m (1.4 lb ft)	5.0 N m (3.7 lb ft)
6	M6 Nut (10 mm AF)		M6 Nut (10 mm AF)		M6 Nut (10 mm AF)	
	6.0 N m (4.4 lb ft)	8.0 N m (6.0 lb ft)	6.0 N m (4.4 lb ft)	8.0 N m (6.0 lb ft)	6.0 N m (4.4 lb ft)	8.0 N m (6.0 lb ft)
7	M8 Nut (13 mm AF)		M8 Nut (13 mm AF)		M8 Nut (13 mm AF)	
	12 N m (8.8 lb ft)	14 N m (10.0 lb ft)	12 N m (8.8 lb ft)	14 N m (10.0 lb ft)	12 N m (8.8 lb ft)	14 N m (10.0 lb ft)
8	M10 Nut (17 mm AF)		M10 Nut (17 mm AF)		M10 Nut (17 mm AF)	
	15 N m (11.1 lb ft)	20 N m (14.8 lb ft)	15 N m (11.1 lb ft)	20 N m (14.8 lb ft)	15 N m (11.1 lb ft)	20 N m (14.8 lb ft)

Table 12-41 Terminal block maximum cable sizes

Model size	Terminal block description	Max cable size
All	Control connector	1.5 mm^2 (16 AWG)
All	2-way relay connector	2.5 mm^2 (12 AWG)
1 to 4	STO connector	0.5 mm^2 (20 AWG)
	AC input power connector	6 mm^2 (10 AWG)
	AC output power connector	2.5 mm^2 (12 AWG)
5	3-way AC power connector 3-way motor connector	8 mm^2 (8 AWG)
5 to 8	STO connector	2.5 mm^2 (12 AWG)

12.1.26 Electromagnetic compatibility (EMC)

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

Table 12-42 Immunity compliance

Standard	Type of immunity	Test specification	Application	Level
IEC61000-4-2 EN61000-4-2	Electrostatic discharge	6 kV contact discharge 8 kV air discharge	Module enclosure	Level 3 (industrial)
IEC61000-4-3 EN61000-4-3	Radio frequency radiated field	10 V/m prior to modulation 80 - 1000 MHz 80 % AM (1 kHz) modulation	Module enclosure	Level 3 (industrial)
IEC61000-4-4 EN61000-4-4	Fast transient burst	5/50 ns 2 kV transient at 5 kHz repetition frequency via coupling clamp	Control lines	Level 4 (industrial harsh)
		5/50 ns 2 kV transient at 5 kHz repetition frequency by direct injection	Power lines	Level 3 (industrial)
IEC61000-4-5 EN61000-4-5	Surges	Common mode 4 kV 1.2/50 µs waveshape	AC supply lines: line to ground	Level 4
		Differential mode 2 kV 1.2/50 µs waveshape	AC supply lines: line to line	Level 3
		Lines to ground	Signal ports to ground [1]	Level 2
IEC61000-4-6 EN61000-4-6	Conducted radio frequency	10V prior to modulation 0.15 - 80 MHz 80 % AM (1 kHz) modulation	Control and power lines	Level 3 (industrial)
IEC61000-4-11 EN61000-4-11	Voltage dips and interruptions	-30 % 10 ms +60 % 100 ms -60 % 1 s <-95 % 5 s	AC power ports	
IEC61000-6-1 EN61000-6-1:2007	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
IEC61000-6-2 EN61000-6-2:2005	Generic immunity standard for the industrial environment			Complies
IEC61800-3 EN61800-3:2004	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

[1] See section *Surge immunity of control circuits - long cables and connections outside a building* on page 82 for control ports for possible requirements regarding grounding and external surge protection

Emission

The drive contains an in-built filter for basic emission control. An additional optional external filter provides further reduction of emission. The requirements of the following standards are met, depending on the motor cable length and switching frequency.

Table 12-43 Size 1 emission compliance (200 V drives)

Motor cable length (m)	Switching frequency (kHz)					
	3	4	6	8	12	16
Using internal filter:						
0 – 2						
Using internal filter and external ferrite ring (1 turn):						
0 – 10						
10 - 20						
Using external filter:						
0 – 20						
20 - 100						

Table 12-44 Size 1 emission compliance (400 V drives)

Motor cable length (m)	Switching frequency (kHz)					
	3	4	6	8	12	16
Using internal filter:						
0 – 5						
Using internal filter and external ferrite ring (2 turns):						
0 – 10						
Using external filter:						
0 – 20						
20 - 100						

Key (shown in decreasing order of permitted emission level):

E2R EN 61800-3:2004 second environment, restricted distribution (Additional measures may be required to prevent interference)

E2U EN 61800-3:2004 second environment, unrestricted distribution

I Industrial generic standard EN 61000-6-4:2007
EN 61800-3:2004 first environment restricted distribution (The following caution is required by EN 61800-3:2004)

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

R Residential generic standard EN 61000-6-3:2007
EN 61800-3:2004 first environment unrestricted distribution

EN 61800-3:2004 defines the following:

- The first environment is one that includes residential premises. It also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for residential purposes. The second environment is one that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for residential purposes.
- Restricted distribution is defined as a mode of sales distribution in which the manufacturer restricts the supply of equipment to suppliers, customers or users who separately or jointly have technical competence in the EMC requirements of the application of drives.

IEC 61800-3:2004 and EN 61800-3:2004

The 2004 revision of the standard uses different terminology to align the requirements of the standard better with the EC EMC Directive.

Power drive systems are categorized C1 to C4:

Category	Definition	Corresponding code used above
C1	Intended for use in the first or second environments	R
C2	Not a plug-in or movable device, and intended for use in the first environment only when installed by a professional, or in the second environment	I
C3	Intended for use in the second environment, not the first environment	E2U
C4	Rated at over 1000 V or over 400 A, intended for use in complex systems in the second environment	E2R

Note that category 4 is more restrictive than E2R, since the rated current of the PDS must exceed 400 A or the supply voltage exceed 1000 V, for the complete PDS.

12.2 Optional external EMC filters

Table 12-45 EMC filter cross reference

Model	CT part number
200 V	
05200250	4200-0312
06200330 to 06200440	4200-2300
07200610 to 07200830	4200-1132
08201160 to 08201320	4200-1672
400 V	
05400270 to 05400300	4200-0402
06400350 to 06400470	4200-4800
07400660 to 07401000	4200-1132
08401340 to 08401570	4200-1972
575 V	
05500030 to 05500069	4200-0122
06500100 to 06500350	4200-3690
07500440 to 07500550	4200-0672
08500630 to 08500860	4200-1662
690 V	
07600190 to 07600540	4200-0672
08600630 to 08600860	4200-1662

12.2.1 EMC filter ratings

Table 12-46 Optional external EMC filter details

CT part number	Maximum continuous current		Voltage rating		IP rating	Power dissipation at rated current		Ground leakage		Discharge resistors
	@ 40 °C (104 °F)	@ 50 °C (122 °F)	IEC	UL		@ 40 °C (104 °F)	@ 50 °C (122 °F)	Balanced supply phase-to-phase & phase-to-ground	Worst case	
	A	A	V	V		W	W	mA	mA	MΩ
4200-0312	31	28.5	250	300	20	20	17	2.0	80	1.68
4200-2300	55	51	250	300		41	35	4.2	69	
4200-0402	40	36.8	528	600		47	40	18.7	197	
4200-4800	63	58	528	600		54	46	11.2	183	
4200-0122	12	11	760	600						
4200-3690	42	39	760	600		45	39	12	234	

12.2.2 Overall EMC filter dimensions

Table 12-47 Optional external EMC filter dimensions

CT part number	Dimension (mm)						Weight	
	H		W		D			
	mm	inch	mm	inch	mm	inch	kg	lb
4200-0312	437	17.20	143	5.63	60	2.36	5.5	12.13
4200-2300	434	17.09	210	8.27	60	2.36	6.5	14.30
4200-0402	437	17.20	143	5.63	60	2.36	5.5	12.13
4200-4800	434	17.09	210	8.27	60	2.36	6.7	14.80
4200-0122	437	17.20	143	5.63	60	2.36	5.5	12.13
4200-3690	434	17.09	210	8.27	60	2.36	7.0	15.40

12.2.3 EMC filter torque settings

Table 12-48 Optional external EMC Filter terminal data

CT part number	Power connections				Ground connections		
	Max cable size		Max torque		Ground stud size	Max torque	
	mm^2	AWG	N m	lb ft		N m	lb ft
4200-2300	16	6	2.3	1.70	M6	4.8	2.8
4200-4800							
4200-3690							

13 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:

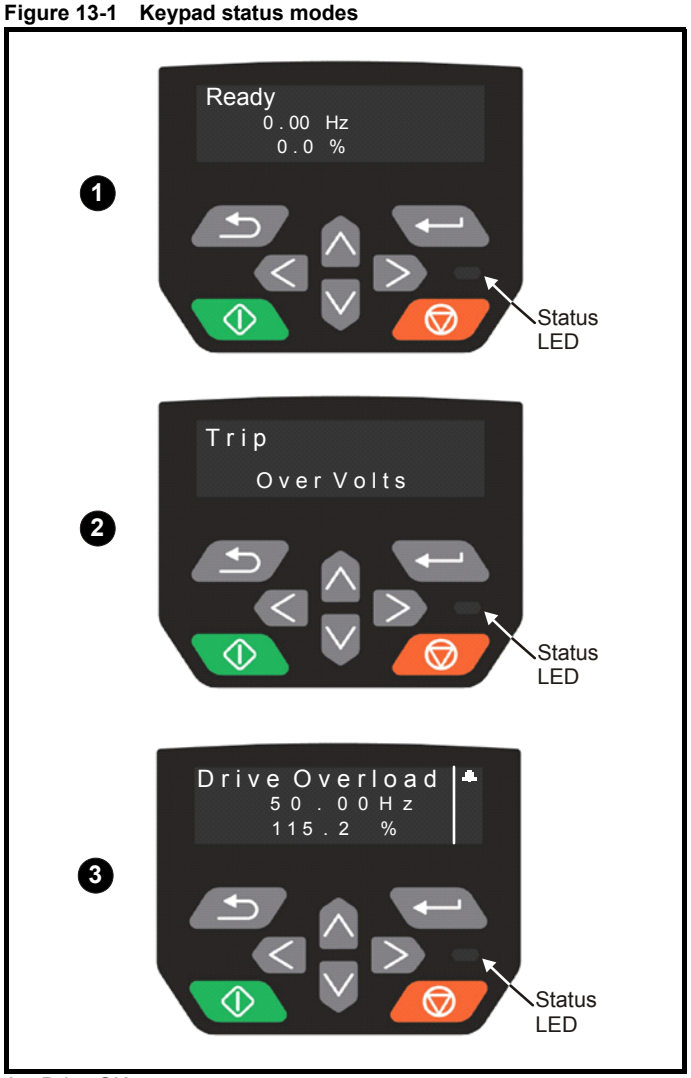
- Trip indications
- Alarm indications
- Status indications

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.

13.1 Status modes (Keypad and LED status)

Figure 13-1 Keypad status modes



1 Drive OK status

2 Trip status

3 Alarm status

13.2 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.

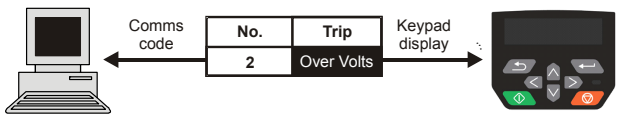
During a trip condition, where a CI-Keypad is being used, the upper row of the display indicates that a trip has occurred and the lower row of the keypad display will show the trip string. Some trips have a sub-trip number to provide additional information about the trip. If a trip has a sub-trip number, the sub-trip number is flashed alternately with the trip string unless there is space on the second row for both the trip string and the sub-trip number in which case both the trip string and sub-trip information is displayed separated by a decimal point.

If a display is not being used , the drive LED Status indicator will flash with 0.5 s duty cycle if the drive has tripped. Refer to Figure 13-2 *Key to sub-trip number* .

Trips are listed alphabetically in Table 13-3 *Serial communications look up table* on page 225 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 HF19) do not have trip numbers. The trip number must be checked in Table 13-3 to identify the specific trip.

Example

1. Trip code 2 is read from Pr **10.020** via serial communications.
2. Checking Table 13-2 shows Trip 2 is an Over Volts trip.



3. Look up Over Volts in Table 13-2.
4. Perform checks detailed under *Diagnosis*.

13.3 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 13-1 is in the form xxyzz and used to identify the source of the trip.

Table 13-1 Trips associated with xxyzz sub-trip number

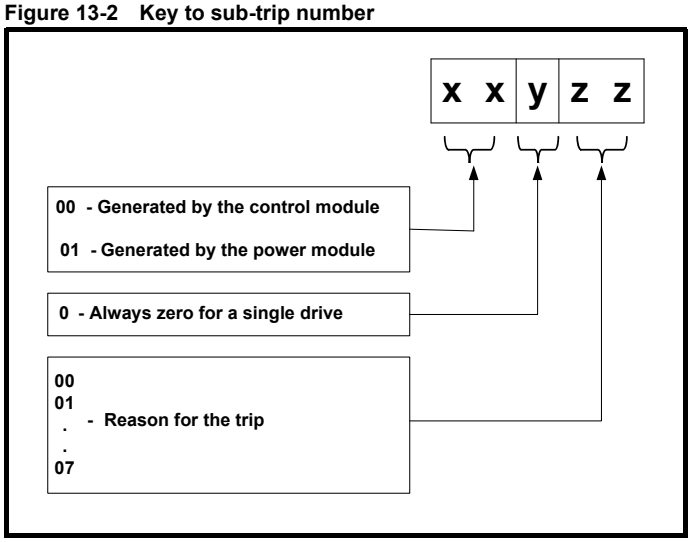
Over Volts	Phase Loss
OI ac	Power Comms
OI Brake	OI Snubber
PSU	OHt Rectifier
OHt Inverter	Temp Feedback
OHt Power	Power Data
OHt dc bus	Soft Start

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 13-2 Key to sub-trip number



13.4 Trips, Sub-trip numbers

Table 13-2 Trip indications

Trip	Diagnosis
An Input 1 Loss	**Analog input 1 current loss**
28	The *An Input 1 Loss* 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. **Recommended actions:** • Check control wiring is correct • Check control wiring is undamaged • Check the *Analog Input 1 Mode* (07.007) • Current signal is present and greater than 3 mA
An Input 1 OI	**Analog input 1 over-current**
189	Current input on analog input 1 exceeds 24mA.
An Input 2 Loss	**Analog input 2 current loss**
29	The *An Input 2 Loss* trip indicates that a current loss was detected in current mode on Analog input 2 (Terminal 5). In 4-20 mA and 20-4 mA modes loss of input is detected if the current falls below 3 mA. Recommend actions: • Check control wiring is correct • Check control wiring is undamaged • Check the Analog Input 2 Mode (07.011) • Current signal is present and greater than 3 mA
An Input 2 OI	**Analog input 2 over-current**
190	Current input on analog input 2 exceeds 24 mA.
Autotune	**Measured inertia has exceeded the parameter range**
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. **Sub-trip** / **Reason** 1 / Measured inertia has exceeded the parameter range during a mechanical load measurement **Recommended actions:** • Check motor cable wiring is correct
Autotune Stopped	**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. **Recommended actions:** • Check the drive enable signal (Terminal 31 & 34) were active during the autotune
Brake R Too Hot	**Braking resistor overload timed out (I^2t)**
19	The *Brake R Too Hot* 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 *Brake R too Hot* trip is initiated when the *Braking Resistor Thermal Accumulator* (10.039) reaches 100 %. **Recommended actions:** • Ensure the values entered in Pr **10.030**, Pr **10.031** and Pr **10.061** are correct • 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.
Card Access	**NV Media Card Write fail**
185	The *Card Access* 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. **Recommended actions:** • Check NV Media Card is installed / located correctly • Replace the NV Media Card
Card Boot	**The Menu 0 parameter modification cannot be saved to the NV Media Card**
177	Menu 0 changes are automatically saved on exiting edit mode. The *Card Boot* trip will occur if a write to a Menu 0 parameter has been initiated via the keypad by exiting edit mode and Pr **11.042** is set for auto or boot mode, but the necessary boot file has not been created on the NV Media Card to take the new parameter value. This occurs when Pr **11.042** is changed to Auto (3) or Boot (4) mode, but the drive is not subsequently reset. **Recommended actions:** • Ensure that Pr **11.042** is correctly set, and then reset the drive to create the necessary file on the NV Media Card • Re-attempt the parameter write to the Menu 0 parameter

Card Busy	**NV Media Card cannot be accessed as it is being accessed by an option module**
178	The *Card Busy* 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. **Recommended actions:** • Wait for the option module to finish accessing the NV Media Card and re-attempt the required function
Card Compare	**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, a *Card Compare* trip is initiated if the parameters on the NV Media Card are different to the drive. **Recommended actions:** • Set Pr **mm.000** to 0 and reset the trip • Check to ensure the correct data block on the NV Media Card has been used for the compare
Card Data Exists	**NV Media Card data location already contains data**
179	The *Card Data Exists* trip indicates that an attempt has been made to store data on a NV Media Card in a data block which already contains data. **Recommended actions:** • Erase the data in data location • Write data to an alternative data location
Card Drive Mode	**NV Media Card parameter set not compatible with current drive mode**
187	The *Card Drive Mode* 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. **Recommended actions:** • Ensure the destination drive supports the drive operating mode in the parameter file. • Clear the value in Pr **mm.000** and reset the drive • Ensure destination drive operating mode is the same as the source parameter file
Card Error	**NV Media Card data structure error**
182	The *Card Error* 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. The cause of the trip can be identified by the sub-trip. **Sub-trip** / **Reason** 1 – The required folder and file structure is not present 2 – The HEADER.DAT file is corrupted 3 – Two or more files in the <MCDF\> folder have the same file identification number **Recommended actions:** • Erase all the data block and re-attempt the process • Ensure the card is located correctly • Replace the NV Media Card
Card Full	**NV Media Card full**
184	The *Card Full* 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. **Recommended actions:** • Delete a data block or the entire NV Media Card to create space • Use a different NV Media Card
Card No Data	**NV Media Card data not found**
183	The *Card No Data* trip indicates that an attempt has been made to access non-existent file or block on the NV Media Card. **Recommended actions:** • Ensure data block number is correct
Card Option	**NV Media Card trip; option modules installed are different between source drive and destination drive**
180	The *Card Option* trip indicates that parameter data or default difference 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 attempted between the data block and the drive. **Recommended actions:** • Ensure the correct option module is installed. • Press the red reset button to acknowledge that the parameters for the option module installed will be at their default values • This trip can be suppressed by setting Pr **mm.000** to 9666 and resetting the drive.

Card Product	**NV Media Card data blocks are not compatible with the drive derivative**
175	The *Card Product* trip is initiated either at power-up or when the card is accessed, If *Drive Derivative* (11.028) is 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. **Recommended actions:** • Use a different NV Media Card • This trip can be suppressed by setting Pr **mm.000** to 9666 and resetting the drive
Card Rating	**NV Media Card Trip; The voltage and / or current rating of the source and destination drives are different**
186	The *Card Rating* 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 attempted between the data block on a NV Media Card and the drive. The Card Rating 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. **Recommended actions:** • Reset the drive to clear the trip • Ensure that the drive rating dependent parameters have transferred correctly
Card Read Only	**NV Media Card has the Read Only bit set**
181	The *Card Read Only* trip indicates that an attempt has been made to modify a read-only NV Media Card or a read-only data block. A NV Media Card is read-only if the read-only flag has been set. **Recommended actions:** • Clear the read only flag by setting Pr **mm.000** to 9777 and reset the drive. This will clear the read-only flag for all data blocks in the NV Media Card
Card Slot	**NV Media Card trip; Option module file transfer has failed**
174	The Card Slot 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.
Control Word	**Trip initiated from the *Control Word* (06.042)**
35	The *Control Word* 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). **Recommended actions:** • Check the value of Pr **06.042.** • Disable the control word in *Control Word Enable* (Pr **06.043**) Bit 12 of the control word set to a one causes the drive to trip on Control Word When the control word is enabled, the trip can only be cleared by setting bit 12 to zero
Current Offset	**Current feedback offset error**
225	The *Current Offset* trip indicates that the current offset is too large to be trimmed. **Recommended actions:** • Ensure that there is no possibility of current flowing in the output phases of the drive when the drive is not enabled • Hardware fault – Contact the supplier of the drive
Data Changing	**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. **Recommended actions:** • Ensure the drive is not enabled when defaults are loading
Derivative ID	**Derivative file error**
246	Derivative file error with sub-trips: **Sub-trip** / **Reason** 1 – Derivative file different 2 – Derivative file missing

Derivative Image — **Derivative product image error**

248

The *Derivative Image* 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.

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 and 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 derivative image has been changed for an image with a different derivative number	As 30
40	The timed task has not completed in time and has been suspended	
41	Undefined function called, i.e. a function in the host system vector table that has not been assigned	As 40
51	Core menu customization table CRC check failed	As 30
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 derivative menu and the trip will keep occurring until drive parameters are saved.
61	The option module installed in slot 1 is not allowed with the derivative image	As 30
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	As 80

Recommended actions:

- Contact the supplier of the drive

Destination — **Two or more parameters are writing to the same destination parameter**

199

The *Destination* trip indicates that destination output parameters of two or more logic functions (Menus 7, 8, 9, 12 or 14) within the drive are writing to the same parameter.

Recommended actions:

- Set Pr **mm.000** to 'Destinations' or 12001 and check all visible parameters in all menus for parameter write conflicts

Drive config — **Drive configuration**

232

The hardware ID does not match the user software ID.

EEPROM Fail

31

Default parameters have been loaded

The *EEPROM Fail* trip indicates that default parameters have been loaded. The exact cause/reason of the trip can be identified from the sub-trip number.

Sub-trip	Reason
1	The most significant digit of the internal parameter database version number has changed
2	The CRC's applied to the parameter data stored in internal non-volatile memory indicate that a valid set of parameters cannot be loaded
3	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
4	The drive derivative image has changed
5	The power stage hardware has changed
6	The internal I/O hardware has changed
7	Reserved
8	The control board hardware has changed
9	The checksum on the non-parameter area of the EEPROM has failed

Recommended actions:

- Default the drive and perform a reset
- Allow sufficient time to perform a save before the supply to the drive is removed
- If the trip persists - return drive to supplier

External Trip

6

An External trip is initiated

An *External Trip* 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**.

Sub-trip	Reason
1	*External Trip* (10.032) = 1

Recommended actions:

- Check the value of Pr **10.032**.
- Select 'Destinations' (or enter 12001) in Pr **mm.000** and check for a parameter controlling Pr **10.032**.
- Ensure Pr **10.032** or Pr **10.038** (= 6) is not being controlled by serial comms

Fan Fail

173

Fan fail

Recommended actions:

- Check that the fan is installed and connected correctly.
- Check that the fan is not obstructed.
- Contact the supplier of the drive to replace the fan.

File changed

247

File changed

Recommended action:

- Power cycle the drive.

FW incompatible

237

Firmware incompatibility

The *FW incompatible* trip indicates that the user firmware is incompatible with the power firmware.

Recommended actions:

- Re-program the drive with the latest version of the drive firmware for Unidrive M400.

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.

Recommended actions:

- 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.

Recommended actions:

- 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.

Recommended actions:

- 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.

Recommended actions:

- 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.

Recommended actions:

- 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.

Recommended actions:

- 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.

Recommended actions:

- 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.

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.

HF12 **Data processing error: Main program stack overflow**

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.

Sub-trip	Stack
1	Freewheeling tasks
2	Reserved
3	Main system interrupts

Recommended actions:

- Hardware fault - Contact the supplier of the drive

HF13 **Reserved**

HF14 **Reserved**

HF15 **Reserved**

HF16 **Data processing error: RTOS error**

The *HF16* trip indicates that a RTOS error has occurred. This trip indicates that the control PCB on the drive has failed.

Recommended actions:

- Hardware fault – Contact the supplier of the drive

HF17 **Reserved**

HF18 — **Data processing error: Internal flash memory has failed**

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.

Sub-trip	Reason
1	Option module initialization timed out
2	Programming error while writing menu in flash
3	Erase flash block containing setup menus failed
4	Erase flash block containing application menus failed
5	Incorrect setup menu CRC contained in flash
6	Incorrect application menu CRC contained in flash

Recommended actions:

- Hardware fault - Contact the supplier of the drive

HF19 — **Data processing error: CRC check on the firmware has failed**

HF19 trip indicates that the CRC check on the drive firmware has failed.

Recommended actions:

- Re-program the drive
- Hardware fault - Contact the supplier of the drive

Hot Rect/Brake — **Hot rectifier/brake**

250 — Over-temperature detected on input rectifier or braking IGBT.

I cal. range — Current calibration range

231 — Current calibration range error.

I/O Overload — **Digital output overload**

The *I/O Overload* trip indicates that the total current drawn from 24 V user supply or from the digital output has exceeded the limit. A trip is initiated if the following condition is met:

- Maximum output current from one digital output is 100 mA.

26

Recommended actions:

- Check total loads on digital outputs
- Check control wiring is correct
- Check output wiring is undamaged

Keypad Mode — **Keypad has been removed when the drive is receiving the reference from the keypad**

The *Keypad Mode* 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.

34

Recommended actions:

- Re-install keypad and reset
- Change *Reference Selector* (01.014) to select the reference from another source

LF Power Comms — **Communication has been lost / errors detected between power, control and rectifier modules**

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.

90

Source	xx	y	zz
Control system	00	0	01: No communications between the control system and the power system.
Control system	00	0	02: Excessive communication errors between the control system and power system.
Control system	01	1	00: Excessive communications errors detected by the rectifier module.

Recommended actions:

- Hardware fault - contact the supplier of the drive.

Motor Too Hot — **Output current overload timed out (I^2t)**

The *Motor Too Hot* trip indicates a motor thermal overload based on the output 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 *Motor Too Hot* when Pr **04.019** gets to 100 %.

20

Recommended actions:

- Ensure the load is not jammed / sticking
- Check the load on the motor has not changed
- Tune the motor rated speed parameter (Pr **5.008**) (RFC-A mode only)
- Ensure the motor rated current is not zero

No power board	**No power board**
236	No communication between the power and control boards. **Recommended actions**: • Check connection between power and control board.
OHt Brake	**Braking IGBT over-temperature**
101	The *OHt Brake* over-temperature trip indicates that braking IGBT over-temperature has been detected based on software thermal model. **Recommended actions:** • Check braking resistor value is greater than or equal to the minimum resistance value
OHt Control	**Control stage over temperature**
219	This trip indicates that a control stage over-temperature has been detected if Cooling Fan control (06.045) = 0. Recommended actions: • Increase ventilation by setting Cooling Fan control (06.045) > 0
OHt dc bus	**DC bus over temperature**
27	The *OHt dc bus* 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 *OHt dc bus* 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. **Source** | **xx** | **y** | **zz** | **Description** Control system | 00 | 2 | 00 | DC bus thermal model gives trip with sub-trip 0 **Recommended actions:** • Check the AC supply voltage balance and levels • Check DC bus ripple level • Reduce duty cycle • Reduce motor load • Check the output current stability. If unstable; 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) Disable slip compensation (Pr **05.027** = 0) – (Open loop) Disable dynamic V to F operation (Pr **05.013** = 0) - (Open loop) Select fixed boost (Pr **05.014** = Fixed) – (Open loop) Select high stability space vector modulation (Pr **05.019** = 1) – (Open loop) Disconnect the load and complete a rotating auto-tune (Pr **05.012**) Reduce frequency loop gains (Pr **03.010**, Pr **03.011**, Pr **03.012**) – (RFC-A)
OHt Inverter	**Inverter over temperature based on thermal model**
21	This trip indicates that an IGBT junction over-temperature has been detected based on a software thermal model. **Source** | **xx** | **y** | **zz** | **Description** Control system | 00 | 1 | 00 | Inverter thermal model gives {OHt Inverter} trip with sub-trip 0 **Recommended actions:** • Reduce the selected drive switching frequency • Ensure *Auto-switching Frequency Change Disable* (05.035) is set to OFF • Reduce duty cycle • Increase acceleration / deceleration rates • Reduce motor load • Check DC bus ripple • Ensure all three input phases are present and balanced

OHt Power

22

Power stage over temperature

This trip indicates that a power stage over-temperature has been detected. From the sub-trip 'xxyzz', the Thermistor location is identified by 'zz'.

Source	xx	y	zz	Description
Power system	01	0	zz	Thermistor location in the drive defined by zz

Recommended actions:

- Check enclosure / drive fans are still functioning correctly
- Force the heatsink fans to run at maximum speed
- Check enclosure ventilation paths
- Check enclosure door filters
- Increase ventilation
- Reduce the drive switching frequency
- Reduce duty cycle
- Increase acceleration / deceleration rates
- Reduce motor load
- Check the derating tables and confirm the drive is correctly sized for the application.
- Use a drive with larger current / power rating

OHt Rectifier

102

Rectifier over temperature

The *Oht Rectifier* trip indicates that a rectifier over-temperature has been detected. The thermistor location can be identified from the sub-trip number.

Source	xx	y	zz	Description
Power system	Power module number	Rectifier number	zz	Thermistor location defined by zz

Recommend actions:

- Check the motor and motor cable insulation with an insulation tester
- Fit an output line reactor or sinusoidal filter
- Force the heatsink fans to run at maximum speed by setting Pr **06.045** = 1
- Check enclosure / drive fans are still functioning correctly
- Check enclosure ventilation paths
- Check enclosure door filters
- Increase ventilation
- Increase acceleration / deceleration rates
- Reduce duty cycle
- Reduce motor load

OI ac

3

Instantaneous output over current detected

The instantaneous drive output current has exceeded VM_DRIVE_CURRENT_MAX.

Source	xx	y	zz	Description
Control system	00	0	00	Instantaneous over-current trip when the measured a.c. current exceeds VM_DRIVE_CURRENT[MAX].

Recommended actions/checks:

- Increase acceleration/deceleration rate
- If seen during auto-tune reduce the voltage boost
- Check for short circuit on the output cabling
- Check integrity of the motor insulation using an insulation tester
- Is the motor cable length within limits for the frame size?
- Reduce the values in the frequency loop gain parameters - (Pr **03.010**, **03.011**, **03.012**) or (Pr **03.013**, **03.014**, **03.015**)
- Reduce the values in the current loop gain parameters

OI Snubber — **Snubber over-current detected**

92

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.

Source	xx	y	zz
Power system	01	1	00: Rectifier snubber over-current trip detected.

Recommended actions:

- Ensure the internal EMC filter is installed.
- Ensure the motor cable length does not exceed the maximum for selected switching frequency.
- Check for supply voltage imbalance.
- Check for supply disturbance such as notching from a DC drive.
- Check the motor and motor cable insulation with a Megger.
- Fit an output line reactor or sinusoidal filter

OI.Brake — **Braking IGBT over current detected: short circuit protection for the braking IGBT activated**

4

The *OI.Brake* trip indicates that over current has been detected in braking IGBT or braking IGBT protection has been activated.

Source	xx	y	zz	Description
Power system	01	0	00	Braking IGBT instantaneous over-current trip

Recommended actions:

- Check brake resistor wiring
- Check braking resistor value is greater than or equal to the minimum resistance value
- Check braking resistor insulation

OI.dc — **Power module over current detected from IGBT on state voltage monitoring**

109

The *OI.dc* trip indicates that the short circuit protection for the drive output stage has been activated.

Recommended actions:

- Disconnect the motor cable at the drive end and check the motor and cable insulation with an insulation tester
- Replace the drive

Option Disable — **Option module does not acknowledge during drive mode changeover**

215

The *Option Disable* trip indicates that the option module did not acknowledge notifying the drive that communications with the drive has been stopped during the drive mode changeover with in the allocated time.

Recommended trip:

- Reset the trip
- If the trip persists replace the option module

Out Phase Loss — **Output phase loss detected**

98

The *Out Phase Loss* trip indicates that a phase loss has been detected at the drive output. If *Output Phase Loss Detection Enable* (06.059) = 1 then output phase loss is detected as follows:

1. When the drive is enabled short pulses are applied to make sure each output phase is connected.
2. During running the output current is monitored and the output phase loss condition is detected if the current contains more than TBD % negative phase sequence current for TBDs.

Recommended action:

- Check motor and drive connections
- To disable the trip set *Output Phase Loss Detection Enable* (06.059) = 0

Output phase s/c — **Output phase short-circuit**

228

Over-current detected on drive output when enabled. Possible motor ground fault.

Recommended actions:

- Check for short circuit on the output cabling
- Check integrity of the motor insulation using an insulation tester
- Is the motor cable length within limits for the frame size?

Over Speed — **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 Over Speed 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 Over Speed trip is produced. If Pr **03.008** is set to 0.0 the threshold is then equal to 1.2 x the value set in Pr **01.006**.

Recommended actions:

- Reduce the *Frequency Controller Proportional Gain* (03.010) to reduce the speed overshoot (RFC-A mode only)

Over Volts

DC bus voltage has exceeded the peak level or maximum continuous level for 15 seconds

2

The *Over Volts* 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.

Voltage rating	VM_DC_VOLTAGE[MAX]	VM_DC_VOLTAGE_SET[MAX]
100	415	410
200	415	410
400	830	815

Sub-trip Identification

Source	xx	y	zz
Control system	00	0	01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX].
Control system	00	0	02: Time delayed trip indicating that the DC bus voltage is above VM_DC_VOLTAGE_SET[MAX].
Power system	01	0	00: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX].

Recommended actions:

- Increase deceleration ramp (Pr **00.004**)
- Decrease the braking resistor value (staying above the minimum value)
- Check nominal AC supply level
- Check for supply disturbances which could cause the DC bus to rise
- Check motor insulation using a insulation tester

Phase Loss

Supply phase loss

32

The *Phase Loss* 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 *Phase Loss* 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 Phase Loss. Potential causes of the DC bus ripple are input phase loss, Large supply impedance and severe output current instability.

Source	xx	y	zz
Control system	00	0	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.

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).

Recommended actions:

- Check the AC supply voltage balance and level at full load
- Check the DC bus ripple level with an isolated oscilloscope
- Check the output current stability
- Reduce the duty cycle
- Reduce the motor load
- Disable the phase loss detection, set Pr **06.047** to 2.

Power Board HF

Power board HF

235

Power processor hardware fault.

Recommended action:

- Hardware fault - Contact the supplier of the drive

Power Comms

Communication has been lost / errors detected between power control

93

The *Power Comms* trip is initiated if there is no communications between power control. The reason for the trip can be identified by the sub-trip number.

Sub-trip	Reason
1	PLL operating range out of lock
2	Power board lost communications with user board
3	User board lost communication with power board
4	Communication CRC error

Recommended actions:

- Hardware fault – Contact the supplier of the drive

Power Data

220

Power system configuration data error

The *Power Data* trip indicates that there is an error in the configuration data stored in the power system.

Source	xx	y	zz	Description
Control system	00	0	01	No data was obtained from the power board.
Control system	00	0	02	There is no data table in node 1.
Control system	00	0	03	The power system data table is bigger than the space available in the control pod to store it.
Control system	00	0	04	The size of the table given in the table is incorrect.
Control system	00	0	05	Table CRC error.
Control system	00	0	06	The version number of the generator software that produced the table is too low.
Control system	0	0	07	The power data table failed to be stored in the power board.
Power system	01	0	00	The power data table used internally by the power module has an error.
Power system	01	0	01	The power data table that is uploaded to the control system on power up has an error.
Power system	01	0	02	The power data table used internally by the power module does not match the hardware identification of the power module.

Recommended actions:

- Hardware fault – Contact the supplier of the drive

Power Down Save

37

Power down save error

The *Power Down Save* trip indicates that an error has been detected in the power down save parameters saved in non-volatile memory.

Recommended actions:

- Perform a 1001 save in Pr **mm.000** to ensure that the trip doesn't occur the next time the drive is powered up.

PSU

5

Internal power supply fault

The *PSU* trip indicates that one or more internal power supply rails are outside limits or overloaded.

Source	xx	y	zz	Description
Control system	00	0	00	Internal power supply overload.
Power system	01	1		

Recommended actions:

- Remove the option module and perform a reset
- There is a hardware fault within the drive – return the drive to the supplier

Reserved

14-17
11
09
01
94 - 95
103 - 108
191 - 198
168 - 173
238 - 245
23, 39, 99, 176,
205 - 214
223 - 224

Reserved trips

These trip numbers are reserved trip numbers for future use. These trips should not be used by the user application programs.

Trip Number	Description
01	Reserved resettable trip
94 -95	Reserved resettable trip
103 - 108	Reserved resettable trip
191 – 198	Reserved resettable trip
168 - 173	Reserved resettable trip
238 - 245	Reserved non-resettable trip

Resistance	**Measured resistance has exceeded the parameter range**
33	The *Resistance* trip indicates that the measured stator resistance during an auto-tune test has exceeded the maximum possible value of *Stator Resistance* (05.017). 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. **Recommended actions:** • Check the motor cable / connections • Check the integrity of the motor stator winding using a insulation tester • Check the motor phase to phase resistance at the drive terminals • Check the motor phase to phase resistance at the motor terminals • Ensure the stator resistance of the motor falls within the range of the drive model • Select fixed boost mode (Pr **05.014** = Fd) and verify the output current waveforms with an oscilloscope • Replace the motor
Slot 1 Different	**Option module in option slot 1 has changed**
204	The *Slot 1 Different* 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. **Sub-trip** / **Reason** 1 — No module was installed previously 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. 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. 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. >99 — Shows the identifier of the module previously installed. **Recommended actions:** • Turn off the power, ensure the correct option module is installed in the option slot and re-apply the power. • 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.**
Slot 1 Error	**Option module in option slot 1 has detected a fault**
202	The *Slot 1 Error* 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. **Recommended actions:** • See relevant *option module User Guide* for details of the trip
Slot 1 HF	**Option module 1 hardware fault**
200	The *Slot 1 HF* trip indicates that the option module in option slot 1 on the drive has indicated a hardware fault. The possible causes of the trip can be identified by the sub-trip number. **Sub-trip** / **Reason** 1 — The module category cannot be identified 2 — All the required customized menu table information has not been supplied or the tables supplied are corrupt 3 — There is insufficient memory available to allocate the comms buffers for this module 4 — The module has not indicated that it is running correctly during drive power-up 5 — Module has been removed after power-up or it has stopped working 6 — The module has not indicated that it has stopped accessing drive parameters during a drive mode change 7 — The module has failed to acknowledge that a request has been made to reset the drive processor **Recommended actions:** • Ensure the option module is installed correctly • Replace the option module • Replace the drive
Slot 1 Not Fitted	**Option module in option slot 1 has been removed**
203	The *Slot 1 Not Fitted* trip indicates that the option module in option slot 1 on the drive has been removed since the last power up. **Recommended actions:** • Ensure the option module is installed correctly. • Re-install the option module. • To confirm that the removed option module is no longer required perform a save function in Pr **mm.000**.

Slot 1 Watchdog — **Option module watchdog function service error**

201

The *Slot 1 Watchdog* trip indicates that the option module installed in Slot 1 has started the option watchdog function and then failed to service the watchdog correctly.

Recommended actions:

- Replace the option module

Soft Start — **Soft start relay failed to close, soft start monitor failed**

226

The *Soft Start* 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.

Sub-trip	Reason
1	Soft-start failure
2	DC bus capacitor failure on 110 V drive (size 2 only)

Recommended actions:

- Hardware fault – Contact the supplier of the drive

STO Error — **No Safe Torque Off board fitted**

234

STO board not fitted

Stored HF — **Hardware trip has occurred during last power down**

221

The *Stored HF* trip indicates that a hardware trip (HF01 –HF19) has occurred and the drive has been power cycled. The sub-trip number identifies the HF trip i.e. stored HF19.

Recommended actions:

- Enter 1299 in Pr **mm.000** and press reset to clear the trip

Sub-array RAM — **RAM allocation error**

227

The *Sub-array RAM* 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.

Parameter size	Value
1 bit	1
8 bit	2
16 bit	3
32 bit	4
64 bit	5

Parameter type	Value
Volatile	0
User save	1
Power-down save	2

Sub-array	Menus	Value
Derivative image	29	2
Option slot 1 set-up	15	4

Temp Feedback — **Internal thermistor has failed**

218

The *Temp Feedback* trip indicates that an internal thermistor has failed. The thermistor location can be identified by the sub-trip number.

Source	xx	y	zz
Power system	01	0	Thermistor location defined by zz

Recommended actions:

- Hardware fault – Contact the supplier of the drive

Th Brake Res — **Brake resistor over temperature**

10

The *Th Brake Res* 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.

Recommended actions:

- Check brake resistor wiring
- Check braking resistor value is greater than or equal to the minimum resistance value
- Check braking resistor insulation

Th Short Circuit — **Motor thermistor short circuit**

25

The *Th Short Circuit* 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).

Recommended actions:

- Check thermistor continuity
- Replace motor / motor thermistor

Thermistor	**Motor thermistor over-temperature**
24	The *Thermistor* trip indicates that the motor thermistor connected to terminal 14 (digital input 5) on the control connections has indicated a motor over temperature. **Recommended actions:** • Check motor temperature • Check thermistor continuity
User 24V	**User 24 V supply is not present on Adaptor Interface terminals (1, 2)**
91	A *User 24V* trip is initiated if the *User Supply Select* (Pr **06.072**), is set to 1 and no user 24 V supply is present on the user 24 V input on the Adaptor Interface. **Recommended actions:** • Ensure the user 24 V supply is present on the user terminals on the Adaptor Interface.
User OI ac	**User OI ac**
8	A *User OI ac* trip is initiated if the output current of the drive exceeds the trip level set by User Over Current Trip Level (Pr **04.041**).
User Prog Trip	**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. Recommended actions: • Check the user program

User Program	On board user program error

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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.	An error has been detected in the onboard user program image. The sub-trip indicated the reason for the trip.
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.)	

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)

User Save	**User Save error / not completed**
36	The *User Save* trip indicates that an error has been detected in the user save parameters saved in non-volatile memory. For example, following a user save command, If the power to the drive was removed when the user parameters were being saved. **Recommended actions:** • Perform a user save in Pr **mm.000** to ensure that the trip doesn't occur the next time the drive is powered up. • Ensure that the drive has enough time to complete the save before removing the power to the drive.
Watchdog	**Control word watchdog has timed out**
30	The *Watchdog* trip indicates that the control word has been enabled and has timed out **Recommended actions:**

Table 13-3 Serial communications look up table

No	Trip	No	Trip	No	Trip
1	**Reserved**	90	**LF Power Comms**	200	**Slot 1 HF**
2	**Over Volts**	91	**User 24V**	201	**Slot 1 Watchdog**
3	**OI ac**	92	**OI Snubber**	202	**Slot 1 Error**
4	**OI Brake**	93	**Power Comms**	203	**Slot 1 Not Fitted**
5	**PSU**	94 - 95	**Reserved**	204	**Slot 1 Different**
6	**External Trip**	96	**User Prog Trip**	205 - 214	**Reserved**
7	**Over Speed**	97	**Data Changing**	215	**Option Disable**
8	**User OI ac**	98	**Out Phase Loss**	216 - 217	**Reserved**
9	**Reserved**	99	**Reserved**	218	**Temp Feedback**
10	**Th Brake Res**	100	**Reset**	219	**OHt Control**
11	**Reserved**	101	**OHt Brake**	220	**Power Data**
12	**Reserved**	102	**OHt Rectifier**	221	**Stored HF**
13	**Autotune**	103 - 108	**Reserved**	222	**Reserved**
14 - 17	**Reserved**	109	**OI dc**	223 - 224	**Reserved**
18	**Autotune Stopped**	110 - 111	**Reserved**	225	**Current Offset**
19	**Brake R Too Hot**	112 - 167	**t112 - t167**	226	**Soft Start**
20	**Motor Too Hot**	168 - 172	**Reserved**	227	**Sub-array RAM**
21	**OHt Inverter**	173	**Fan Fail**	228	**Output phase s/c**
22	**OHt Power**	174	**Card Slot**	229	**Reserved**
23	**Reserved**	175	**Card Product**	230	**Reserved**
24	**Thermistor**	176	**Reserved**	231	**I cal. range**
25	**Th Short Circuit**	177	**Card Boot**	232	**Drive config**
26	**I/O Overload**	178	**Card Busy**	233	**Reserved**
27	**OHt dc bus**	179	**Card Data Exists**	234	**STO Error**
28	**An Input 1 Loss**	180	**Card Option**	235	**Power Board HF**
29	**An Input 2 Loss**	181	**Card Read Only**	236	**No power board**
30	**Watchdog**	182	**Card Error**	237	**FW incompatible**
31	**EEPROM Fail**	183	**Card No Data**	238 - 245	**Reserved**
32	**Phase Loss**	184	**Card Full**	246	**Derivative ID**
33	**Resistance**	185	**Card Access**	247	**File changed**
34	**Keypad Mode**	186	**Card Rating**	248	**Derivative Image**
35	**Control Word**	187	**Card Drive Mode**	249	**User Program**
36	**User Save**	188	**Card Compare**	250	**Hot Rect/Brake**
37	**Power Down Save**	189	**An Input 1 OI**	252 - 254	**Reserved**
38	**Reserved**	190	**An Input 2 OI**	255	**Reset logs**
39	**Reserved**	191 - 198	**Reserved**		
40 - 89	**t040 - t089**	199	**Destination**		

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 13-4 Trip categories

Priority	Category	Trips	Comments
1	Internal faults	HF01, HF02, HF03, HF04, HF05, HF06, HF07, HF08, HF09, HF10, HF11, HF12, HF13, HF14, HF15, HF16, HF17, HF 18, HF 19	These indicate internal problems and cannot be reset. All drive features are inactive after any of these trips occur.
1	Stored HF trip	{Stored HF}	This trip cannot be cleared unless 1299 is entered into *Parameter* (**mm.000**) and a reset is initiated.
2	Non-resettable trips	Trip numbers 218 to 247, {Slot 1 HF}	These trips cannot be reset.
3	Volatile memory failure	{EEPROM Fail}	This can only be reset if Parameter **mm.000** 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}	
5	Trips with extended reset times	{OI.ac}, {OI.Brake}, {OI.dc} and {Fan Fail}	These trips cannot be reset until 10 s after the trip was initiated.
5	Phase loss and d.c. link power circuit protection	{Phase Loss} and {OHt dc bus}	The drive will attempt to stop the motor before tripping if a {Phase Loss}. 000 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 {OHt dc bus} occurs.
5	Standard trips	All other trips	

13.5 Internal / Hardware trips

Trips {HF01} to {HF19} are internal faults that do not have trip numbers. 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 Stored HF. Enter 1299 in **mm.000** to clear the Stored HF trip.

13.6 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 "Auto Tune and Limit Switch" the drive may eventually trip. Alarms are not displayed when a parameter is being edited.

Table 13-5 Alarm indications

Alarm string	Description
Brake Resistor	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.
Motor Overload	*Motor Protection Accumulator* (4.019) in the drive has reached 75.0 % of the value at which the drive will trip and the load on the drive is >100 %.
Drive Overload	Drive over temperature. *Percentage of Drive Thermal Trip Level* (07.036) in the drive is greater than 90 %.
Auto Tune	The autotune procedure has been initialized and an autotune in progress.
Limit Switch	Limit switch active. Indicates that a limit switch is active and that is causing the motor to be stopped.
Option Slot 1	Option slot alarm
Low AC	Low voltage mode. See *Low AC Alarm* (10.107).
Current limit	Current limit active. See *Current Limit Active* (10.009).

13.7 Status indications

Table 13-6 Status indications

Upper row string	Description	Drive output stage
Inhibit	The drive is inhibited and cannot be run. The SAFE TORQUE OFF signals are not applied to the 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
Ready	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 frequency.	Enabled
Run	The drive is active and running.	Enabled
Supply Loss	Supply loss condition has been detected.	Enabled
Deceleration	The motor is being decelerated to zero frequency because the final drive run has been deactivated.	Enabled
dc Injection	The drive is applying dc injection braking.	Enabled
Trip	The drive has tripped and no longer controlling the motor. The trip code appears in the lower display.	Disabled
Under Voltage	The drive is in the under voltage state either in low voltage or high voltage mode.	Disabled

Table 13-7 Option module and other status indications at power-up

First row string	Second row string	Status
Waiting For	**Power System**	Waiting for power stage
The drive is waiting for the processor in the power stage to respond after power-up.		
Waiting For	**Option**	Waiting for an option module
The drive is waiting for the option module to respond after power-up		
Uploading From	**Option**	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 'Uploading From Option' is displayed.		

13.8 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 13-2 is the value transmitted.

NOTE

The trip logs can be reset by writing a value of 255 in Pr **10.038**.

13.9 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
02.001	Post-ramp reference
03.001	Final demand ref
03.002	Estimated frequency
03.003	Frequency error
03.004	Frequency controller output
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
07.037	Temperature nearest to trip level

If the parameters are not required to be frozen then this can be disabled by setting bit 4 of Pr **10.037**.

14 UL listing information

14.1 General

Drive sizes 1 to 8 have been assessed to meet both UL and cUL requirements.

UL listings can be viewed online at www.UL.com. The UL file number is E171230.

14.2 Mounting

Drives can be installed in the following configurations:

- Standard or surface mounted. This is described in section 3.5.1 *Surface mounting* on page 34.
- Bookcase mounted. Drives are mounted side by side with no space between them. This configuration minimizes the overall width of the installation.

14.3 Environment

Drives are able to meet the following UL/NEMA environmental ratings:

- Type 1. The drive must either be installed with a UL Type 1 kit or be installed in a Type 1 enclosure.
- Type 12. The drive must be installed in a Type 12 enclosure.
- The remote keypad is rated to both UL Type 1 and UL Type 12.
- Drives must be installed in a pollution degree 2 environment or better.

14.4 Electrical installation

The following precautions must be observed:

- Drives are rated for use at 40 °C and 50 °C surrounding air temperature.
- The temperature rating of the power cables must be at least 75 °C.
- If the drive control stage is powered from an external power supply (+24 V), the power supply must be listed or recognized to UL class 2 with appropriate fusing.
- Ground connections must use UL listed closed loop (ring) terminals.

14.5 UL listed accessories

The following options are UL listed:

- CI-Keypad
- CI-485 Adaptor
- AI-485 Adaptor
- AI-Backup Adaptor
- Remote Keypad
- UL Type 1 kit
- NV Media card

14.6 Motor overload protection

- The drives are installed with solid state motor overload protection.
- The default overload protection level is less than 150 % of full load rated current for open loop operation.
- The default overload protection level is less than 180 % of full load rated current for rotor flux control operation.
- In order for the motor protection to work correctly, the motor rated current must be entered into Pr **00.006** or Pr **05.007**.
- The protection level may be adjusted below 150% if required. See section 8.3 *Current limits* on page 112.

14.7 Motor overspeed protection

The drive is installed with solid state motor overspeed protection.

However, this feature does not provide the level of protection provided by an independent, high-integrity overspeed protection device.

14.8 Thermal memory retention

Drives incorporate thermal memory retention that complies fully with the requirements of UL508C.

The drive is provided with motor load and speed sensitive overload protection with thermal memory retention that complies with the US National Electrical Code (NFPA 70) clause 430.126 and Underwriters Laboratories Standard UL508C, clause 20.1.11 (a). The purpose of this protection is to protect both drive and motor from dangerous overheating in the event of repeated overload or failure to start, even if the power to the drive is removed between overload events.

For full explanation of the thermal protection system, refer to section 8.4 *Motor thermal protection* on page 112.

In order to comply with UL requirements for thermal memory retention, it is necessary to set the *Thermal Protection Mode* (Pr 04.016) to zero; and the *Low Frequency Thermal Protection Mode* (Pr 04.025) must be set to 1 if the drive is operated in Heavy Duty mode.

Alternatively, an external thermal sensor or switch may be used as a means of motor and drive overload protection that complies with the requirements of UL508C, clause 20.1.11 (b). This protection method is particularly recommended where independent forced cooling of the motor is used, because of the risk of overheating if the cooling is lost.

External thermal sensor

The drive is provided with a means to accept and act upon a signal from a thermal sensor or switch imbedded in the motor or from an external protective relay. Refer to section section 4.10.2 *Control terminal specification* on page 84

14.9 Electrical ratings

Drives are listed for connection to an AC supply capable of delivering no more than 100 kA symmetrical amperes. See Table 4-5.

Power and current ratings are given in Table 12-1 to Table 12-4.

Fuse and circuit breaker (size 1 only with short circuit rating of 10 kA. Only the listed DIVQ/DIVQ7 type SU203UP ABB (E212323) circuit breaker may be used) ratings are given in Table 4-6 to Table 4-10

Unless indicated otherwise in Table 4-6 to Table 4-10, fuses may be any UL listed Class J or CC with a voltage rating of at least 600 Vac.

Unless indicated otherwise in Table 4-6 to Table 4-10, circuit breakers may be any UL listed type, category control number: DIVQ or DIVQ7, with a voltage rating of at least 600 Vac.

14.10 cUL requirements for frame size 4

For frame size 4, models Mxxx-042 00133A, Mxxx-042 00176A, Mxxx-044 00135A and Mxxx-044 00170A, transient surge suppression shall be installed on the line side of this equipment and shall be rated 480 Vac (phase to ground), 480 Vac (phase to phase), suitable for overvoltage category III, and shall provide protection for a rated impulse withstand voltage peak of 6 kV and a clamping voltage of maximum 2400 V.

NOTE

Mxxx denotes M100, M101, M200, M201, M300 or M400.

14.11 cUL requirements for 575 V frame size 7 and 8

For size 7 and 8 575Vac models only (07500440, 07500550, 08500630, 08500860), the following must be adhered to in order to comply with cUL approval requirements:

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 WITHSTAND VOLTAGE PEAK OF 6 kV AND A CLAMPING VOLTAGE OF MAXIMUM 2400 V.

14.12 Group installation

14.12.1 Definition

Group Installation Definition: A motor branch circuit for two or more motors, or one or more motors with other loads, protected by a circuit breaker or a single set of fuses.

14.12.2 Limitations on use

All motors rated less than 1 hp

The drives may be used in group installations where each of the motors is rated 1 hp or less. The full-load current rating of each motor must not exceed 6 A. The motor drive provides individual overload protection in accordance with the NEC clause 430.32.

Smallest motor protected

The drives may be used in group installations where the smallest motor is protected by the branch fuses or circuit breaker. Limits on the current rating of branch circuit protective fuses and circuit breakers are given in the NEC Table: 430.52.

Other installations

The motor drives described in this user guide are not UL listed for group installation.

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