EMERSON
Industrial Automation

User Guide

Digitax ST

AC variable speed drive for servo motors

Part Number: 0475-0001-05
Issue: 5

DRIVE CENTRE
Industrial Automation Systems Integrators

57 Galaxy Blvd., Units 1 & 2, Toronto, ON M9W 5P1
TEL: (416) 231-6767
www.drivecentre.ca

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.

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Drive software version

This product is supplied with the latest software version. If this drive is to be connected to an existing system or machine, all drive software 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 an Emerson Industrial Automation Service Centre or Repair Centre. If there is any doubt please contact the supplier of the product.

The software version of the drive can be checked by looking at Pr **11.29** and Pr **11.34**. This takes the form of xx.yy.zz where Pr **11.29** displays xx.yy and Pr **11.34** displays zz. (e.g. for software version 01.01.00, Pr **11.29** = 1.01 and Pr **11.34** displays 0).

Environmental statement

Emerson Industrial Automation 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:

http://www.emersonindustrial.com/en-EN/controltechniques/aboutus/environment/Pages/environment.aspx

The electronic variable-speed drives manufactured by Emerson Industrial Automation 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. Emerson Industrial Automations' 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.

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

For current information on how this requirement applies in relation to specific Emerson Industrial Automations' products, please approach your usual contact in the first instance. Emerson Industrial Automations' position statement can be viewed at:

www.emersonindustrial.com/en-EN/controltechniques/aboutus/environment/reachregulation/Pages/reachregulation.aspx.

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Software: 01.06.00 onwards

For patent and intellectual property related information please go to: www.ctpatents.info.

How to use this guide

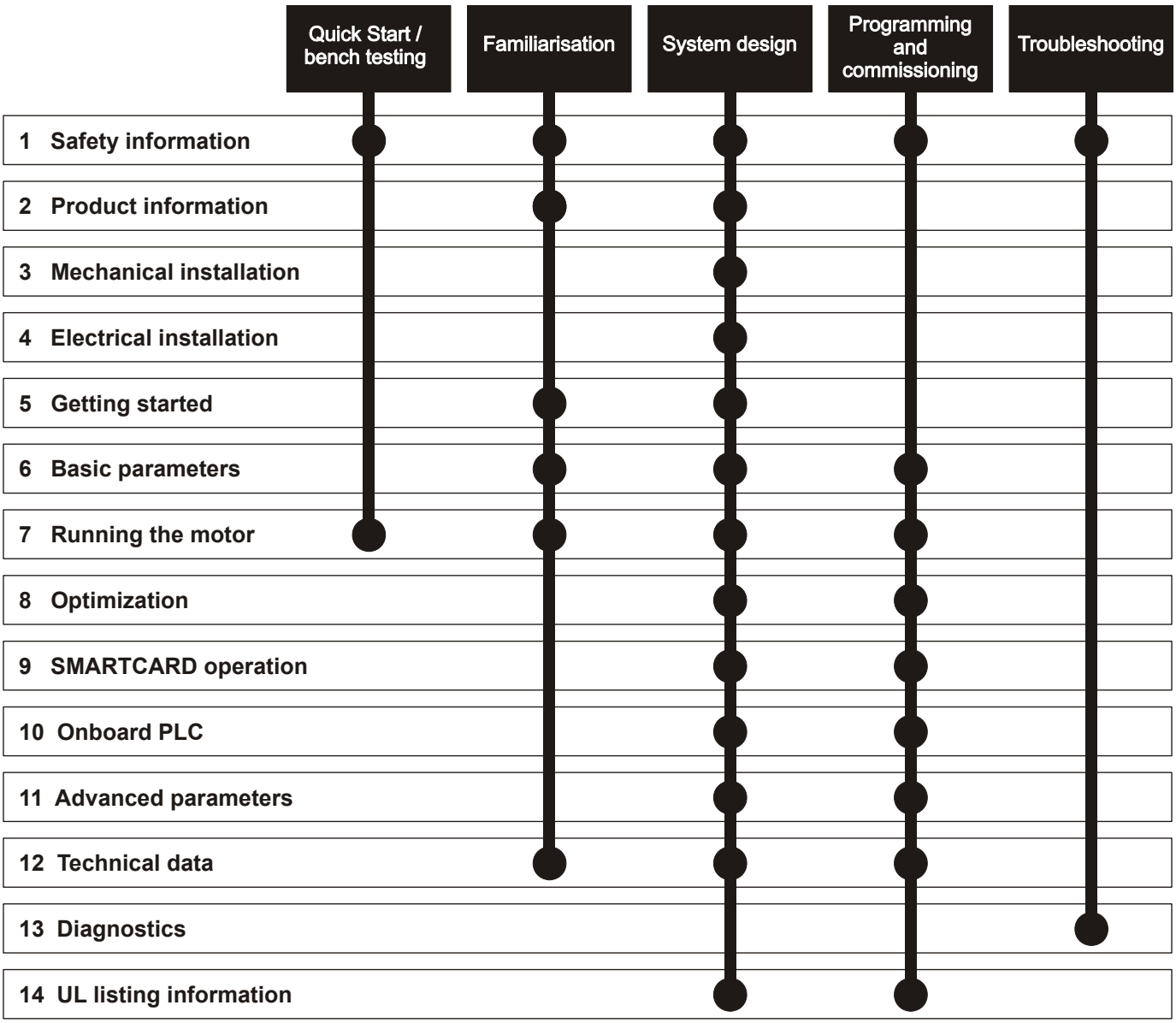
This *User Guide* provides information for operating the drive from start to finish.

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* on page 6 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:



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1 Safety Information

1.1 Warnings, Cautions and Notes

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

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

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 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, set-up and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this 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 has been approved by IFA as meeting the requirements of the following standards, for the prevention of unexpected starting of the drive:

EN 61800-5-2:2007 SIL 3

EN ISO 13849-1:2006 PL e

EN 954-1:1997 Category 3 (This standard is withdrawn and should not be used for new designs, information provided for legacy applications only).

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 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

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 details regarding fire protection please refer to *section 3.2.5 Fire protection* on page 15.

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.

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.

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 **0.46** 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
- DC bus, dynamic 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.

1.11.2 Isolation device

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

1.11.3 STOP function

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

1.11.4 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.

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 Emerson Industrial Automation or their authorized distributor.

1.11.5 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).

1.11.6 Permanent magnet motors

Permanent magnet motors generate electrical power if they are rotated, even when the supply to the drive is disconnected. If that happens then the drive will become energized through its motor terminals.

If the motor load is capable of rotating the motor when the supply is disconnected, then the motor must be isolated from the drive before gaining access to any live parts.

2 Product information

2.1 Introduction

The Digitax ST family of servo drives are available with five levels of intelligence:

- Digitax ST Base
- Digitax ST Indexer
- Digitax ST Plus
- Digitax ST EZMotion
- Digitax ST EtherCAT

The Digitax ST Base drive operates in velocity or torque modes and is designed to operate with a centralized motion controller or as a standalone drive.

The Digitax ST Indexer drive performs point-to-point motion profiling including relative, absolute, rotary plus, rotary minus, registration and homing motion. The Digitax ST Indexer will operate as a single standalone system controller. Alternatively, the Digitax ST Indexer can form part of a distributed system where commands are sent over a fieldbus or through digital input/output signals. The Digitax ST Indexer drive is commissioned using a simple and easy to use indexing tool that resides within CTSoft, a set-up tool for Emerson Industrial Automation products.

The Digitax ST plus drive offers all the features available o the Digitax ST Indexer drive with the addition of performing complex motion as a single axis or synchronized to a reference axis. This offers digital lock and electronic camming via a virtual master reference. The Digitax ST Plus drive is commissioned using a simple and easy to use indexing tool that resides within CT Soft, a set-up tool for Emerson Industrial Automation products.

For more complex systems using the Digitax ST Indexer and Digitax ST Plus drives, an export feature is available that allows the user to import applications into SYPTPro for further development.

The Digitax ST EZMotion drive is part of the Motion Made Easy family of servo drives and allows the user to create programs to sequence motion, I/O control, and other machine operations in one environment. Digitax ST EZMotion also supports advanced functions such as a Position Capture Object, Multiple Profile Summation, Queuing, and Program Multitasking.

The Digitax ST EtherCAT drive offers onboard EtherCAT allowing the product to be connected to an EtherCAT network as a slave device. It can be used in a variety of applications, including those requiring accurate synchronization and precise motion control.

All variants provide a Safe Torque Off function.

Four documentation guides are available for Digitax ST, these cover all variants:

All guides are available for download at:

http://www.emersonindustrial.com/en-EN/controltechniques/downloads/userguidesandsoftware/Pages/downloads.aspx

or

www.emersonindustrial.com/en-EN/leroy-somer-motors-drives/downloads/Pages/manuals.aspx

Installation Guide (packed with product)

- Designed to be used by an "Electrician/Wireman" installing the drive (FIGS Available).

Technical Data Guide

- Designed as a reference guide for experienced drive users (FIGS Available).

User Guide

- Designed as a step by step guide to help the user become familiar with the product, and as a reference guide for experienced drive users (FIGS Available).

Advanced User Guide

- In-depth parameter descriptions.

2.2 Drive ratings

The drive rating is limited by numerous systems which protect the power stage hardware. (Rectifier, DC bus, inverter)

These systems come into operation under various extremes of operating conditions. (I.e. ambient, supply imbalance, output power.)

2.2.1 Maximum ratings

Table 2-1 Maximum ratings

Model	No of input phases	Nominal current I_n A	Peak current I_{MAX} A
DST1201	1	1.1*	2.2
DST1202	1	2.4*	4.8
DST1203	1	2.9*	5.8
DST1204	1	4.7*	9.4
DST1201	3	1.7	5.1
DST1202	3	3.8	11.4
DST1203	3	5.4	16.2
DST1204	3	7.6	22.8
DST1401	3	1.5	4.5
DST1402	3	2.7	8.1
DST1403	3	4.0	12.0
DST1404	3	5.9	17.7
DST1405	3	8.0	24.0

*The maximum rating information, in Table 2-1 above, for the 200 V single phase supply, illustrates a 200 % overload capability. When the Digitax ST 120x is used with a single phase supply it is possible to achieve the three phase nominal current rating as long as the single phase peak current rating is observed.

The rating information shown in section 2.3 *Drive model numbers* on page 9 is based on the limitations of the drive output stage only.

The ratings are based on the following operating conditions:

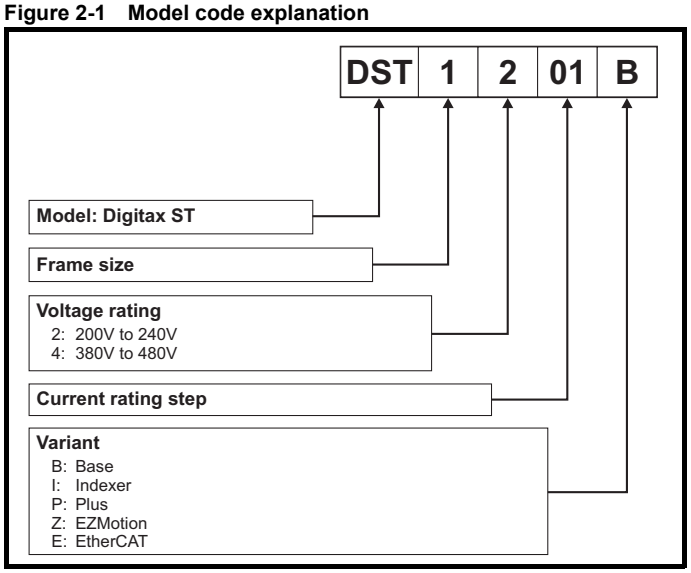
- Ambient temperature = 40 °C
- Altitude = 1000 m
- Not exceeding power ratings
- DC bus voltage = 565 V for DST140X
- DC bus voltage = 325 V for DST120X

The sizing tool should be used to select a drive for a profile or condition that is not given as an example in section 13.1.2 *Typical pulse duty* on page 173.

2.3 Drive model numbers

Each drive variant and rating has a unique model number.

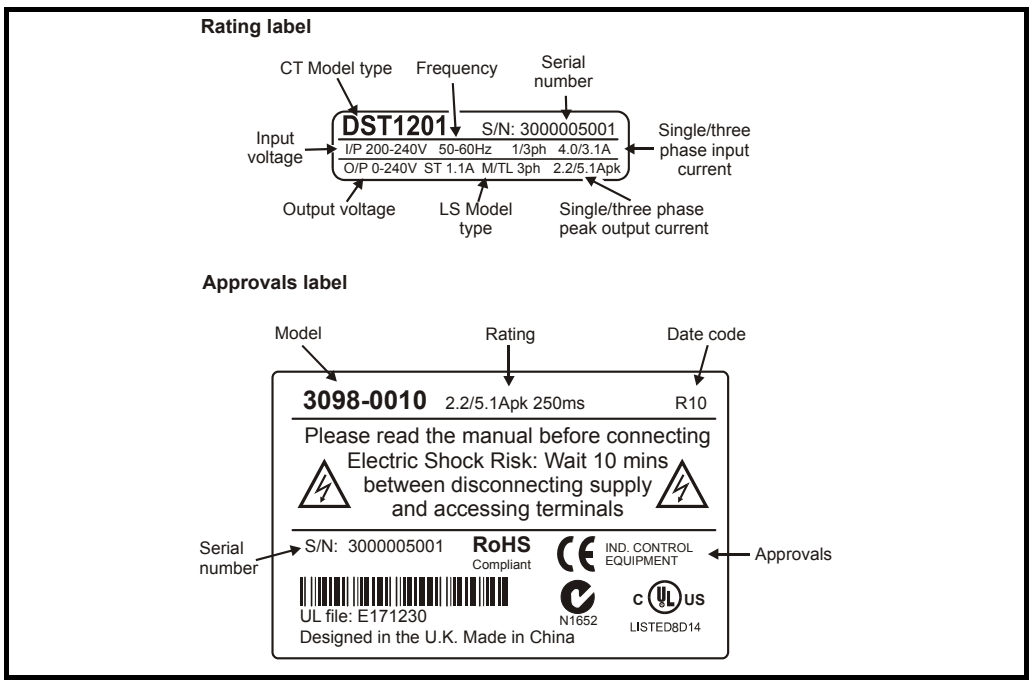
Figure 2-1 Model code explanation



2.4 Drive nameplate description

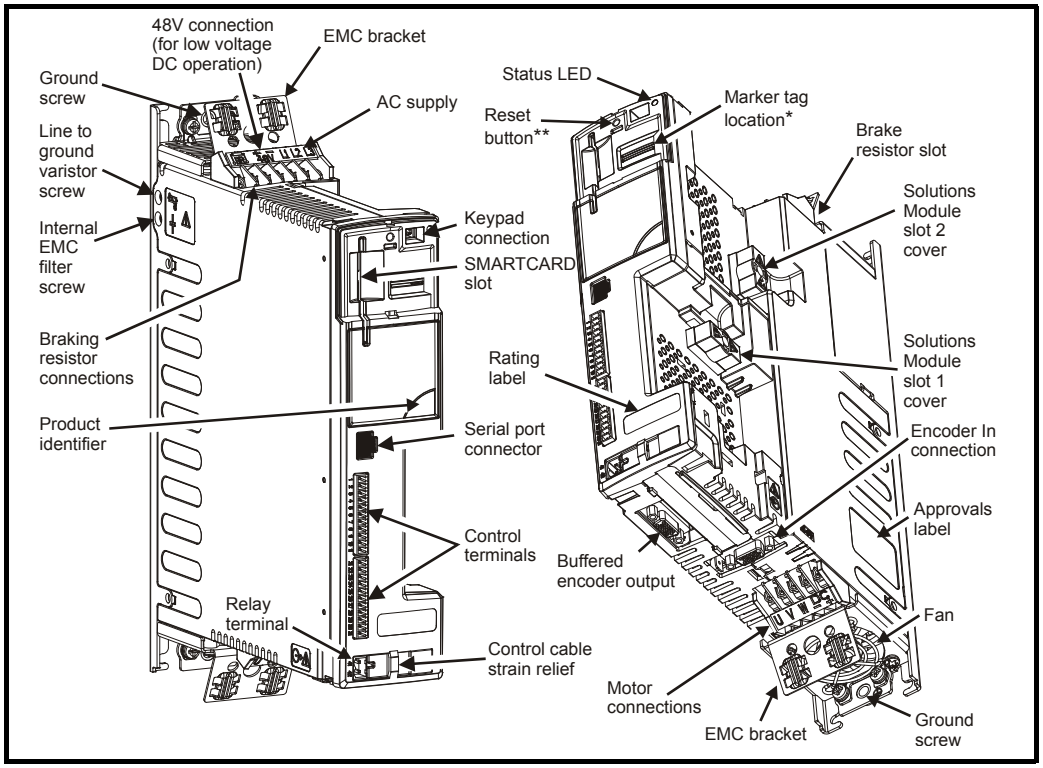
The drive rating label provides the user with various details relating to the drive variant and rating.

Figure 2-2 Typical drive label



2.5 Features of the drive

Figure 2-3 Features of the drive



* The Marker Tag (as shown in Figure 2-3 above), is where markers can be placed to identify a particular drive which can prove beneficial where several Digitax ST drives are located in the same panel.

** A drive reset can be performed even when a keypad is not installed, by pressing the recessed reset button.

NOTE

If the embedded interface is removed, the warranty for the drive will be void.

NOTE

The drive is supplied with a SMARTCARD installed. Do not remove until after first power-up, as defaults are stored on the SMARTCARD.

WARNING

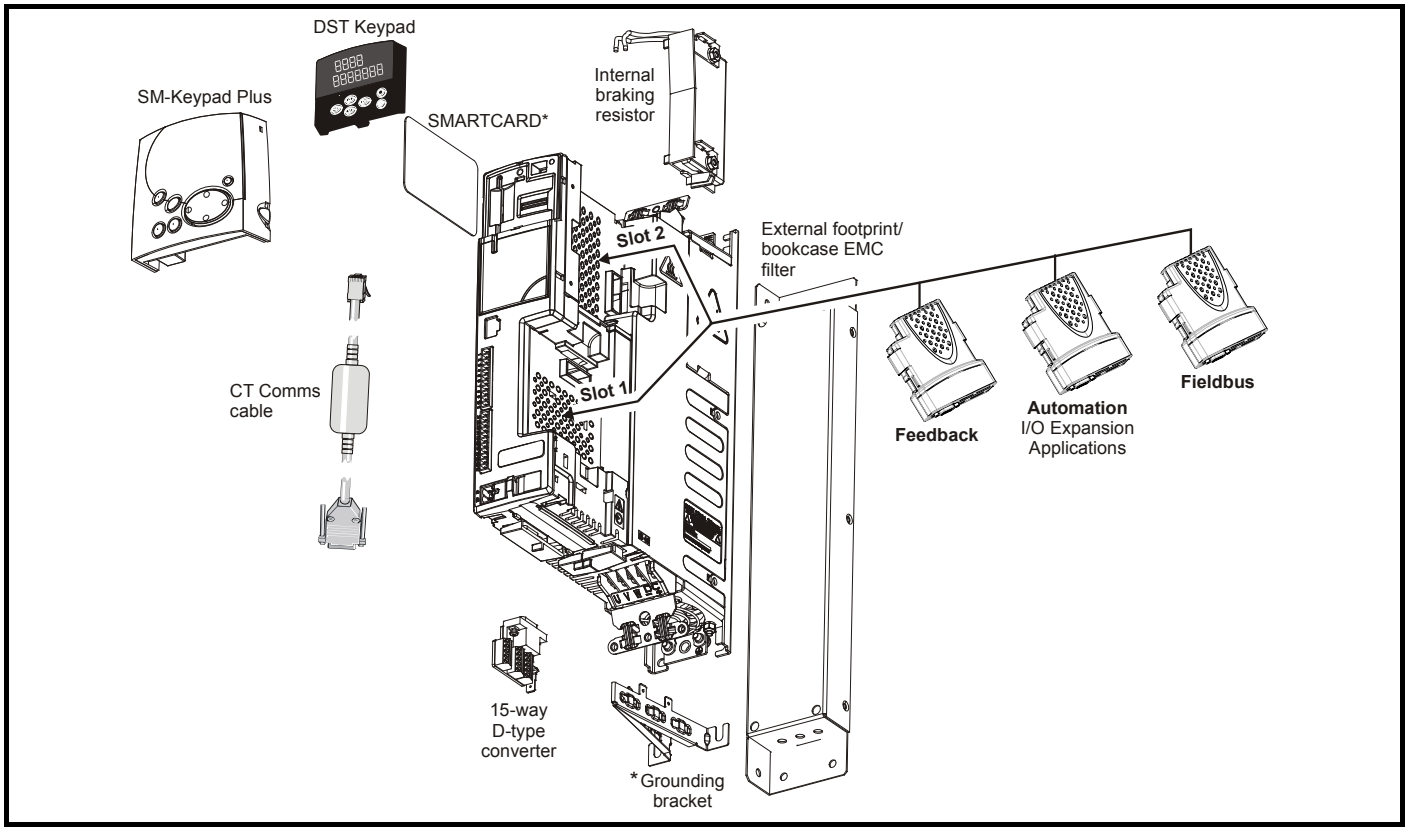
Be aware of possible live terminals when inserting the SMARTCARD.

CAUTION

Static precautions must be taken when removing the Solutions Module slot covers.

2.6 Options

Figure 2-4 Options available with Digitax ST

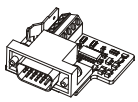
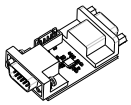


* A SMARTCARD is provided as standard. For further information refer to Chapter 10 *SMARTCARD Operation* on page 101.

All Solutions Modules are color-coded in order to make identification easy. The following table shows the color-code key and gives further details on their function.

Table 2-2 Solutions Module identification

Type	Solutions Module	Color	Name	Further Details
Feedback		Light Green	SM-Universal Encoder Plus	**Universal Feedback interface** Feedback interface for the following devices: **Inputs** • Incremental encoders • SinCos encoders • SSI encoders • EnDat encoders **Outputs** • Quadrature • Frequency and direction • SSI simulated outputs
		Light Blue	SM-Resolver	**Resolver interface** Feedback interface for resolvers. Simulated quadrature encoder outputs
		Brown	SM-Encoder Plus	**Incremental encoder interface** Feedback interface for incremental encoders without commutation signals. No simulated encoder outputs available

Type	Solutions Module	Color	Name	Further Details
Feedback		Dark Brown	SM-Encoder Output Plus	**Incremental encoder interface** Feedback interface for incremental encoders without commutation signals. Simulated encoder output for quadrature, frequency and direction signals
		N/A	15-way D-type converter	**Drive encoder input converter** Provides screw terminal interface for encoder wiring and spade terminal for shield
		N/A	Single ended encoder interface (15 V or 24 V)	**Single ended encoder interface** Provides an interface for single ended ABZ or UVW encoder signals, such as those from hall effect sensors. 15 V and 24 V versions are available.
		N/A	ERN1387 Encoder Interface Board	**ERN1387 Encoder Interface Board** Provides an interface for Heidenhain ERN1387 and ERN487 SinCos encoder which use a single SinCos cycle per revolution commutation track. A SM-Universal Encoder Plus module is required to use this interface board.
Automation (I/O Expansion)		Yellow	SM-I/O Plus	**Extended I/O interface** Increases the I/O capability by adding the following to the existing I/O in the drive: • Digital inputs x 3 • Digital I/O x 3 • Analog inputs (voltage) x 2 • Analog output (voltage) x 1 • Relay x 2
		Yellow	SM-I/O 32	**Extended I/O interface** Increase the I/O capability by adding the following to the existing I/O in the drive: • High speed digital I/O x 32 • +24 V output
		Dark Yellow	SM-I/O Lite	**Additional I/O** 1 x Analog input (±10 V bi-polar or current modes) 1 x Analog output (0-10 V or current modes) 3 x Digital input and 1 x Relay
		Dark Red	SM-I/O Timer	**Additional I/O with real time clock** As per SM-I/O Lite but with the addition of a Real Time Clock for scheduling drive running
		Turquoise	SM-I/O PELV	**Isolated I/O to NAMUR NE37 specifications** For chemical industry applications 1 x Analog input (current modes) 2 x Analog outputs (current modes) 4 x Digital input / outputs, 1 x Digital input, 2 x Relay outputs
		Olive	SM-I/O 120V	**Additional I/O conforming to IEC 61131-2 120 Vac** 6 digital inputs and 2 relay outputs rated for 120 Vac operation
		Cobalt Blue	SM-I/O 24V Protected	**Additional I/O with overvoltage protection up to 48 V** 2 x Analog outputs (current modes) 4 x Digital input / outputs, 3 x Digital inputs, 2 x Relay outputs
Automation (Applications)		Golden brown	SM-Register	**Applications Processor** 2nd processor for running position capture functionality with CTNet support.

Type	Solutions Module	Color	Name	Further Details
Fieldbus		Purple	SM-PROFIBUS-DP-V1	**Profibus option** PROFIBUS DP adapter for communications with the drive
		Medium Grey	SM-DeviceNet	**DeviceNet option** Devicenet adapter for communications with the drive
		Dark Grey	SM-INTERBUS	**Interbus option** Interbus adapter for communications with the drive
		Pink	SM-CAN	**CAN option** CAN adapter for communications with the drive
		Light Grey	SM-CANopen	**CANopen option** CANopen adapter for communications with the drive
		Red	SM-SERCOS	**SERCOS option** Class B compliant. Torque velocity and position control modes supported with data rates (bit/sec): 2 MB, 4 MB, 8 MB and 16 MB. Minimum 250 µsec network cycle time. Two digital high speed probe inputs 1 µsec for position capture
		Beige	SM-Ethernet	**Ethernet option** 10 base-T / 100 base-T; Supports web pages, SMTP mail and multiple protocols: DHCP IP addressing; Standard RJ45 connection
		Pale Green	SM-LON	**LonWorks option** LonWorks adapter for communications with the drive
		Brown Red	SM-EtherCAT	**EtherCAT option** EtherCAT adapter for communications with the drive
SLM		Orange	SM-SLM	**SLM interface** The SM-SLM allows SLM feedback to be connected directly to the Digitax ST drive and allows operation in either of the following modes: • Encoder only mode • Host mode

Table 2-3 Keypad identification

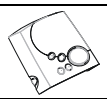
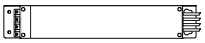
Type	Keypad	Name	Further Details
Keypad		Digitax ST Keypad	**LED keypad option** Keypad with a LED display
		SM-Keypad Plus	**Remote keypad option** Keypad with an alpha-numeric LCD display with Help function

Table 2-4 Other options

Type	Option	Name	Further details
EMC		EMC Filters	These additional filters are designed to operate together with the drive's own integral EMC filter in areas of sensitive equipment
Communications		CT Comms cable	Cable with isolation RS232 to RS485 converter. For connecting PC/Laptop to the drive when using the various interface software (e.g. CTSoft)
		CTSoft	Software for PC or Laptop which allows the user to commission and store parameter settings.
		SyPTLite	Software for PC or Laptop which allows the user to program PLC functions within the drive.
		Both CTSoft and SyPTLite can be downloaded at: http://www.emersonindustrial.com/en-EN/controltechniques/downloads/userguidesandsoftware/Pages/digitaxst.aspx	
Internal braking resistor		Braking resistor	Optional braking resistor 70R 50 W
SMARTCARD		SMARTCARD	Standard feature that enables simple configuration of parameters in a variety of ways

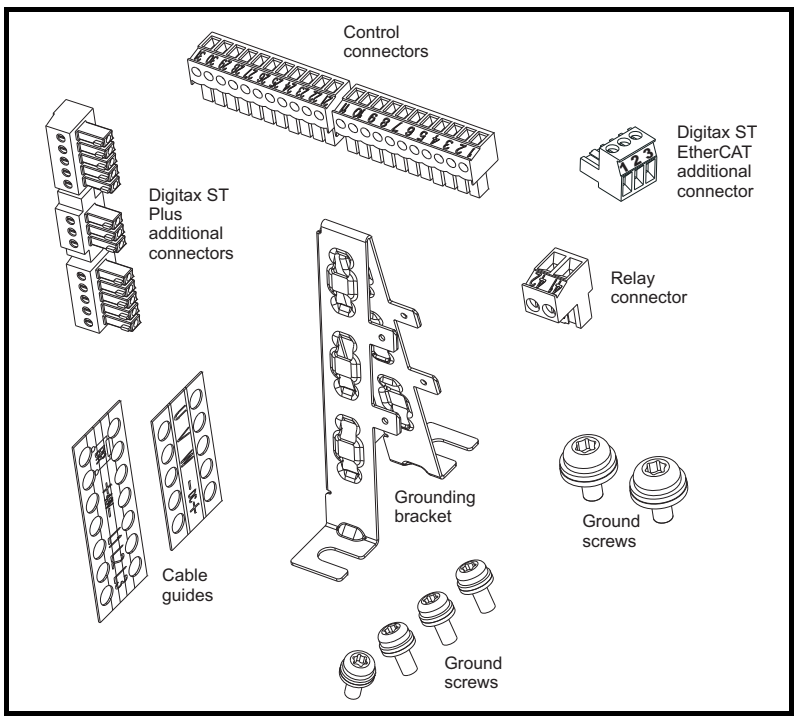
2.7 Items supplied with the drive

The drive is supplied with the following items:

- Installation Guide
- SMARTCARD
- Safety Information booklet
- Certificate of Quality

An accessory box containing the items illustrated in Figure 2-5 is also provided.

Figure 2-5 Accessory box contents



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
- IP54 as standard or through-panel mounting
- Enclosure sizing and layout
- Solutions 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

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. 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 Emerson Industrial Automation or their authorized distributor.

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.

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.

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 21*.

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.

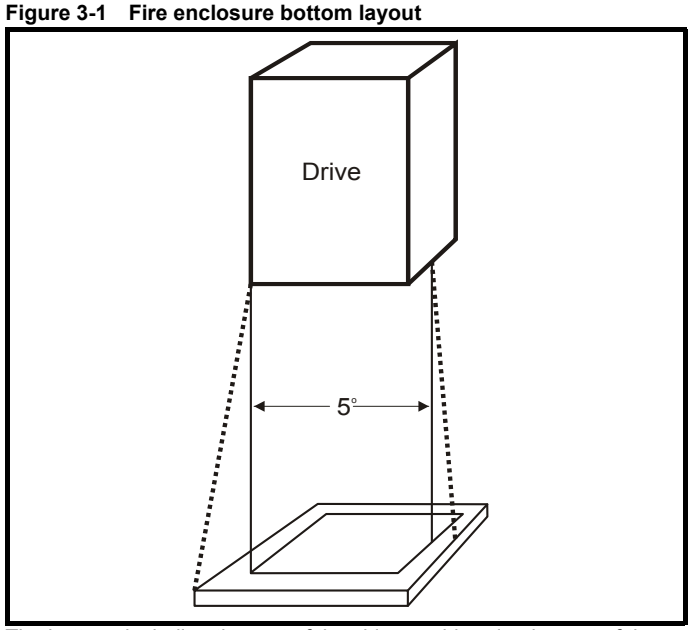
For installation outside the USA, the following (based on IEC 62109-1, standard for PV inverters) is recommended.

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.

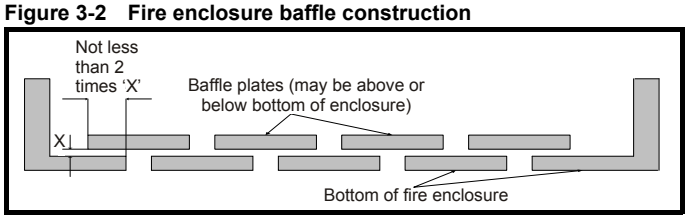
The location and size of the bottom shall cover the area shown in Figure 3-1. Any part of the side which is within the area traced out by the 5° angle is also considered to be part of the bottom of the fire enclosure.

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 4.10 *EMC (Electromagnetic compatibility) on page 28*.

3.2.7 Hazardous areas

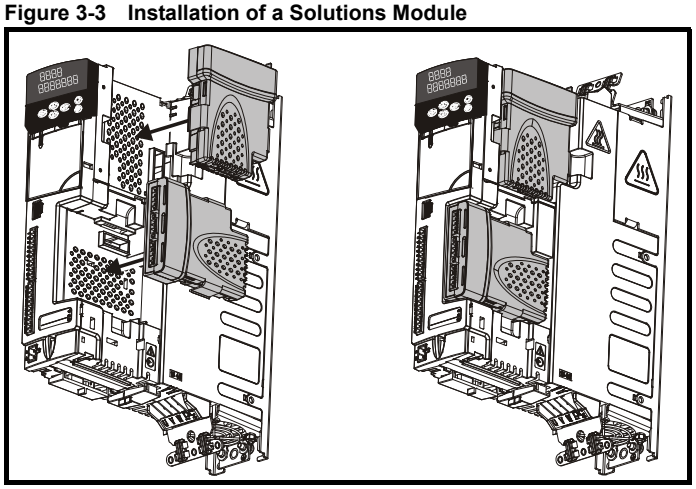
The drive must not be located in a classified hazardous area unless it is installed in an approved enclosure and the installation is certified.

3.3 Solutions Module / keypad installation / removal

CAUTION

Power down the drive before installing / removing the Solutions Module. Failure to do so may result in damage to the product.

Figure 3-3 Installation of a Solutions Module



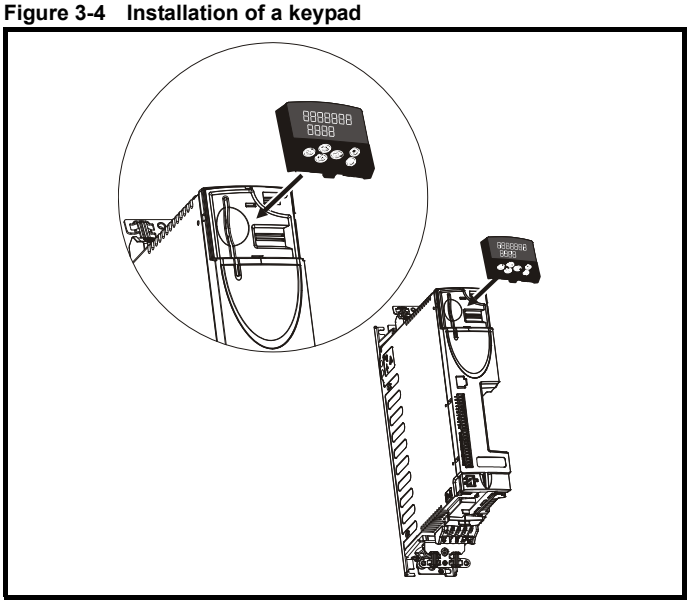
NOTE

The protective tab from the Solutions Module slot must be removed before attempting to install a Solutions Module.

WARNING

Be aware of possible live terminals when installing the keypad.

Figure 3-4 Installation of a keypad



3.4 Drive dimensions

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.

The drive complies with the requirements of IP20 as standard.

Figure 3-5 Dimensions

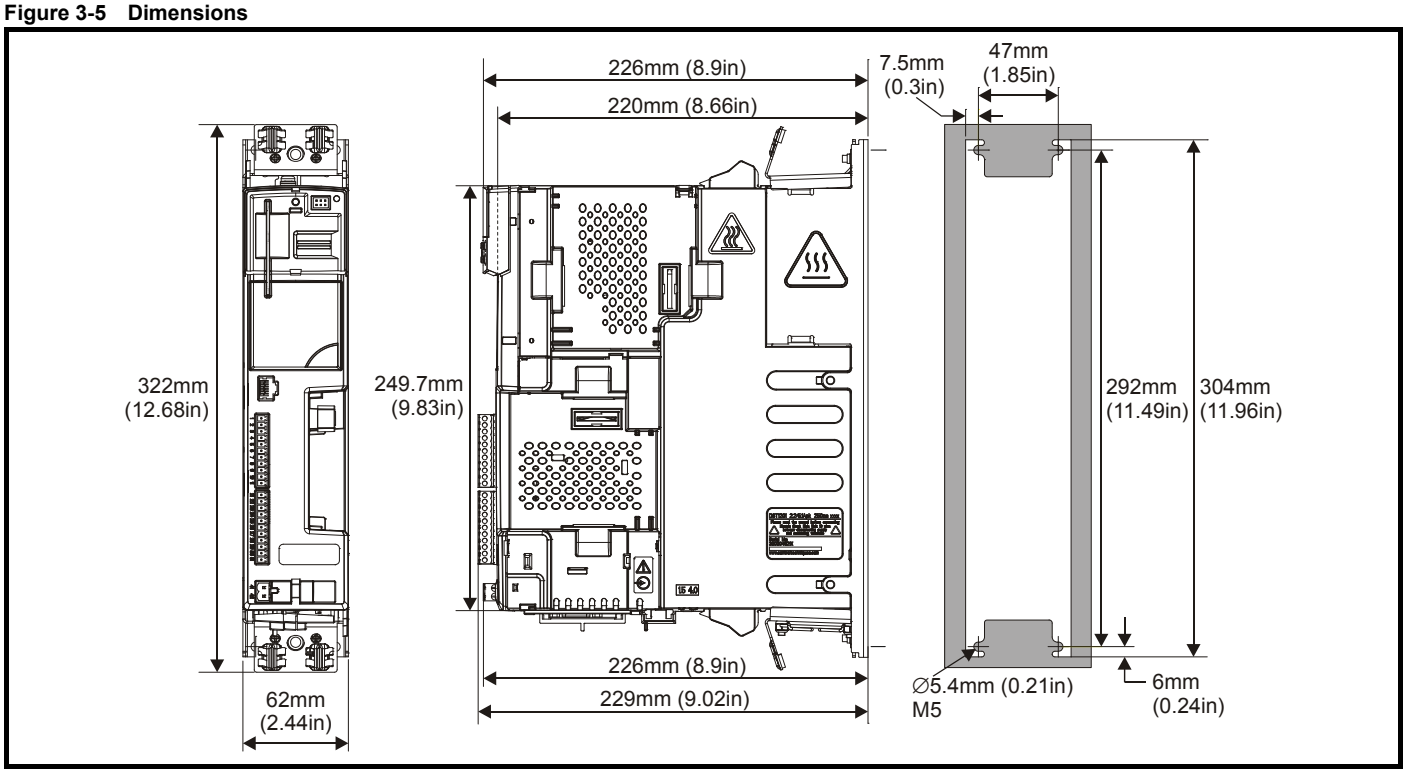
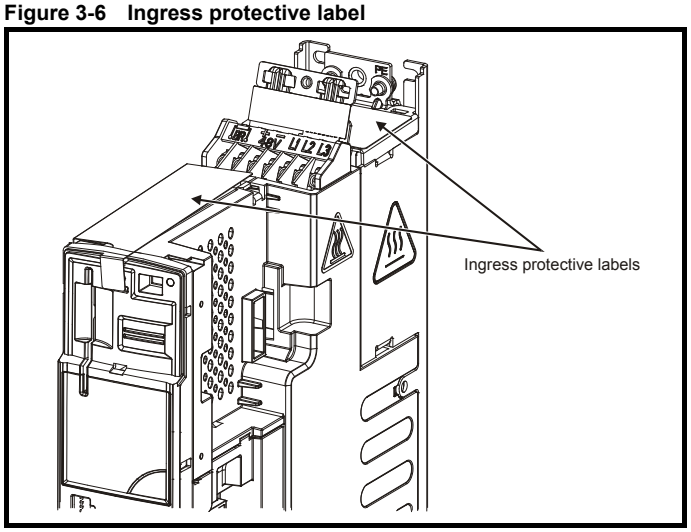


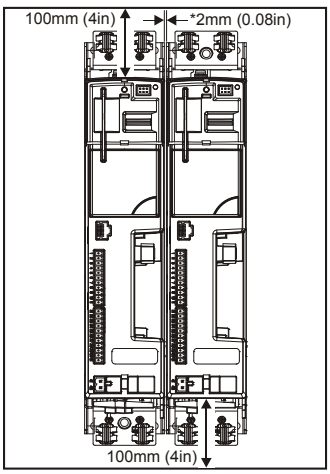
Figure 3-6 Ingress protective label



NOTE

The ingress protective labels (shown on Figure 3-6 above) should remain in place while the drive is mounted, and until all the electrical wires have been connected. The labels should be removed before first power up.

Figure 3-7 Minimum mounting clearances

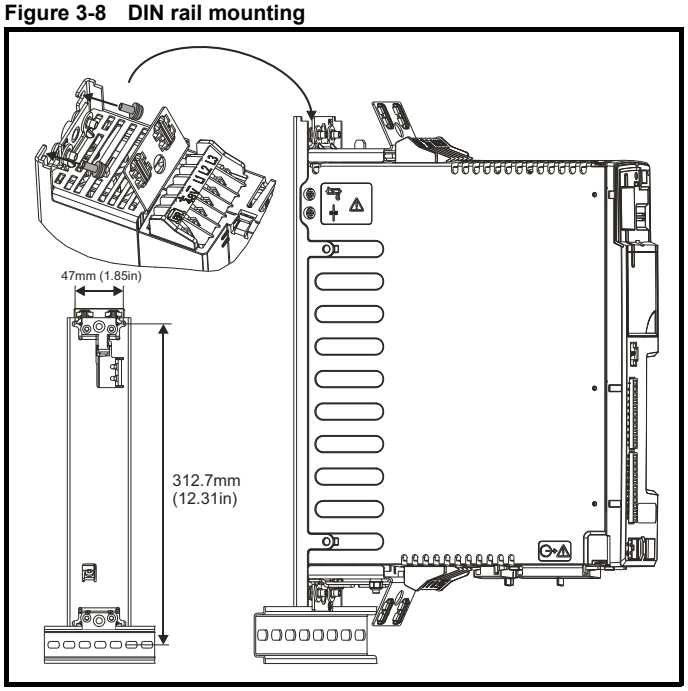


NOTE

*2 mm clearance between drives to allow for mechanical tolerance.
If Solutions Modules are installed, a larger clearance between drives will be required if access to the modules is needed without removing the drive.

Digitax ST can be mounted using a DIN rail, either fixed at the top or the bottom of the drive (as illustrated in Figure). Two screws are required to fix the drive to the backplate at the opposite end to the DIN rail.

Figure 3-8 DIN rail mounting



3.5 External EMC filter rating

Filter details for each drive rating are provided in the tables below.

Table 3-1 External EMC filter ratings

Used with	Number of phases	Filter part number		Maximum continuous current		Power losses at rated current	IP rating	Weight		Operational leakage current	Worst case leakage current	Filter terminal tightening torque	
		CT	Schaffner	@40°C (104°F) A	@50°C (122°F) A	W		Kg	lb	mA	mA	Nm	lb ft
DST120X	1	4200-6000	FS23072-19-07	19	17.3	11	20	1.2	2.64	29.5	56.9	0.8	0.6
DST120X	3	4200-6001	FS23073-17-07	17	15.5	13		1.2	2.64	8	50	0.8	0.6
DST140X	3	4200-6002	FS23074-11-07	11	10	10		1.2	2.64	16	90	0.8	0.6

The external EMC filters can be footprint or bookcase mounted, see Figure 3-9 and Figure 3-10.

Figure 3-9 Bookcase mounting

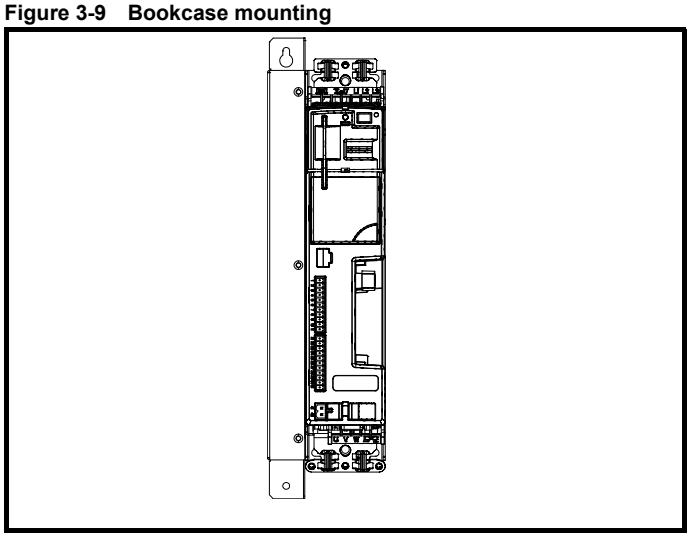


Figure 3-10 Footprint mounting

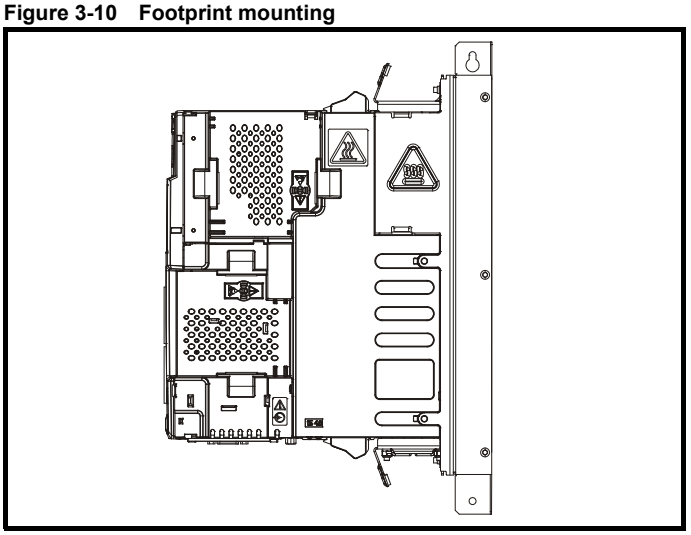


Figure 3-11 External EMC filter dimensions

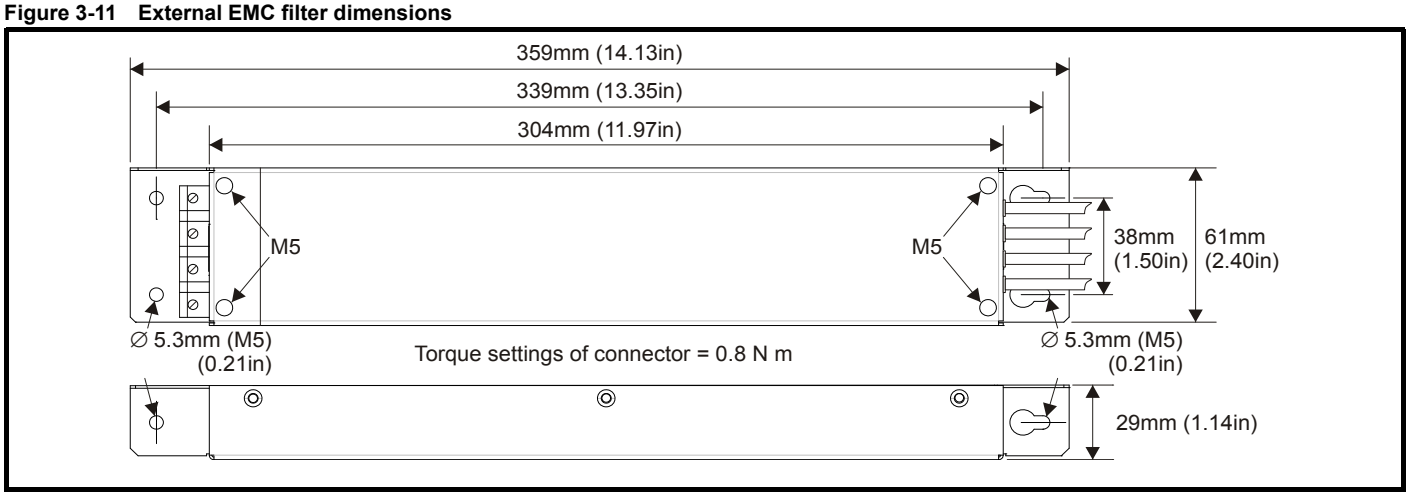
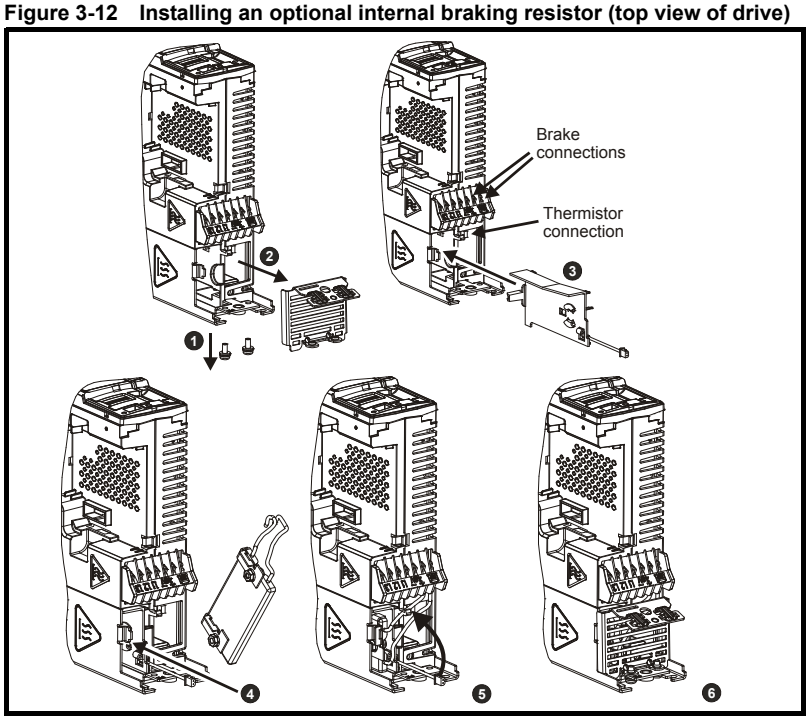


Figure 3-11 shows a 3 phase filter. For a single phase filter, there are only 3 input terminals (L1, N, ground) and 3 output cables (L1, N, ground).

3.6 Optional braking resistor

3.6.1 Optional internal braking resistor

Figure 3-12 Installing an optional internal braking resistor (top view of drive)



1. Remove screws.
2. Remove grill.
3. Install the braking resistor shield.
4. Install the optional internal braking resistor in the slot provided (note the angle).
5. Electrically connect the braking resistor and thermistor (connections shown in Figure 4-1 *Power terminal connections* on page 22).
6. Re-install the grill and mounting screws by reversing the procedure in points 1 and 2.

3.6.2 Optional external braking resistor

If using an external braking resistor, the following Warning must be adhered to:

WARNING

Braking resistor: High temperatures and overload protection
Braking resistors can reach high temperatures. Locate braking resistors so that damage cannot result. Use cable having insulation capable of withstanding the high temperatures.

3.7 Terminal torque settings

Table 3-2 Torque settings

Terminals	Torque setting*
Power terminals	1.0 N m (12.1 lb in)
Control terminals	0.2 N m (1.7 lb in)
Status relay terminals	0.5 N m (4.5 lb in)
Ground terminals	4 N m (35 lb in)
Small ground terminal screws	2 N m (17.7 lb in)

*Torque tolerance = 10 %

Table 3-3 Plug-in terminal block maximum cable sizes

Model size	Terminal block description	Max cable size
All	11 way control connectors	1.5 mm^2 (16 AWG)
All	2 way relay connector	2.5 mm^2 (12 AWG)

3.8 Routine maintenance

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

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

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)

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.

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

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

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

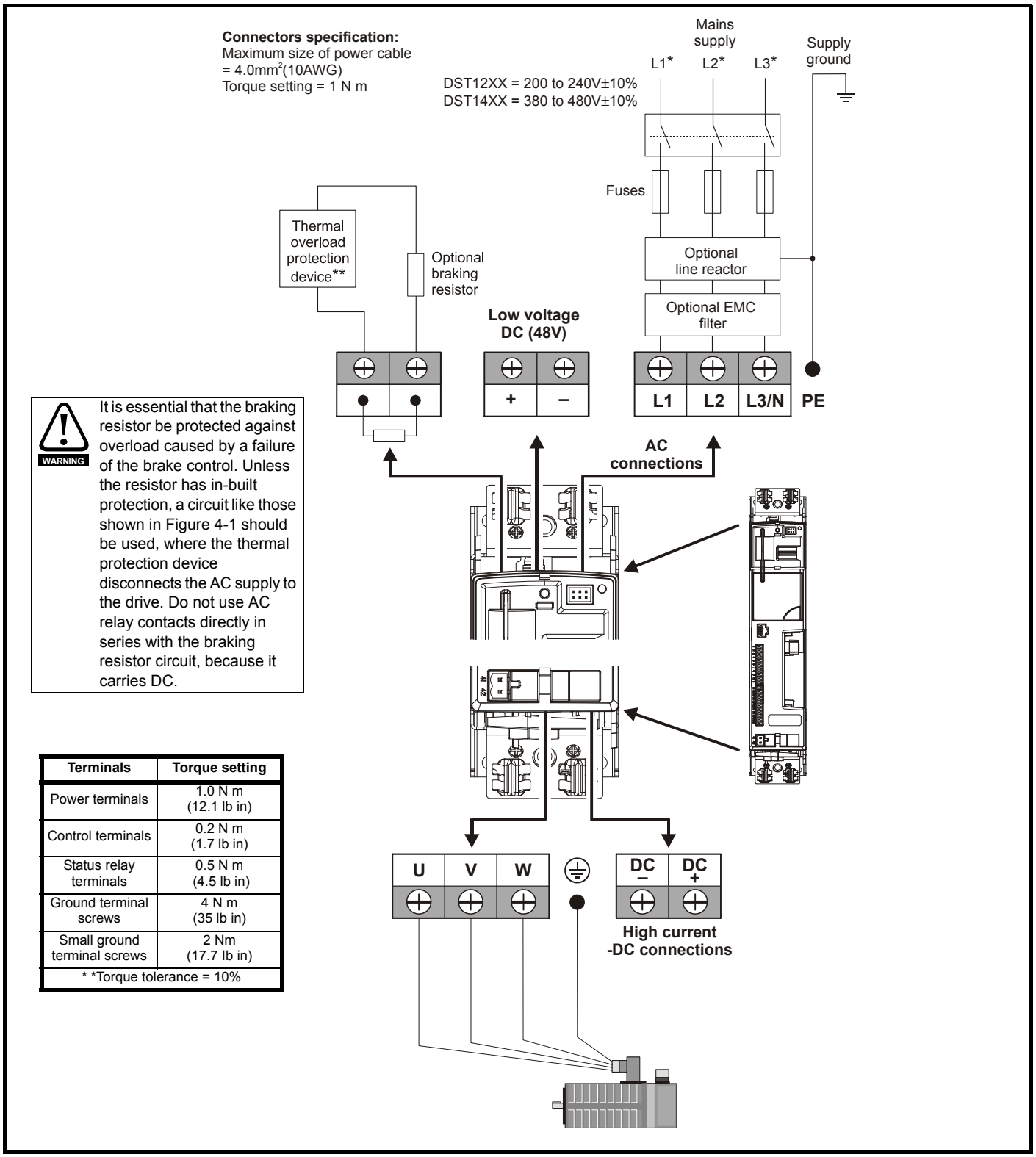
Stored charge
The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.
Normally, the capacitors are discharged by an internal 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 Emerson Industrial Automation or their authorized distributor.

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).

Permanent magnet motors
Permanent magnet motors generate electrical power if they are rotated, even when the supply to the drive is disconnected. If that happens then the drive will become energized through its motor terminals.
If the motor load is capable of rotating the motor when the supply is disconnected, then the motor must be isolated from the drive before gaining access to any live parts.

4.1 Power terminal connections

Figure 4-1 Power terminal connections



WARNING

It is essential that the braking resistor be protected against overload caused by a failure of the brake control. Unless the resistor has in-built protection, a circuit like those shown in Figure 4-1 should be used, where the thermal protection device disconnects the AC supply to the drive. Do not use AC relay contacts directly in series with the braking resistor circuit, because it carries DC.

Terminals	Torque setting
Power terminals	1.0 N m (12.1 lb in)
Control terminals	0.2 N m (1.7 lb in)
Status relay terminals	0.5 N m (4.5 lb in)
Ground terminal screws	4 N m (35 lb in)
Small ground terminal screws	2 Nm (17.7 lb in)
* *Torque tolerance = 10%	

NOTE

* When using a 200 V drive on a single phase supply, the live and neutral conductors can be connected to any of the AC connections on the drive.
** This is not required if the optional internal braking resistor is used.

4.2 Ground connections

WARNING

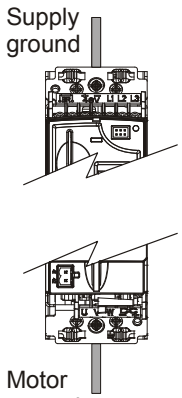
Electrochemical corrosion of grounding terminals
Ensure that grounding terminals are protected against corrosion i.e. as could be caused by condensation.

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. The supply and motor ground connections are made using the M6 threaded hole in the metal back plate of the drive located at the top and bottom of the drive. See Figure 4-2 for details.

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.

Figure 4-2 Ground connection



4.3 AC supply requirements

Table 4-1 Supply requirements

Model	Voltage	Frequency range
DST120X	200 V to 240 V ±10 % single phase	48 Hz to 65 Hz
DST120X	200 V to 240 V ±10 % three phase*	48 Hz to 65 Hz
DST140X	380 V to 480 V ±10 % three phase*	48 Hz to 65 Hz

*Maximum supply in-balance: 2 % negative phase sequence (equivalent to 3 % voltage in-balance between phases).

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

4.3.1 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 (removed) or additional independent motor ground fault protection must be provided. Refer to Table 4-2.
For instructions on removal, refer to Figure 4-4 Removing the internal EMC filter and line to ground varistors on page 28. 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.

Table 4-2 Behavior of the drive in the event of a motor circuit ground (earth) fault with an IT supply

Drive size	Internal filter only	External filter (with internal)
0 (200 V)	May not trip – precautions required	Drive trips on fault
0 (400 V)	Drive trips on fault	Drive trips on fault

4.3.2 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 imbalance 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
- Direct-on-line 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.

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

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

Repetitive peak current:
Not less than three times the continuous input current rating of the drive.

4.3.3 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

4.4 DC bus design

4.4.1 DC bus design

Parallel connections

The power limit of the rectifier must be adhered to for all combinations of drives in parallel. In addition to this If the total rated bus power required exceeds the capability of 1 x Digitax ST rectifier then two or more Digitax ST's can be connected with the AC & DC in parallel. If the AC supply is connected to more than one drive in a parallel DC bus application, balancing of the current in the input stage of each drive must be considered.

Using DC bus chokes makes the current in the rectifier diodes of each drive the same, so providing a solution to sharing.

There are many possible combinations for paralleling drives through the DC bus connections. Table 4-3 gives details of the internal capacitance for each drive and the additional capacitance which can be powered from the drive. The capacitance must incorporate its own soft-start circuit. All Digitax ST drives incorporate this feature.

Table 4-3 DC bus data

Drive	Internal DC bus capacitance (µF)	Maximum additional DC bus capacitance which can be connected (µF)
DST1201	440	1760
DST1202	880	1320
DST1203	880	1320
DST1204	1320	880
DST1401	220	660
DST1402	220	660
DST1403	220	660
DST1404	220	660
DST1405	220	660

NOTE

For additional details regarding DC bus paralleling please contact the supplier of the drive.

4.5 DC drive voltage levels

4.5.1 Low voltage DC operation

The drive can be operated from low voltage DC supplies, nominally 24 Vdc (control) and 48 Vdc (power). The low voltage DC power operating mode is designed either, to allow for motor operation in an emergency back-up situation following failure of the AC supply, for example in robotic arm applications; or to limit the speed of a servo motor during set-up of equipment, for example a robot cell.

WARNING

With low voltage DC operation there is a reduction in the level of safety of the Safe Torque Off function. There exist certain unlikely faults which might permit the drive to produce some limited motor torque, if the DC supply has its negative terminal connected to ground.
See section 4.17 *Safe Torque Off* on page 42 for methods on preventing a loss of the safety function under these conditions.

The working voltage range of the low voltage DC power supply is shown in Table 4-4.

Table 4-4 Low voltage DC levels

Condition	Value
Minimum continuous operating voltage	36 V
Minimum start up voltage	40 V
Nominal continuous operating voltage	48 V to 72 V
Maximum braking IGBT turn on voltage	63 V to 95 V
Maximum over voltage trip threshold	69 V to 104 V

4.5.2 High voltage DC levels

Table 4-5 High voltage DC levels

Condition	DST120X V	DST140X V
Undervoltage trip level	175	330
Undervoltage reset level*	215	425
Overvoltage trip level	415	830
Braking level	390	780
Maximum continuous voltage level for 15 s	400	800

* These are the absolute minimum DC voltages that the drive is capable of operating from. If the drive is not supplied with the minimum voltage, it will not reset following a UV trip at power-up.

4.5.3 Control 24 Vdc supply

The 24 Vdc input has three main 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.
- It can be used to supplement the drive's own internal 24 V when multiple SM-I/O Plus modules are being used and the current drawn by these modules is greater than the drive can supply. (If too much current is drawn from the drive, the drive will initiate a 'PS.24V' trip)
- It can be used to commission the drive when line power supply voltages are not available, as the display operates correctly. However, the drive will be in the UV trip state unless either line power supply is reapplied or low voltage DC operation 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 power supply is shown in Table 4-6.

Table 4-6 Control supply voltage levels

Condition	Value
Maximum continuous operating voltage	30.0 V
Minimum continuous operating voltage	19.2 V
Nominal operating voltage	24.0 V
Minimum start up voltage	21.6 V
Maximum power supply requirement at 24 V	60 W
Recommended fuse	3 A, 50 Vdc

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

4.6 Ratings

WARNING

Fuses
The AC supply to the drive must be installed with suitable protection against overload and short-circuits. The following section shows recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

Table 4-7 Fuse ratings and cable sizes

Model	No of input phases	Typical input current A	Maximum continuous input current A	Fuse rating		Cable size			
				IEC class gG	Class CC	Input		Output	
						mm^2	AWG	mm^2	AWG
DST1201	1		4.0	6	10	0.75	16	0.75	24
DST1202	1		7.6	10	10	1	16	0.75	22
DST1203	1		9.0	16	15	2.5	14	0.75	20
DST1204	1		13.4	16	20	2.5	12	0.75	18
DST1201	3	3.1	3.5	6	10	0.75	16	0.75	24
DST1202	3	6.4	7.3	10	10	1	16	0.75	22
DST1203	3	8.6	9.4	16	15	2.5	14	0.75	20
DST1204	3	11.8	13.4	16	20	2.5	12	0.75	18
DST1401	3	2.6	2.8	4	10	0.75	16	0.75	24
DST1402	3	4.2	4.3	6	10	0.75	16	0.75	24
DST1403	3	5.9	6.0	8	10	0.75	16	0.75	22
DST1404	3	7.9	8.0	10	10	1	16	0.75	20
DST1405	3	9.9	9.9	12	15	1.5	14	0.75	18
Control cable						≥0.5	20		

NOTE

PVC insulated cable should be used.

Installation class (ref: IEC60364-5-52:2001)
B1 - Separate cables in conduit.
B2 - Multicore cable in conduit
C - Multicore cable in free air.

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).

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

The recommended cable sizes above 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.

NOTE

The recommended 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.

NOTE

UL listing is dependent on the use of the correct type of UL-listed fuse, and applies when symmetrical short-circuit current does not exceed 100kA. See Chapter 15 *UL listing information* on page 204 for sizing information.

An MCB (miniature circuit breaker) may be used in place of fuses under the following conditions:

- The fault-clearing capacity must be sufficient for the installation
- The I^2T rating of the MCB must be less than or equal to that of the fuse rating listed above.

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

For a parallel DC bus system the maximum AC input fusing is shown in Table 4-8 below.

Table 4-8 Maximum AC input fusing

Model	Fuse rating IEC class gG A	Fuse rating class CC A	Input cable size	
			mm^2	AWG
All	20	20	4.0	12

NOTE

Refer to the supplier of your drive for further information regarding DC bus paralleling.

4.7 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 five 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, Pr **0.46** *Motor rated current* must be set to suit the motor.

WARNING

Pr **0.46** *Motor rated current* 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.

4.7.1 Motor cable size and maximum 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 4-9.

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
- When operating in ambient >45 °C UL 75 °C cable should be used.

Cable sizes are given for guidance only and may be changed depending on the application and the method of installation of the cables.

The mounting and grouping of cables affect their current capacity, in some cases a larger cable is required to avoid excessive temperature or voltage drop.

Input cable sizes should generally be regarded as a minimum, since they have been selected for co-ordination with the recommended fuses.

Output cable sizes assume that the maximum motor 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.

- 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 6 kHz.

The drive power terminals are designed for a maximum cable size of 4.0 mm^2 (minimum 0.2 mm / 24 AWG).

Where more than one cable per terminal is used the combined diameters should not exceed the maximum.

The terminals are suitable for both solid and stranded wires.

Table 4-9 Motor cable size and maximum lengths

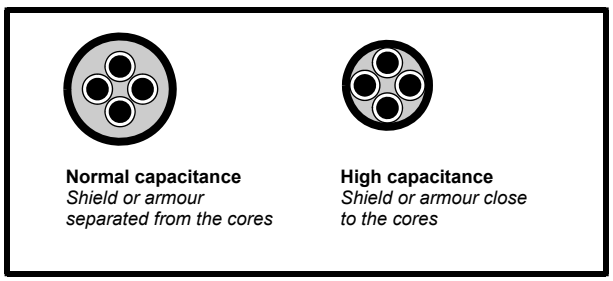
Model	Output cable		6kHz	8kHz	12kHz
	mm^2	AWG	m	m	m
DST1201	0.75	24	50		
DST1202		22			
DST1203		20			
DST1204		18			
DST1401		24			
DST1402					
DST1403		22			
DST1404		20			
DST1405		18			

High-capacitance cables

The maximum cable length is reduced from that shown in Table 4-9 if high capacitance 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 4-3 shows how to identify the two types).

Figure 4-3 Cable construction influencing the capacitance



The cable used for Table 4-9 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).

4.7.2 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

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

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.

4.7.3 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) when opened provides a Safe Torque Off function. This can in many cases replace output contactors.

For further information see section 4.17 *Safe Torque Off* on page 42.

4.8 Braking

The internal braking resistor can be used with the drive even though its resistance is lower than the minimum resistance values given in Table 4-11, because of the following reasons.

- The braking resistor overload protection function in the drive is set up to limit the power dissipated in the resistor.
- The braking resistor is installed with a thermistor which will trip the drive if the resistor is too hot.
- The power rating of the resistor is only 50 W

CAUTION The internal braking resistor for Digitax ST is installed with a thermistor which must be connected to the drive whenever the internal braking resistor in installed.

If an external resistor is used with the drive, its resistance must be equal to or greater than the value given in Table 4-11.

Table 4-10 Internal braking resistor data

Parameter		
Part number	1299-0001	
DC resistance at 25 °C	70 Ω	
Peak instantaneous power over 1ms at nominal resistance	200 V	400 V
	2.2 kW	8.7 kW
Average power over 60 s	50 W	

CAUTION

Braking resistor overload protection parameter settings
Failure to observe the following information may damage the resistor.
The drive's software contains an overload protection function for a braking resistor. On Digitax ST this function is enabled at default to protect the internally mounted resistor. Below are the parameter settings.

Parameter		200 V drive	400 V drive
Full power braking time	Pr **10.30**	0.06	0.01
Full power braking period	Pr **10.31**	2.6	1.7

For more information on the braking resistor software overload protection, see Pr **10.30** and Pr **10.31** full descriptions in the *Advanced User Guide*.

If the internally mounted braking resistor is to be used at more than half of its average power rating then the drive's cooling fan must be at full speed, controlled by setting Pr **6.45** to On (1).

4.8.1 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.

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 4.10 *EMC (Electromagnetic compatibility) on page 28* for further details.

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

Table 4-11 Minimum resistance and power ratings

Model	Minimum resistance* Ω	Peak power rating kW	Continuous power rating kW	Average power for 0.25s kW
DST1201	23	6.6	0.5	1.6
DST1202			1.2	3.5
DST1203			1.6	4.9
DST1204	16	9.3	2.3	7.0
DST1401	111	5.5	0.8	2.3
DST1402			1.4	4.1
DST1403	75	8.1	2.0	6.1
DST1404	28	21.7	3.0	9.0
DST1405			4.1	12.2

* Resistor tolerance: ±10 %

4.9 Ground leakage

The ground leakage current depends upon whether the internal EMC filter is installed. The drive is supplied with the filter installed. Instructions for removing the internal filter are given in Figure 4-4.

With the internal EMC filter installed the ground leakage current is as follows:

Table 4-12 Ground leakage current with internal EMC filter installed

Model	3 phase Star ground	3 phase Delta ground	1 phase
	mA		
DST120X at 220 V	4	10	3
DST140X at 400 V	12	40	

NOTE

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

With internal EMC filter removed the ground leakage current = <1 mA.

NOTE

In both cases, there is an internal voltage surge suppression device connected to ground. Under normal circumstances, this carries negligible current.

WARNING

When the internal EMC filter is installed, the leakage current is high. In this case, a permanent fixed ground connection must be provided with a cross sectional area equal to 10mm^2.

4.9.1 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 50ms 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.

4.10 EMC (Electromagnetic compatibility)

4.10.1 Internal EMC filter

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

Special attention is required when using a DST120X model on an ungrounded supply (IT supply). In the event of a ground fault in the motor circuit the drive may not trip and the filter could be overstressed. In this case, either the filter must be removed or additional independent motor ground fault protection must be provided.

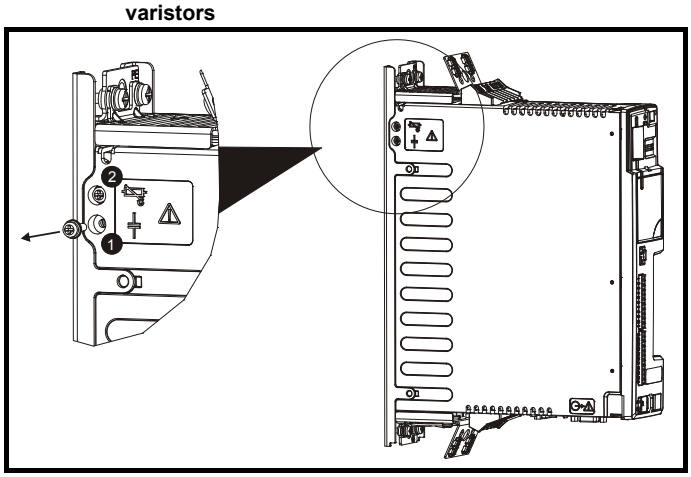
The internal EMC filter reduces radio-frequency emissions into the line power supply. Where the motor cable is short, it permits the requirements of EN 61800-3:2004 to be met for the second environment.

For longer motor cables, the filter continues to provide a useful reduction in emission level, and when used with any length of shielded 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 ground leakage current is unacceptable or the above conditions are true.

WARNING

The supply must be disconnected before removing the internal EMC filter or line to ground varistor screws.

Figure 4-4 Removing the internal EMC filter and line to ground varistors



1. Internal EMC filter. Remove the bottom screw as shown.
2. Line to ground varistors. Remove the top screw as shown.

NOTE

The line to ground varistors should only be removed in special circumstances.

4.10.2 Further EMC precautions

Further EMC precautions are required if more stringent EMC emission requirements apply:

- Operation in the first environment of EN 61800-3:2004
- Conformity to the generic emission standards
- Equipment which is sensitive to electrical interference operating nearby

In this case it is necessary to use:

- The optional external EMC filter
- A shielded motor cable, with shield clamped to the grounded metal panel
- A shielded control cable, with shield clamped to the grounded metal panel via the grounding bracket.

NOTE

It is not necessary to remove the external EMC filter when using an IT supply.

4.10.3 Recommended cable management

Figure 4-5 Drive cable clearances

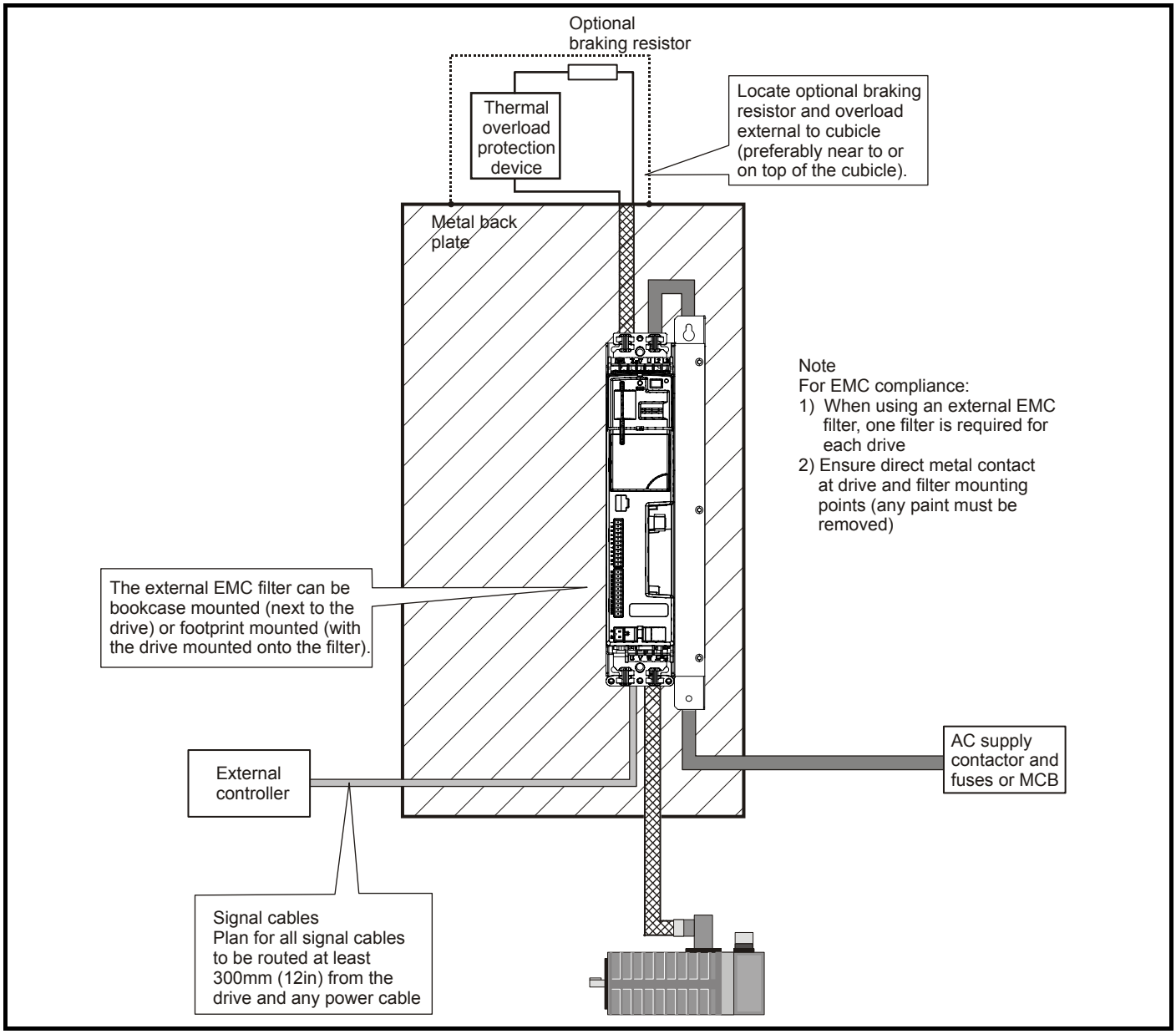


Figure 4-6 Grounding bracket at the top of the drive

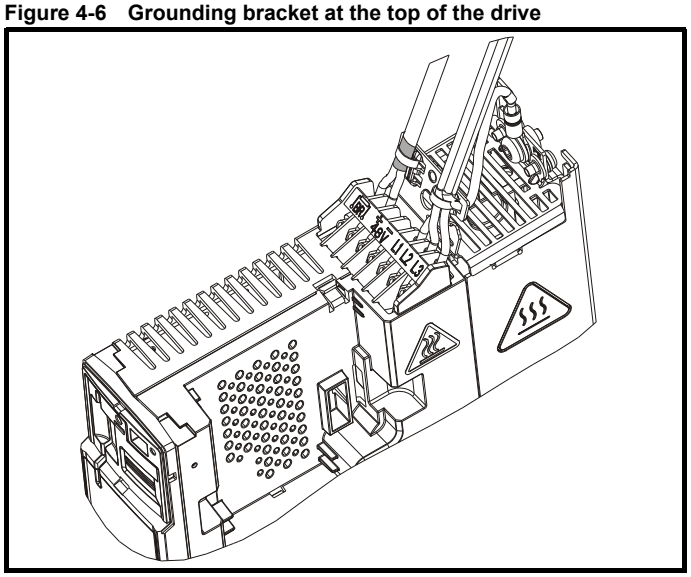
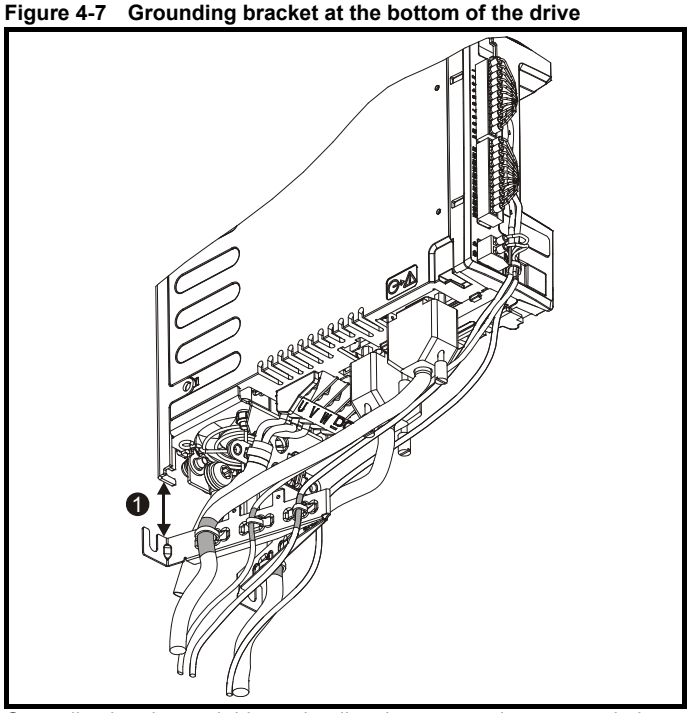


Figure 4-7 Grounding bracket at the bottom of the drive



Grounding bracket and drive to be directly connected to a grounded backplate.

NOTE

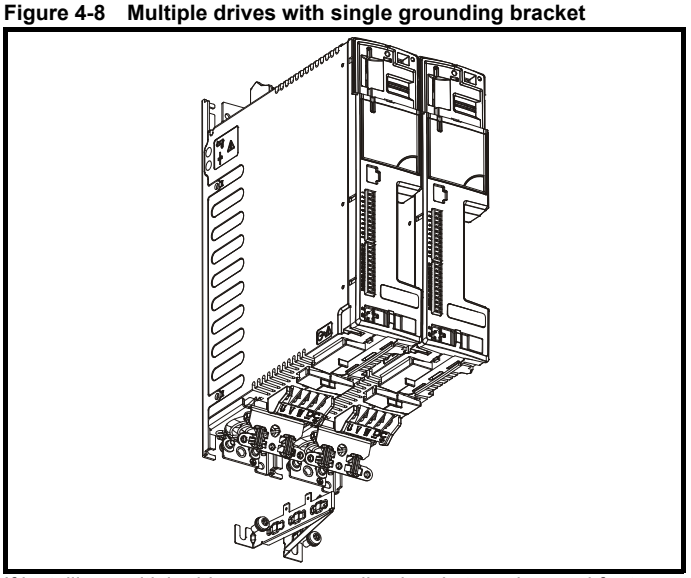
1. The distance for EMC (shown in Figure 4-7 above) from the drive is as follows:

200 V drive - Allowance up to 65 mm (2.56 in)
400 V drive - Allowance up to 100 mm (3.94 in)

NOTE

The grounding bracket can remain mounted when the drive is removed. as follows.

Figure 4-8 Multiple drives with single grounding bracket



If installing multiple drives, one grounding bracket can be used for two drives.

4.11 Internal and external conducted emissions conformity

Table 4-13 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	10V/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	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
EN 61800-3:2004 IEC61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

Table 4-14 DST120X (200 V) emission compliance (single and three phase drives

Motor cable length (m)	Switching frequency (kHz)				
	3	4	6	8	12
Using internal filter:					
0 to 7	E2U				
7 to 9	E2U				E2R
9 to 11	E2U		E2R		
>11	E2R				
Using external filter:					
0 to 20	R			I	
20 to 100	I				

Table 4-15 DST140X (400 V) emission compliance

Motor cable length (m)	Switching frequency (kHz)				
	3	4	6	8	12
Using internal filter:					
0 to 6	E2U			E2R	
6 to 12	E2U		E2R		
12 to 14	E2U	E2R			
>14	E2R				
Using external filter:					
0 to 20	R			I	
20 to 70	I				
70 to 100	I	Do not use			

Key to Table 4-14 and Table 4-15

(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)

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.

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 properties 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.

NOTE

Where the drive is incorporated into a system with rated input current exceeding 100 A, the higher emission limits of EN 61800-3:2004 for the second environment are applicable, and no filter is then required.

NOTE

Operation without an external filter is a practical cost-effective possibility in an industrial installation where existing levels of electrical noise are likely to be high, and any electronic equipment in operation has been designed for such an environment. This is in accordance with EN 61800-3:2004 in the second environment, with restricted distribution. There is some risk of disturbance to other equipment, and in this case the user and supplier of the drive system must jointly take responsibility for correcting any problem which occurs.

4.12 Serial communications connections

The drive has a serial communications port (serial port) as standard supporting 2 wire EIA485 communications. Please see Table 4-16 for the connection details for the RJ45 connector.

Figure 4-9 Location of the RJ45 serial comms connector

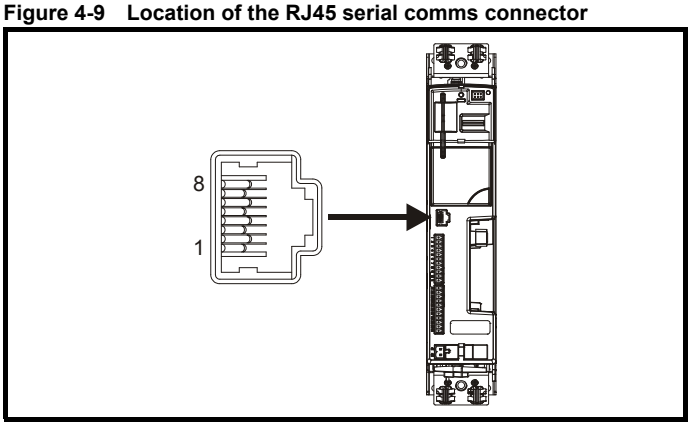


Table 4-16 Connection details for RJ45 connector

Pin	Function
1	120 Ω Termination resistor
2	RX TX
3	Isolated 0V
4	+24 V (100 mA)
5	Isolated 0V
6	TX enable
7	RX\ TX\
8	RX\ TX\ (if termination resistors are required, jumper to pin 1)
Shield	Isolated 0V

The communications port applies a 2 unit load to the communications network.

Minimum number of connections are 2, 3, 7 and shield. Shielded cable must be used at all times.

4.12.1 Isolation of the serial communications port

The serial communications port is double insulated and meets the requirements for SELV in IEC61800-5-1.

WARNING

In order to meet the requirements for SELV in IEC60950 (IT equipment) it is necessary for the control computer to be grounded. Alternatively, when a lap-top or similar device is used which has no provision for grounding, an isolation device must be incorporated in the communications lead.

An isolated serial communications lead has been designed to connect the drive to IT equipment (such as lap-top computers), and is available from the supplier of the drive. See Table 4-17 below for details:

Table 4-17 Isolated serial comms lead details

Part number	Description
4500-0087	CT EIA232 Comms cable
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.

NOTE

When using the CT EIA232 Comms cable the available baud rate is limited to 19.2 k baud.

4.12.2 Multi-drop network

The drive can be used on a 2 wire EIA485 multi-drop network using the drive's serial communications port when the following guidelines are adhered to.

Connections

The network should be a daisy chain arrangement and not a star, although short stubs to the drive are allowed.

The minimum connections are pins 2 (RX TX), 3 (isolated 0V), 7 (RX\ TX\) and the shield.

Pin 4 (+24 V) on each drive can be connected together but there is no power sharing mechanism between drives and therefore the maximum power available is the same as a single drive. (If pin 4 is not linked to the other drives on the network and has an individual load then the maximum power can be taken from pin 4 of each drive.)

Termination resistors

If a drive is on the end of the network chain then pins 1 and 8 should be linked together. This will connect an internal 120 Ω termination resistor between RXTX and RX\TX\. (If the end unit is not a drive or the user wishes to use their own termination resistor, a 120 Ω termination resistor should be connected between RXTX and RX\TX\ at the end unit.)

If the host is connected to a single drive then termination resistors should not be used unless the baud rate is high.

CT Comms Cable

The CT Comms Cable can be used on a multi-drop network but should only be used occasionally for diagnostic and set up purposes. The network should be made up entirely of Digitax ST drives.

If the CT Comms Cable is to be used, then pin 6 (TX enable) should be connected on all drives and pin 4 (+24 V) should be linked to at least 1 drive to supply power to the converter in the cable.

Only one CT Comms Cable can be used on a network.

4.13 Control connections

4.13.1 General

Table 4-18 The control connections consist of:

Function	Qty	Control parameters available	Terminal number
Differential analog input	1	Destination, offset, offset trim, invert, scaling	5,6
Single ended analog input	2	Mode, offset, scaling, invert, destination	7,8
Analog output	2	Source, mode, scaling,	9,10
Digital input	3	Destination, invert, logic select	27, 28, 29
Digital input / output	3	Input / output mode select, destination / source, invert, logic select	24, 25, 26
Relay	1	Source, invert	41,42
Drive enable (Safe Torque Off)	1		31
+10V User output	1		4
+24V User output	1	Source, invert	22
0V common	6		1, 3, 11, 21, 23, 30
+24V External input	1		2

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, i.e. positive / negative logic (the Drive Enable terminal is fixed in positive logic), open collector.

All analog terminal functions can be programmed in menu 7.

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

The setting of Pr **1.14** and Pr **6.04** can cause the function of digital inputs T25 to T29 to change. For more information, please refer to section 12.22.1 *Reference modes* on page 166 and section 12.22.7 *Start / stop logic modes* on page 170.

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 or outputs (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.

CAUTION

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 terminal is a positive logic input only. It is not affected by the setting of Pr **8.29** *Positive logic select*.

NOTE

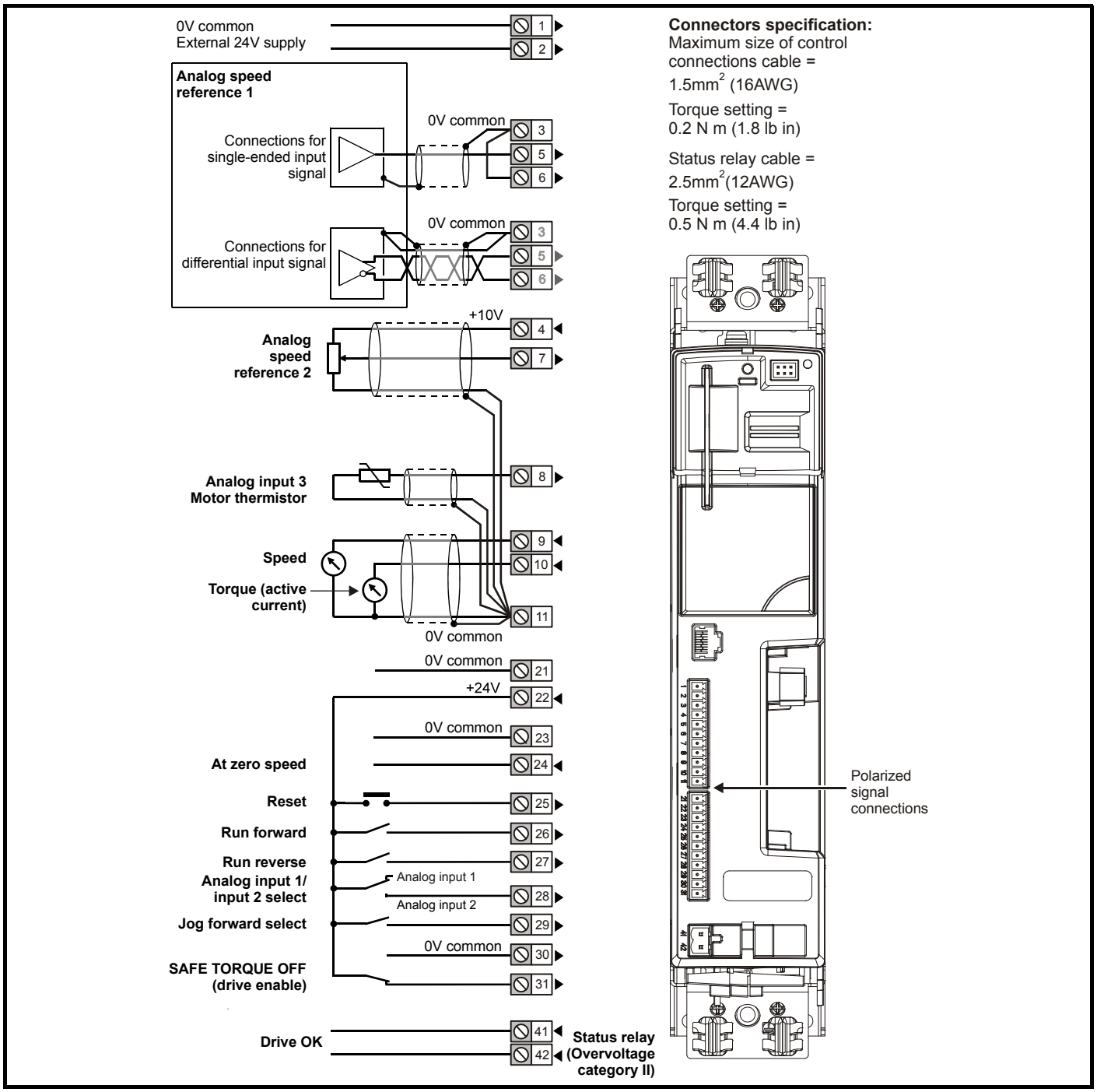
The common 0V from analog signals should, wherever possible, not be connected to the same 0V terminal as the common 0V from digital signals. Terminals 3 and 11 should be used for connecting the 0V common of analog signals and terminals 21, 23 and 30 for digital signals. This is to prevent small voltage drops in the terminal connections causing inaccuracies in the analog signals.

4.14 Control terminals

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.

Figure 4-10 Default terminal functions



For control terminal specification, refer to Chapter 4.14.1 *Control terminal specification* on page 35.

NOTE

If Terminal 31 is used as a *Safe Torque Off* function, the cable must be shielded or segregated.

4.14.1 Control terminal specification

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

2	+24 V external input
Function	**To supply the control circuit without providing a supply to the power stage**
Nominal voltage	+24.0 Vdc
Minimum continuous operating voltage	+19.2 Vdc
Maximum continuous operating voltage	+30.0 Vdc
Minimum start-up voltage	21.6 Vdc
Recommended power supply	60 W 24 Vdc nominal
Recommended fuse	3 A, 50 Vdc

3	0V common
Function	**Common connection for all external devices**

4	+10V user output
Function	**Supply for external analog devices**
Voltage tolerance	±1 %
Maximum output current	10 mA
Protection	Current limit and trip @ 30 mA

	Precision reference Analog input 1
5	Non-inverting input
6	Inverting input
Default function	Speed reference
Type of input	Bipolar differential analog (For single-ended use, connect terminal 6 to terminal 3)
Full scale voltage range	±9.8 V ±1 %
Absolute maximum voltage range	±36 V relative to 0V
Working common mode voltage range	±13 V relative to 0V
Input resistance	100 kΩ ±1%
Resolution	16-bit plus sign (as speed reference)
Monotonic	Yes (including 0V)
Dead band	None (including 0V)
Jumps	None (including 0V)
Maximum offset	700 µV
Maximum non linearity	0.3 % of input
Maximum gain asymmetry	0.5 %
Input filter bandwidth single pole	~1 kHz
Sampling period	250 µs with destinations as Pr **1.36**, Pr **1.37** or Pr **3.22**.

7	Analog input 2
Default function	Speed reference
Type of input	Bipolar single-ended analog voltage or unipolar current
Mode controlled by...	Pr **7.11**
Operating in Voltage mode	
Full scale voltage range	±9.8 V ±3 %
Maximum offset	±30 mV
Absolute maximum voltage range	±36 V relative to 0V
Input resistance	>100 kΩ
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)	−36 V max
Absolute maximum current	+70 mA
Equivalent input resistance	≤200 Ω at 20 mA
Resolution	10 bit + sign
Sample period	250 µs when configured as voltage input with destinations as Pr **1.36**, Pr **1.37**, Pr **3.22** or Pr **4.08**.

8	Analog input 3
Default function	Motor thermistor input (PTC)
Type of input	Bipolar single-ended analog voltage, unipolar current or motor thermistor input
Mode controlled by...	Pr **7.15**
Operating in Voltage mode (default)	
Voltage range	±9.8 V ±3 %
Maximum offset	±30 mV
Absolute maximum voltage range	±36 V relative to 0V
Input resistance	>100 kΩ
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)	−36 V max
Absolute maximum current	+70 mA
Equivalent input resistance	≤200 Ω at 20 mA
Operating in thermistor input mode	
Internal pull-up voltage	<5 V
Trip threshold resistance	3.3 kΩ ±10 %
Reset resistance	1.8 kΩ ±10 %
Short-circuit detection resistance	50 Ω ±30 %
Resolution	10 bit + sign
Sample period	250 µs when configured as voltage input with destinations as Pr **1.36**, Pr **1.37**, Pr **3.22** or Pr **4.08**.

T8 analog input 3 has a parallel connection to terminal 15 of the drive input encoder connector.

9	**Analog output 1**
10	**Analog output 2**
Terminal 9 default function	SPEED output signal
Terminal 10 default function	Motor active current
Type of output	Bipolar single-ended analog voltage or unipolar single ended current
Mode controlled by...	Pr **7.21** and Pr **7.24**
Operating in Voltage mode (default)	
Voltage range	±9.6 V ±5 %
Maximum offset	100 mV
Maximum output current	±10 mA
Load resistance	1 kΩ min
Protection	35 mA max. Short circuit protection
Operating in current mode	
Current ranges	0 to 20 mA ±10 % 4 to 20 mA ±10 %
Maximum offset	600 µA
Maximum open circuit voltage	+15 V
Maximum load resistance	500 Ω
Resolution	10-bit (plus sign in voltage mode)
Update period	250 µs when configured as a high speed output with sources as Pr **4.02**, Pr **4.17**, Pr **3.02** or Pr **5.03**. 4ms when configured as any other type of output or with all other sources.

11	**0V common**
Function	**Common connection for all external devices**

21	**0V common**
Function	**Common connection for all external devices**

22	**+24V user output (selectable)**
Terminal 22 default function	+24 V user output
Programmability	Can be switched on or off to act as a fourth digital output (positive logic only) by setting the source Pr **8.28** and source invert Pr **8.18**
Nominal output current	200 mA (including all digital I/O)
Maximum output current	240 mA (including all digital I/O)
Protection	Current limit and trip

23	**0V common**
Function	**Common connection for all external devices**

24	**Digital I/O 1**
25	**Digital I/O 2**
26	**Digital I/O 3**
Terminal 24 default function	AT ZERO SPEED output
Terminal 25 default function	DRIVE RESET input
Terminal 26 default function	RUN FORWARD input
Type	Positive or negative logic digital inputs, positive or negative logic push-pull outputs or open collector outputs
Input / output mode controlled by...	Pr **8.31**, Pr **8.32** and Pr **8.33**
Operating as an input	
Logic mode controlled by...	Pr **8.29**
Absolute maximum applied voltage range	±30 V
Impedance	6 kΩ
Input thresholds	10.0 V ±0.8 V
Operating as an output	
Open collector outputs selected	Pr **8.30**
Nominal maximum output current	200 mA (total including terminal 22)
Maximum output current	240 mA (total including terminal 22)
Nominal working voltage range	0V to +24 V
Sample / Update period	250 µs when configured as an input with destinations as Pr **6.35** or Pr **6.36**. 600 µs when configured as an input with destination as Pr **6.29**. 4 ms in all other cases.

27	**Digital Input 4**
28	**Digital Input 5**
29	**Digital Input 6**
Terminal 27 default function	RUN REVERSE input
Terminal 27 special function	High Speed Freeze input (with destination set as Pr **8.40**)
Terminal 28 default function	Analog INPUT 1 / INPUT 2 select
Terminal 29 default function	JOG SELECT input
Type	Positive or negative logic digital inputs
Logic mode controlled by...	Pr **8.29**
Voltage range	0V to +24 V
Absolute maximum applied voltage range	±30 V
Impedance	6 kΩ
Input thresholds	10.0 V ±0.8 V
Sample / Update period	1 µs when T27 (Digital Input 4) destination is Pr **8.40**. 250µs with destinations as Pr **6.35** or Pr **6.36**. 600µs with destination as Pr **6.29**. 4ms in all other cases.

30	**0V common**
Function	**Common connection for all external devices**

31	Safe Torque Off function (drive enable)
Type	Positive logic only digital input
Voltage range	0V to +24 V
Absolute maximum applied voltage	±30 V
LogicThreshold	15.5 V ±2.5 V
Low state maximum voltage for SIL3 and EN954-1 category 3	2 V (or open-circuit)
Response time	Nominal: 8 ms Maximum: 20 ms

Safe Torque Off function has been approved by IFA as meeting the requirements of the following standards, for the prevention of unexpected starting of the drive:

EN 61800-5-2:2007 SIL 3
EN ISO 13849-1:2006 PL e
EN 954-1:1997 Category 3 (This standard is withdrawn and should not be used for new designs, information provided for legacy applications only).

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.

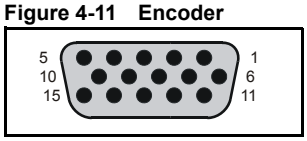
Refer to section 4.17 *Safe Torque Off* on page 42 for further information.

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 0.5 A DC 30 V inductive load (L/R = 40 ms)
Contact minimum recommended rating	12 V 100 mA
Contact type	Normally open
Default contact condition	Closed when power applied and drive OK
Update period	4 ms

WARNING A fuse or other over-current protection should be Installed to the relay circuit.

4.15 Encoder connections

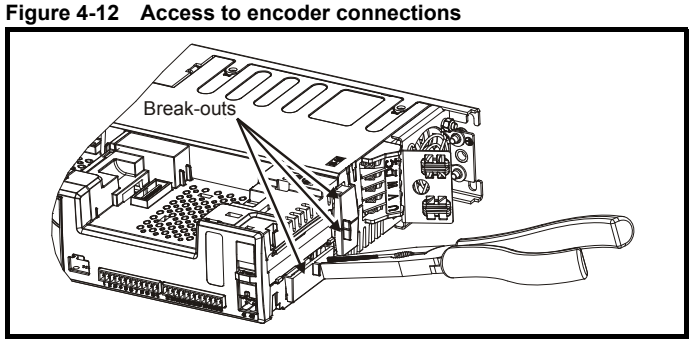
Figure 4-11 Encoder



4.15.1 Location of encoder connector

Before using the encoder connectors for the first time, the break-outs need removing as shown in Figure 4-12.

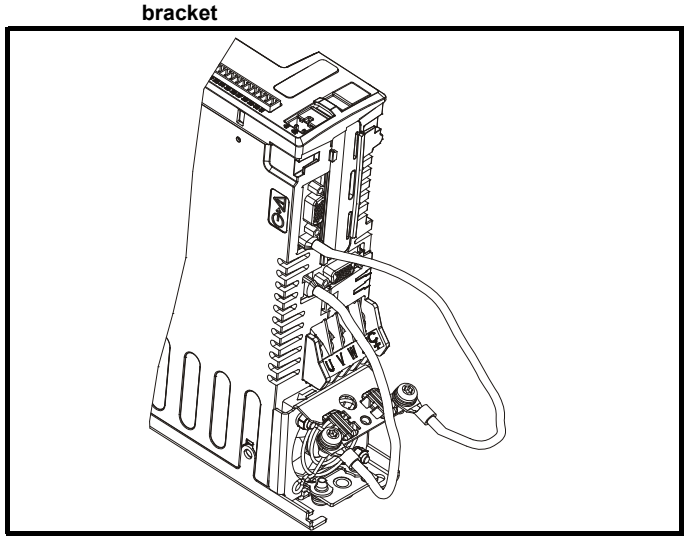
Figure 4-12 Access to encoder connections



WARNING After removing the break-out, ensure that the ground tab is connected to ground (see Figure 4-13). This will connect 0V of the drive to ground. This is required to enable the drive to meet IP20 when the break-out is removed.

NOTE
Do not remove break-out if the connections are not required.

Figure 4-13 Connecting the encoder ground tab to the EMC bracket

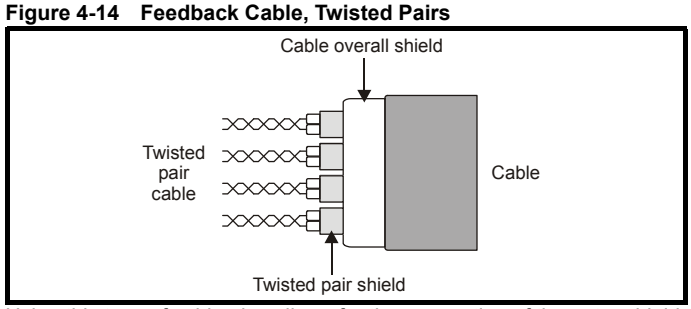


NOTE
The size of the connecting cable between the encoder ground tab and the EMC bracket should be equal to the input cable.

Recommended cable

The recommended cable for feedback signals are shielded twisted pairs, shielded with an overall shield as shown in Figure 4-14.

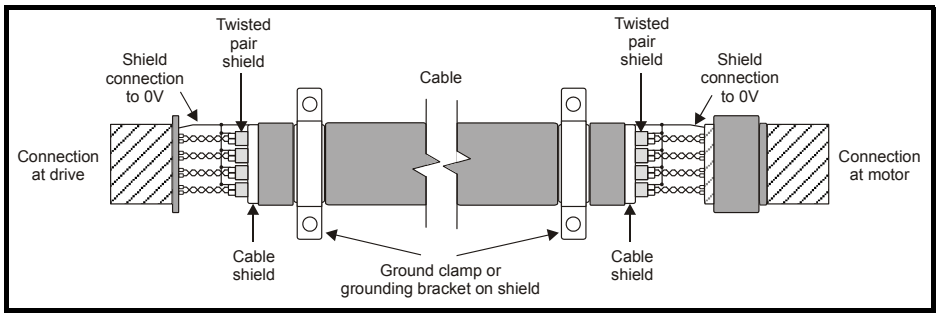
Figure 4-14 Feedback Cable, Twisted Pairs



Using this type of cable also allows for the connection of the outer shield to ground and the inner shields to 0V alone at both drive and encoder end, when required.

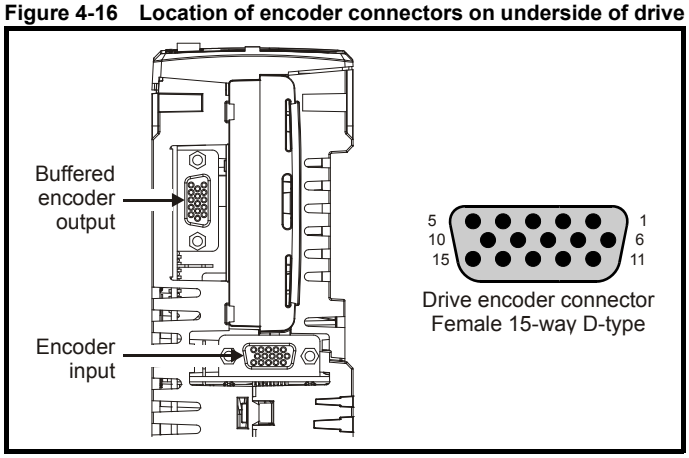
NOTE
Ensure that feedback cables are kept as far away as possible from power cables and avoid parallel routing.

Figure 4-15 Feedback cable connections



4.16 Encoder terminals

Figure 4-16 Location of encoder connectors on underside of drive



4.16.1 Encoder In connections

Table 4-19 Encoder types

Setting of Pr 3.38	Description
Ab (0)	Quadrature incremental encoder with or without marker pulse
Fd (1)	Incremental encoder with frequency pulses and direction, with or without marker pulse
Fr (2)	Incremental encoder with forward pulses and reverse pulses, with or without marker pulse
Ab.SErVO (3)	Quadrature incremental encoder with UVW commutation signals, with or without marker pulse Encoder with UVW commutation signals only (Pr **3.34** set to zero)*
Fd.SErVO (4)	Incremental encoder with frequency pulses and direction with commutation signals**, with or without marker pulse
Fr.SErVO (5)	Incremental encoder with forward pulses and reverse pulses with commutation signals**, with or without marker pulse
SC (6)	SinCos encoder without serial communications
SC.HiPEr (7)	Absolute SinCos encoder with HiperFace serial communications protocol (Stegmann)
EndAt (8)	Absolute EndAt serial communications encoder (Heidenhain)
SC.EndAt (9)	Absolute SinCos encoder with EnDat serial communications protocol (Heidenhain)
SSI (10)	Absolute SSI only encoder
SC.SSI (11)	Absolute SinCos encoder with SSI

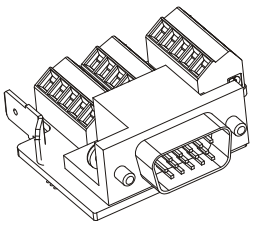
* This feedback device provides very low resolution feedback and should not be used for applications requiring a high level of performance

** The U, V & W commutation signals are required with an incremental type encoder when used with a servo motor. The UVW commutation signals are used to define the motor position during the first 120° electrical rotation after the drive is powered-up or the encoder is initialized.

Drive encoder input converter connector

A 15-way D-type converter is available to provide a screw terminal interface for encoder wiring, and a spade terminal for the shield.

Figure 4-17 Drive encoder input converter connector



WARNING

If using the Drive Encoder Input Converter connector, the Single Ended Encoder Interface or the ERN1387 Encoder Interface protection to at least IP2X must be provided for the connector.

Table 4-20 Encoder In connector details

Term.	Setting of Pr 3.38											
	Ab (0)	**Fd (1)**	**Fr (2)**	**Ab.SErVO (3)**	**Fd.SErVO (4)**	**Fr.SErVO (5)**	**SC (6)**	**SC.HiPEr (7)**	**EndAt (8)**	**SC.EndAt (9)**	**SSI (10)**	**SC.SSI (11)**
1	A	F	F	A	F	F	Cos			Cos		Cos
2	A\	F\	F\	A\	F\	F\	Cosref			Cosref		Cosref
3	B	D	R	B	D	R	Sin			Sin		Sin
4	B\	D\	R\	B\	D\	R\	Sinref			Sinref		Sinref
5	Z*							Encoder input - Data (input/output)				
6	Z*							Encoder input - Data\ (input/output)				
7				U								
8				U\								
9				V								
10				V\								
11				W					Encoder input - Clock (output)			
12				W\					Encoder input - Clock\ (output)			
13	+V**											
14	0V common											
15	th***											
Shell	0V common											

* Marker pulse is optional

** The encoder supply is selectable through parameter configuration to 5 Vdc, 8 Vdc and 15 Vdc

*** Terminal 15 is a parallel connection to T8 analog input 3. If this is to be used as a thermistor input, ensure that Pr **7.15** is set to 'th.sc' (7), 'th' (8) or 'th.diSP' (9)

Table 4-21 Simulated encoder output connector details

Term.	Setting of Pr 3.54				
	Ab (0)	**Fd (1)**	**Fr (2)**	**Ab.L (3)**	**Fd.L (4)**
1	A	F	F	A	F
2	A\	F\	F\	A\	F\
3	B	D	R	B	D
4	B\	D\	R\	B\	D\
5	Z*				
6	Z*				
14	0V				
Shell	0V common				

NOTE

SSI encoders typically have maximum baud rate of 500 kBaud. When a SSI only encoder is used for speed feedback with a servo motor, a large speed feedback filter (Pr **3.42**) is required due to the time taken for the position information to be transferred from the encoder into the drive. The addition of this filter means that SSI only encoders are not suitable for speed feedback in dynamic or high-speed applications.

Specifications

Feedback device connections

Ab, Fd, Fr, Ab.SErVO, Fd.SErVO and Fr.SErVO encoders

1	**Channel A, Frequency or Forward inputs**
2	**Channel A\, Frequency\ or Forward\ inputs**
3	**Channel B, Direction or Reverse inputs**
4	**Channel B\, Direction\ or Reverse\ inputs**

Type	EIA 485 differential receivers
Maximum input frequency	500 kHz
Line loading	<2 unit loads
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to –7 V
Absolute maximum applied voltage relative to 0V	±25 V
Absolute maximum applied differential voltage	±25 V

5	**Marker pulse channel Z**
6	**Marker pulse channel Z**
7	**Phase channel U**
8	**Phase channel U**
9	**Phase channel V**
10	**Phase channel V**
11	**Phase channel W**
12	**Phase channel W**

Type	EIA 485 differential receivers
Maximum input frequency	512 kHz
Line loading	32 unit loads (for terminals 5 and 6) 1 unit load (for terminals 7 to 12)
Line termination components	120 Ω (switchable for terminals 5 and 6, always in circuit for terminals 7 to 12)
Working common mode range	+12 V to –7 V
Absolute maximum applied voltage relative to 0V	+14 V to -9 V
Absolute maximum applied differential voltage	+14 V to -9 V

SC, SC.HiPEr, EndAt, SC.EndAt, SSI and SC.SSI encoders

1	**Channel Cos***
2	**Channel Cosref***
3	**Channel Sin***
4	**Channel Sinref***

Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-22
Maximum applied differential voltage and common mode voltage range	±4V

For the SinCos encoder to be compatible with Digitax ST, the output signals from the encoder must be a 1 V peak to peak differential voltage (across Sin to Sinref and Cos to Cosref).

The majority of encoders have a DC offset on all signals. A number of encoder manufactures typically have a 2.5 Vdc offset. The Sinref and Cosref are a flat DC level at 2.5 Vdc and the Cos and Sin signals have a 1 V peak to peak waveform biased at 2.5 Vdc.

Encoders are available which have a 1 V peak to peak voltage on Sin, Sinref, Cos and Cosref. This results in a 2 V peak to peak voltage seen at the drive's encoder terminals. It is not recommended that encoders of this type are used with Digitax ST, and that the encoder feedback signals should meet the above parameters (1 V peak to peak).

Resolution: The sinewave frequency can be up to 500 kHz but the resolution is reduced at high frequency. Table 4-22 shows the number of bits of interpolated information at different frequencies and with different voltage levels at the drive encoder port. The total resolution in bits per revolution is the ELPR plus the number of bits of interpolated information. Although it is possible to obtain 11 bits of interpolation information, the nominal design value is 10 bits.

* Not used with EndAt and SSI communications only encoders.

Table 4-22 Feedback resolution based on frequency and voltage level

Volt/Freq	1 kHz	5 kHz	50 kHz	100 kHz	200 kHz	500 kHz
1.2	11	11	10	10	9	8
1.0	11	11	10	9	9	7
0.8	10	10	10	9	8	7
0.6	10	10	9	9	8	7
0.4	9	9	9	8	7	6

5	**Data****
6	**Data****
11	**Clock*****
12	**Clock*****

Type	EIA 485 differential transceivers
Maximum frequency	2 MHz
Line loading	32 unit loads (for terminals 5 and 6) 1 unit load (for terminals 11 and 12)
Working common mode range	+12 V to –7 V
Absolute maximum applied voltage relative to 0V	+14 V to -9 V
Absolute maximum applied differential voltage	+14 V to -9 V

** Not used with SC encoders.

*** Not used with SC and SC.HiPEr encoders.

14	**0V common**

15	**Motor thermistor input**

This terminal is connected internally to terminal 8 of the signal connector. Connect only one of these terminals to a motor thermistor. Analog input 3 must be in thermistor mode, Pr **7.15** = th.SC (7), th (8) or th.diSP (9).

4.16.2 Buffered encoder output

NOTE

The buffered encoder output is sourced from the drive encoder input and can be any incremental type or any SINCOS type (Note: - No output is available if EndAt only or SSI communications only encoders are used). If a SINCOS is used as the source the buffered output is derived from the zero crossings of the sine waves and does not include interpolated information. The buffered encoder output provides an output with minimal delay from the drive encoder input (maximum delay is 0.5 µs). If the source encoder does not have a marker pulse, then no marker pulse can be obtained from the buffered encoder output.

Table 4-23 Encoder output types

Setting of Pr 3.54	Description
Ab (0)	Quadrature outputs
Fd (1)	Frequency and direction outputs
Fr (2)	Frequency and reverse outputs
Ab.L (3)	Quadrature outputs with marker lock
Fd.L (4)	Frequency and direction outputs with marker lock

Table 4-24 Buffered encoder connections

Term.	Setting of Pr 3.54				
	Ab (0)	**Fd (1)**	**Fr (2)**	**Ab.L (3)**	**Fd.L (4)**
1	A	F	F	A	F
2	A\	F\	F\	A\	F\
3	B	D	R	B	D
4	B\	D\	R\	B\	D\
5	Z*				
6	Z*				
14	0V				

*Available when marker pulse input connected

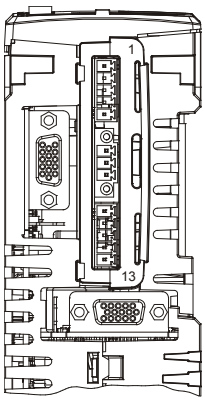
1	**A, F**
2	**A\, F**
3	**B, D, R**
4	**B\, D\, R**
5	**Z**
6	**Z**

Type	EIA 485 differential transmitter
Max frequency	512 KHz
Max load capability	31 units
Working common mode range	+12 V to -7 V
Absolute maximum applied voltage relative to 0V	+14 V to -14 V
Absolute maximum applied differential voltage	+14 V to -14 V

14	**0V common**

4.16.3 Digitax ST Plus additional connections

Figure 4-18 Digitax ST Plus terminals view



Connector specification:

Maximum size cable = 1.5 mm^2

Torque = 0.2 N m (1.8 lb in)

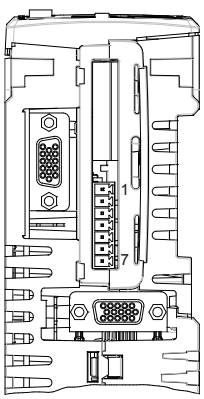
The terminals are numbered from terminal 1 at the top, to terminal 13 at the bottom as per the orientation shown in Figure 4-18. The terminal functions are given in Table 4-25:

Table 4-25 Digitax ST Plus connector details

Terminal	Function	Description
1	0V SC	0V connection for EIA-RS485 port
2	/RX	EIA-RS485 Receive line (negative). Incoming.
3	RX	EIA-RS485 Receive line (positive). Incoming.
4	/TX	EIA-RS485 Transmit line (negative). Outgoing.
5	TX	EIA-RS485 Transmit line (positive). Outgoing.
6	Fieldbus Type A	Fieldbus Type data line
7	Fieldbus Type Shield	Shield connection for Fieldbus Type
8	Fieldbus Type B	Fieldbus Type data line
9	0V	0V connection for digital I/O
10	DI0	Digital input 0
11	DI1	Digital input 1
12	DO0	Digital output 0
13	DO1	Digital output 1

4.16.4 Digitax ST EZMotion additional connections

Figure 4-19 Digitax ST EZMotion terminals view



Connector specification:

Maximum size cable = 1.5 mm^2

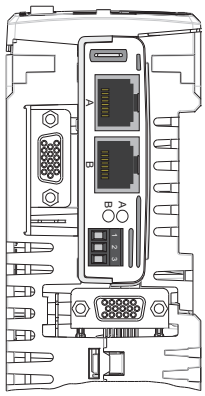
Torque = 0.2 N m (1.8 lb in)

Table 4-26 Digitax EZMotion connector details

Terminal	Function	Description
1	0V common	0V common connection for digital I/O
2	Input 1	Digital input 1
3	Input 2	Digital input 2
4	Input 3	Digital input 3
5	Input 4	Digital input 4
6	Output 1	Digital output 1
7	Output 2	Digital output 2

4.16.5 Digitax ST EtherCAT additional connections

Figure 4-27 Digitax ST EtherCAT terminals view



Connector specification:

Maximum size cable = 1.5mm^2

Torque = 0.2 N m (1.8 lb in)

Table 4-20 Digitax EtherCAT connector details

Terminal	Function (A - IN)	Terminal	Function (B - OUT)	Digital Inputs	Function
1	Transmit +	1	Transmit +	1	0V Common
2	Transmit -	2	Transmit -	2	Digital input 0
3	Receive +	3	Receive +	3	Digital input 1
4	Not used	4	Not used		
5	Not used	5	Not used		
6	Receive -	6	Receive -		
7	Not used	7	Not used		
8	Not used	8	Not used		

1	**0V common**
Function	**Common connection for Digital I/O**

2	**Input 1**
3	**Input 2**
4	**Input 3**
5	**Input 4**
Input turn on voltage	15 Vdc ± 0.5 Vdc
Input voltage range	0 Vdc to +24 Vdc
Maximum input voltage	+ 30 Vdc

6	**Output 1**
7	**Output 2**
Output voltage	Depends on 24 Vdc supply
Maximum output current	20mA total for both outputs

4.17 Safe Torque Off

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 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.[1]

EN 61800-5-2:2007 SIL 3 (PFH $\leq 10^{-8}$)

EN ISO 13849-1:2006 PL e ($MTTF_D > 10^5$ yr)

EN954-1:1997 Category 3 (This standard is withdrawn and should not be used for new designs, information provided for legacy applications only).

On drives with date code P04 and later the Safe Torque Off input also meets the requirements (of EN 81-1 clause 12.7.3 b) as part of a system for preventing unwanted operation of the motor in a lift (elevator).[2]

[1] Independent approval has been given by IFA.

[2] Independent approval of concept has been given by TÜV. Please consult the separate guide for lift applications for further information.

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

Note On Response Time Of Safe Torque Off, And Use With Safety Controllers With Self-testing Outputs (Drives With Date Code P04 And Later).

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.

For Applications Where A Fast-acting Disable Function Is Required, section 12.22.10 *Fast Disable* on page 172

Note On The Use Of Servo Motors, Other Permanent-magnet Motors, Reluctance Motors And Salient-pole Induction Motors

When The Drive Is Disabled Through Safe Torque Off, A Possible (Although Highly Unlikely) Failure Mode Is For Two Power Devices In The Inverter Circuit To Conduct Incorrectly.

This Fault Cannot Produce A Steady Rotating Torque In Any Ac Motor. It Produces No Torque In A Conventional Induction Motor With A Cage Rotor. If The Rotor Has Permanent Magnets And/or Saliency, Then A Transient Alignment Torque May Occur. The Motor May Briefly Try To Rotate By Up To 180° Electrical, For A Permanent Magnet Motor, Or 90° Electrical, For A Salient Pole Induction Motor Or Reluctance Motor. This Possible Failure Mode Must Be Allowed For In The Machine Design.

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

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

Low voltage DC operation

With low voltage DC operation there is a reduction in the level of safety of the Safe Torque Off function. There exist certain unlikely faults which might permit the drive to produce some limited motor torque when disabled, but only if the DC supply has its negative pole connected to ground.

To prevent a loss of the safety function in the event of such a fault, one of the following methods can be used:

1. Monitor the state of Pr **8.09**. This parameter value should match the state of the enable input. If it does not match then there is a fault and further operation must be prevented.
2. Connect the positive pole of the DC supply to ground.
3. Connect neither pole of the DC supply to ground. Use a ground fault detection circuit to prevent further operation in the event of a ground fault in the DC circuit. If the detection circuit requires the supply to be biased relative to ground, ensure that the bias is negative, i.e. both DC rails are negative relative to ground.

Note that in lift (elevator) applications designed to meet EN 81-1 with the use of one contactor or no contactors, method 1 is normally implemented as part of the standard lift safety control system.

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 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 Can Be Excluded Under 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.

If the use of protected wiring is not acceptable, so that the possibility of this short circuit occurring is anticipated, then a relay must be used to monitor the state of the Safe Torque Off input, together with a single safety contactor to prevent operation of the motor after a fault.

For more information regarding the Safe Torque Off input, please see the *Safe Torque Off Engineering Guide* available for download from http://www.emersonindustrial.com/en-EN/controltechniques/downloads/userguidesandsoftware/Pages/downloads.aspx.

5 Getting started

5.1 User interfaces

There are six user interfaces available for the various drive variants.

- CTSoft
- SYPT Pro
- EZMotion PowerTools Pro
- DST Keypad (LED)
- SM-Keypad Plus (LCD)

Table 5-1 User interface compatibility

	Digitax ST Base	Digitax ST Indexer	Digitax ST Plus	Digitax ST EZMotion	Digitax ST EtherCAT
CTSoft	√	√			
SYPT Pro		√	√		
EZMotion PowerTools pro				√	
DST Keypad	√	√	√	√	√
SM-Keypad Plus	√	√	√	√	√

5.1.1 User software system requirements

System requirements are:

- Windows 7, Windows Vista, Windows XP or Windows 2000 (Including the latest Service Packs) only.
- Internet Explorer 5.0 or later.
- Minimum of 800x600 screen resolution with 256 colors. 1024x768 is recommended.
- 512 MB RAM.
- Microsoft.Net frameworks 2.0.
- Pentium IV 1000 MHz or better recommended.
- Adobe Acrobat Reader 5.05 or later for parameter help files access
- Windows™ Administrator rights to install.

5.2 CT Soft

CTSoft is a Windows based drive commissioning / start-up program that allows the complete control and display of all parameters within Emerson Industrial Automations' ranges of drives.

CTSoft provides the user with a graphical interface that is logically split into a series of screens offering quick and easy viewing and, where appropriate, the ability to edit parameter values. Individual detailed parameter information can at any time be displayed showing the parameter function, type and range of permitted values.

CTSoft can be used for set-up and monitoring, drive parameters can be uploaded, downloaded and compared, and simple or custom menu listings can be created. Drive menus can be displayed in standard list format or as live block diagrams. CTSoft is able to communicate with a single drive or network.

The drive's parameter set is split up into a series of related groups or menus. Many of these menus have an associated graphical block diagram which may be displayed and used interactively within CTSoft. For full details of the drive's parameters, the relevant pages from the drive and Solutions Module Advanced User Guides can also be displayed by simply clicking any parameter on any displayed list or block diagram view.

For the Digitax ST Indexer and Digitax ST Plus variants, CTSoft allows users to specify and execute motion sequences using sequential function chart style diagrams.

Refer to the on-line set-up wizard and help files in CTSoft for further information.

CTSoft is available to download from:

http://www.emersonindustrial.com/en-EN/controltechniques/downloads/userguidesandsoftware/Pages/digitaxst.aspx

5.3 SYPTPro (Indexer & Plus only)

SYPTPro is a professional drive programming toolkit for OEM's and End Users who wish to maximize performance of the Digitax ST Indexer or the Digitax ST Plus. SYPTPro allows the user to program in a choice of three languages, with a real-time multi-tasking environment

SYPTPro incorporates IEC61131-3 style ladder language editor. This form of programming will be familiar to all PLC programmers and is the ideal format for sequencing and I/O control.

For further information on programming with SYPTPro refer to the *SM-Applications Module And Motion Processors User Guide*.

SM-Applications Module And Motion Processors User Guide is available to download from: http://www.emersonindustrial.com/en-EN/controltechniques/downloads/userguidesandsoftware/Pages/digitaxst.aspx

5.4 EZMotion PowerTools Pro

Applications for the Digitax ST EZMotion are developed using PowerTools Pro software. PowerTools Pro is an easy to use, Windows™ based set-up and diagnostics tool. It provides the user with the ability to create, edit and maintain the system set-up.

PowerTools Pro is designed to be the easiest to use software available for the 1 ½ axis motion controllers.

Features of PowerTools Pro include:

- Hierarchy Tree for quick navigation to any set-up view.
- Simple I/O function assignments.
- Powerful on-line diagnostic capability.
- Fill in black motion profile parameters

For further information on programming with PowerTools Pro refer to the *EZMotion User/Programming Guide*.

5.5 Keypad operation

WARNING

Beware of possible live terminals when installing the keypad.

5.6 Understanding the display

There are two keypads available for the Digitax ST. The Digitax ST Keypad has an LED display and the SM-Keypad Plus has an LCD display. The Digitax ST Keypad can be installed to the drive and the SM -Keypad Plus is remotely mounted on an enclosure door.

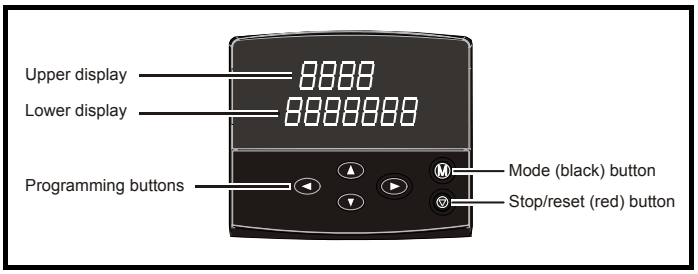
5.6.1 Digitax ST Keypad (LED)

The display consists of two horizontal rows of 7 segment LED displays.

The upper display shows the drive status or the current menu and parameter number being viewed.

The lower display shows the parameter value or the specific trip type.

Figure 5-1 Digitax ST Keypad

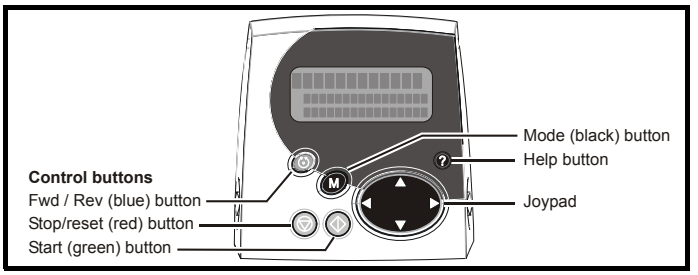


5.6.2 SM-Keypad Plus (LCD)

The display consists of three lines of text.

The top line shows the drive status or the current menu and parameter number being viewed on the left, and the parameter value or the specific trip type on the right. The lower two lines show the parameter name or the help text.

Figure 5-2 SM-Keypad Plus (remote mount only)

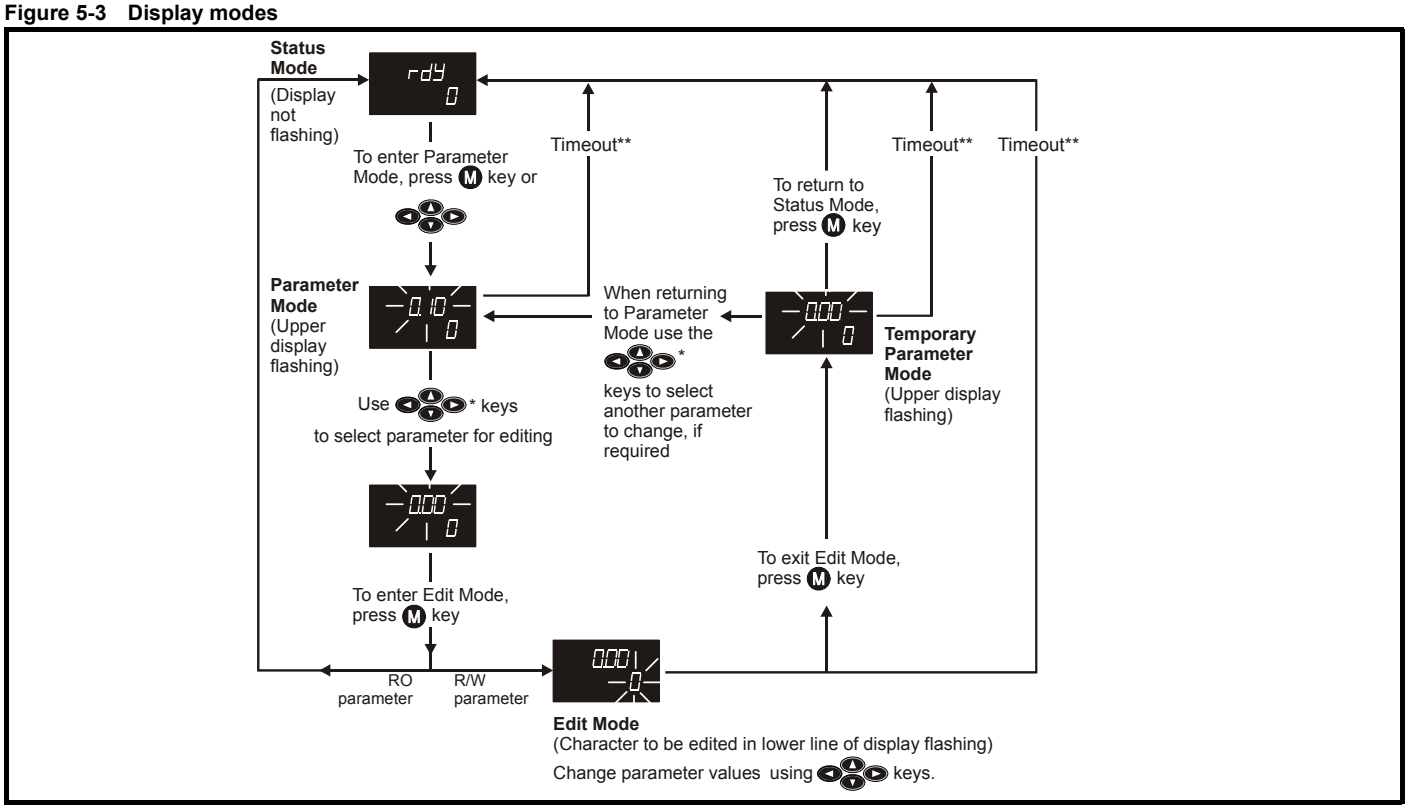


Control buttons

The keypad consists of:

1. Programming buttons: used to navigate the parameter structure and change parameter values.
2. Mode button: used to change between the display modes – parameter view, parameter edit, status.
3. Reset button
4. Help button (Keypad Plus only) - displays text briefly describing the selected parameter.
5. Start, Fwd/Rev buttons (Keypad Plus only) - used to control the drive if Keypad mode is selected.

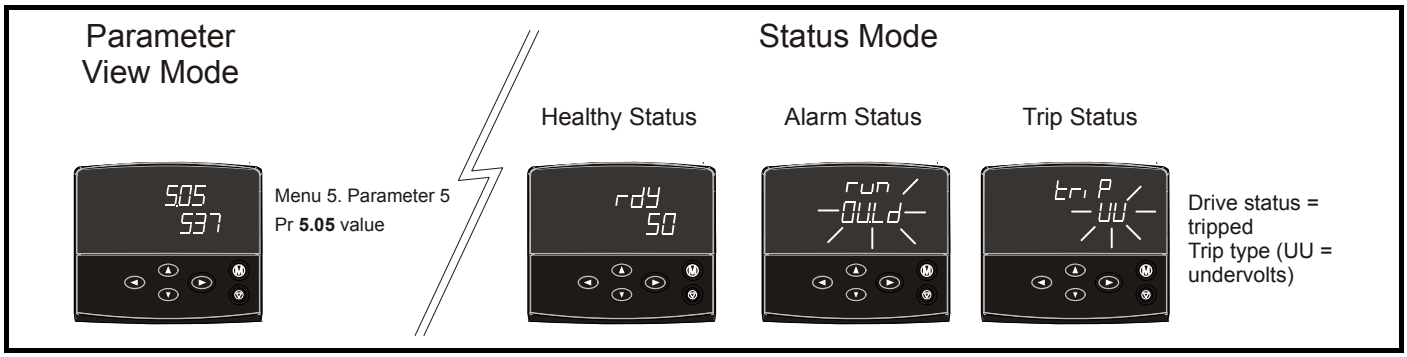
Figure 5-3 Display modes



*Can only be used to move between menus if L2 access has been enabled (Pr **0.49**). Refer to section 5.6.7 *Parameter access level and security* on page 46.

Timeout defined by Pr **11.41 (default value = 240 s).

Figure 5-4 Mode examples



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

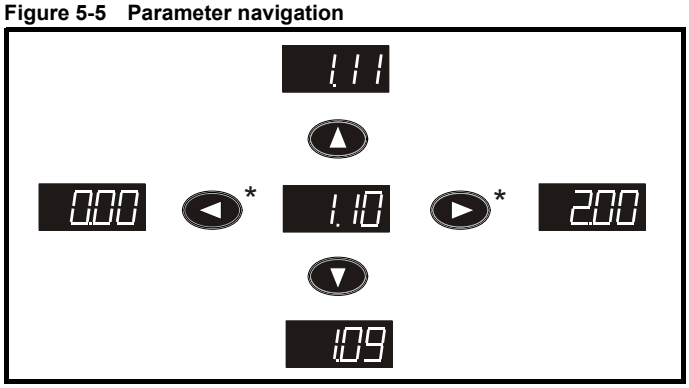
For new parameter-values to apply after the AC supply to the drive is interrupted, new values must be saved. Refer to section 5.6.5 *Saving parameters* on page 46.

5.6.3 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 level 2 access (L2) has been enabled (see Pr **0.49**) the left and right buttons are used to navigate between menus. For further information, refer to section 5.6.7 *Parameter access level and security* on page 46.

Figure 5-5 Parameter navigation



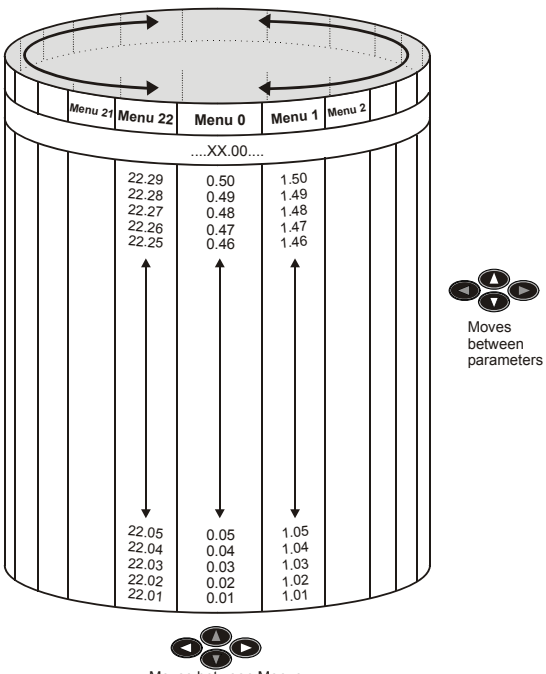
*Can only be used to move between menus if L2 access has been enabled (Pr **0.49**). Refer to section 5.6.7 *Parameter access level and security* on page 46.

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.

Figure 5-6 Menu structure



5.6.4 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 both keypads. Menus 40 and 41 are specific to the Keypad Plus (LCD).

Menu	Description
0	Commonly used basic set up parameters for quick / easy programming
1	Speed reference
2	Ramps
3	Speed feedback and speed 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 and binary sum
10	Status and trips
11	General drive set-up
12	Threshold detectors and variable selectors
13	Position control
14	User PID controller
15, 16	Solutions Module set-up
17	Motion processor
18	Application menu 1
19	Application menu 2
20	Application menu 3
21	Second motor parameters
22	Additional Menu 0 set-up

5.6.5 Saving parameters

When changing a parameter in Menu 0, the new value is saved when pressing the M Mode 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

Enter 1000* in Pr. **xx.00**

Either:

- Press the red reset button
- Toggle the reset digital input
- Carry out a drive reset through serial communications by setting Pr **10.38** to 100 (ensure that Pr. **xx.00** returns to 0).

*If the drive is in the under voltage trip state or is being supplied from a low voltage DC supply, a value of 1001 must be entered into Pr **xx.00** to perform a save function.

5.6.6 Restoring parameter defaults

Restoring parameter defaults by this method saves the default values in the drive's memory. (Pr **0.49** and Pr **0.34** are not affected by this procedure.)

Procedure

1. Ensure the drive is not enabled, i.e. terminal 31 is open or Pr **6.15** is Off (0)
2. Enter 1233 (EUR 50 Hz settings) or 1244 (USA 60 Hz settings) in Pr **xx.00**.
3. Either:

- Press the red reset button
- Toggle the reset digital input
- Carry out a drive reset through serial communications by setting Pr **10.38** to 100 (ensure that Pr. **xx.00** returns to 0).

5.6.7 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 the table below:

Parameter Access Level	User Security	Menu 0 status	Advanced menus status
L1	Open	RW	Not visible
L1	Closed	RO	Not visible
L2	Open	RW	RW
L2	Closed	RO	RO

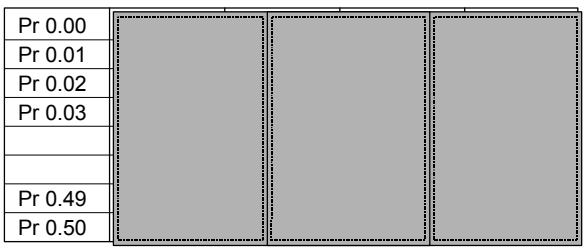
RW = Read / write access RO = Read only access

The default settings of the drive are Parameter Access Level L1 and user Security Open, i.e. read / write access to Menu 0 with the advanced menus not visible.

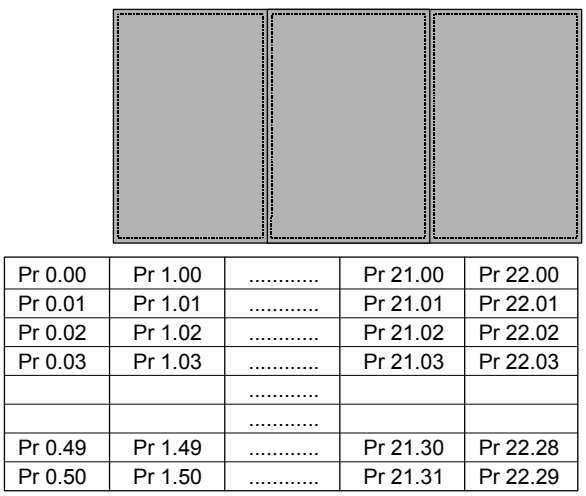
Access Level

The access level is set in Pr **0.49** and allows or prevents access to the advanced menu parameters.

L1 access selected - Menu 0 only visible



L2 access selected - All parameters visible



Pr 0.00	Pr 1.00	.....	Pr 21.00	Pr 22.00
Pr 0.01	Pr 1.01	.....	Pr 21.01	Pr 22.01
Pr 0.02	Pr 1.02	.....	Pr 21.02	Pr 22.02
Pr 0.03	Pr 1.03	.....	Pr 21.03	Pr 22.03
		.....		
		.....		
Pr 0.49	Pr 1.49	.....	Pr 21.30	Pr 22.28
Pr 0.50	Pr 1.50	.....	Pr 21.31	Pr 22.29

Changing the Access Level

The Access Level is determined by the setting of Pr **0.49** as follows:

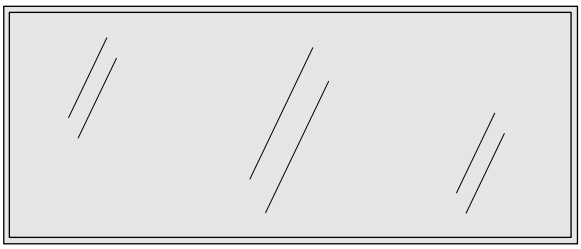
String	Value	Effect
L1	0	Access to menu 0 only
L2	1	Access to all menus (menu 0 to menu 22)

The Access Level can be changed through the keypad even if the User Security has been set.

5.6.8 User Security

The User Security, when set, prevents write access to any of the parameters (other than Pr. **0.49** and Pr **11.44** *Access Level*) in any menu.

User security open - All parameters: Read / Write access



Pr 0.00	Pr 1.00	.....	Pr 21.00	Pr 22.00
Pr 0.01	Pr 1.01	.....	Pr 21.01	Pr 22.01
Pr 0.02	Pr 1.02	.....	Pr 21.02	Pr 22.02
Pr 0.03	Pr 1.03	.....	Pr 21.03	Pr 22.03
		.....		
		.....		
Pr 0.49	Pr 1.49	.....	Pr 21.30	Pr 22.28
Pr 0.50	Pr 1.50	.....	Pr 21.31	Pr 22.29

User security closed - All parameters: Read Only access (except Pr **0.49** and Pr **11.44**)

Pr 0.00	Pr 1.00	.....	Pr 21.00	Pr 22.00
Pr 0.01	Pr 1.01	.....	Pr 21.01	Pr 22.01
Pr 0.02	Pr 1.02	.....	Pr 21.02	Pr 22.02
Pr 0.03	Pr 1.03	.....	Pr 21.03	Pr 22.03
		.....		
		.....		
Pr 0.49	Pr 1.49	.....	Pr 21.30	Pr 22.28
Pr 0.50	Pr 1.50	.....	Pr 21.31	Pr 22.29

Setting User Security

Enter a value between 1 and 999 in Pr **0.34** and press the M button; the security code has now been set to this value. In order to activate the security, the Access level must be set to Loc in Pr **0.49**. When the drive is reset, the security code will have been activated and the drive returns to Access Level L1. The value of Pr **0.34** will return to 0 in order to hide the security code. At this point, the only parameter that can be changed by the user is the Access Level Pr **0.49**.

Unlocking User Security

Select a read write parameter to be edited and press the M button, the display will now show CodE. Use the arrow buttons to set the security code and press the M 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 display will revert to parameter view mode.

To lock the User Security again, set Pr **0.49** to Loc and press the reset button.

Disabling User Security

Unlock the previously set security code as detailed above. Set Pr **0.34** to 0 and press the M 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.

5.7 Displaying parameters with non-default values only

By entering 12000 in Pr **xx.00**, the only parameters that will be visible to the user will be those containing a non-default value. This function does not require a drive reset to become active. In order to deactivate this function, return to Pr **xx.00** and enter a value of 0.

Please note that this function can be affected by the access level enabled, refer to section 5.6.7 *Parameter access level and security* for further information regarding access level.

5.8 Displaying destination parameters only

By entering 12001 in Pr **xx.00**, the only parameters that will be visible to the user will be destination parameters. This function does not require a drive reset to become active. In order to deactivate this function, return to Pr **xx.00** and enter a value of 0.

Please note that this function can be affected by the access level enabled, refer to section 5.6.7 *Parameter access level and security* for further information regarding access level.

5.9 Communications

5.9.1 Introduction

The Digitax ST has a standard 2-wire EIA485 interface (serial communications interface) which enables all drive set-up, operation and monitoring to be carried out with a PC or PLC if required. Therefore, it is possible to control the drive entirely by serial communications without the need for a -keypad or other control cabling. The Digitax ST supports two protocols selected by parameter configuration:

- Modbus RTU
- CT ANSI

Modbus RTU has been set as the default protocol, as it is used with the PC-tools set-up software as provided on the CD ROM.

The communications port of the drive is a RJ45 socket, and is isolated from the power stage and the other control terminals.

The communications port applies a 2 unit load to the communications network.

USB/EIA232 to EIA485 Communications

An external USB/EIA232 hardware interface such as a PC cannot be used directly with the 2-wire interface of the drive. Therefore a suitable converter is required.

Suitable USB to EIA485 and EIA232 to EIA485 isolated converters are available from Emerson Industrial Automation as follows:

- CT USB Comms cable (CT Part No. 4500-0096)
- CT EIA232 Comms cable (CT Part No. 4500-0087)

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

5.9.2 Communications set-up parameters

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

0.35 {11.24}	Serial mode								
RW	Txt							US	
⇳	AnSI (0) rtU (1)				⇨	rtU (1)			

This parameter defines the communications protocol used by the 485 comms port on the drive. This parameter can be changed via the drive keypad, via a Solutions Module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original protocol. The master should wait at least 20ms before send a new message using the new protocol. (Note: ANSI uses 7 data bits, 1 stop bit and even parity; Modbus RTU uses 8 data bits, 2 stops bits and no parity.)

Comms value	String	Communications mode
0	AnSI	ANSI
1	rtU	Modbus RTU protocol
2	Lcd	Modbus RTU protocol, but with an Keypad Plus only

ANSIx3.28 protocol
Full details of the CT ANSI communications protocol are given in the *Advanced User Guide*.

Modbus RTU protocol
Full details of the CT implementation of Modbus RTU are given in the *Advanced User Guide*.

Modbus RTU protocol, but with an SM-Keypad Plus only
This setting is used for disabling communications access when the -Keypad Plus is used as a hardware key. See the *Advanced User Guide* for more details.

0.36 {11.25}	Serial communications baud rate								
RW	Txt							US	
⇳	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8)*, 115200 (9)*				⇨	19200 (6)			

* only applicable to Modbus RTU mode

This parameter can be changed via the drive keypad, via a Solutions 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.

NOTE
When using the CT EIA232 Comms cable the available baud rate is limited to 19.2 k baud.

0.37 {11.23}	Serial communications address								
RW	Txt							US	
⇳	0 to 247				⇨	1			

Used to define the unique address for the drive for the serial interface. The drive is always a slave.

Modbus RTU
When the Modbus RTU protocol is used addresses between 0 and 247 are permitted. Address 0 is used to globally address all slaves, and so this address should not be set in this parameter

ANSI
When the ANSI protocol is used the first digit is the group and the second digit is the address within a group. The maximum permitted group number is 9 and the maximum permitted address within a group is 9. Therefore, Pr **0.37** is limited to 99 in this mode. The value 00 is used to globally address all slaves on the system, and x0 is used to address all slaves of group x, therefore these addresses should not be set in this parameter.

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 11 and 22 can be used to change most of the parameters in menu 0. Menu 0 can also contain up to 59 parameters by setting up menu 22.

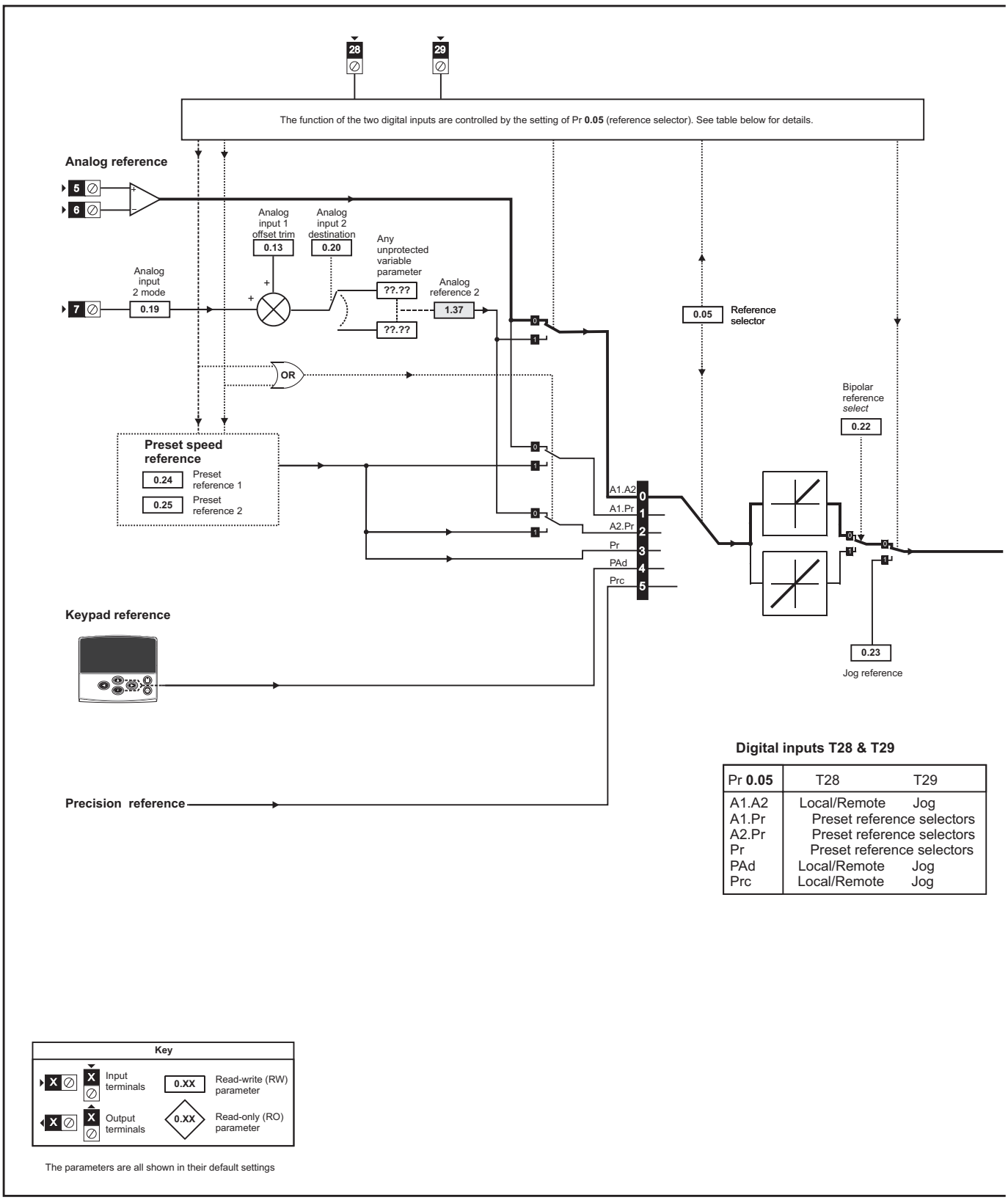
6.1 Single line descriptions

Parameter			Range(⇳)	Default(⇨)	Type					
0.00	**xx.00**	{**x.00**}	0 to 32,767	0	RW	Uni				
0.01	Minimum reference clamp	{**1.07**}	±SPEED_LIMIT_MAX rpm	0.0	RW	Bi			PT	US
0.02	Maximum reference clamp	{**1.06**}	SPEED_LIMIT_MAX rpm	3,000.0	RW	Uni				US
0.03	Acceleration rate	{**2.11**}	0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
0.04	Deceleration rate	{**2.21**}	0.000 to 3,200.000 s/1,000rpm	0.200	RW	Uni				US
0.05	Reference select	{**1.14**}	A1.A2 (0), A1.Pr (1), A2.Pr (2), Pr (3), PAd (4), Prc (5)	A1.A2 (0)	RW	Txt		NC		US
0.06	Current limit	{**4.07**}	0 to MOTOR1_CURRENT_LIMIT_MAX %	300.0	RW	Uni		RA		US
0.07	Speed controller P gain	{**3.10**}	0.0000 to 6.5535 1/rad s^{-1}	0.0100	RW	Uni				US
0.08	Speed controller I gain	{**3.11**}	0.00 to 655.35 1/rad	1.00	RW	Uni				US
0.09	Speed controller D gain	{**3.12**}	0.00000 to 0.65535 (s)	0.00000	RW	Uni				US
0.10	Motor speed	{**3.02**}	±SPEED_MAX rpm		RO	Bi	FI	NC	PT	
0.11	Drive encoder position	{**3.29**}	0 to 65,535 $1/2^{16}$ths of a revolution		RO	Uni	FI	NC	PT	
0.12	Total motor current	{**4.01**}	0 to DRIVE_CURRENT_MAX A		RO	Uni	FI	NC	PT	
0.13	Analog input 1 offset trim	{**7.07**}	±10.000 %	0.000	RW	Bi				US
0.14	Torque mode selector	{**4.11**}	0 to 4	Speed control mode (0)	RW	Uni				US
0.15	Ramp mode select	{**2.04**}	FASt (0) Std (1)	Std (1)	RW	Txt				US
0.16	Ramp enable	{**2.02**}	OFF (0) or On (1)	On (1)	RW	Bit				US
0.17	Current demand filter filter	{**4.12**}	0.0 to 25.0 ms	0.0	RW	Uni				US
0.18	Positive logic select	{**8.29**}	OFF (0) or On (1)	On (1)	RW	Bit			PT	US
0.19	Analog input 2 mode	{**7.11**}	0-20 (0), 20-0 (1), 4-20tr (2), 20-4tr (3), 4-20 (4), 20-4 (5), VOLt (6)	VOLt (6)	RW	Txt				US
0.20	Analog input 2 destination	{**7.14**}	Pr **0.00** to Pr **21.51**	Pr **1.37**	RW	Uni	DE		PT	US
0.21	Analog input 3 mode	{**7.15**}	0-20 (0), 20-0 (1), 4-20tr (2), 20-4tr (3), 4-20 (4), 20-4 (5), VOLt (6), th.SC (7), th (8), th.diSp (9)	th (8)	RW	Txt			PT	US
0.22	Bipolar reference select	{**1.10**}	OFF (0) or On (1)	OFF (0)	RW	Bit				US
0.23	Jog reference	{**1.05**}	0 to 4000.0 rpm	0.0	RW	Uni				US
0.24	Pre-set reference 1	{**1.21**}	±SPEED_LIMIT_MAX rpm	0.0	RW	Bi				US
0.25	Pre-set reference 2	{**1.22**}	±SPEED_LIMIT_MAX rpm	0.0	RW	Bi				US
0.26	Overspeed threshold	{**3.08**}	0 to 40,000 rpm	0	RW	Uni				US
0.27	Drive encoder lines per revolution	{**3.34**}	0 to 50,000	4096	RW	Uni				US
0.28	Keypad fwd/rev key enable	{**6.13**}	OFF (0) or On (1)	OFF (0)	RW	Bit				US
0.29	SMARTCARD parameter data	{**11.36**}	0 to 999	0	RO	Uni		NC	PT	US
0.30	Parameter copying	{**11.42**}	nonE (0), rEAd (1), Prog (2), AutO (3), boot (4)	nonE (0)	RW	Txt		NC		*
0.31	Drive rated voltage	{**11.33**}	200 (0), 400 (1)		RO	Txt		NC	PT	
0.32	Drive rated current	{**11.32**}	0.00 to 9999.99 A		RO	Uni		NC	PT	
0.34	User security code	{**11.30**}	0 to 999	0	RW	Uni		NC	PT	PS
0.35	Serial comms mode	{**11.24**}	AnSI (0), rtu (1), Lcd (2)	rtU (1)	RW	Txt				US
0.36	Serial comms baud rate	{**11.25**}	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8) Modbus RTU only, 115200 (9) Modbus RTU only	19200 (6)	RW	Txt				US
0.37	Serial comms address	{**11.23**}	0 to 247	1	RW	Uni				US
0.38	Current loop P gain	{**4.13**}	0 to 30,000	200V drive: 75 400V drive: 150	RW	Uni				US
0.39	Current loop I gain	{**4.14**}	0 to 30,000	200V drive: 1000 400V drive: 2000	RW	Uni				US
0.40	Autotune	{**5.12**}	0 to 6	0	RW	Uni				
0.41	Maximum switching frequency	{**5.18**}	3 (0), 4 (1), 6 (2), 8 (3), 12 (4)	6 (2)	RW	Txt		RA		US
0.42	No. of motor poles	{**5.11**}	0 to 60 (Auto to 120 pole)	6 POLE (3)	RW	Txt				US
0.43	Encoder phase angle	{**3.25**}	0.0 to 359.9°	0.0	RW	Uni				US
0.44	Motor rated voltage	{**5.09**}	0 to AC_VOLTAGE_SET_MAX V	200 V drive: 230 400 V drive: EUR> 400, USA> 460	RW	Uni		RA		US
0.45	Motor thermal filter	{**4.15**}	0.0 to 3000.0	20.0	RW	Uni				US
0.46	Motor rated current	{**5.07**}	0 to RATED_CURRENT_MAX A	Drive rated current [**11.32**]	RW	Uni		RA		US
0.48	User drive mode	{**11.32**}	SErVO (3)	SErVO (3)	RO	Txt		NC	PT	
0.49	Security status	{**11.44**}	L1 (0), L2 (1), Loc (2)		RW	Txt			PT	US
0.50	Software version	{**11.29**}	1.00 to 99.99		RO	Uni		NC	PT	
0.51	Action on trip detection	{**10.37**}	0 to 15	0	RW					US

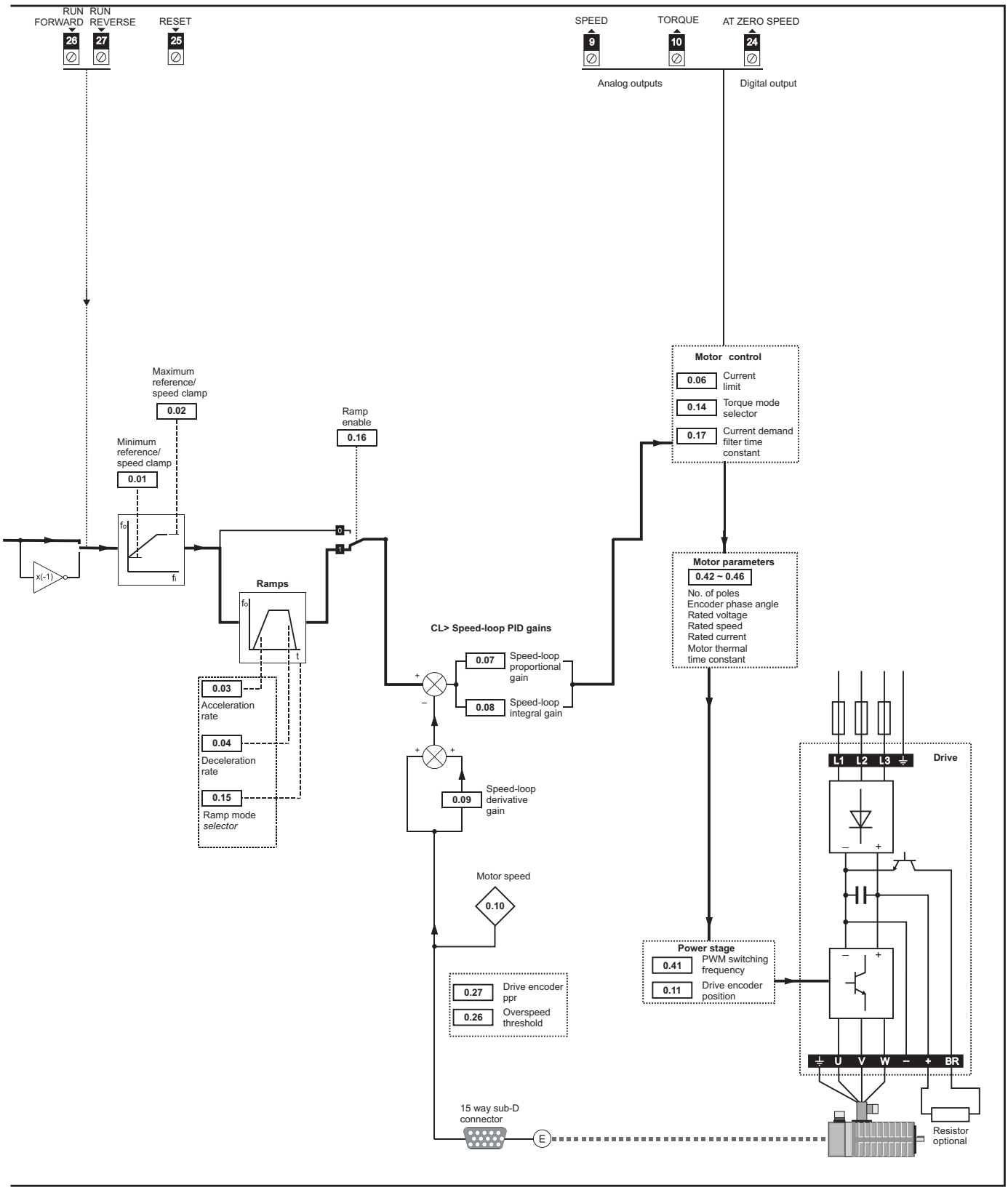
Key:

Coding	Attribute
{X.XX}	Copied advanced parameter
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
Bi	Bipolar parameter
Uni	Unipolar parameter
Txt	Text: the parameter uses text strings instead of numbers.
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 not be transferred to the destination drive by SMARTCARDs when the rating of the destination drive is different from the source drive and the file is a parameter file.
NC	Not copied: not transferred to or from SMARTCARDs 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) trip occurs.

Figure 6-1 Menu 0 logic diagram



The parameters are all shown in their default settings


RUN FORWARD
26
RUN REVERSE
27
RESET
25
SPEED
9
TORQUE
10
AT ZERO SPEED
24
Analog outputs
Digital output
Motor control
0.06 Current limit
0.14 Torque mode selector
0.17 Current demand filter time constant
Maximum reference/ speed clamp
0.02
Minimum reference/ speed clamp
0.01
Ramp enable
0.16
Ramps
0.03 Acceleration rate
0.04 Deceleration rate
0.15 Ramp mode selector
CL> Speed-loop PID gains
0.07 Speed-loop proportional gain
0.08 Speed-loop integral gain
0.09 Speed-loop derivative gain
Motor speed
0.10
Motor parameters
0.42 ~ 0.46
No. of poles
Encoder phase angle
Rated voltage
Rated speed
Rated current
Motor thermal time constant
Power stage
0.41 PWM switching frequency
0.11 Drive encoder position
0.27 Drive encoder ppr
0.26 Overspeed threshold
Drive
L1 L2 L3
U V W – + BR
15 way sub-D connector
Resistor optional

6.2 Full descriptions

6.2.1 Parameter x.00

0.00 {x.00}	Parameter zero								
RW	Uni								
⇳	0 to 32,767				⇨	0			

Pr **x.00** is available in all menus and has the following functions.

Value	Action
1000	Save parameters when under voltage is not active (Pr **10.16** = 0) and low voltage DC supply is not active (Pr **6.44** = 0).
1001	Save parameters under all conditions
1070	Reset all Solutions Modules
1233	Load standard defaults
1244	Load US defaults
1255	Change drive mode with standard defaults (excluding menus 15 to 20)
1256	Change drive mode with US defaults (excluding menus 15 to 20)
2001*	Transfer drive parameters as difference from default to a bootable SMARTCARD block in data block number 001
3yyy*	Transfer drive EEPROM data to a SMARTCARD block number yyy
4yyy*	Transfer drive data as difference from defaults to SMARTCARD block number yyy
5yyy*	Transfer drive ladder program to SMARTCARD block number yyy
6yyy*	Transfer SMARTCARD data block number yyy to the drive
7yyy*	Erase SMARTCARD data block number yyy
8yyy*	Compare drive parameters with SMARTCARD data block number yyy
15yyy	Transfer the user program in the applications module in slot 1 to data block number yyy on a SMARTCARD
16yyy	Transfer the user program in the applications module in slot 2 to data block number yyy on a SMARTCARD
17yyy	Transfer the user program in the SM-Applications Modules And Motion Processors (Digitax ST Plus and Indexer) to data block number yyy on a SMARTCARD
18yyy	Transfer a user program in data block number yyy on a SMARTCARD to the applications module in slot 1
19yyy	Transfer a user program in data block number yyy on a SMARTCARD to the applications module in slot 2
20yyy	Transfer a user program in data block number yyy on a SMARTCARD to the SM-Applications Modules And Motion Processors (Digitax ST Plus and Indexer)
9555*	Clear SMARTCARD warning suppression flag
9666*	Set SMARTCARD warning suppression card
9777*	Clear SMARTCARD read-only flag
9888*	Set SMARTCARD read-only flag
9999*	Erase SMARTCARD data block 1 to 499
110zy	Transfer electronic nameplate parameters to/from drive from/to encoder. See the *Advanced User Guide* for more information on this function.
12000**	Display non-default values only
12001**	Display destination parameters only

* See Chapter 10 *SMARTCARD Operation* for more information of these functions.

** These functions do not require a drive reset to become active. All other functions require a drive reset to initiate the function.

6.2.2 Speed limits

0.01 {1.07}	Minimum reference clamp								
RW	Bi						PT	US	
⇳	±SPEED_LIMIT_MAX rpm				⇨	0.0			

(When the drive is jogging, [**0.01**] has no effect.)

0.02 {1.06}	Maximum reference clamp								
RW	Uni							US	
⇳	SPEED_LIMIT_MAX rpm				⇨	3,000.0			

(The drive has additional over-speed protection.)

6.2.3 Ramps, speed reference selection, current limit

0.03 {2.11}	Acceleration rate								
RW	Uni							US	
⇳	0.000 to 3,200.000 s/1,000 rpm				⇨	0.200			

Set Pr **0.03** at the required rate of acceleration.

Note that larger values produce lower acceleration. The rate applies in both directions of rotation.

0.04 {2.21}	Deceleration rate								
RW	Uni							US	
⇳	0.000 to 3,200.000 s/1,000 rpm				⇨	0.200			

Set Pr **0.04** at the required rate of deceleration.

Note that larger values produce lower deceleration. The rate applies in both directions of rotation.

0.05 {1.14}	Reference selector								
RW	Txt					NC		US	
⇳	0 to 5				⇨	A1.A2 (0)			

Use Pr **0.05** to select the required speed reference as follows:

Setting		
A1.A2	0	Analog input 1 OR analog input 2 selectable by digital input, terminal 28
A1.Pr	1	Analog input 1 OR preset speed selectable by digital input, terminal 28 and 29
A2.Pr	2	Analog input 2 OR preset speed selectable by digital input, terminal 28 and 29
Pr	3	Pre-set speed
PAd	4	Keypad reference
Prc	5	Precision reference

Setting Pr **0.05** to 1, 2 or 3 will re-configure T28 and T29. Refer to Pr **8.39** (Pr **0.16** in OL) to disable this function.

0.06 {4.07}	Current Limit								
RW	Uni				RA			US	
⇳	0 to MOTOR1_CURRENT_LIMIT_MAX %				⇨	300.0			

Pr **0.06** limits the maximum output current of the drive (and hence maximum motor torque) to protect the drive and motor from overload.

Set Pr **0.06** at the required maximum torque as a percentage of the rated torque of the motor, as follows:

$$[\mathbf{0.06}] = \frac{T_R}{T_{RATED}} \times \mathbf{100\ (\%)}$$

Where:

T_R Required maximum torque

T_{RATED} Motor rated torque

Alternatively, set 0.06 at the required maximum active (torque-producing) current as a percentage of the rated active current of the motor, as follows:

$$[\mathbf{0.06}] = \frac{I_R}{I_{RATED}} \times \mathbf{100\ (\%)}$$

Where:

I_R Required maximum active current

I_{RATED} Motor rated active current

0.07 {3.10}	**Speed controller proportional gain**									
RW	Uni								US	
⇳	0.0000 to 6.5535 1/rad s^{-1}				⇨	0.0100				

Pr **0.07** (**3.10**) operates in the feed-forward path of the speed-control loop in the drive. See Figure 12-3 on page 124 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* .

0.08 {3.11}	**Speed controller integral gain**									
RW	Uni								US	
⇳	0.00 to 655.35 1/rad				⇨	1.00				

Pr **0.08** (**3.11**) operates in the feed-forward path of the speed-control loop in the drive. See Figure 12-3 on page 124 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* .

0.09 {3.12}	**Speed controller differential feedback gain**									
RW	Uni								US	
⇳	0.00000 to 0.65535(s)				⇨	0.00000				

Pr **0.09** (**3.12**) operates in the feedback path of the speed-control loop in the drive. See Figure 12-3 on page 124 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* .

0.10 {3.02}	**Motor speed**									
RO	Bi	FI				NC	PT			
⇳	±SPEED_MAX rpm				⇨					

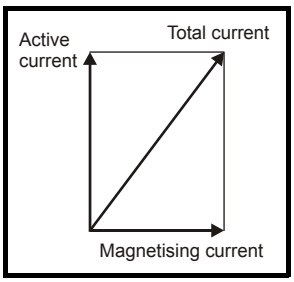
Pr **0.10** (**3.02**) indicates the value of motor speed that is obtained from the speed feedback.

0.11 {3.29}	**Drive encoder position**									
RO	Uni	FI				NC	PT			
⇳	0 to 65,535 1/2^{16}ths of a revolution				⇨					

Pr **0.11** displays the position of the encoder in mechanical values of 0 to 65,535. There are 65,536 units to one mechanical revolution.

0.12 {4.01}	**Total motor current**									
RO	Uni	FI					NC	PT		
⇳	0 to DRIVE_CURRENT_MAX A				⇨					

Pr **0.12** displays the rms value of the output current of the drive in each of the three phases. The phase currents consist of an active component and a reactive component, which can form a resultant current vector as shown in the following diagram.



The active current is the torque producing current and the reactive current is the magnetising or flux-producing current.

0.13 {7.07}	**Analog input 1 offset trim**									
RW	Bi								US	
⇳	±10.000 %				⇨	0.000				

Pr **0.13** can be used to trim out any offset in the user signal to analog input 1.

6.2.4 Jog reference, Ramp mode selector, Stop and torque mode selectors

0.14 {4.11}	**Torque mode selector**									
RW	Uni								US	
⇳	0 to 4				⇨	Speed control (0)				

Pr **0.14** is used to select the required control mode of the drive as follows:

Setting	Function
0	Speed control
1	Torque control
2	Torque control with speed override
3	Coiler/uncoiler mode
4	Speed control with torque feed-forward

0.15 {2.04}	**Ramp mode select**									
RW	Txt								US	
⇳	FASt (0) Std (1)				⇨	Std (1)				

Pr **0.15** sets the ramp mode of the drive as shown below:

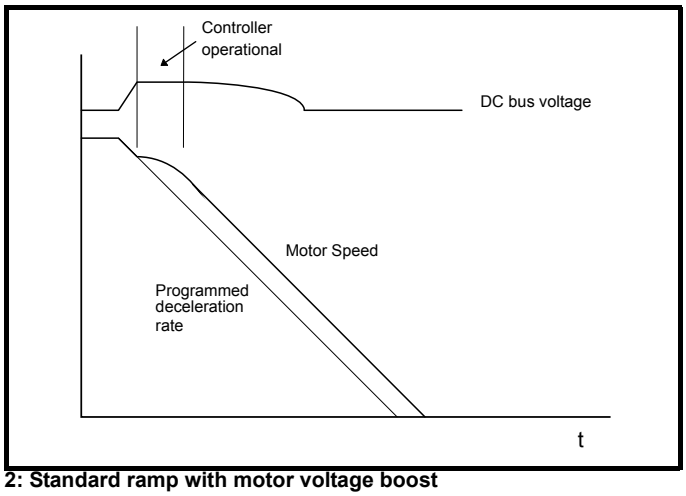
0: Fast ramp

Fast ramp is used where the deceleration follows the programmed deceleration rate subject to current limits. This mode must be used if a braking resistor is connected to the drive.

1: Standard ramp

Standard ramp is used. During deceleration, if the voltage rises to the standard ramp level (Pr **2.08**) it causes a controller to operate, the output of which changes the demanded load current in the motor. As the controller regulates the DC bus voltage, the motor deceleration increases as the speed approaches zero speed. When the motor deceleration rate

reaches the programmed deceleration rate the controller ceases to operate and the drive continues to decelerate at the programmed rate. If the standard ramp voltage (Pr **2.08**) is set lower than the nominal DC bus level the drive will not decelerate the motor, but it will coast to rest. The output of the ramp controller (when active) is a current demand that is fed to the torque producing current controller (Servo mode). The gain of these controllers can be modified with Pr **4.13** and Pr **4.14**.



2: Standard ramp with motor voltage boost

This mode is the same as normal standard ramp mode except that the motor voltage is boosted by 20 %. This increases the losses in the motor, dissipating some of the mechanical energy as heat giving faster deceleration.

0.16 {2.02}	Ramp enable								
RW	Bit							US	
⇳	OFF (0) or On (1)				⇨	On (1)			

Setting Pr **0.16** to 0 allows the user to disable the ramps. This is generally used when the drive is required to closely follow a speed reference which already contains acceleration and deceleration ramps.

0.17 {4.12}	Current demand filter								
RW	Uni							US	
⇳	0.0 to 25.0 ms				⇨	0.0			

A first order filter, with a filter defined by Pr **0.17**, is provided on the current demand to reduce acoustic noise and vibration produced as a result of position feedback quantization noise. The filter introduces a lag in the speed loop, and so the speed loop gains may need to be reduced to maintain stability as the filter is increased.

0.19 {7.11}	Analog input 2 mode								
RW	Txt							US	
⇳	0 to 6				⇨	VOLt (6)			

In modes 2 & 3 a current loop loss trip is generated if the current falls below 3 mA.

In modes 2 & 4 the analog input level goes to 0.0 % if the input current falls below 4 mA.

Pr value	Pr string	Mode	Comments
0	0-20	0 - 20 mA	
1	20-0	20 - 0 mA	
2	4-20.tr	4 - 20 mA with trip on loss	Trip if I < 3 mA
3	20-4.tr	20 - 4 mA with trip on loss	Trip if I < 3 mA
4	4-20	4 - 20 mA with no trip on loss	0.0 % if I ≤ 4 mA
5	20-4	20 – 4 mA with no trip on loss	100 % if I ≤ 4 mA
6	VOLt	Voltage mode	

0.20 {7.14}	Analog input 2 destination								
RW	Uni		DE				PT	US	
⇳	Pr **0.00** to Pr **21.51**				⇨	Pr **1.37**			

Pr **0.20** sets the destination of analog input 2.

0.21 {7.15}	Analog input 3 mode								
RW	Txt						PT	US	
⇳	0 to 9				⇨	th (8)			

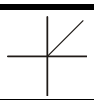
In modes 2 & 3 a current loop loss trip is generated if the current falls below 3 mA.

In modes 2 & 4 the analog input level goes to 0.0 % if the input current falls below 4 mA.

Pr value	Pr string	Mode	Comments
0	0-20	0 - 20 mA	
1	20-0	20 - 0 mA	
2	4-20.tr	4 - 20 mA with trip on loss	Trip if I < 3 mA
3	20-4.tr	20 - 4 mA with trip on loss	Trip if I < 3 mA
4	4-20	4 - 20 mA with no trip on loss	0.0% if I ≤ 4 mA
5	20-4	20 - 4 mA with no trip on loss	100 % if I ≤ 4 mA
6	VOLt	Voltage mode	
7	th.SC	Thermistor mode with short-circuit detection	Th trip if R > 3K3 Th reset if R < 1K8 ThS trip if R < 50R
8	th	Thermistor mode with no short-circuit detection	Th trip if R > 3K3 Th reset if R < 1K8
9	th.diSp	Thermistor mode with display only and no trip	

0.22 {1.10}	Bipolar reference select								
RW	Bit							US	
⇳	OFF (0) or On (1)				⇨	OFF (0)			

Pr **0.22** determines whether the reference is uni-polar or bi-polar as follows:

Pr 0.22	Function	
0	Unipolar speed/reference	
1	Bipolar speed/reference	

0.23 {1.05}	Jog reference								
RW	Uni							US	
⇳	0 to 4,000.0 rpm				⇨	0.0			

Enter the required value of jog/speed.

The speed limits affect the drive when jogging as follows:

Speed-limit parameter	Limit applies
Pr **0.01** Minimum reference clamp	No
Pr **0.02** Maximum reference clamp	Yes

0.24 {1.21}	Preset reference 1								
RW	Bi							US	
⇳	±SPEED_LIMIT_MAX rpm				⇨	0.0			

0.25 {1.22}	Preset reference 2								
RW	Bi							US	
⇳	±SPEED_LIMIT_MAX rpm				⇨	0.0			

0.26 {3.08}	Overspeed threshold								
RW	Uni							US	
⇳	0 to 40,000 rpm				⇨	0			

If the speed feedback (Pr **3.02**) exceeds this level in either direction, an overspeed trip is produced. If this parameter is set to zero, the overspeed threshold is automatically set to 120 % x SPEED_REF_MAX.

0.27 {3.34}	Drive encoder lines per revolution								
RW	Uni							US	
⇳	0 to 50,000				⇨	4096			

Enter in Pr **0.27** the number of lines per revolution of the drive encoder.

0.28 {6.13}	Keypad fwd/rev key enable								
RW	Bit							US	
⇳	OFF (0) or On (1)				⇨	OFF (0)			

When a keypad is installed, this parameter enables the forward/reverse key.

0.29 {11.36}	SMARTCARD parameter data								
RO	Uni					NC	PT	US	
⇳	0 to 999				⇨	0			

This parameter shows the number of the data block last transferred from a SMARTCARD to the drive.

0.30 {11.42}	Parameter copying								
RW	Txt					NC		*	
⇳	0 to 4				⇨	nonE (0)			

* Modes 1 and 2 are not user saved, Modes 0, 3 and 4 are user saved.

NOTE

If Pr **0.30** is equal to 1 or 2 this value is not transferred to the EEPROM or the drive. If Pr **0.30** is set to a 3 or 4 the value is transferred.

Pr String	Pr value	Comment
nonE	0	Inactive
rEAd	1	Read parameter set from the SMARTCARD
Prog	2	Programming a parameter set to the SMARTCARD
Auto	3	Auto save
boot	4	Boot mode

For further information, please refer to Chapter 10 *SMARTCARD Operation* .

0.31 {11.33}	Drive rated voltage								
RO	Txt					NC	PT		
⇳	200 V (0), 400 V (1)				⇨				

Pr **0.31** indicates the voltage rating of the drive.

0.32 {11.32}	Drive rated current								
RO	Uni					NC	PT		
⇳	0.00 to 9,999.99 A				⇨				

Pr **0.32** indicates the maximum current rating (which will allow for an overload of 300 %).

0.34 {11.30}	User security code								
RW	Uni					NC	PT		PS
⇳	0 to 999				⇨	0			

If any number other than 0 is programmed into this parameter, user security is applied so that no parameters except parameter **0.49** can be adjusted with the keypad. When this parameter is read via a keypad it appears as zero.

For further details refer to section 5.6.7 *Parameter access level and security* .

0.35 {11.24}	Serial comms mode								
RW	Txt							US	
⇳	AnSI (0), rtu (1), Lcd (2)				⇨	rtU (1)			

This parameter defines the communications protocol used by the EIA485 comms port on the drive. This parameter can be changed via the drive keypad, via a Solutions Module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original protocol. The master should wait at least 20 ms before send a new message using the new protocol. (Note: ANSI uses 7 data bits, 1 stop bit and even parity; Modbus RTU uses 8 data bits, 2 stops bits and no parity.)

Comms value	String	Communications mode
0	AnSI	ANSI
1	rtU	Modbus RTU protocol
2	Lcd	Modbus RTU protocol, but with an SM-Keypad Plus only

ANSIx3.28 protocol

Full details of the CT ANSI communications protocol are the *Advanced User Guide*.

Modbus RTU protocol

Full details of the CT implementation of Modbus RTU are given in the *Advanced User Guide*.

Modbus RTU protocol, but with an SM-Keypad Plus only

This setting is used for disabling communications access when the SM-Keypad Plus is used as a hardware key. See the *Keypad Plus User Guide* for more details.

0.36 {11.25}	Serial comms baud rate								
RW	Txt							US	
⇳	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8)*, 115200 (9)*	⇨	19200 (6)						

* only applicable to Modbus RTU mode

This parameter can be changed via the drive keypad, via a Solutions 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 send a new message using the new baud rate.

0.37 {11.23}	Serial address								
RW	Uni							US	
⇳	0 to 247	⇨	1						

Used to define the unique address for the drive for the serial interface. The drive is always a slave.

Modbus RTU

When the Modbus RTU protocol is used addresses between 0 and 247 are permitted. Address 0 is used to globally address all slaves, and so this address should not be set in this parameter

ANSI

When the ANSI protocol is used the first digit is the group and the second digit is the address within a group. The maximum permitted group number is 9 and the maximum permitted address within a group is 9. Therefore, Pr **0.37** is limited to 99 in this mode. The value 00 is used to globally address all slaves on the system, and x0 is used to address all slaves of group x, therefore these addresses should not be set in this parameter.

0.38 {4.13}	Current loop P gain								
RW	Uni							US	
⇳	0 to 30,000	⇨	200 V drive: 75 400 V drive: 150						

0.39 {4.14}	Current loop I gain								
RW	Uni							US	
⇳	0 to 30,000	⇨	200 V drive: 1,000 400 V drive: 2,000						

These parameters control the proportional and integral gains of the current controller used in the open loop drive. The current controller either provides current limits or closed loop torque control by modifying the drive output frequency. The control loop is also used in its torque mode during line power supply loss, or when the controlled mode standard ramp is active and the drive is decelerating, to regulate the flow of current into the drive.

0.40 {5.12}	Autotune								
RW	Uni								
⇳	0 to 6	⇨	0						

There are five autotune tests available, a short low speed test, a normal low speed test, an inertia measurement test, a stationary test and a minimal movement test. A normal low speed should be done where possible as the drive measures the stator resistance and inductance of the motor, and from these calculates the current loop gains. An inertia measurement test should be performed separately to a short low speed or normal low speed autotune.

- A short low speed test will rotate the motor by 2 electrical revolutions (i.e. up to 2 mechanical revolutions) in the forward direction, and measure the encoder phase angle. The motor must be free from load for this test.
- A normal low speed test will rotate the motor by 2 electrical revolutions (i.e. up to 2 mechanical revolutions) in the forward direction. This test measures the encoder phase angle and updates other parameters including the current loop gains. The motor must be free from load for this test.
- The inertia measurement test can measure the total inertia of the load and the motor. This is used to set the speed loop gains and to provide torque feed forward when required during acceleration. During the inertia measurement test the motor speed changes from $^1/_3$ to $^2/_3$ rated speed in the forward direction several times. The motor can be loaded with a constant torque load and still give an accurate result, however, non-linear loads and loads that change with speed will cause measurement errors.
- The stationary test only measures the motor resistance and inductance, and updates the current loop gain parameters. This test does not measure the encoder phase angle so this test needs to be done in conjunction with either the short low speed or minimal movement tests.
- The minimal movement test will move the motor through a small angle to measure the encoder phase angle. This test will operate correctly when the load is an inertia, and although a small amount of cogging and stiction is acceptable, this test cannot be used for a loaded motor.

To perform an autotune, set Pr **0.40** to 1 for a short low speed test, 2 for a normal low speed test, 3 for an inertia measurement test, 4 for a stationary test or 5 for a minimal movement test, and provide the drive with both an enable signal (on terminal 31) and a run signal (on terminal 26 or 27).

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, setting the drive enable parameter Pr **6.15** to OFF (0) or disabling the drive via the control word (Pr **6.42** & Pr **6.43**).

Setting Pr **0.40** to 6 will cause the drive to calculate the current loop gains based on the previously measured values of motor resistance and inductance. The drive does apply any voltage to the motor during this test. The drive will change Pr **0.40** back to 0 as soon as the calculations are complete (approximately 500 ms).

For further information refer to section *Pr 0.40 {5.12} Autotune* on page 69.

0.41 {5.18}	Maximum switching frequency								
RW	Txt				RA			US	
⇳	3 (0), 4 (1), 6 (2), 8 (3), 12 (4)	⇨	6 (2)						

This parameter defines the required switching frequency. The drive may automatically reduce the actual switching frequency (without changing this parameter) if the power stage becomes too hot. A thermal model of the IGBT junction temperature is used based on the heatsink temperature and an instantaneous temperature drop using the drive output current and switching frequency. The estimated IGBT junction temperature is displayed in Pr **7.34**. If the temperature exceeds 145 °C/ 170 °C (variant dependant) the switching frequency is reduced if this is possible (i.e >3 kHz). Reducing the switching frequency reduces the drive losses and the junction temperature displayed in Pr **7.34** also reduces. If the load condition persists the junction temperature may continue to rise again above 145 °C/170 °C (variant dependant) and the drive cannot reduce the switching frequency further the drive will initiate an 'O.ht1' trip. Every second the drive will attempt to restore the switching frequency to the level set in Pr **0.41**.

6.2.5 Motor parameters

0.42 {5.11}	No. of motor poles								
RW	Txt							US	
⇳	0 to 60 (Auto to 120 Pole)				⇨	6 POLE (3)			

This parameter must be set correctly for the vector control algorithms to operate correctly. When auto is selected the number of poles is set to 6.

0.43 {3.25}	Encoder phase angle								
RW	Uni							US	
⇳	0.0 to 359.9°				⇨	0.0			

The phase angle between the rotor flux in a servo motor and the encoder position is required for the motor to operate correctly. If the phase angle is known it can be set in this parameter by the user. Alternatively the drive can automatically measure the phase angle by performing a phasing test (see autotune in servo mode Pr **0.40**). When the test is complete the new value is written to this parameter. The encoder phase angle can be modified at any time and becomes effective immediately. This parameter has a factory default value of 0.0, but is not affected when defaults are loaded by the user.

0.44 {5.09}	Motor rated voltage								
RW	Uni				RA			US	
⇳	0 to AC_VOLTAGE_SET_MAX V				⇨	200 V drive: 230 400 V drive: EUR> 400 USA> 460			

0.45 {4.15}	Motor thermal filter								
RW	Uni							US	
⇳	0 to 3000.0				⇨	20.0			

Pr **0.45** is the motor thermal filter of the motor, and is used (along with the motor rated current Pr **0.46**, and total motor current Pr **0.12**) in the thermal model of the motor in applying thermal protection to the motor.

Setting this parameter to 0 disables the motor thermal protection.

0.46 {5.07}	Motor rated current								
RW	Uni				RA			US	
⇳	0 to RATED_CURRENT_MAX A				⇨	Drive rated current [**11.32**]			

Enter the name-plate value for the motor rated current.

0.48 {11.31}	User drive mode								
RO	Txt					NC	PT		
⇳	SErVO (3)				⇨	SErVO (3)			

This parameter is read only.

6.2.6 Status information

0.49 {11.44}	Security status								
RW	Txt						PT	US	
⇳	0 to 2				⇨	0			

This parameter controls access via the drive keypad as follows:

Value	String	Action
0	L1	Only menu 0 can be accessed
1	L2	All menus can be accessed
2	Loc	Lock user security when drive is reset. (This parameter is set to L1 after reset.)

The keypad can adjust this parameter even when user security is set.

0.50 {11.29}	Software version number								
RO	Uni					NC	PT		
⇳	1.00 to 99.99				⇨				

The parameter displays the software version of the drive.

0.51 {10.37}	Action on trip detection								
RW	Uni							US	
⇳	0 to 15				⇨	0			

Each bit in this parameter has the following functions:

Bit	Function
0	Stop on non-important trips
1	Disable braking IGBT trips
2	Disable phase loss trip
3	Disable braking resistor temperature monitoring failure detection

Stop on non-important trips
If bit 0 is set to zero then the drive simply trips when a non-important trip occurs. Non-important trips are: th, ths, Old1, cL2, cL3, SCL. If bit 0 is set to one the drive will stop before tripping when one of these trips is initiated, except in Regen mode where the drive trips immediately.

Disable braking IGBT trips
For details of braking IGBT trip mode see Pr **10.31**.

Disable phase loss trip
The user can disable the phase loss trip in 200 V drives as these are allowed to operate from a single phase supply. If bit 2 is set to zero the phase loss trip is enabled. If bit 2 is set to one the phase loss trip is disabled in 200 V drives only.

Disable braking resistor temperature monitoring failure detection
Digitax ST have an internal user install braking resistor with a thermistor to detect overheating of the resistor. If the resistor is not installed the trip can be disabled by setting Pr **10.37** (**0.51**) to 8. If the resistor is installed then no trip is produced unless the thermistor fails. With the resistor installed Pr **10.37** must be set to zero.

7 Running the motor

This chapter takes the new user through all the essential steps to running a motor for the first time.

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 **0.46** *Motor rated current*. This affects the thermal protection of the motor.

CAUTION

If the keypad mode has been used previously, ensure that the keypad reference has been set to 0 using the buttons as if the drive is started using the keypad it will run to the speed defined by the keypad reference (Pr **1.17**).

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. For minimal parameter settings to run, please see the relevant part of section 7.2 *Quick Start set-up* on page 64.

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

Drive control method	Requirements
Terminal mode	Drive Enable Speed reference Run forward or run reverse command
Keypad mode	Drive Enable
Serial communications	Drive Enable Serial communications link

Table 7-2 Minimum control connection requirements

Operating mode	Requirements
Closed loop servo mode	Permanent magnet motor with speed and position feedback

Speed and position feedback

Suitable devices are:

- Incremental encoder (A, B or F, D with or without Z) with commutation signals (U, V, W)
- Incremental encoder with forward and reverse outputs (F, R with or without Z) and commutation outputs (U, V, W)
- SINCOS encoder (with Stegmann Hiperface, EnDat or SSI communications protocols)
- EnDat absolute encoder

For Solutions Module terminal information see section 12.15 *Menus 15 and 16: Solutions Module set-up* on page 159 or the appropriate *Solutions Module Option User Guide*.

Figure 7-1 Minimum connections to get the motor running via Serial Communications (e.g. CTSoft)

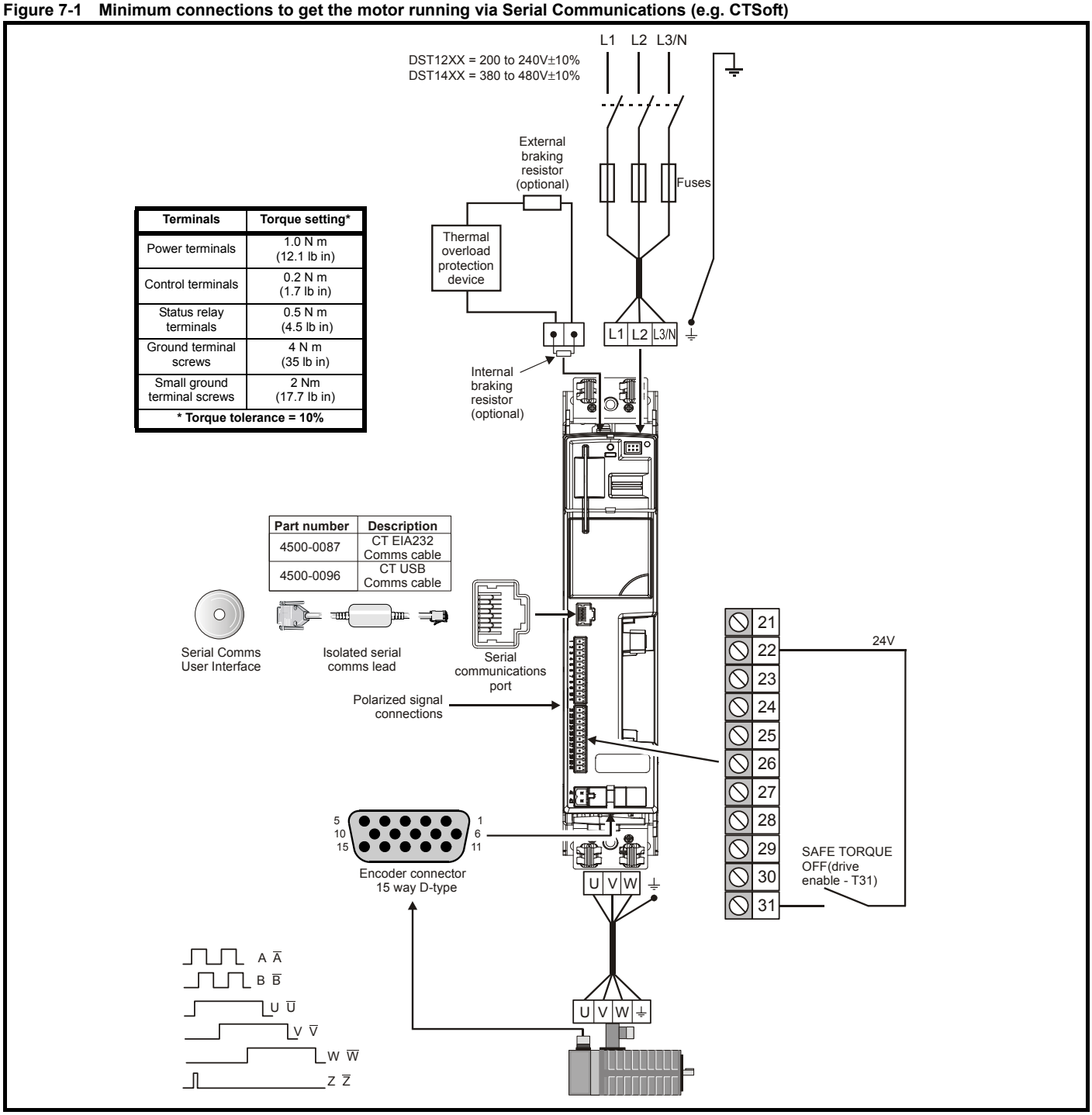
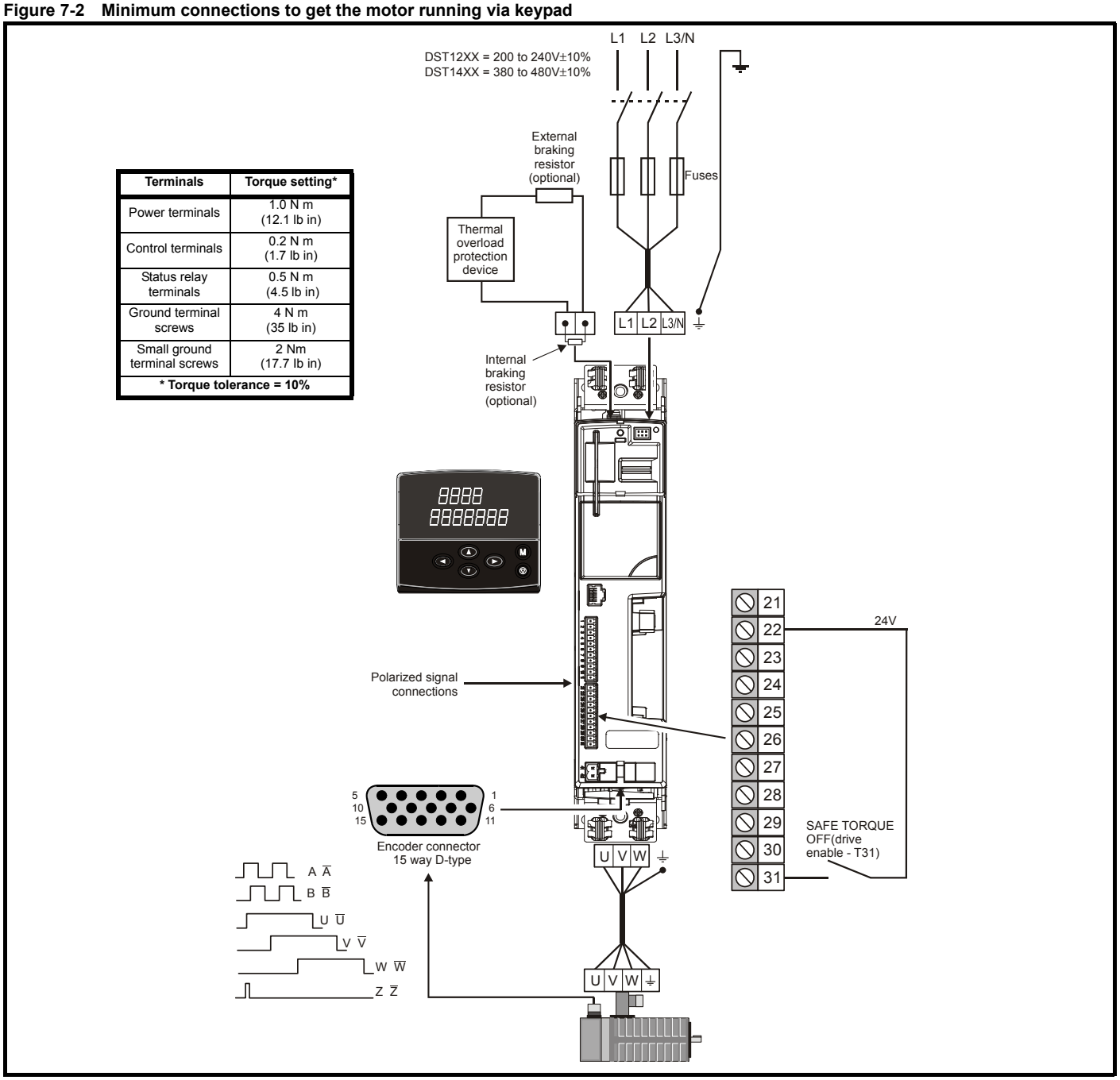
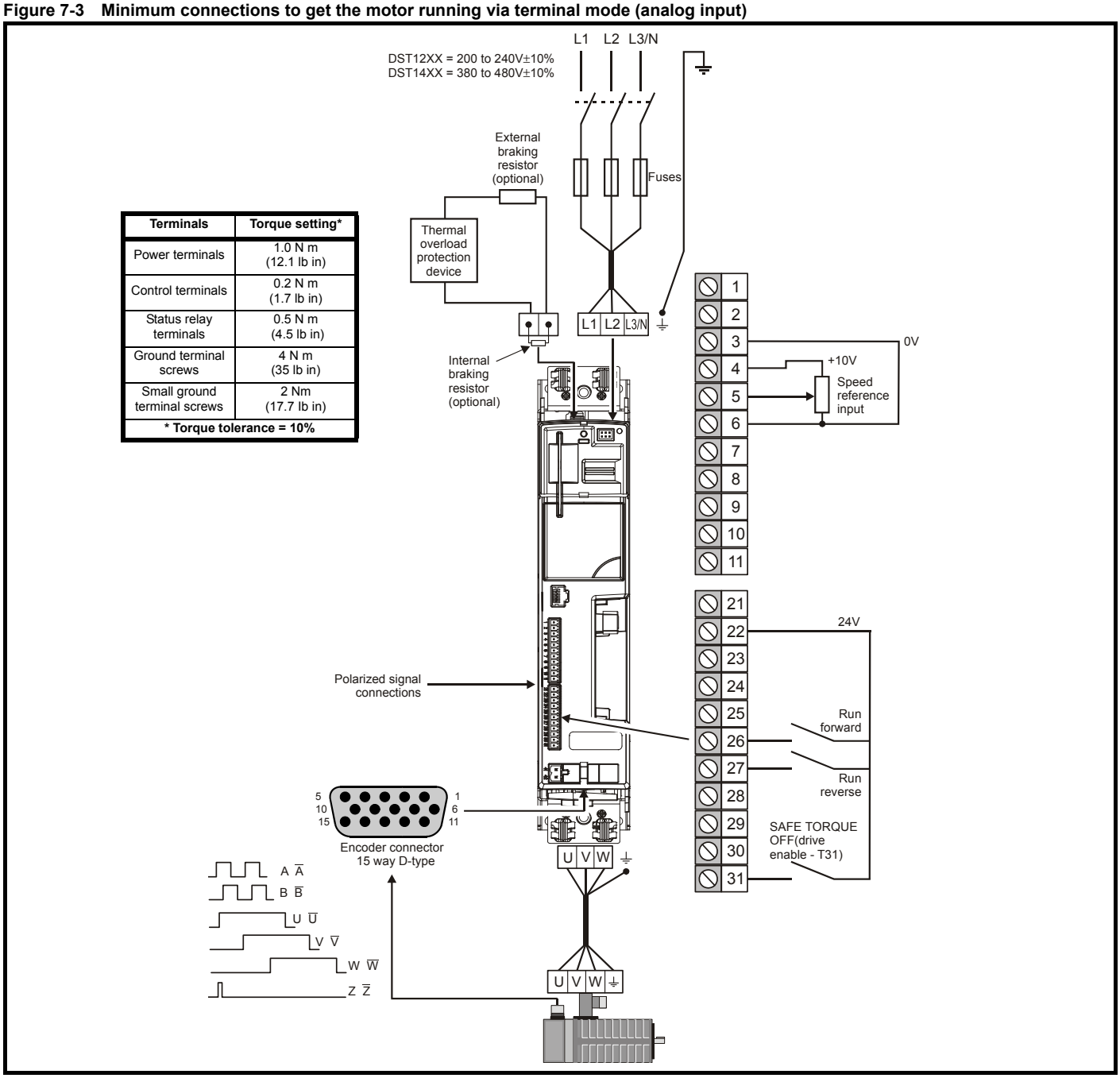


Figure 7-2 Minimum connections to get the motor running via keypad



Terminals	Torque setting*
Power terminals	1.0 N m (12.1 lb in)
Control terminals	0.2 N m (1.7 lb in)
Status relay terminals	0.5 N m (4.5 lb in)
Ground terminal screws	4 N m (35 lb in)
Small ground terminal screws	2 Nm (17.7 lb in)
*** Torque tolerance = 10%**	

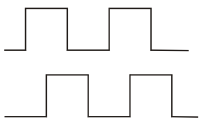
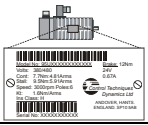
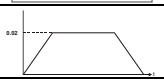
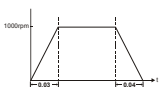
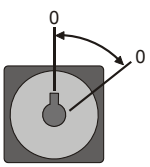
Figure 7-3 Minimum connections to get the motor running via terminal mode (analog input)



Terminals	Torque setting*
Power terminals	1.0 N m (12.1 lb in)
Control terminals	0.2 N m (1.7 lb in)
Status relay terminals	0.5 N m (4.5 lb in)
Ground terminal screws	4 N m (35 lb in)
Small ground terminal screws	2 Nm (17.7 lb in)
*** Torque tolerance = 10%**	

7.2 Quick Start set-up

For simplicity only an incremental quadrature encoder will be considered here. For information on setting up one of the other supported speed feedback devices, refer to section 7.3 *Setting up a feedback device* on page 65.

Action	Detail	
Before power-up	Ensure: • Drive Enable signal is not given (terminal 31) • Run signal is not given • Motor is connected • Feedback device is connected	
Power-up the drive	If a motor thermistor is not connected and the drive trips on 'th' set Pr **0.21** = VOLt and press the red reset button. Ensure: • SMARTCARD is installed (first power-up only) • Drive displays 'inh' If the drive trips, see Chapter 14 *Diagnostics* on page 183. * If no internal braking resistor is installed, then the drive will trip 'br.th'. If no internal braking resistor is required, then set Pr **0.51** to 8 to disable the trip.	
Set motor feedback parameters	**Incremental encoder basic set-up** Enter: • Drive encoder type in Pr. **3.38** = Ab.SErVO (3): Quadrature encoder with commutation outputs • Encoder power supply in Pr. **3.36** = 5 V (0), 8 V (1) or 15 V (2). **NOTE** If Ab encoder voltage is greater than 5 V, then the termination resistors must be disabled Pr **3.39** to 0. **CAUTION** Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device. • Drive encoder Pulses Per Revolution in Pr. **3.34** (set according to encoder) • Drive encoder termination resistor setting in Pr. **3.39**: **0** = A-A\, B-B\, Z-Z\ termination resistors disabled **1** = A-A\, B-B\, termination resistors enabled, Z-Z\ termination resistors disabled **2** = A-A\, B-B\, Z-Z\ termination resistors enabled	
Enter motor nameplate details	Enter: • Motor rated current in Pr **0.46** (A) Ensure that this equal to or less than the Heavy Duty rating of the drive otherwise It.AC trips may occur during the autotune. • Number of poles in Pr **0.42**	
Set maximum speed	Enter: • Maximum speed in Pr **0.02** (rpm)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **0.03** (s/1000 rpm) • Deceleration rate in Pr **0.04** (s/1000 rpm) (If braking resistor installed, set Pr **0.15** = FAST. Also ensure Pr **10.30** and Pr **10.31** are set correctly, otherwise premature 'It.br' trips may be seen.)	
Autotune	Digitax ST is able to perform a short low speed, a normal low speed or a minimal movement autotune. The motor must be at a standstill before an autotune is enabled. A normal low speed autotune will measure the encoder phase offset angle and calculate the current gains. **WARNING** The short low speed and normal low speed tests will rotate the motor by up to 2 revolutions in the direction selected, regardless of the reference provided. The minimal movement test will move the motor through an angle defined by Pr **5.38**. Once complete the motor will come to a standstill. 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. The motor must not be loaded when attempting an autotune. • The short low speed and normal low speed tests will rotate the motor by up to 2 rotations in the direction selected and the drive measures the encoder phase angle and updates the value in Pr **3.25**. The normal low speed test also measures the stator resistance, and inductance of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **0.38** and Pr **0.39** are updated. The short low speed test takes approximately 2 s and the normal low speed test approximately 20 s to complete. • The minimal movement autotune will move the motor through an angle defined by Pr **5.38**. The motor must not be loaded for this test although it will operate correctly when the load is an inertia. To perform an autotune: • Set Pr **0.40** = 1 for a short low speed autotune, Pr **0.40** = 2 for a normal low speed test or Pr **0.40** = 5 for a minimal movement autotune. • Close the run signal (terminal 26 or 27). • Close the Drive Enable signal (terminal 31). The lower display will flash 'Auto' and 'tunE' alternatively, while the drive is performing the test. • Wait for the drive to display 'rdy' or 'inh' and for the motor to come to a standstill. If the drive trips it cannot be reset until the drive enable signal (terminal 31) has been removed. See Chapter 14 *Diagnostics* on page 183. Remove the drive enabled and run signal from the drive.	
Save parameters	Enter 1000 in Pr **xx.00** Press the red reset button or toggle the reset digital input (ensure Pr **xx.00** returns to 0)	
Run	Drive is now ready to run	

7.3 Setting up a feedback device

This section shows the parameter settings which must be made to use each of the compatible encoder types with Digitax ST. For more information on the parameters listed here please refer to the *Advanced User Guide*.

7.3.1 Overview

Table 7-3 Parameters required for feedback device set-up

Parameter		Ab, Fd, Fr, Ab.SErVO, Fd.SErVO, Fr.SErVO, or SC encoders	SC.HiPEr encoder	SC.EndAt or SC.SSI encoders	EndAt encoder	SSI encoder
3.33	Drive encoder turns		✓ x	✓ x	✓ x	✓
3.34	Drive encoder lines per revolution	✓	✓ x	✓ x		
3.35	Drive encoder comms resolution		✓ x	✓ x	✓ x	✓
3.36	Drive encoder supply voltage*	✓	✓	✓	✓	✓
3.37	Drive encoder comms baud rate			✓	✓	✓
3.38	Drive encoder type	✓	✓	✓	✓	✓
3.41	Drive encoder auto configuration enable or SSI binary format select		✓	✓	✓	✓

✓ Information required

x Parameter can be set-up automatically by the drive through auto-configuration

* Pr **3.36**: If A + B >5 V then disable termination resistors

Table 7-3 shows a summary of the parameters required to set-up each feedback device. More detailed information follows.

7.3.2 Detailed feedback device set-up information

Standard quadrature encoder with or without commutation signals (A, B, Z or A, B, Z, U, V, W), or Sincos encoder without serial communications		
Encoder type	Pr **3.38**	**Ab** (0) for a quadrature encoder without commutation signals **Ab.SErVO** (3) for a quadrature encoder with commutation signals **SC** (6) for a Sincos encoder without serial communications
Encoder power supply voltage	Pr **3.36**	**5 V** (0), **8 V** (1) or **15 V** (2) **NOTE** If Ab encoder voltage is greater than 5 V, then the termination resistors must be disabled Pr **3.39** to 0
Encoder number of lines per revolution	Pr **3.34**	Set to the number of lines or sine waves per revolution of the encoder.
Encoder termination selection (Ab or Ab.SErVO only)	Pr **3.39**	**0** = A, B, Z termination resistors disabled **1** = A, B termination resistors enabled and Z termination resistors disabled **2** = A, B, Z termination resistors enabled
Encoder error detection level	Pr **3.40**	**0** = Error detection disable **1** = Wire break detection on A, B and Z inputs enabled **2** = Phase error detection (Ab.SErVO only) **3** = Wire break detection on A, B and Z inputs and phase error detection (Ab.SErVO only) Termination resistors must be enabled for wire break detection to operate

Incremental encoder with frequency and direction (F and D), or Forward and Reverse (CW and CCW) signals, with or without commutation signals		
Encoder type	Pr **3.38**	**Fd** (1) for frequency and direction signals without commutation signals **Fr** (2) for forward and reverse signals without commutation signals **Fd.SErVO** (4) for a frequency and direction encoder with commutation signals **Fr.SErVO** (5) for forward and reverse signals with commutation signals
Encoder power supply voltage	Pr **3.36**	**5 V** (0), **8 V** (1) or **15 V** (2) **NOTE** If Ab encoder voltage is greater than 5 V, then the termination resistors must be disabled Pr **3.39** to 0
Encoder number of lines per revolution	Pr **3.34**	Set to the number of pulses per revolution of the encoder divide by 2.
Encoder termination selection	Pr **3.39**	**0** = F or CW, D or CCW, Z termination resistors disabled **1** = F or CW, D or CCW termination resistors enabled and Z termination resistors disabled **2** = For CW, D or CCW, Z termination resistors enabled
Encoder error detection level	Pr **3.40**	**0** = Error detection disable **1** = Wire break detection on F & D or CW & CCW, and Z inputs enabled **2** = Phase error detection (Fd.SErVO and Fr.SErVO only) **3** = Wire break detection on F & D or CW & CCW, and Z inputs and Phase error detection (Fd.SErVO and Fr.SErVO only) Termination resistors must be enabled for wire break detection to operate

Absolute Sincos encoder with Hiperface or EnDat serial communications, or Absolute EnDat communications only encoder		
The Digitax ST is compatible with the following Hiperface encoders: SCS 60/70, SCM 60/70, SRS 50/60, SRM 50/60, SHS 170, LINCODER, SCS-KIT 101, SKS36, SKM36, SEK-53.		
Encoder type	Pr **3.38**	**SC.HiPEr** (7) for a Sincos encoder with Hiperface serial communications **EndAt** (8) for an EnDat communications only encoder **SC.EndAt** (9) for a Sincos encoder with EnDat serial communications
Encoder power supply voltage	Pr **3.36**	**5 V** (0), **8 V** (1) or **15 V** (2)
Encoder auto configure enable	Pr **3.41**	Setting this to 1 automatically sets up the following parameters: Pr **3.33** Encoder turn bits Pr **3.34** Encoder number of lines of revolution (SC.HiPEr and SC.EndAt only) * Pr **3.35** Encoder single turn comms resolution Alternatively these parameters can be entered manually.
Encoder comms baud rate (EndAt and SC.EndAt only)	Pr **3.37**	**100** = 100 k, **200** = 200 k, **300** = 300 k, **500** = 500 k, **1000** = 1M, **1500** = 1.5 M, or **2000** = 2 M
Encoder error detection level (SC.HiPEr and SC.EndAt only)	Pr **3.40**	**0** = Error detection disabled **1** = Wire break detection on Sin and Cos inputs **2** = Phase error detection **3** = Wire break detection on Sin and Cos inputs and phase error detection

Absolute SSI communications only encoder, or Absolute Sincos encoder with SSI		
Encoder type	Pr **3.38**	**SSI** (10) for a SSI communications only encoder **SC.SSI** (11) for a Sincos encoder with SSI
Encoder power supply voltage	Pr **3.36**	**5 V** (0), **8 V** (1) or **15 V** (2) **NOTE** If Ab encoder voltage is greater than 5 V, then the termination resistors must be disabled Pr **3.39** to 0
Encoder number of lines per revolution. (SC.SSI only)	Pr **3.34**	Set to the number of sine waves per revolution of the encoder.
SSI binary format select	Pr **3.41**	**OFF** (0) for gray code, or **On** (1) for binary format SSI encoders
Encoder turn bits	Pr **3.33**	Set to the number of turn bits for the encoder (this is usually 12 bits for a SSI encoder)
Encoder single turn comms resolution	Pr **3.35**	Set to the single turn comms resolution for the encoder (this is usually 13 bits for a SSI encoder)
Encoder comms baud rate	Pr **3.37**	**100** = 100 k, **200** = 200 k, **300** = 300 k, **500** = 500 k, **1000** = 1 M, **1500** = 1.5 M, or **2000** = 2 M
Encoder error detection level	Pr **3.40**	**0** = Error detection disabled **1** = Wire break detection on Sin and Cos inputs (SC.SSI only) **2** = Phase error detection (SC.SSI only) **3** = Wire break detection and phase error detection (SC.SSI only) **4** = SSI power supply bit monitor **5** = SSI power supply bit monitor and wire break detection (SC.SSI only) **6** = SSI power supply bit monitor and phase error detection (SC.SSI only) **7** = SSI power supply bit monitor, wire break detection and phase error detection (SC.SSI only)

UVW commutation signal only encoders*		
Encoder type	Pr **3.38**	Ab.servo
Encoder power supply voltage	Pr **3.36**	**5 V** (0), **8 V** (1) or **15 V** (2)
Encoder number of lines per revolution	Pr **3.34**	Set to zero
Encoder error detection level	Pr **3.40**	Set to zero to disable wire break detection

* This feedback device provides very low resolution feedback and should not be used for applications requiring a high level of performance.

7.3.3 Restriction of encoder number of lines per revolution

Although Pr **3.34** can be set to any value from 0 to 50,000 there are restrictions on the values actually used by the drive. These restrictions are dependent on the software version as follows:

Software version V01.06.01 and later

Table 7-4 Restrictions of drive encoder lines per revolution with software version V01.06.01 and later

Position feedback device	Equivalent Lines per revolution used by the drive
Ab, Fd, Fr, Ab.SErVO, Fd.SErVO, Fr.SerVO, SC	The drive uses the value in Pr **3.34**.
SC.HiPEr, SC.EndAt, SC.SSI (rotary encoders)	If Pr **3.34** ≤1, the drive uses the value of 1. If 1< Pr **3.34** <32,768, the drive uses the value in Pr **3.34** rounded down to nearest value that is a power of 2. If Pr **3.34** ≥32,768, the drive uses the value of 32,768.
SC.HiPEr, SC.EndAt, SC.SSI (linear encoders	The drive uses the value in Pr **3.34**.

At power-up Pr **3.48** is initially zero, but is set to one when the drive encoder and any encoders connected to any Solutions Modules have been initialized. The drive cannot be enabled until this parameter is one.

Encoder initialization will occur as follows:

- At drive power-up
- When requested by the user via Pr **3.47**
- When trips PS.24V, Enc1 to Enc8, or Enc11 to Enc17 trips are reset
- The encoder number of lines per revolution (Pr **3.34**) or the number of motor poles (Pr **5.11** and Pr **21.11**) are changed (software version V01.08.00 and later).

Initialization causes an encoder with communications to be re-initialized and auto-configuration to be performed if selected. After initialization Ab.SErVO, Fd.SErVO and Fr.SErVO encoders will use the UVW commutations signals to give position feedback for the first 120° (electrical) of rotation when the motor is restarted.

7.4 Setting up a buffered encoder output

The Digitax ST has a buffered encoder output, which derives its position from the drive encoder input.

The buffered encoder output is sourced from the drive encoder input and can be any incremental type or any SINCOS type.

NOTE

No output is available if EndAt only or SSI communications only encoders are used

If a SINCOS is used as the source the buffered output is derived from the zero crossings of the sine waves and does not include interpolated information. The buffered encoder output provides an output with minimal delay from the drive encoder input (maximum delay is 0.5 µs). If the source encoder does not have a marker pulse then no marker pulse can be obtained from the buffered encoder output.

This section shows the parameter settings required for the buffered Encoder output.

Pr **3.54** selects the type of buffered encoder output as shown in Table 7-5:

Table 7-5 Buffered encoder output type

Pr 3.54	String	Mode
0	Ab	Quadrature outputs
1	Fd	Frequency and direction outputs
2	Fr	Forward and reverse outputs
3	Ab.L	Quadrature outputs with marker lock
4	Fd.L	Frequency and direction outputs with marker lock

The buffered encoder output can be scaled using Pr **3.52** as shown in the table below:

Pr 3.52	Ratio
0.0312	1/32
0.0625	1/16
0.1250	1/8
0.2500	1/4
0.5000	1/2
1.0000	1

For more information on the parameters mentioned above please refer to the *Advanced User Guide*.

8 Optimization

This chapter takes the user through methods of optimizing the product set-up, maximizing performance. The auto-tuning features of the drive simplify this task.

8.1 Motor map parameters

8.1.1 Motor control

Pr 0.46 {5.07} 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
- Motor thermal overload protection

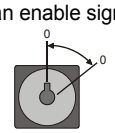
Pr 0.42 {5.11} Motor number of poles	**Defines the number of motor poles**

The motor number of poles parameter defines the number of electrical revolutions in one whole mechanical revolution of the motor. This parameter must be set correctly for the control algorithms to operate correctly. When Pr **0.42** is set to "Auto" the number of poles is 6.

Pr 0.40 {5.12} Autotune

There are five autotune tests available, a short low speed test, a normal low speed test, an inertia measurement test, a stationary test to set up current controller gains and a minimal movement phasing test. A normal low speed should be done where possible as the drive measures the stator resistance and inductance of the motor, and from these calculates the current loop gains. An inertia measurement test should be performed separately to a short low speed or normal low speed autotune.

- A short low speed test will rotate the motor by 2 electrical revolutions (i.e. up to 2 mechanical revolutions) in the direction selected. The drive applies rated current to the motor during the test and measures the encoder phase angle (Pr **3.25**). The phase angle measurement is taken when the motor has stopped at the end of the test, therefore there must be no load on the motor when it is at rest for the correct angle to be measured. This test takes approximately 2 seconds to complete and can only be used where the rotor settles to a stable position in a short time. To perform a short low speed autotune, set Pr **0.40** to 1, and provide the drive with both an enable signal (on terminal 31) and a run signal (on terminal 26 or 27).
- A normal low speed test will rotate the motor by 2 electrical revolutions (i.e. up to 2 mechanical revolutions) in the direction selected. The drive applies rated current to the motor during the test and measures the encoder phase angle (Pr **3.25**). The phase angle measurement is taken when the motor has stopped at the end of the test, therefore there must be no load on the motor when it is at rest for the correct angle to be measured. The motor resistance (Pr **5.17**) and inductance (Pr **5.24**) are then measured, and the values are used to set up the current loop gains (Pr **0.38** {**4.13**} and Pr **0.39** {**4.14**}). The whole test takes approximately 20 seconds and can be used with motors that take time to settle after the rotor has moved. During the motor inductance measurement the drive applies current pulses to the motor that produces flux that opposes the flux produced by the magnets. The maximum current applied is a quarter of rated current (Pr **0.46**). This current is unlikely to affect the motor magnets, however, if this level of current could permanently de-magnetise the magnets the rated current should be set to a lower level for the tests to avoid this. To perform a normal low speed autotune, set Pr **0.40** to 2, and provide the drive with both an enable signal (on terminal 31) and a run signal (on terminal 26 or 27).



- The inertia measurement test can measure the total inertia of the load and the motor. This is used to set the speed loop gains (see *Speed loop gains*) and to provide torque feed-forwards when required during acceleration.

  During the inertia measurement test the drive attempts to accelerate the motor in the direction selected up to $^{3}/_{4}$ x rated load rpm and then back to standstill. The drive uses rated torque/16, but if the motor cannot be accelerated to the required speed the drive then increases the torque progressively to x$^{1}/_{8}$, x$^{1}/_{4}$, x$^{1}/_{2}$ and x1 rated torque. If the required speed is not achieved on the final attempt the test is aborted and a tunE1 trip is initiated. If the test is successful the acceleration and deceleration times are used to calculate the motor and load inertia which is then written to Pr **3.18**. The value of the value of motor torque per amp in Pr **5.32** and the motor rated speed in Pr **5.08** must be set up correctly before performing an inertia measurement test. To perform an Inertia measurement autotune, set Pr **0.40** to 3, and provide the drive with both an enable signal (on terminal 31) and a run signal (on terminal 26 or 27).
- The stationary test to set up current controller gains measures the stator resistance and the transient inductance of the motor, calculates the current loop gains and updates the current loop gain parameters. This test does not measure the encoder phase angle. This test should only be performed when the correct phasing angle has been set in Pr **0.43**. If the phasing angle is not correct the motor may move and the results may be incorrect. To perform a stationary test to set up current controller gains, set Pr **0.40** to 4, and provide the drive with both an enable signal (on terminal 31) and a run signal (on terminal 26 or 27).
- A minimal movement phasing test can measure the encoder phase offset by moving the motor through a small angle. Short current pulses are applied to the motor to produce a small movement and then to move the motor back to the original position. The size and length of the pulses are gradually increased (up to a maximum of motor rated current) until the movement is approximately at the level defined by Pr **5.38** electrical degrees. The resulting movements are used to estimate the phase angle. To perform a minimal movement phasing test, set Pr **0.40** to 5, and provide the drive with both an enable signal (on terminal 31) and a run signal (on terminal 26 or 27).

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, setting the drive enable parameter Pr **6.15** to OFF (0) or disabling the drive via the control word (Pr **6.42** & Pr **6.43**).

Current loop gains (Pr 0.38 {4.13} / Pr 0.39 {4.14})

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 proportional gain (Pr **4.13**) is the most critical value in controlling the performance. The values for the current loop gains can be calculated by one of the following:

- During a stationary or rotating autotune (see *Autotune Pr **0.40***, earlier in this table) the drive measures the stator resistance (Pr **5.17**) and transient inductance (Pr **5.24**) of the motor and calculates the current loop gains.
- By setting Pr **0.40** to 6 the drive will calculate the current loop gains from the values of stator resistance (Pr **5.17**) and transient inductance (Pr **5.24**) set in the drive.

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 closed-loop induction motor applications) the integral gain may need to have a significantly higher value.

Speed loop gains (Pr 0.07 {3.10}, Pr 0.08 {3.11}, Pr 0.09 {3.12})

The speed loop gains control the response of the speed controller to a change in speed demand. The speed 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 speed controller with Pr **3.16**. If Pr **3.16** = 0, gains Kp1, Ki1 and Kd1 (Pr **0.07** to Pr **0.09**) are used, and if Pr **3.16** = 1, gains Kp2, Ki2 and Kd2 (Pr **3.13** to Pr **3.15**) are used. Pr **3.16** may be changed when the drive is enabled or disabled. If the load is predominantly a constant inertia and constant torque, the drive can calculate the required Kp and Ki gains to give a required compliance angle or bandwidth dependant on the setting of Pr **3.17**.

*Proportional gain (Kp), Pr **0.07 {3.10}** and Pr **3.13***

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 speed error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual speeds. This effect, called regulation, depends on the level of the proportional gain, the higher the gain the smaller the speed error for a given load. If the proportional gain is too high either the acoustic noise produced by speed feedback quantization becomes unacceptable, or the closed-loop stability limit is reached.

*Integral gain (Ki), Pr **0.08 {3.11}** and Pr **3.14***

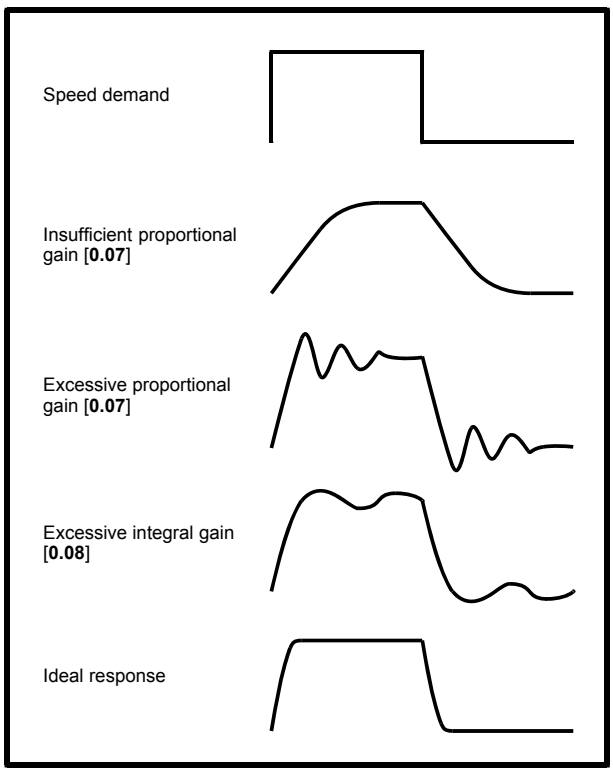
The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of 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.

*Differential gain (Kd), Pr **0.09 {3.12}** and Pr **3.15***

The differential gain is provided in the feedback of the speed 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.

There are three methods of tuning the speed loop gains dependant on the setting of Pr **3.17**:

1. Pr **3.17** = 0, User set-up.
   This involves the connecting of an oscilloscope to analog output 1 to monitor the speed feedback.
   Give the drive a step change in speed 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 speed overshoots and then reduced slightly.
   The integral gain (Ki) should then be increased up to the point where the speed 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 matches the ideal response as shown.
   The diagram shows the effect of incorrect P and I gain settings as well as the ideal response.
2. Pr **3.17** = 1, Bandwidth set-up
   If bandwidth based set-up is required, the drive can calculate Kp and Ki if the following parameters are set up correctly:
   - Pr **3.20** - Required bandwidth,
   - Pr **3.21** - Required damping factor,
   - Pr **5.32** - Motor torque per amp (Kt).
   - Pr **3.18** - Motor and load inertia. The drive can be made to measure the motor and load inertia by performing an inertia measurement autotune (see Autotune Pr **0.40**, earlier in this table).
3. Pr **3.17** = 2, Compliance angle set-up
   If compliance angle based set-up is required, the drive can calculate Kp and Ki if the following parameters are set up correctly:
   - Pr **3.19** - Required compliance angle,
   - Pr **3.21** - Required damping factor,
   - Pr **5.32** - Motor torque per amp (Kt).
   - Pr **3.18** - Motor and load inertia The drive can be made to measure the motor and load inertia by performing an inertia measurement autotune (see Autotune Pr **0.40**, earlier in this table).



9 EtherCAT interface

9.1 Features

- Standard RJ45 with support for shielded twisted pair, half-duplex / full-duplex and 10Mbs / 100Mbs connectivity
- Dual 100 Mbps EtherCAT interfaces for use in line topologies i.e. daisy chaining
- Control loop synchronization
- Control cycle times down to 250 µs
- Configured Station Alias
- CANopen over EtherCAT (CoE) which includes:
  Support of CANopen DSP-402 (Device Profile for Drives and Motion)
  - Cyclic sync position mode
  - Interpolated position mode
  - Velocity mode
  - Profile torque mode
  - Homing mode
  - Two transmit and two receive PDOs
  - SDO access to all profile objects and drive parameters
  - Two digital inputs available for use in homing mode
  - EoE (Ethernet over EtherCAT)

9.2 What is EtherCAT?

EtherCAT is an open high performance Ethernet-based fieldbus system that overcomes the system limitations of other Ethernet solutions. The Ethernet packet is no longer received, then interpreted and copied as process data at every connection; instead the Ethernet frame is processed on the fly. The development goal of EtherCAT was to apply Ethernet to automation applications that require short data update times (also called cycle times) with low communication jitter (for synchronization purposes) and low hardware costs. Typical application fields for EtherCAT are machine controls (e.g. semiconductor tools, metal forming, packaging, injection moulding, assembly systems, printing machines, robotics and many others).

9.3 EtherCAT interface information

9.3.1 Bus media

The EtherCAT interface incorporates two 100 BASE-TX RJ45 interfaces.

9.3.2 Cabling considerations

To ensure long-term reliability it is recommended that any cables used to connect a system together be tested using a suitable Ethernet cable tester, this is of particular importance when cables are constructed on site.

9.3.3 Cable

Cables should be shielded and as a minimum, meet TIA Cat 5e requirements.

NOTE

Cabling issues are the single biggest cause of network downtime. Ensure cabling is correctly routed, wiring is correct, connectors are correctly installed and any switches or routers used are rated for industrial use. Office grade Ethernet equipment does not generally offer the same degree of noise immunity as equipment intended for industrial use.

9.3.4 Maximum network length

The main restriction imposed on Ethernet cabling is the length of a single segment of cable. The EtherCAT interface has two 100BASE-TX Ethernet ports, which support segment lengths of up to 100 m. This means that the maximum cable length which can be used between one EtherCAT interface port and another 100BASE-TX port is 100 m however it is not recommended that the full 100 m cable length is used. The total network length is not restricted by the Ethernet standard but depends on the number of devices on the network and the transmission media (copper, fiber optic, etc.).

NOTE

The EtherCAT system designer must consider the impact that the selected network structure will have on performance.

9.4 EtherCAT interface terminal descriptions

The EtherCAT interface has two RJ45 Ethernet ports for the EtherCAT network. There are also two digital inputs available for use in Homing Mode.

Figure 9-1 EtherCAT connection

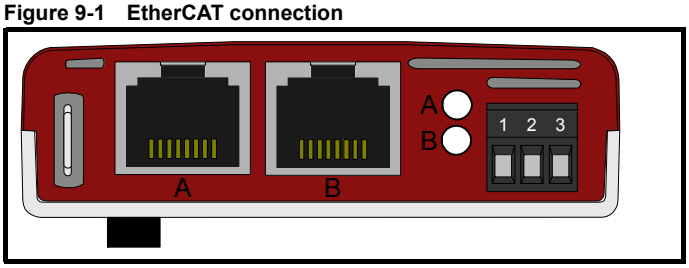


Table 9-1 EtherCAT terminal descriptions

Pin	A - IN	Pin	B - OUT	Digital Inputs	Function
1	Transmit +	1	Transmit +	1	0V Common
2	Transmit -	2	Transmit -	2	Digital input 0
3	Receive +	3	Receive +	3	Digital input 1
4	Not used	4	Not used		
5	Not used	5	Not used		
6	Receive -	6	Receive -		
7	Not used	7	Not used		
8	Not used	8	Not used		

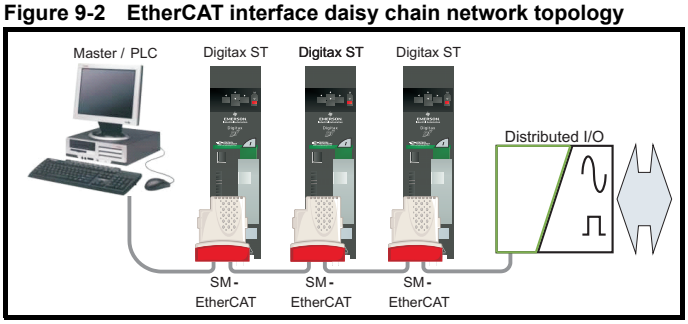
9.5 Module grounding

EtherCAT interface is supplied with a grounding tag on the module that should be connected to the closest possible grounding point using the minimum length of cable. This will greatly improve the noise immunity of the module.

9.6 Network topology

Emerson Industrial Automation recommend implementing daisy chaining on EtherCAT networks (see Figure 9-2). Other Ethernet network topologies can be used but care must be taken to ensure that the system still operates within the constraints specified by the designer.

Figure 9-2 EtherCAT interface daisy chain network topology



9.7 Minimum node-to-node cable length

There is no minimum length of cable recommended in the Ethernet standards. To avoid possible problems it is recommended that you allow sufficient cable length to ensure good bend radii on cables and avoid unnecessary strain on connectors.

9.8 Quick start guide

This section is intended to provide a generic guide for setting up EtherCAT interface with a master/controller PLC. It will cover the basic steps required to get cyclic data communicating using the CANopen over EtherCAT (CoE) protocol on the EtherCAT interface.

9.8.1 PDO test mappings

For the purpose of the example this section will follow the steps required to set up cyclic communications using one RxPDO and two TxPDOs. These PDOs will consist of the mappings shown in Table 9-2:

Table 9-2 PDO test mappings

	RxPDO1	TxPDO1	TxPDO6
Mapping 1	0x6040 (*controlword*) (16-bits)	0x6041 (*statusword*) (16-bits)	Pr **18.22** (16-bits)
Mapping 2	0x6042 (*vl_target_velocity*) (16-bits)	0x6064 (*position_actual_value*) (32-bits)	Pr **20.21** (32-bits)
Mapping 3	Pr **20.21** (32-bits)	N/A	N/A

NOTE

It is strongly recommended that the latest firmware be used where possible to ensure that all features are supported.

Due to the large number of different masters that support CoE, details cannot be provided for a specific master. Generic support is available through your supplier or local Emerson Industrial Automation centre. Before contacting your supplier or local Emerson Industrial Automation centre for support please ensure you have read Chapter 14 *Diagnostics* on page 183 of this manual and have checked that the SDO/PDO configurations are correct.

9.8.2 EtherCAT XML file

Emerson Industrial Automation provides EtherCAT device description files (in the form of .xml files). These files provide the master with information about the EtherCAT interface and drive configuration to aid with its configuration. These files can be obtained from your local Emerson Industrial Automation Centre or supplier. They should be placed in the directory specified by the master e.g. when using TwinCAT this could be C:\TwinCAT\Io\EtherCAT.

NOTE

The master may have to be re-started for the file to be loaded.

9.8.3 Configuring the EtherCAT interface for cyclic communications

Unlike other Emerson Industrial Automation fieldbus communication protocols, CoE does not require that any module parameters be changed in order to achieve communications. The baud rate of the network is fixed and the module is automatically allocated an address.

To check that the ethernet cable connected to the EtherCAT interface on the drive is connected correctly, look at the LED on the front of the EtherCAT interface relating to the connector being used, if this light is a solid green color then a link is established with the master, if this light is off then check the cabling and also check that the master has started communications.

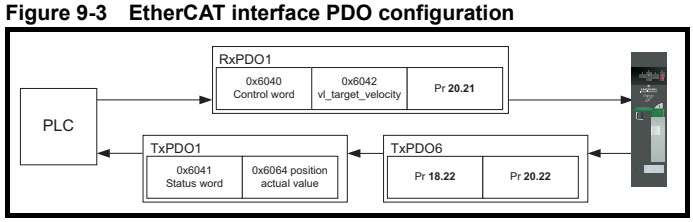
In the master, scan the network ensuring that the EtherCAT interface is connected correctly to the master. If the network is configured correctly the EtherCAT node(s) should be visible in the PLC master.

Decide on the input / output data you wish to send cyclically (objects and/or parameters).

Cyclic data is implemented on CoE networks by using "Process Data Objects" or PDOs. Separate data objects are used for receiving (TxPDOs - from the slave to the master) and transmitting (RxPDOs - from the master to the slave) data.

These PDOs contain the cyclic data (objects and/or parameters), the RxPDOs available are 1, 2, 6 and 22, the TxPDOs available are 1, 2, 3, 6 and 22 (for more information on these PDOs including default mappings please see section 9.16.2 *RxPDO mappings* on page 77 and section 9.16.3 *TxPDO mappings* on page 77).

Figure 9-3 EtherCAT interface PDO configuration



RxPDO1, TxPDO1 and TxPDO6 will need to be enabled in the master. Once enabled you will need to add mappings to the PDOs.

The format used when mapping objects to PDOs is as follows:

- Index: Object index number (0x0000)
- Sub-index: Object sub-index number (0x00)
- Size: Dependant on the size (in bytes) of the object to be mapped (range: 1-4)

The format used when mapping drive parameters to PDOs is as follows:

- Index: 0x2000 + menu number
- Sub-index: 0x00 + parameter number
- Size: Dependant on the size (in bytes) of the object to be mapped (range: 1-4)

For example Pr **20.21** would be index 0x2014, sub-index 0x15 and the size would be 4 (the parameter is a 32-bit signed value).

NOTE

The values are normally expressed in hexadecimal, so care must be taken to enter the correct parameter number.

For this example the following objects will need to be set in order to achieve the mappings of the parameters/objects in the PDOs.

Table 9-3 Cyclic data mapping configuration

RxPDO1:		TxPDO1:		TxPDO6:	
Object:	0x1600	Object:	0x1A00	Object:	0x1A05
Sub-index:	0x00	Sub-index:	0x00	Sub-index:	0x00
Size:	1	Size:	1	Size:	1
Value:	3	Value:	2	Value:	2
Sub-index:	0x01	Sub-index:	0x01	Sub-index:	0x01
Size:	4	Size:	4	Size:	4
Value:	0x60400010	Value:	0x60410010	Value:	0x20121610
Sub-index:	0x02	Sub-index:	0x02	Sub-index:	0x02
Size:	4	Size:	4	Size:	4
Value:	0x60420010	Value:	0x60640020	Value:	0x20141620
Sub-index:	0x03	Not Used		Not Used	
Size:	4				
Value:	0x20141520				

NOTE

The format used to define the value of a mapped object is as follows:
Bit 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).
Bit 8 to 15: Sub-index of the mapped object (if a gap, zero).
Bit 16 to 31: Index of the mapped object (if a gap, zero).

NOTE

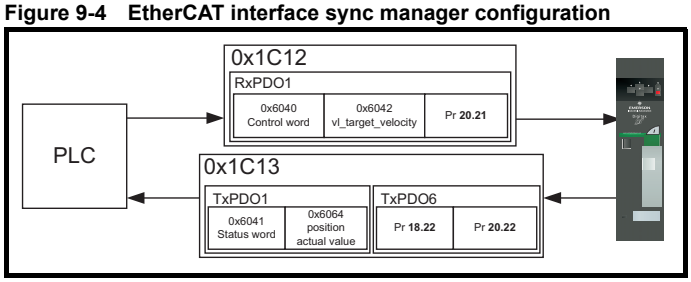
The maximum number of mappings in one PDO is five. There are no restrictions on the data length of these 5 parameters (i.e. It is possible to map five, 32-bit parameters in one PDO). It is also possible to use a maximum of two RxPDOs and two TxPDOs.

9.8.4 Configuring the sync managers

The sync manager is used to control the transmission of CANopen PDOs over the EtherCAT network.

The following objects 0x1C12 - sync manager 2 PDO assignment (RxPDO) and 0x1C13 - sync manager 3 PDO assignment (TxPDO) are required to assign PDOs to the synchronization task. For the purpose of the example assign one RxPDO to sync manager 2 and two TxPDOs to sync manager 3.

Figure 9-4 EtherCAT interface sync manager configuration



Assigning RxPDO to the sync manager

To assign RxPDO1 to sync manager 2 PDO assignment set the values below to the following objects:

- Index: 0x1C12
- Sub index:0x00
- Size: 1
- Value: 1

Setting object 0x1C12, sub-index 0 to a value of 1 (as above) indicates that one RxPDO will be assigned to the sync manager 2 assignment.

- Index: 0x1C12
- Sub index:0x01
- Size: 2
- Value: 0x1600

Setting object 0x1C12, sub-index 1 to a value of 0x1600 (as above) maps RxPDO1 to the process data output sync.

Assigning TxPDO to the sync manager

To assign TxPDO1 to sync manager 3 PDO assignment set the values below to the following objects:

- Index: 0x1C13
- Sub index:0x00
- Size: 1
- Value: 2

Setting object 0x1C13, sub-index 0 to a value of 2 (as above) indicates that two TxPDOs will be assigned to the sync manager 3 assignment.

- Index: 0x1C13
- Sub index:0x01
- Size: 2
- Value: 0x1A00

- Index: 0x1C13
- Sub index:0x02
- Size: 2
- Value: 0x1A05

Setting object 0x1C13, sub-index 1 to a value of 0x1A00 and sub-index 2 to a value of 0x1A05 (as above) maps TxPDO1 and TxPDO6 to the process data input sync.

Download the configuration to the master.

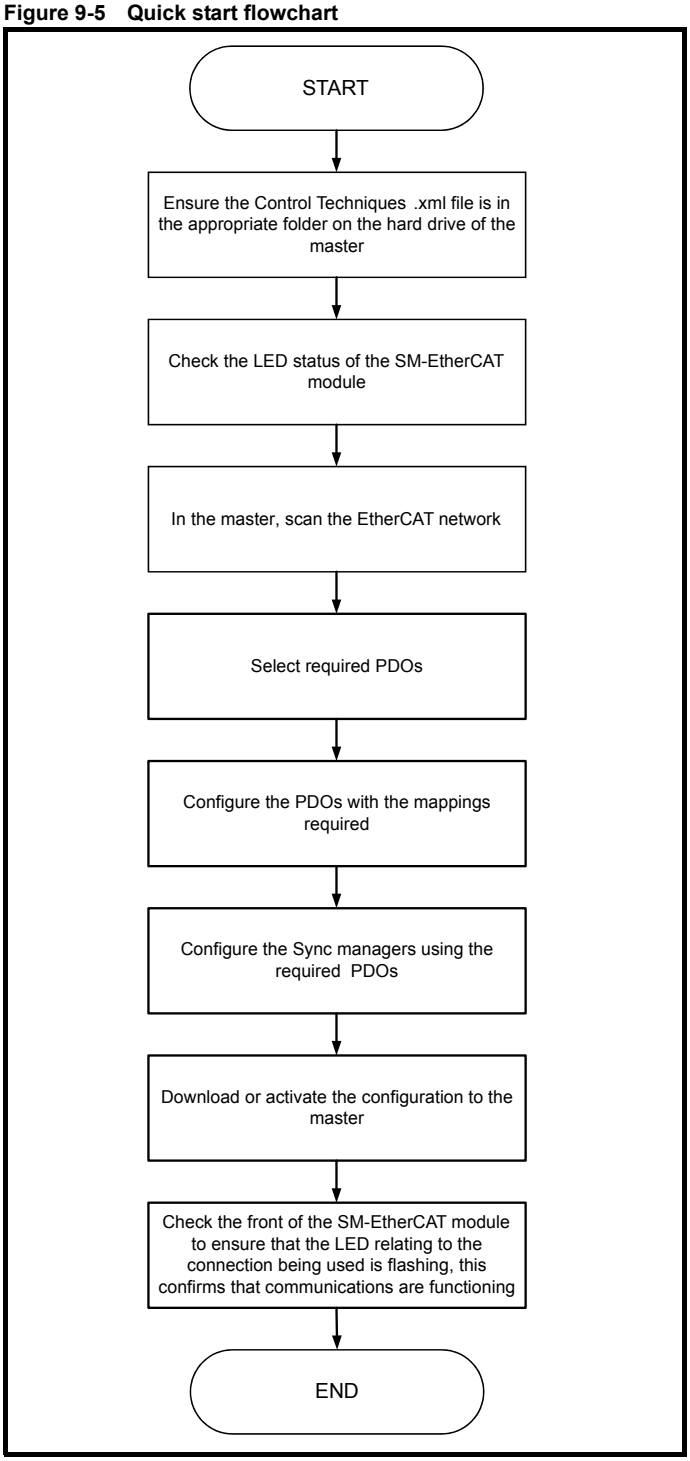
After downloading the configuration to the master the LED(s) on the front of the EtherCAT interface should flash, depending on the port(s) connected.

Values written to parameters over RxPDOs should now be viewable using the drive's keypad so long as the master has put the slave into the operational state; also, parameter values changed using the drive keypad will be updated on the master.

9.9 Quick start flowchart

Figure 9-5 details the steps required to achieve cyclic communications on the EtherCAT network. This flowchart should be used as the starting point for all configurations.

Figure 9-5 Quick start flowchart



9.10 Saving parameters to the drive

To avoid loss of the configured settings when the drive is powered down it is necessary to write 1000 to Pr **17.00** followed by pressing the reset button to perform a drive save.

To store drive parameters:

- Set Pr **17.00** to 1000.
- Press the red RESET button.

The drive will store all parameters (except Menu 20) but the operation of the EtherCAT interface will not be affected. Changes made to the EtherCAT interface configuration parameters will not take effect until the EtherCAT interface is reset.

NOTE

Menu 20 applications parameters may be saved if an Applications Module is installed, menu 20 is stored in the Applications Module's memory. See the relevant Applications Module documentation for more information. If the drive is running on backup supply only, Pr **17.00** must be set to 1001 to perform a save.

NOTE

This saves only drive and module parameters and not EtherCAT interface related objects.

9.11 EtherCAT interface Node address

Table 9-4 EtherCAT interface Node address

EtherCAT interface Node address		
Pr **17.03**	Default	0
	Range	0 to 65535
	Access	RW

It is not necessary for a user to set a node address manually in order to initiate EtherCAT communications; however, this parameter can be used to configure an EtherCAT Station Alias. When changed, this value will be stored in the option non-volatile storage upon a transition from the INIT state to the PRE-OPERATIONAL state; this change will also cause an AL Status Code to be set to indicate that the option needs to be reset. It will be possible to read the value at the 16-bit word address 0x0004 of the SII (Slave Information Interface) data, and in EtherCAT register 0x0012 (a 16-bit word).

9.12 EtherCAT interface RUN

Table 9-5 EtherCAT interface RUN

EtherCAT interface RUN		
Pr **17.04**	Default	1
	Range	1 to 8
	Access	RW

This parameter displays the EtherCAT interface RUN state as required by the EtherCAT indicator and Marking Specification. It will contain one of the values in Table 9-6.

Table 9-6 EtherCAT State Machine State

Value	ESM State
1	INIT
2	PRE-OPERATIONAL
4	SAFE-OPERATIONAL
8	OPERATIONAL

Although this parameter has the read/write attribute, it will be forced to the state value continuously to prevent it being written by another entity.

9.13 Re-initializing the EtherCAT interface

Table 9-7 EtherCAT interface re-initialize

EtherCAT interface re-initialize		
Pr **17.32**	Default	0 (OFF)
	Range	0 (OFF) to 1 (ON)
	Access	RW

Changes to the EtherCAT interface configuration in menu 17 parameters will not take effect until the EtherCAT interface has been re-initialized.

To re-initialize EtherCAT interface:

1. Set Pr **17.32** to ON.
2. When the sequence has been completed, Pr **17.32** will be reset to OFF.
3. The EtherCAT interface will re-initialize using the updated configuration.

NOTE

The above sequence does NOT store the EtherCAT interface configuration parameters in the drive or the EtherCAT interface's internal FLASH memory. This parameter will change back to OFF immediately and as such the change may not be visible on the display. related objects.

9.14 Process Data Objects (PDOs)

Cyclic data is implemented on EtherCAT networks by using "Process Data Objects" or PDOs. Separate data objects are used for transmitting (TxPDOs) and receiving (RxPDOs) data. PDO configuration objects are usually pre-configured in the EtherCAT master controller and downloaded to the EtherCAT interface at network Initialization using SDOs.

9.14.1 PDO Priority

If 2 PDOs are mapped in a sync manager then the second PDO will always be considered to be low priority (and, as such, should not be used for deterministic process data).

Mappings to slow parameters (such as SM-Applications PLC parameters, etc) should always be placed in the second PDO. When there is more than one PDO mapping in a Sync Manager, placing a slow parameter in the first PDO will trigger an SDO abort code. If only one PDO is mapped to a sync manager, then placing a slow parameter in that PDO will make it low priority (so slow parameter accesses should not be placed in PDOs where deterministic data access is required).

It is possible to map any drive parameters in PDOs.

9.15 Service Data Object (SDO) parameter access

The service data object (SDO) provides access to all objects in the EtherCAT object dictionary and the drive parameters are mapped into the object dictionary as 0x2XXX objects in the following way:

Index: 0x2000 + menu

Sub-index: parameter

For example Pr **20.21** would be index 0x2014 and the sub-index would be 0x15. The values are usually expressed in base 16 (hexadecimal), so care must be taken to enter the correct parameter number.

All other supported entries in the EtherCAT interface object dictionary can also be accessed using SDOs. Refer to the master controller documentation for full details about implementing SDO transfers within the particular master controller.

NOTE

Sub-index 0 for any menu will return the highest sub-index available for the object (i.e. the highest parameter number). Pr **17.00** in any drive can only be accessed as Pr **61. 01** (0x203D, sub-index changes to 1).

NOTE

The following SDO services are supported:

- Initiate SDO Download (Write)
- Initiate SDO Upload (Read)
- Abort SDO Transfer (Error)

9.16 CANopen over EtherCAT (CoE)

The CoE protocol over EtherCAT uses a modified form of the CANopen object dictionary. This is specified in Table 9-8.

Table 9-8 CoE object dictionary

Index	Object dictionary area
0x0000 to 0x0FFF	Data type area
0x1000 to 0x1FFF	CoE communication area
0x2000 to 0x5FFF	Manufacturer specific area
0x6000 to 0x9FFF	Profile area
0xA000 to 0xFFFF	Reserved area

The object description format describes object related information such as size, range and descriptions and is detailed in Table 9-9.

Table 9-9 Object description format

<index>	**<object name>**		
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default:	<default>		
Description:	<description>		

For entries having sub-indices

Table 9-10 Object description format with sub-indices

<index>	**<object name>**		
Sub-index 0			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default:	<default>		
Description:	<description>		
Sub-index 1			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default:	<default>		
Description:	<description>		
...			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default:	<default>		
Description:	<description>		
Sub-index n-1			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default:	<default>		
Description:	<description>		
Sub-index n			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default:	<default>		
Description:	<description>		

Definitions:

- <index> : A signed 16-bit number. This is the index of the object dictionary entry specified in four hexadecimal characters.
- <access> : A value describing how the object may be accessed (RW = read/write, RO = read-only and WO = write-only).
- <size> : The size of the object/sub-index in bytes.
- <unit> : The physical unit (e.g. ms, counts per second etc.).

9.16.1 CoE communication area

The first set of objects specify general communication settings.

Table 9-11 Device type object

0x1000	**Device type**		
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x00030192		
Description:	The primary CoE functional profile is DSP-402, the value of the object is defined as follows: Bits 0 to 15 (Device profile number): 402 (0x192) Bit 16 (Frequency converter): x Bit 17 (Servo drive): y Bit 18 (Stepper motor): 0 Bit 24 (DC drive - manufacturer specific : z Bits 25 to 31 (Manufacturer specific): 0 This value will depend on the drive operating mode and/or type. On a Digitax ST, bit 17 will be set, while bits 16 and 24 will be cleared.		

Table 9-12 Identity object

0x1018	**Identity object**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default:	4		
Description:	The number of the last sub-index in this object.		
Sub-index 1			
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x000000F9		
Description:	This contains the EtherCAT Technology Group vendor ID for Emerson Industrial Automation (0x000000F9).		
Sub-index 2			
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	See Pr **17.01**		
Description:	This has the value of the option ID code.		
Sub-index 3			
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	High word: Pr **17.02** Low word: Pr **17.51**		
Description:	Contains the Solutions Module software version number (the major and minor version parameter placed in the high word of this object, and the sub-version parameter (Pr **17.51**) is the low word).		
Sub-index 4			
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	See Pr **17.35**		
Description:	Contains the option hardware serial number.		

9.16.2 RxPDO mappings

Objects with indices from 0x1600 to 0x17FF specify receive PDO mappings. The mappings from DSP-402 are included as standard (the PDO mappings will have the following default values).

Table 9-13 RxPDO mappings

PDO number	Mapping object index	Mapping object name
1	0x6040	*controlword*
2	0x6040 0x6060	*controlword* *modes of operation*
6	0x6040 0x6042	*controlword* *vl_target _velocity*

The RxPDO mapping objects are defined in the following tables. Each mapping object has the maximum number of sub-indices (each representing an object mapped to a PDO) defined in the XML configuration file (specified as “CF” in the following descriptions).

Table 9-14 RxPDO mapping 1

0x1600	**Receive PDO mapping 1**		
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to (CF)	Size: 1 byte	Unit: N/A
Default:	1		
Description:	The number of mapped objects in thie PDO		
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60400010 - the DSP-402 control word (0x6040)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 9-15 RxPDO mapping 2

0x1601	**Receive PDO mapping 2**		
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to (CF)	Size: 1 byte	Unit: N/A
Default:	2		
Description:	The number of mapped objects in this PDO.		
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60400010 - the DSP-402 control word (0x6040)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60600008 - the DSP-402 modes of operation object (0x6060)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 9-16 RxPDO mapping 6

0x1605	**Receive PDO mapping 6**		
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to (CF)	Size: 1 byte	Unit: N/A
Default:	2		
Description:	The number of mapped objects in this PDO.		
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60400010 - the DSP-402 control word (0x6040)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60600008 - the DSP-402 modes of operation object (0x6060)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 9-17 RxPDO mapping 22

0x1615	**Receive PDO mapping 22**		
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to (CF)	Size: 1 byte	Unit: N/A
Default:	0		
Description:	The number of mapped objects in thie PDO		
Sub-indices 1 to 255: 1st to 255th mapped objects in this PDO.			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

9.16.3 TxPDO mappings

Objects with the indices from 0x1A00 to 0x1BFF specify transmit PDO mappings. The following mappings from DSP-402 are included as standard.

Table 9-18 TxPDO mappings

PDO number	Mapping object index	Mapping object name
1	0x6041	*statusword*
2	0x6041 0x6061	*statusword* *modes_of_operation_display*
3	0x6041 0x6064	*statusword* *position_actual_value*
6	0x6041 0x6044	*statusword* *vl_velocity_actual_value*

The PDO mapping objects are defined below. Each mapping object has the maximum number of sub-indices (each representing an object mapped to a PDO) defined in the XML configuration file.

Table 9-19 TxPDO mapping 1

0x1A00	**Transmit PDO mapping 1**		
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to (CF)	Size: 1 byte	Unit: N/A
Default:	1		
Description:	The number of mapped objects in thie PDO		
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60410010 - the DSP-402 status word (0x6041)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 9-20 TxPDO mapping 2

0x1A01	**Transmit PDO mapping 2**		
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to (CF)	Size: 1 byte	Unit: N/A
Default:	2		
Description:	The number of mapped objects in this PDO.		
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60410010 - the DSP-402 status word (0x6041)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60610008 - the DSP-402 modes of operation display object (0x6061)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 9-21 TxPDO mapping 3

0x1A02	**Transmit PDO mapping 3**		
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to (CF)	Size: 1 byte	Unit: N/A
Default:	2		
Description:	The number of mapped objects in this PDO.		
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60410010 - the DSP-402 status word (0x6041)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60640020 - the DSP-402 actual position (0x6064)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 9-22 TxPDO mapping 6

0x1A05	**Transmit PDO mapping 6**		
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to (CF)	Size: 1 byte	Unit: N/A
Default:	2		
Description:	The number of mapped objects in this PDO.		
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60410010 - the DSP-402 status word (0x6041)		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60440010 - the DSP-402 actual motor speed (0x6044).		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 9-23 TxPDO mapping 22

0x1A15	Transmit PDO mapping 22		
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to (CF)	Size: 1 byte	Unit: N/A
Default:	0		
Description:	The number of mapped objects in thie PDO		
Sub-indices 1 to 255: 1st to 255th mapped objects in this PDO.			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0		
Description:	A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

9.16.4 Sync manager configuration

The sync managers are the EtherCAT means for setting access attributes for different areas of memory and triggering or notifying the application when the memory is accessed. The following objects specify how the sync managers (and thus corresponding memory areas) are utilized by the CoE protocol.

Table 9-24 Sync manager communication type object

0x1C00	Sync manager communication type		
Sub-index 0 - number of sync manager channels used			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default:	4		
Description:	The number of sync manager protocols used by the CoE protocol.		
Sub-index 1 - Usage of sync manager 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default:	1		
Description:	Sync manager 0 is used by CoE as the mailbox receive channel (master to slave).		
Sub-index 2 - Usage of sync manager 1			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default:	2		
Description:	Sync manager 1 is used by CoE as the mailbox send channel (slave to master).		
Sub-index 3 - Usage of sync manager 2			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default:	3		
Description:	Sync manager 2 is used by CoE as the process data output (RxPDOx - master to slave).		
Sub-index 4 - Usage of sync manager 3			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default:	4		
Description:	Sync manager 3 is used by CoE as the process data input (TxPDOs - slave to master).		

Table 9-25 Sync manager 0 PDO assignment object

0x1C10	Sync manager 0 PDO assignment		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default:	0		
Description:	Number of assigned PDOs. The mailbox received sync manager can never have PDOs assigned to it.		

Table 9-26 Sync manager 1 PDO assignment object

0x1C11	Sync manager 1 PDO assignment		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default:	0		
Description:	Number of assigned PDOs. The mailbox send sync manager can never have PDOs assigned to it.		

Table 9-27 Sync manager 2 PDO assignment object

0x1C12	Sync manager 2 PDO assignment		
Sub-index 0			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: N/A
Default:	1		
Description:	The number of RxPDOs assigned to this sync manager (used for process data output).		
Sub-indices 1 to (sub-index 0)			
Access: RW	Range: 0x1600 to 0x17FF	Size: 2 bytes	Unit: N/A
Default:	0x1605		
Description:	The object index of a RxPDO to assign to this sync manager. By default this is assigned to RxPDO mapping 6 (*vl_target_velocity* and *controlword*).		

Table 9-28 Sync manager 3 PDO assignment object

0x1C13	Sync manager 3 PDO assignment		
Sub-index 0			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: N/A
Default:	1		
Description:	The number of TxPDOs assigned to this sync manager (used for process data input).		
Sub-indices 1 to (sub-index 0)			
Access: RW	Range: 0x1A00 to 0x1BFF	Size: 2 bytes	Unit: N/A
Default:	0x1A05		
Description:	The object index of a TxPDO to assign to this sync manager. By default this is assigned to TxPDO mapping 6 (*vl_velocity_actual_value* and *statusword*).		

9.16.5 Feedback encoder source

Table 9-29 Feedback encoder source

0x2802	Feedback encoder source		
Sub-index 0			
Access: RW	Range: 0 to 3	Size: 1 byte	Unit: N/A
Default:	0		
Description:	This object specifies the source position for position controller feedback.		

0 = Use drive as the feedback source
1 = Use the encoder module in slot 1 as the encoder source
2 = Use the encoder module in slot 2 as the encoder source
3 = Use the encoder module in slot 3 as the encoder source

9.17 Ethernet over EtherCAT (EoE)

This protocol allows standard Ethernet messages and protocols to be tunnelled through the EtherCAT network. This provides users with the possibility of connecting to the Emerson Industrial Automation PC Tools (SyPT Pro, SyPTLite, CTSoft, CTScope and Winflasher) along the same connection currently being used for EtherCAT communications.

9.17.1 EoE IP address

The EtherCAT interface EoE IP address is defined in the EtherCAT Master and is displayed in the module parameters as shown in Figure 9-6.

Figure 9-6 EoE IP address format

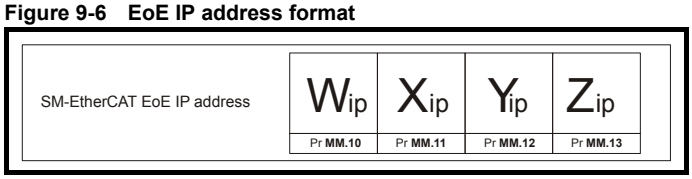


Table 9-30 EoE - IP address W_{ip}

EoE - IP address W_{ip}		
Pr **17.10**	Default	0
	Range	0 to 255
	Access	RW

This is the most significant octet of the EtherCAT interface EoE IP address.

Table 9-31 EoE - IP address X_{ip}

EoE - IP address X_{ip}		
Pr **17.11**	Default	0
	Range	0 to 255
	Access	RW

This is the second most significant octet of the EtherCAT interface EoE IP address.

Table 9-32 EoE - IP address Y_{ip}

EoE - IP address Y_{ip}		
Pr **17.12**	Default	0
	Range	0 to 255
	Access	RW

This is the third most significant octet of the EtherCAT interface EoE IP address.

Table 9-33 EoE - IP address Z_{ip}

EoE - IP address Z_{ip}		
Pr **17.13**	Default	0
	Range	0 to 255
	Access	RW

This is the least significant octet of the EtherCAT interface EoE IP address.

9.17.2 EoE Subnet mask

The EtherCAT interface EoE Subnet mask is defined in the EtherCAT Master and is displayed in the module parameters as shown in Figure 9-7.

Figure 9-7 EoE Subnet mask format

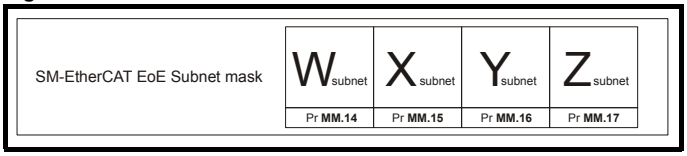


Table 9-34 EoE - Subnet mask W_{subnet}

EoE - Subnet Mask W_{subnet}		
Pr **17.14**	Default	0
	Range	0 to 255
	Access	RW

This is the most significant octet of the EtherCAT interface EoE Subnet mask.

Table 9-35 EoE - Subnet mask X_{subnet}

EoE - Subnet Mask X_{subnet}		
Pr **17.15**	Default	0
	Range	0 to 255
	Access	RW

This is the second most significant octet of the EtherCAT interface EoE Subnet mask.

Table 9-36 EoE - Subnet mask Y_{subnet}

EoE - Subnet Mask Y_{subnet}		
Pr **17.16**	Default	0
	Range	0 to 255
	Access	RW

This is the third most significant octet of the EtherCAT interface EoE Subnet mask.

Table 9-37 EoE - Subnet mask Z_{subnet}

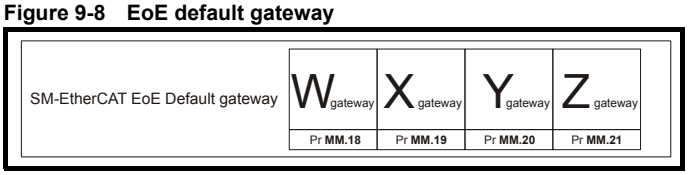
EoE - Subnet Mask Z_{subnet}		
Pr **17.17**	Default	0
	Range	0 to 255
	Access	RW

This is the least significant octet of the EtherCAT interface EoE Subnet mask.

9.17.3 EoE default gateway

The EtherCAT interface EoE default gateway is defined in the EtherCAT Master and is displayed in the drive parameters as shown in Figure 9-8.

Figure 9-8 EoE default gateway



NOTE

The default gateway is a routing device that allows a host to reach other devices that are not on the same subnet. The default gateway must be on the same subnet as the host that is trying to use it.

Table 9-38 EoE - Default gateway $W_{gateway}$

EoE - Default gateway $W_{gateway}$		
Pr **17.18**	Default	0
	Range	0 to 255
	Access	RW

This is the most significant octet of the EtherCAT interface EoE default gateway.

Table 9-39 Default gateway $X_{gateway}$

EoE - Default gateway $X_{gateway}$		
Pr **17.19**	Default	0
	Range	0 to 255
	Access	RW

This is the second most significant octet of the EtherCAT interface EoE default gateway.

Table 9-40 Default gateway $Y_{gateway}$

EoE - Default gateway $Y_{gateway}$		
Pr **17.20**	Default	0
	Range	0 to 255
	Access	RW

This is the third most significant octet of the EtherCAT interface EoE default gateway.

Table 9-41 Default gateway $Z_{gateway}$

EoE - Default gateway $Z_{gateway}$		
Pr **17.21**	Default	0
	Range	0 to 255
	Access	RW

This is the least significant octet of the EtherCAT interface EoE default gateway.

NOTE

Although parameters Pr **17.10** - Pr **17.21** have RW access, changing them via the parameters will have no affect to the EoE settings. The EoE configuration for the EtherCAT interface can only be done with an EtherCAT master which supports the EoE protocol (e.g. TwinCAT). The settings for Pr **17.10** - Pr **17.21** will need to be set by the Master and these parameters are for display purposes only.

9.17.4 EtherCAT interface reduce serial interface priority

Table 9-42 Reduce Drive serial interface priority

Reduce Drive serial interface priority		
Pr **17.37**	Default	OFF
	Range	OFF - ON
	Access	RW

It is not possible for the both the Drive and the EtherCAT interface to support all of the available serial communication protocols simultaneously. This means that the user must decide if they wish the drive to provide the primary communication interface via its serial RJ45 connector, or the EtherCAT interface. In the default state the primary interface will be provided by the drive.

Pr **17.37** = OFF (default):

It will not be possible to forward on messages that are intended for either the drive or another Solutions Module. The EtherCAT interface will be able to handle two types of messages:

1. Those that access Drive parameters
2. Those that access SM-Applications parameters.

Pr **17.37** = ON:

The EtherCAT interface will request that the drive permits it to become the primary communication interface. If the drive is able to transfer control then the following restrictions will be imposed:

1. The drives serial interface will only be able to handle messages that are 32 bytes or less. A Remote LCD keypad would continue to work, although SM-Application parameters would not be visible. If a message is received that is too long for the drive to handle, no reply will be sent.
2. Any LCD keypad installed (not remotely mounted) to the drive will stop working.

NOTE

Pr **17.37** must be set to ON to achieve EoE communications.

9.18 Drive profile (DSP-402) support

EtherCAT interface supports the following modes of the DSP-402 profile:

- Cyclic sync position mode
- Interpolated position mode
- vl velocity mode
- Profile torque mode
- Homing mode

9.18.1 0x6040 Controlword

This provides the primary method of controlling the behavior of the drive e.g. enabling, disabling, resetting, etc. Table 9-43 describes the format of the control word. The individual bits are used in combinations (see Table 9-44) to sequence the drive through the state machine described in Figure 9-9.

Table 9-43 Controlword

0x6040	**Controlword**		
Access: RW	Range: 0 to 65535	Size: Unsigned 16	Unit: N/A
Default:	N/A		
Description:	Provides the primary method of controlling the behavior of the drive.		

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved				ila	r	oms	h	fr	oms		hos	eo	qs	ev	so

LEGEND: ms = manufacturer-specific; r = reserved; oms = operation mode specific; h = halt; fr = fault reset; hos = homing operation start; eo = enable operation; qs = quick stop; ev = enable voltage; so = switch on

Table 9-44 Command coding

Command	Bits of the controlword				
	Bit 7	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Shutdown	0	X	1	1	0
Switch on	0	0	1	1	1
Switch on + enable operation	0	1	1	1	1
Disable voltage	0	X	X	0	X
Quick stop	0	X	0	1	X
Disable operation	0	0	1	1	1
Enable operation	0	1	1	1	1
Fault reset		X	X	X	X

NOTE: Automatic transition to Enable operation state after executing SWITCHED ON state functionality.

9.18.2 0x6041 Statusword

This provides feedback about the current operating state of the drive. Table 9-45 describes the format of the status word and illustrates how the individual statusword bits are combined to represent the current state of the drive.

Table 9-45 Statusword

0x6041	Statusword		
Access: RW	Range: 0 to 65535	Size: Unsigned 16	Unit: N/A
Default:	N/A		
Description:	This provides feedback about the current operating state of the drive.		

Table 9-46 Statusword bit functions

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms			ha	ila	tr	rm	ms	w	sod	qs	ve	f	oe	so	rtso

LEGEND: ms = manufacturer-specific; ha = homing attained; oms = operation mode specific; ila = internal limit active; tr = target reached; rm = remote; w = warning; sod = switch on disabled; qs = quick stop; ve = voltage enabled; f = fault; oe = operation enabled; so = switched on; rtso = ready to switch on

Table 9-47 State coding

Statusword	State
xxxx xxxx x0xx 0000b	Not ready to switch on
xxxx xxxx x1xx 0000b	Switch on disabled
xxxx xxxx x01x 0001b	Ready to switch on
xxxx xxxx x01x 0011b	Switched on
xxxx xxxx x01x 0111b	Operation enabled
xxxx xxxx x00x 0111b	Quick stop active
xxxx xxxx x0xx 1111b	Fault reaction active
xxxx xxxx x0xx 1000b	Fault

9.18.3 Common profile features

Sequencing control

These are the supported objects used to control the drive:

Table 9-48 Sequencing control supported objects

Index	Name
0x6040	*controlword*
0x6041	*statusword*
0x605B	*shutdown_option_code*
0x605C	*disable_operation_option_code*
0x605A	*quick_stop_option_code*
0x605D	*halt_option_code*
0x605E	*fault_reaction_option_code*
0x6060	*modes_of_operation*
0x6061	*modes_of_operation_display*
0x6085	*quick_stop_deceleration*

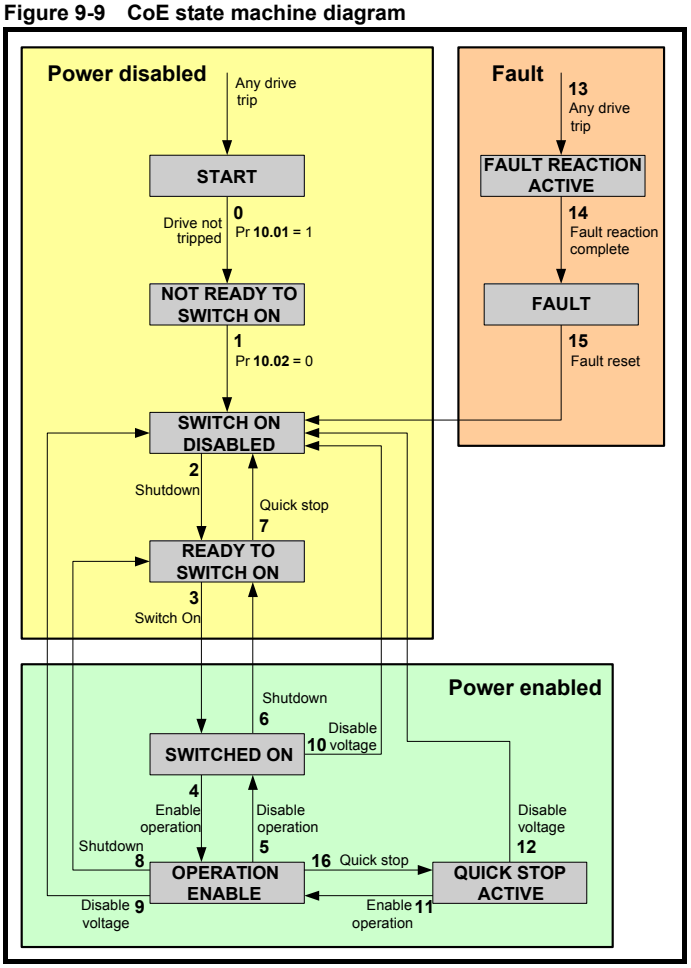
The behavior of the sequencing control is shown in Figure 9-9 *CoE state machine diagram* . This state machine indicates how the drive will be controlled. For clarity the Statusword is abbreviated to 'SW' in the diagram.

When in the 'QUICK STOP ACTIVE' state, the currently selected mode of operation indicates how a quick stop function should be handled. When the drive is stopped, and the Quick stop option code doesn't indicate that the state should remain at 'QUICK STOP ACTIVE', the state will move to 'SWITCH ON DISABLED'.

When in the 'OPERATION ENABLED' or 'QUICK STOP ACTIVE' states it is not possible to change the *mode_of_operation* object. This is to ensure that the motor is stopped before changing the operation mode.

The EtherCAT interface master device must be in the operational state before the state machine can move from the 'SWITCH ON DISABLED' state to the 'READY TO SWITCH ON' state. If the master leaves the operational state while the state machine is in the 'SWITCH ON', 'OPERATION ENABLE' , 'QUICK STOP ACTIVE' or 'READY TO SWITCH ON' state then the EtherCAT interface will transition to the 'SWITCH ON DISABLED' state. This implies that the drive will be inhibited and the motor will coast.

Figure 9-9 CoE state machine diagram



NOTE

On the Drive with the default drive parameters the 'Switched on' state will correspond to a drive status of 'STOP'. If the STOP state is not acceptable for any applications that do not use the menu 12 brake controller, Pr **6.08** will have to be set to OFF. With Pr **6.08** set to OFF the 'Switched on' state will now correspond to a drive status of 'Rdy'.

Table 9-49 CoE state machine transition and events

Transition	Event(s)	Action(s)
0	Automatic transition after power-on or reset application	Drive device self-test and/or self Initialization shall be performed
1	Automatic transition	Communication shall be activated
2	Shutdown command from control device or local signal	None
3	Switch on command received from control device or local signal	Power section shall be switched on if not already switched on
4	Enable operation command received from control device or local signal	Drive function shall be enabled and clear all internal set-points
5	Disable operation command received from control device or local signal	Drive function shall be disabled
6	Shutdown command received from control device or local signal	The high-power shall be switched off immediately, and the motor shall be free to rotate if not braked; additional action depends on the shutdown option code
7	Quick stop or disable voltage command from control device or local signal	None
8	Shutdown command from control device or local signal	The high-power shall be switched off immediately if possible, and the motor shall be free to rotate if not braked
9	Disable voltage command from control device or local signal	The high-power shall be switched off immediately if possible, and the motor shall be free to rotate if not braked
10	Disable voltage or quick stop command from control device or local signal	The high-power shall be switched off immediately if possible, and the motor shall be free to rotate if not braked
11	Quick stop command from control device or local signal	The quick stop function shall be started
12	Automatic transition when the quick stop function is completed and quick stop option code 1, 2, 3 or 4 disable voltage command received from control device (dependant on the quick stop option code)	The power section shall be switched off
13	Fault signal	The configure fault reaction function shall be executed
14	Automatic transition	The drive function shall be disabled; the high-power may be switched off
15	Fault reset command from control device or local signal	A reset of the fault condition is carried out, if no fault exists currently on the drive device; after leaving the Fault state, the Fault reset bit in the controlword shall be cleared by the control device
16	Enable operation command from control device, if the quick stop option code is 5, 6, 7 or 8	The drive function shall be enabled

When the EtherCAT interface transitions from the EtherCAT Safe-operational state to the EtherCAT Operational state, a number of drive parameters are set to allow the CoE profiles to control the drive and motor. These parameters are set in the following order:

- Pr **6.42** to 0
- Pr **6.43** to On (1)
- Pr **3.22** to 0 (where present)
- Pr **3.23** to On (1) (where present)
- Pr **3.13** to OFF (0) (In open-loop operating modes)
- Pr **2.10** to 1
- Pr **2.20** to 1
- Pr **2.02** to On (1)
- Pr **1.04** to 0
- Pr **1.21** to 0
- Pr **1.38** to 0
- Pr **1.08** to OFF (0)
- Pr **1.10** to On (1)
- Pr **1.09** to OFF (0)
- Pr **1.15** to 1
- Pr **1.14** to 3

These values are set once and not continuously forced. They are not reset when leaving the Operational state. In addition, the option starts to write parameters implicitly mapped by the CoE profiles, when moving to the Operational state.

9.18.4 0x605A Quick stop option code

This object indicates what action is performed when the quick stop function is executed. The slow down ramp is the deceleration value of the used mode of operations.

Table 9-50 Quick_stop_option_code

0x605A	Quick_stop_option_code		
Access: RW	Range: 0 to 6	Size: Unsigned 16	Unit: N/A
Default:	2		
Description:	Specifies what action is performed in the event of a quick stop function. See Table 9-49 *CoE state machine transition and events* on page 83 for more information.		

Table 9-51 Quick stop value definitions

Value	Definition
0	Disable drive function
1	Slow down on slow down ramp and transit into Switch on disabled
2	Slow down on quick stop ramp and transit into Switch on disabled
5	Slow down on slow down ramp and stay in Quick stop active
6	Slow down on quick stop ramp and stay in Quick stop active

9.18.5 0x605B Shutdown_option_code

This object is used to control what action is performed if there is a transition from the Operation Enabled state to the Ready To Switch On state.

Table 9-52 Shutdown_option_code

0x605B	Shutdown_option_code		
Access: RW	Range: 0 to 1	Size: Unsigned 16	Unit: N/A
Default:	N/A		
Description:	Used to control what action is performed if there is a transition from the Operation Enabled state to the Ready To Switch On state.		

Table 9-53 Shutdown_option_code values

Value	Definition
0	Disable drive function (switch off the drive power stage)
1	Slow down with slow down ramp; disable the drive function

9.18.6 0x605C Disable_operation_option_code

Disable drive function (switch off the drive power stage).

This object is used to control what action is performed if there is a transition from the 'Operation Enabled' state to the 'Switched On' state.

Table 9-54 Disabled_operation_option_code

0x605C	Disable_operation_option_code		
Access: RW	Range: 0 to 1	Size: Unsigned 16	Unit: N/A
Default:	N/A		
Description:	This object is used to control what action is performed if there is a transition from the Operation Enabled state to the Switched On state.		

Table 9-55 Disable_operation_option_code values

Value	Definition
0	Disable drive function (switch off the drive power stage)
1	Slow down with slow down ramp; disable the drive function

9.18.7 0x605E Fault_reaction_option_code

This object is used to control what action is performed when a fault is detected. This object is ignored if the drive is tripped.

Table 9-56 Fault_reaction_option_code

0x605E	Fault_reaction_option_code		
Access: RW	Range: 0 to 2	Size: Unsigned 16	Unit: N/A
Default:	N/A		
Description:	This object is used to control what action is performed when a fault is detected.		

Table 9-57 Fault_reaction_option_code values

Value	Definition
0	Disable drive function, motor is free to rotate
1	Slow down on slow down ramp
2	Slow down on quick stop ramp

9.18.8 0x6060 Modes_of_operation

This object is used to request a change in the mode of operation.

Table 9-58 Modes_of_operation

0x6060	Modes_of_operation		
Access: RW	Range: 0 to 8	Size: Unsigned 8	Unit: N/A
Default:	2		
Description:	This object is used to request a change in the mode of operation.		

Table 9-59 Modes_of_operation values

Value	Definition
0	No mode change
2	vl velocity mode
4	Profile torque mode
6	Homing mode
7	Interpolated position mode
8	Cyclic sync position mode

9.18.9 0x6061 Modes_of_operation_display

This read only object indicates the active mode of operation.

Table 9-60 Modes_of_operation_display

0x6061	Modes_of_operation_display		
Access: RO	Range: 0 to 8	Size: Unsigned 8	Unit: N/A
Default:	N/A		
Description:	Used to provide the active mode of operation.		

Table 9-61 Modes_of_operation_display values

Value	Definition
0	No mode change
2	vl velocity mode
4	Profile torque mode
6	Homing mode
7	Interpolated position mode
8	Cyclic sync position mode

9.18.10 0x6084 Profile decleration

Table 9-62 Profile decleration

0x6084	Profile deceleration		
Access: RW	Range:0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default: 65536			
Description: Provides the deceleration ramp for the positioning modes			

9.18.11 0x6085 Quick_stop_deceleration

This object is used to configure the deceleration rate used to stop the motor when the quick stop function is activated and the quick stop code object (0x605A) is set to 2 or 6. The quick stop deceleration is also used if the fault reaction code object (0x605E) is 2. The value is given in user-defined acceleration units.

Table 9-63 Quick_stop_deceleration

0x6085	Quick_stop_deceleration		
Sub-index 0			
Access: RW	Range:0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default: 2			
Description: Quick stop function for the positioning related modes.			

9.18.12 Profile units

The EtherCAT interface implementation provides a means to convert profile units into position controller and drive units. All scaling values are standard profile objects. The following objects are supported:

Table 9-64 Supported profile units

Index	Name
0x608F	*position_encoder_resolution*
0x6091	*gear_ratio*
0x6092	*feed_constant*

For positions, the scaling control includes a feed constant, a gear ratio and an encoder revolution. These values are combined by the implementation into a simple scaling numerator and denominator. It is possible to change these values non-cyclically (i.e. using SDOs), in which case the scaling numerator and denominator and any position limit values are recalculated in the background. It is not, however, possible to change these values cyclically (i.e. by mapping PDOs to them).

For velocities, in addition to the position constants described above, these values are combined into a simple numerator and denominator to scale velocities to internal velocity units. This scaling also properly handles remainders (i.e. when used on a reference or feedback, accumulate the remainder and add it to subsequent velocity values, and when used with a limit, round up or down). It is possible to change these values non-cyclically (i.e. using SDOs), in which case the scaling numerator and denominator is recalculated in the background. It is also necessary to re-scale velocity limit values with the new factor. It is not possible to change these values cyclically (i.e. by mapping PDOs to them).

9.18.13 0x608F Position_encoder_resolution

This read only object indicates the configured encoder increments per number of motor revolutions. The information is read from the drive's encoder configuration.

Table 9-65 Position_encoder_resolution

0x608F	Position_encoder_resolution		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default: 2			
Description:			
Sub-index 1			
Access: RO	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default: 1			
Description: Encoder increments			
Sub-index 2			
Access: RO	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default: 1			
Description: Motor revolutions			

9.18.14 0x6091 Gear_ratio

This object is used to apply scaling. When configured, appropriate user units can be used to control the position of the shaft beyond a gearbox. The gear ratio is calculated using the following formula:

gear ratio = motor shaft revolutions / driving shaft revolutions

Table 9-66 Gear_ratio

0x6091	Gear_ratio		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default: 2			
Description:			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default: 1			
Description: Motor revolutions			
Sub-index 2			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default: 1			
Description: Shaft revolutions			

9.18.15 0x6092 Feed_constant

This is used to configure a feed constant. This is the measurement distance per one revolution of the output shaft of the gearbox. The feed constant is calculated using the following formula:

feed constant = feed / driving shaft revolutions

Table 9-67 Feed_constant

0x6092	**Feed_constant**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default: 2			
Description:			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default: 1			
Description: Feed			
Sub-index 2			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default: 1			
Description: Shaft revolutions			

9.18.16 Basic position control

Basic position control is supported. The position control described here is used under the interpolated position mode of operation. Table 9-68 lists the objects that are supported:

Table 9-68 Basic position control supported objects

Index	Name
0x6062	*position_demand_value*
0x6064	*position_actual_value*
0x6065	*following_error_window*
0x6067	*position_window*
0x6080	*max motor speed*
0x60F4	*following_error_actual_value*
0x60FB	*position_control_parameter_set*

9.18.17 0x6062 Position_demand_value

This read only object is used to provide the currently demanded position value. The value is given in user defined position units.

Table 9-69 Position_demand_value

0x6062	**Position_demand_value**		
Access: RO	Range: 0 to 0xFFFFFFFF	Size: signed 32	Unit: N/A
Default: N/A			
Description: Used to provide the currently demanded position value.			

9.18.18 0x6064 Position_actual_value

This read only object provides the actual value of the position feedback device. The value is given in internal units.

Table 9-70 Position_actual_value

0x6064	**Position_actual_value**		
Access: RO	Range: 0 to 0xFFFFFFFF	Size: signed 32	Unit: N/A
Default: N/A			
Description:	This read only object provides the actual value of the position feedback device. The value is given in internal units.		

9.18.19 0x6080 Max motor speed

Table 9-71 Max motor speed

0x6080	**Max motor speed**		
Sub-index 0			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: rpm
Default: 3000			
Description:	This object indicates the configured maximum allowed speed for the motor in either direction. It is used to protect the motor and changing the value of this object will also change Pr **1.06**. The value is given in rotations per minute (rpm).		

9.18.20 0x60F4 Following_error_actual_value

This read only object provides the actual value of the following error. The value is given in user-defined position units.

Table 9-72 Following_error actual_value

0x60F4	**Following_error actual_value**		
Access: RO	Range: 0 to 0xFFFFFFFF	Size: signed 32	Unit: N/A
Default: N/A			
Description:	This read only object provides the actual value of the following error.		

9.18.21 0x60FB Position_control_parameter_set object

Table 9-73 Position_control_parameter_set object

0x60FB	**Position_control_parameter_set**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default: 2			
Description: The number of control loop parameters.			
Sub-index 1			
Access: RW	Range: 0 to 65535	Size: Unsigned 16	Unit: 0.01 rad/ s/rad
Default: 2500			
Description: The position controller proportional gain.			
Sub-index 2			
Access: RW	Range: 0 to 65535	Size: Unsigned 16	Unit: 1 / 1000
Default: 1000 (i.e. a gain of 1)			
Description: The position controller speed feed forward gain.			

The APC position controller kernel is used by the basic internal position control.

The *position_demand_value* object contains the value supplied by either the interpolated position mode or the profile position mode (in user units). It is updated every control loop cycle. This object can be mapped as cyclic data.

9.19 Interpolated position mode

Interpolated position mode operates in servo mode. Table 9-74 lists the objects that are supported:

Table 9-74 Supported Interpolated position mode objects

Index	Name
0x60C0	*interpolation_submode_select*
0x60C1	*interpolation_data_record*
0x60C2	*interpolation_time_period*

NOTE

When using one of the DSP-402 positioning modes, Distributed Clocks must be enabled. Failure to do so may result in the EtherCAT interface going into the SAFE-OPERATIONAL state (Pr **17.04** = 4).

9.19.1 0x60C0 Interpolation_sub-mode_select

Table 9-75 0x60C0 Interpolation_sub-mode_select

0x60C0	**Interpolation_sub-mode_select**		
Access: RW	Range: 0	Size: Signed 16	Unit: N/A
Default:	0 (Linear interpolation)		
Description:	Specifies the interpolation type. At present the only supported Interpolation Sub-Mode is 'Linear Interpolation'.		

9.19.2 0x60C1 Interpolation_data_record

This object is used to specify the target position. Linear interpolation is used to generate position demand values every 250 µs. The position is specified in user-defined position units. The value is written into sub-index 1.

Table 9-76 0x60C1 Interpolation_data_record

0x60C1	**Interpolation_data_record**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default:	1		
Description:	This object is used to specify the target position.		
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default:	N/A		
Description:	The set-point.		

9.19.3 0x60C2 Interpolation_time_period

Table 9-77 Interpolation_time_period

0x60C2	**Interpolation_time_period**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default:	2		
Description:	The number of the last sub-index in this object.		
Sub-index 1			
Access: RW	Range: 0 to 255	Size: Unsigned 8	Unit: (sub-index 2)
Default:	250 (units are dependant on the value in sub-index 2)		
Description:	The number of time units between interpolator re-starts. A time unit is defined by sub-index 2. The interpolator time period value is checked to ensure that it is valid. Valid values are 250 µs, 500 µs or any multiple of 1 ms. An attempt to write other values results in an SDO Abort code.		
Sub-index 2			
Access: RW	Range: -6 to 0	Size: Signed 8	Unit: N/A
Default:	-6 (a time unit of 1 µs)		
Description:	This specifies the time unit for the interpolation time period. Sub-index 2 specifies the unit exponent. The time unit, therefore, is 10 (sub-index 2). The range of values allows for the shortest time unit to be 1 µs, and the longest to be 1 s.		

The implementation of interpolated position mode allows synchronous operation only, where a fixed, common interpolation interval is defined. The time specified must always be an integer multiple of the control loop cycle time. The time period index has a minimum value of -6 (i.e. the smallest time unit will be microseconds), see Table 9-78 for more information.

Table 9-78 Interpolation time period units

Value in 0x60C2, sub-index 2	Description
0	1 second
-1	0.1 of a second
-2	0.01 of a second
-3	0.001 of a second
-4	0.0001 of a second
-5	0.00001 of a second
-6	0.000001 of a second

The time period is checked to ensure that it is an integer multiple of the control loop cycle time. Only linear interpolation is currently supported, this type inserts a delay of one interpolation time period.

The input buffer has a maximum size of 1 data record, and a data record contains one position in profile-defined units. The buffer is a FIFO buffer. On each interpolator time period, a value is read from this buffer. The correct number of data points for a specific interpolation mode are stored internally. When a new position command is loaded in, the oldest position command in the data set is discarded.

9.20 vl velocity mode

Velocity mode is supported and the scaled velocity is written to the drive internal speed shortcut. Table 9-79 lists the objects that are supported:

Table 9-79 vl velocity mode supported objects

Index	Name
0x6042	*vl_target_velocity*
0x6043	*vl_velocity_demand*
0x6044	*vl_velocity_actual_value*
0x6046	*vl_velocity_min_max_amount*
0x6047	*vl_velocity_min_max*
0x6048	*vl_velocity_accleration*
0x6049	*vl_velocity_deceleration*
0x604A	*vl_velocity_quick_stop*
0x604B	*vl_setpoint_factor*
0x604C	*vl_dimension_factor*

9.20.1 0x6042 vl_target_velocity

This object is used to set the required velocity of the system. It is multiplied by the *vl_dimension_factor* and the *vl_setpoint_factor*. The value is given in rpm, If the *vl_dimension_factor* has the value of 1, otherwise the value is in user units. Positive values indicate forward direction and negative values indicate reverse direction.

Table 9-80 vl_target_velocity

0x6042	**vl_target_velocity**		
Access: RW	Range: -32768 to +32767	Size: Signed 16	Unit: rpm
Default:	0		
Description:	Used to set the required velocity of the system.		

9.20.2 0x6043 vl_velocity_demand

This read only object provides the instantaneous velocity demand generated by the drive ramp function. The value is given in rpm if the *vl_dimension_factor* and the *vl_setpoint_factor* have the value 1, otherwise the value is in user units. Positive values indicate forward direction and negative values indicate reverse direction.

Table 9-81 vl_velocity_demand

0x6043	**vl_velocity_demand**		
Access: RO	Range: -32768 to +32767	Size: Signed 16	Unit: rpm
Default:	0		
Description:	Provides the instantaneous velocity demand generated by the drive ramp function.		

9.20.3 0x6044 vl_velocity_actual_value

This read only object provides the velocity at the motor spindle or load. In a closed loop system this is determined from the motor feedback device and in an open loop system it is a copy of *vl_velocity_demand*.

The value is given in rpm if the *vl_dimension_factor* has the value of 1, otherwise the value is in user units. Positive values indicate forward direction and negative values indicate reverse direction.

Table 9-82 velocity_actual_value

0x6044	**vl_velocity_actual_value**		
Access: RO	Range: -32768 to +32767	Size: Signed 16	Unit: N/A
Default:	0		
Description:	Provides the velocity at the motor spindle or load.		

9.20.4 0x6046 vl_velocity_min_max_amount

This object is used to configure the minimum and maximum velocity.

The value is given in rpm if the *vl_dimension_factor* has the value of 1, otherwise the value is in user units.

Table 9-83 vl_velocity_min_max_amount

0x6046	**vl_velocity_min_max_amount**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default:	2		
Description:	The number of sub-indices in this object.		
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: rpm
Default:	0		
Description:	Used to configure the minimum velocity (both in the forward and reverse direction) that the system can operate at. Writing to this sub index will overwrite *vl_velocity_min* positive and *vl_velocity_min* negative.		
Sub-index 2			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: rpm
Default:	2147483647		
Description:	Used to configure the maximum velocity (both in the forward and reverse direction) that the system can operate at. Writing to this sub index will overwrite *vl_velocity_max* positive and *vl_velocity_max* negative.		

9.20.5 0x6047 vl_velocity_min_max

This object is used to configure the minimum and maximum velocity.

The value is given in rpm if the *vl_dimension_factor* has the value of 1, otherwise the value is in user units.

Table 9-84 0x6047 vl_velocity_min_max

0x6047	**vl_velocity_min_max**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default:	4		
Description:	The number of sub-indices in this object.		
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: rpm
Default:	0		
Description:	Used to configure the minimum positive velocity at which the system can operate.		
Sub-index 2			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: rpm
Default:	2147483647		
Description:	Used to configure the maximum positive velocity at which the system can operate.		
Sub-index 3			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: rpm
Default:	0		
Description:	Used to configure the minimum negative velocity at which the system can operate.		
Sub-index 4			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: rpm
Default:	2147483647		
Description:	Used to configure the maximum negative velocity at which the system can operate.		

9.20.6 0x6048 vl_velocity_acceleration

This object is used to configure the delta speed and delta time of the slope of the acceleration ramp.

Example: To ramp to 1000 rpm in 5s, possible values for delta speed and delta time are 10000 and 50 respectively.

vl_velocity_acceleration = delta speed / delta time

Table 9-85 0x6048 vl_velocity_acceleration

0x6048	**vl_velocity_acceleration**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default: 2			
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: rpm
Default: 1000			
Description: The value of delta speed is given in rpm if the *vl_dimension_factor* and the *vl_setpoint_factor* have the value 1, otherwise the value is in user units.			
Sub-index 2			
Access: RW	Range: 0 to 65535	Size: Unsigned 16	Unit: s
Default: 2			
Description: The value of delta time is given in seconds.			

9.20.7 0x6049 vl_velocity_deceleration

This object is used to configure the delta speed and delta time of the slope of the deceleration ramp.

Example: To decelerate by 800 rpm in 10s, possible values for delta speed and delta time are 8000 and 100 respectively.

vl_velocity_deceleration = delta speed / delta time

Table 9-86 0x6049 vl_velocity_deceleration

0x6049	**vl_velocity_deceleration**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default: 2			
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: rpm
Default: 1000			
Description: The value of delta speed is given in rpm if the *vl_dimension_factor* and the *vl_setpoint_factor* have the value 1, otherwise the value is in user units.			
Sub-index 2			
Access: RW	Range: 0 to 65535	Size: Unsigned 16	Unit: s
Default: 2			
Description: The value of delta time is given in seconds.			

9.20.8 0x604A vl_velocity_quick_stop

This object is used to configure the delta speed and delta time of the slope of the deceleration ramp for quick stop.

Example: To decelerate by 800 rpm in 10 s, possible values for delta speed and delta time are 8000 and 100 respectively.

vl velocity deceleration = delta speed / delta time

Table 9-87 0x604A vl_velocity_quick_stop

0x604A	**vl_velocity_quick_stop**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default: 2			
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: rpm
Default: 1000			
Description: The value of delta speed is given in rpm if the *vl_dimension_factor* and the *vl_setpoint_factor* have the value 1, otherwise the value is in user units.			
Sub-index 2			
Access: RW	Range: 0 to 65535	Size: Unsigned 16	Unit: s
Default: 2			
Description: The value of delta time is given in seconds.			

9.20.9 0x604B vl_setpoint_factor

This object is used to configure the numerator and denominator of the *vl_setpoint_factor*. The *vl_setpoint_factor* modifies the resolution or directing range of the specified setpoint. It does not influence the velocity limit function and the ramp function. A value of 0 must not be used.

Table 9-88 0x604B vl_setpoint_factor

0x604B	**vl_setpoint_factor**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default: 2			
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: -32768 to +32767	Size: Signed 16	Unit: N/A
Default: 1			
Description: *vl_setpoint_factor* numerator (a value of 0 is not valid).			
Sub-index 2			
Access: RW	Range: -32768 to +32767	Size: Signed 16	Unit: N/A
Default: 1			
Description: *vl_setpoint_factor* denominator (a value of 0 is not valid).			

9.20.10 0x604C vl_dimension_factor

This object is used to configure the numerator and denominator of the *vl_dimension_factor*. The *vl_dimension_factor* is used to scale the user units so that they can be used in a way that relates to the specific application.

Calculating the vl_dimension_factor:

Every user-specific velocity consists of a specific unit referred to as a specific unit of time (e.g. 1/s, bottles/min, m/s,...). The purpose of the *vl_dimension_factor* is to convert this specific unit to the revolutions/minute unit. A value of 0 must not be used.

Velocity [user-defined unit] / Dimension factor [rpm/user-defined unit] = Velocity [rpm]

Table 9-89 0x604C vl_dimension_factor

0x604C	**vl_dimension_factor**		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default:	2		
Description:	The number of sub-indices in this object.		
Sub-index 1			
Access: RW	Range: -32768 to +32767	Size: Signed 16	Unit: N/A
Default:	1		
Description:	*vl_dimension_factor* numerator (a value of 0 is not valid).		
Sub-index 2			
Access: RW	Range: -32768 to +32767	Size: Signed 16	Unit: N/A
Default:	1		
Description:	*vl_dimension_factor* denominator (a value of 0 is not valid).		

The *vl_target_velocity* object is re-read every new profile cycle. It is scaled to appropriate units using the *vl_dimension_factor* and *vl_setpoint_factor* objects and then written to the drive preset reference 1 parameter (Pr **1.21**).

The object *vl_velocity_min_max* is handled every profile cycle. The *vl_target_velocity* is limited according to the values set in the object *vl_velocity_min_max*, which is read every profile cycle. The object *vl_velocity_min_max_amount* is mapped to *vl_velocity_min_max*.

The value of the *vl_velocity_demand* object is calculated in the background. The option reads the value of parameter Pr **2.01** (post ramp reference), scaled from RPM to user units using *vl_dimension_factor* and *vl_setpoint_factor*, and writes the value to the *vl_velocity_demand* object.

On a closed-loop drive, the speed feedback is read from the drive internally every profile cycle, scaled to the same units as *vl_target_velocity* and written to the *vl_velocity_actual_value* object. On an open-loop drive, the estimated motor speed is read from Pr **5.04** (motor RPM) in the background, scaled to the units of *vl_target_velocity* and written to the *vl_velocity_actual_value* object.

The *vl_velocity_acceleration* and *vl_velocity_deceleration* objects are handled in the background. They are read, scaled to drive acceleration units (depending on the drive operating mode), and written to the drive acceleration rate and deceleration rate presets. In addition, if the drive acceleration rate preset is changed, the *vl_velocity_acceleration* object is updated, and if the drive deceleration rate preset is changed (Pr **2.21**), the *vl_velocity_deceleration* object is updated.

9.21 Profile torque mode

The profile torque mode is supported on the drive. In closed-loop servo mode, this mode operates on the profile cycle time, using the drives internal torque shortcut (which is read by the drive every 250 µs). When using profile torque mode object 0x604A *vl_velocity_quick_stop* will be used in the event of a quick stop (also for quick stop option codes 2 and 6 the 0x6049 *vl_velocity_deceleration* object will be used). Table 9-90 shows the objects that are supported:

Table 9-90 Profile torque mode supported objects

Index	Name
0x6071	*Target_torque*
0x6075	*Motor_rated_current*
0x6078	*Current_actual_value*
0x6087	*Torque_slope*

9.21.1 0x6071 Target_torque

This object indicates the configured input value for the torque controller in profile torque mode. The value of this object is given per thousand of rated torque.

Table 9-91 0x6071 Target_torque

0x6071	**Target_torque**		
Access: RW	Range: -32768 to +32767	Size: Signed 16	Unit: 0.1 % of rated torque
Default:	0		
Description:	Indicates the configured input value for the torque controller in profile torque mode.		

9.21.2 0x6075 Motor_rated_current

This object indicates the configured motor rated current. It is taken from the motor's name-plate. Depending on the motor and drive technology this current is DC, peak or rms (root-mean-square) current. All relative current data refers to this value. The value of this object is given in mA.

Table 9-92 0x6075 Motor_rated_current

0x6075	**Motor_rated_current**		
Access: RO	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: mA
Default:	0		
Description:	Indicates the configured motor rated current (Pr **5.07**).		

9.21.3 0x6078 Current_actual_value

This object provides the actual value of the current. It shall correspond to the current in the motor. The value of this object is given per thousand of rated current.

Table 9-93 0x6078 Current_actual_value

0x6078	**Current_actual_value**		
Access: RO	Range: -32768 to +32767	Size: Signed 16	Unit: 0.1 % of rated current
Default:	0		
Description:	Provides the actual value of the current.		

9.21.4 0x6087 Torque_slope

This object indicates the configured rate of change of torque. The value of this object is given in units of per thousand of rated torque per second.

Table 9-94 Torque_slope

0x6087	**Torque_slope**		
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: 0.1 % of rated torque per second
Default:	0		
Description:	Indicates the configured rate of change of torque.		

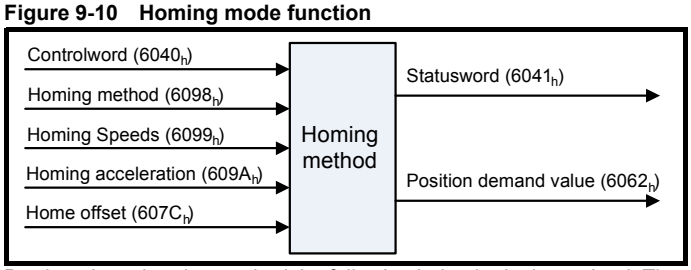
9.22 Homing mode

This section describes the method by which a drive seeks the home position (also called, the datum, reference point or zero point).

Figure 9-10 shows the defined input objects as well as the output objects. The user may specify the speeds, acceleration and the method of homing. There is a further object named home offset, which allows the user to displace zero in the user's coordinate system from the home position.

There is no output data except for those bits in the statusword, which return the status or result of the homing process and the demand to the position control loops.

Figure 9-10 Homing mode function



By choosing a homing method the following behavior is determined: The homing signal (positive limit switch, negative limit switch, home switch), the direction of actuation and where appropriate the position of the index pulse.

An encircled number in Figure 9-11 to Figure 9-18 indicates the code for selection of this homing position. The direction of movement is also indicated.

There are four sources of homing signal available: These are the negative and positive limit switches, the home switch and the index pulse from an encoder.

In the diagrams of homing sequences in Figure 9-11, the encoder count increases as the axis's position moves to the right, in other words the left is the minimum position and the right is the maximum position.

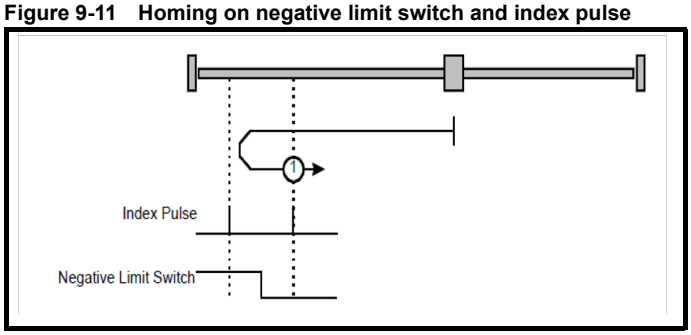
There are two digital inputs on the front of the EtherCAT interface that can be used in Homing Mode, more information is given in the following section.

9.22.1 General homing definitions

Method 1: Homing on negative limit switch and index pulse

Using this method as shown in Figure 9-11, the initial direction of movement shall be leftward if the negative limit switch is inactive (here: low). The home position shall be at the first index pulse to the right of the position where the negative limit switch becomes inactive.

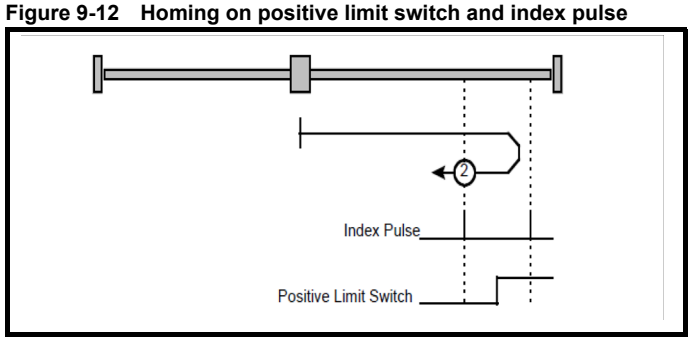
Figure 9-11 Homing on negative limit switch and index pulse



Method 2: Homing on positive limit switch and index pulse

Using this method as shown in Figure 9-12, the initial direction of movement shall be rightward if the positive limit switch is inactive (here: low). The position of home shall be at the first index pulse to the left of the position where the positive limit switch becomes inactive.

Figure 9-12 Homing on positive limit switch and index pulse

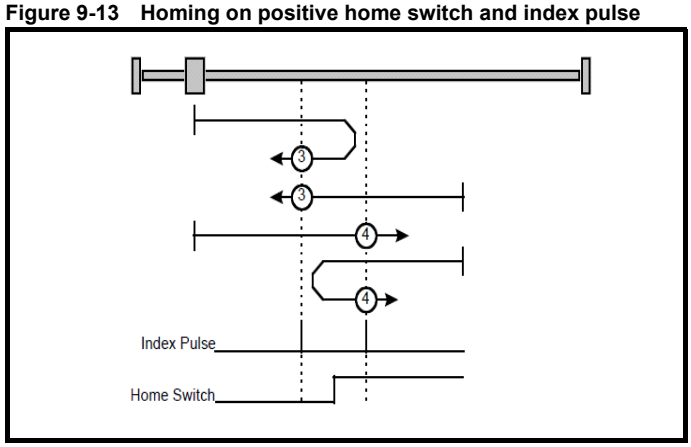


Method 3 and 4: Homing on positive home switch and index pulse

Using these methods as shown in Figure 9-13, the initial direction of movement shall be dependent on the state of the home switch.

The home position shall be at the index pulse either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement shall reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

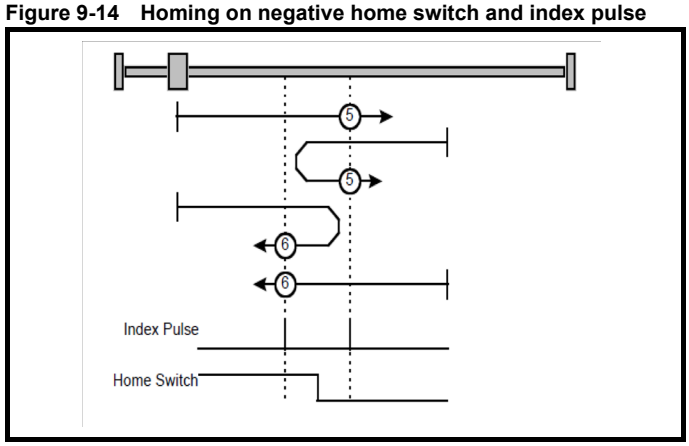
Figure 9-13 Homing on positive home switch and index pulse



Method 5 and 6: Homing on negative home switch and index pulse

Using these methods as shown in Figure 9-14, the initial direction of movement shall be dependent on the state of the home switch. The home position shall be at the index pulse either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement shall reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

Figure 9-14 Homing on negative home switch and index pulse



Method 7 to 14: Homing on home switch and index pulse

These methods use a home switch, which is active over only a portion of the travel; in effect the switch has a 'momentary' action as the axis's position sweeps past the switch. Using the methods 7 to 10, the initial direction of movement shall be to the right, and using methods 11 to 14 the initial direction of movement shall be to the left except if the home switch is active at the start of the motion. In this case the initial direction of motion shall be dependent on the edge being sought. The home position shall be at the index pulse on either side of the rising or falling edges of the home switch, as shown in Figure 9-15 and Figure 9-16. If the initial direction of movement leads away from the home switch, the drive shall reverse on encountering the relevant limit switch.

Figure 9-15 Homing on home switch and index pulse - positive initial motion

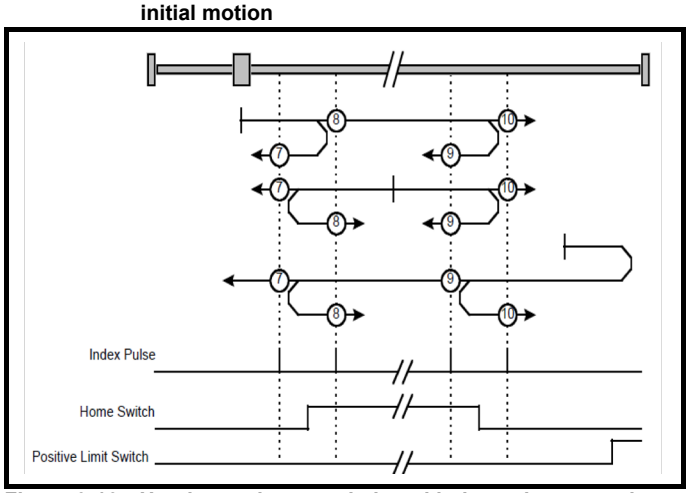
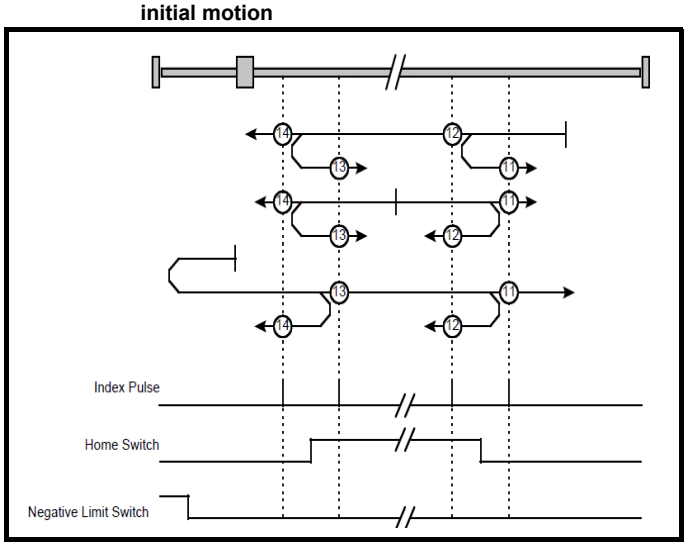


Figure 9-16 Homing on home switch and index pulse - negative initial motion



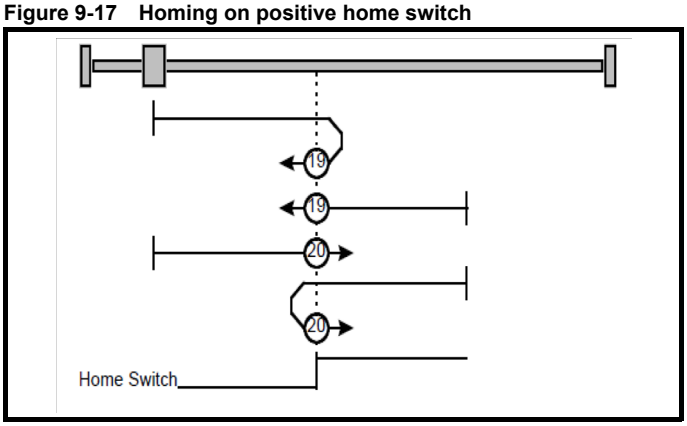
Method 15 and 16: Reserved

These methods are reserved.

Method 17 to 30: Homing without index pulse

These methods are similar to methods 1 to 14 except that the home position is not dependent on the index pulse but only dependent on the relevant home or limit switch transitions. For example methods 19 and 20 are similar to methods 3 and 4 as shown in Figure 9-17.

Figure 9-17 Homing on positive home switch



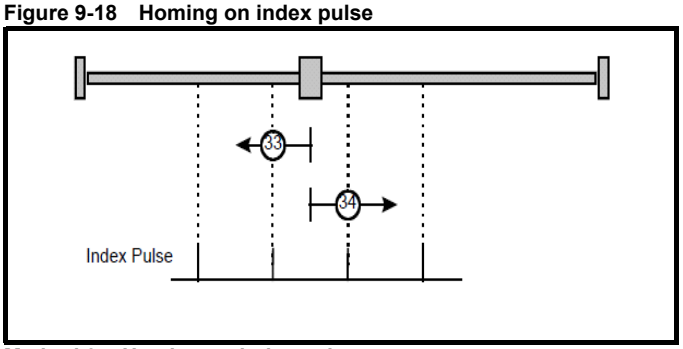
Method 31 and 32: Reserved

These methods are reserved.

Method 33 and 34: Homing on index pulse

Using these methods, the direction of homing is negative or positive respectively. The home position shall be at the index pulse found in the selected direction as shown in Figure 9-18.

Figure 9-18 Homing on index pulse



Method 35: Homing on index pulse

In this method, the current position shall be taken to be the home position. This method does not require the drive device to be in operational enabled state.

Use of controlword and statusword

The homing mode uses some bits of the controlword and the statusword for mode-specific purposes. Table 9-95 defines the values for bits 4 and 8 of the controlword.

Table 9-95 Definition of bits 4 and 8 of the controlword

Bit	Value	Definition
4	0	Do not start homing procedure.
	1	Start or continue homing procedure.
8	0	Enable bit 4.
	1	Stop axis according to halt option code (0x605D).

Table 9-96 Definition of bits 10 and 12 of the statusword

Bit 12	Bit 10	Definition
0	0	Homing procedure is in progress.
0	1	Homing procedure is interrupted or not started.
1	0	Homing is attained, but target is not reached.
1	1	Homing procedure was completed successfully.
0	0	Homing error occurred, velocity is not 0.
0	1	Homing error occurred, velocity is 0.
1	X	Reserved.

9.22.2 Homing mode object definitions

0x2803 Homing source

This object indicates the configured source of the homing switch used during the homing procedure. Table 9-97 specifies the object description.

Table 9-97 Homing source

0x2803	Homing source		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default: 2			
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RW	Range: 1 to 8	Size: Unsigned 8	Unit: N/A
Default: 5			
Description: The source of the homing switch. This will specify a digital input as follows: 1 to 6 - The number of a drive digital input 7 to 8 - EtherCAT interface digital input 0 or 1			
Sub-index 2			
Access: RW	Range: 0 to 1	Size: Unsigned 8	Unit: N/A
Default: 0			
Description: Use the feedback source freeze for homing. This will cause the freeze from the selected feedback device to be used instead of the index (marker) pulse when it is required during homing.			

0x2804 Freeze object

This object is used to configure the freeze function that can be used within the Homing mode profile. Table 9-98 specifies the object description.

Table 9-98 Freeze object

0x2804	Freeze object		
Sub-index 0			
Access: RO	Range: N/A	Size: Unsigned 8	Unit: N/A
Default: 2			
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RW	Range: 0 to 1	Size: Unsigned 8	Unit: N/A
Default: 0			
Description: Route the option freeze onto the drive. Setting a value of 1 here will route the option digital input 0 onto the drive freeze line.			
Sub-index 2			
Access: RW	Range: 0 to 1	Size: Unsigned 8	Unit: N/A
Default: 0			
Description: Option to drive freeze invert. Setting a value of 1 will invert the freeze signal routed onto the drive from the option input 0 (if 0x2804, sub-index 1 is set to 1). This value will be read only on a transition from 0 to 1 in sub-index 1.			

0x607C Home offset

This object indicates the configured difference between the zero position for the application and the machine home position (found during homing). During homing the machine home position is found and once the homing is completed, the zero position is offset from the home position by adding the home offset to the home position. All subsequent absolute moves shall be taken relative to this new zero position. This is illustrated in Figure 9-19. The value of this object shall be given in user-defined position units. Negative values indicate the opposite direction.

Figure 9-19 Home offset definition

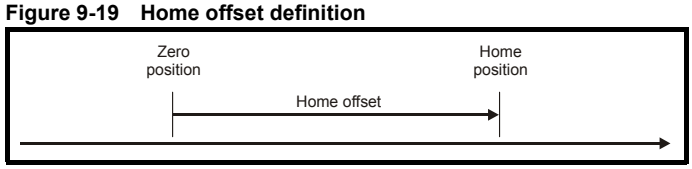


Table 9-99 Home offset

0x607C	Home offset		
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Signed 32	Unit: User-defined position units
Default: 0			
Description: Homing offset value.			

0x6098 Homing method

This object indicates the configured homing method that shall be used. Table 9-100 specifies the object description, and Table 9-101 specifies the value ranges for this object.

Table 9-100 Homing method

0x6098	Homing method		
Access: RW	Range: 0 - 35	Size: Unsigned 8	Unit: N/A
Default: 0			
Description:	The homing method that shall be used.		

Table 9-101 Homing method values

Value	Definition
0	No homing method assigned
1	Method 1 shall be used
to	
34	Method 34 shall be used
35	Method 35 shall be used

0x6099 Homing speeds

This object indicates the configured speeds used during the homing procedure. The values shall be given in user-defined velocity units. Table 9-102 specifies the object description.

Table 9-102 Homing speeds

0x6099	Homing speeds		
Sub-index 0			
Access: RO	Range: 2	Size: Signed 8	Unit: N/A
Default: 2			
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default: 0			
Description: Speed during search for a switch.			
Sub-index 2			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: N/A
Default: 0			
Description: Speed during search for a zero.			

0x609A Homing acceleration

This object indicates the configured acceleration and deceleration to be used during the homing operation. The value shall be given in user-defined acceleration units. Table 9-103 specifies the object description.

Table 9-103 Homing acceleration

0x609A	Homing acceleration		
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Unsigned 32	Unit: User-defined acceleration units
Default:	0		
Description:	Indicates the configured acceleration and deceleration to be used during homing operation.		

9.23 Cyclic sync position mode

Cyclic sync position mode is supported in servo mode.

Table 9-104 Cyclic sync position mode

Index	Name
0x6077	torque_actual_value
0x607A	target_position
0x60B1	velocity_offset
0x60C2	interpolation_time_period

NOTE

When using one of the DSP-402 positioning modes, Distributed Clocks must be enabled. Failure to do so may result in the EtherCAT interface going into the SAFE-OPERATIONAL state (Pr **17.04** = 4).

Cyclic sync position mode provides linear interpolation which will always insert a delay of one position command. The time specified must always be an integer multiple of the control loop cycle time. The time period index has a minimum value of -6 (i.e. the smallest time unit will be microseconds). The time period is checked to ensure that it an integer multiple of the control loop cycle time.

A velocity feed forward will be calculated for the position controller. On each interpolator time period, a value is read from the target_position object. The correct number of data points for linear interpolation is stored internally. When a new target position is loaded in, the oldest position command in the data set will be discarded.

9.23.1 0x6077 Torque_actual_value

This object provides the actual value of the torque. It shall correspond to the instantaneous torque in the motor. The value is given per thousand of rated torque.

Table 9-105 Torque actual value

0x6077	Torque actual value		
Access: RO	Range: -32768 to +32767	Size: Signed 16	Unit: 0.1% of rated torque
Default:	0		
Description:	Provides the actual value of the torque.		

9.23.2 0x607A Target_position

This object indicates the commanded position that the drive should move to in cyclic sync position mode using the current settings of motion control parameters such as velocity, acceleration, deceleration, motion profile type etc. The value of this object is given in user-defined position units.

Table 9-106 Target position

0x607A	Target position		
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Signed 32	Unit: User-defined position units
Default:	N/A		
Description:	Indicates the command positions that the drive should move to in cyclic sync position mode.		

9.23.3 0x60B1 Velocity offset

This object provides the offset for the velocity value. The offset is given in user defined velocity units. In cyclic synchronous position mode this object contains the input value for velocity feed forward.

Table 9-107 Velocity offset

0x60B1	Velocity offset		
Access: RW	Range: 0 to 0xFFFFFFFF	Size: Signed 32	Unit: User-defined velocity units
Default:	0		
Description:	Provides the offset for the velocity value.		

9.24 Advanced features

9.24.1 Distributed Clocks

The EtherCAT interface supports Distributed Clocks. This is the scheme used by EtherCAT to accurately time synchronize slave devices. Position, speed and current control loops can all be synchronized.

When the EtherCAT interface is connected to a drive which can take a time synchronization signal, the EtherCAT Distributed Clocks facility can be used to provide this signal so the drive speed and current tasks are synchronized to the network. The position controller, and appropriate motion features will also be synchronized to the drive speed task.

NOTE

In CoE interpolated position mode the position command provided by the master every interpolation cycle time is used to generate a position command for the drive every 250 µs.

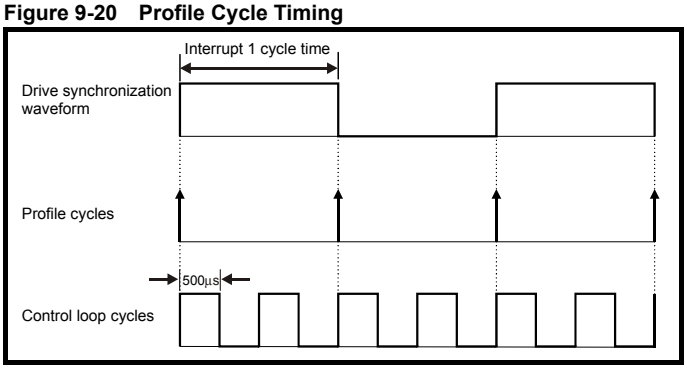
9.24.2 Time synchronization support

When the EtherCAT interface is connected to a drive which can take a time synchronization signal, the EtherCAT Distributed Clocks facility can be used to provide this signal so the drive speed and current tasks are synchronized to the network. The position controller, and appropriate motion features will also be synchronized to the drive speed task.

The time between edges of the drive synchronization square wave (referred to as the drive synchronization interval) will be an integer multiple of 250 µs (up to a maximum value of 15 ms).

The position controller will be executed at the interval defined in the Distributed Clock settings, if Distributed Clocks is disabled the controller will execute each 250 µs. When the profile torque or velocity control mode is used with Distributed Clocks enabled, a new profile cycle will be started every sync interval in the control loop cycle starting at the sync signal edge as shown in Figure 9-20. This will be referred to as a profile cycle. When Distributed Clocks are not enabled, a new profile cycle will be started every 250 µs.

Figure 9-20 Profile Cycle Timing



It is expected that most systems will have the interpolation cycle time equal to the drive synchronization interval. An interpolation cycle is referred to as a profile cycle. The inter-operation between a profile cycle when interpolation position mode is being used and the drive synchronization interval is described as follows:

1. Interpolation cycle time = drive synchronization interval. In this case, each new interpolation cycle will be synchronized to the drive synchronization interval. Interpolation will be performed in each of the subsequent control loop cycles until the next sync signal edge.

Command and feedback values which are handled cyclically will be read at defined times in the cycle. Command values handled/used every cycle (profile or control loop) will be cached from the object dictionary in the 90 µs period at the beginning of that cycle.

Any feedback values read during a cycle will be scaled as appropriate in that cycle, cached, and then written during the 90 µs period at the beginning of the next cycle. Feedback values that change internally between control loop cycles (but whose objects are only updated every profile cycle) will be read from the last control loop cycle in the profile cycle.

PDO data will be copied to and from the object dictionary (from and to the sync manager memory areas) in the 90 µs period at the beginning of every profile cycle. PDO data mapped to drive parameters (but not SM-Applications PLC parameters or other parameters accessed using Inter-Option Communications), will be written to those parameters in the 90 µs period at the beginning of every control loop cycle.

9.24.3 EtherCAT interface protocol support

The following are supported:

- Four Sync Managers. Two are used for the Mailbox Protocol (non-cyclic data) and two are used for process data (cyclic data)
- Distributed Clocks
- CANopen over EtherCAT (CoE)
- Ethernet over EtherCAT (EoE)
- CMP protocol through Modbus RTU

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Parameter 1.00 shortcut

Table 9-108 Parameter 1.00 shortcut

Parameter 1.00 shortcut		
Pr **61.01**	Default	0
	Range	0 to 32767
	Access	RW

This Parameter can be used as a shortcut to Pr **1.00** as DSP-402 objects do not permit access to parameter zero.

9.24.5 Drive synchronization control

Table 9-109 Drive synchronization control

Drive synchronization control		
Pr **61.03**	Default	1
	Range	0 to 2
	Access	RW

Table 9-110 Synchronization control values

Value	Description
0	Independent. The EtherCAT interface should not try to become synchronization master to the drive.
1	Master with sync. The EtherCAT interface should try to become synchronization master to the drive only when fieldbus specific synchronization has been achieved.
2	Master always. The EtherCAT interface should always try to become synchronization master to the drive.

9.24.6 Inter-option module synchronization control

Table 9-111 Inter-option module synchronization control

Inter-option module synchronization control		
Pr **61.04**	Default	1
	Range	0 to 2
	Access	RW

Table 9-112 Inter-option module synchronization control values

Value	Description
0	Independent. The EtherCAT interface should not try to become synchronization master to other EtherCAT interfaces.
1	Master with sync. The EtherCAT interface should try to become synchronization master to other EtherCAT interfaces only when fieldbus specific synchronization has been achieved.
2	Master always. The EtherCAT interface should always try to become synchronization master to other EtherCAT interfaces.

9.24.7 Inter-option clock synchronization control

Table 9-113 Inter-option clock synchronization control

Inter-option clock synchronization control		
Pr **61.05**	Default	0
	Range	0 to 2
	Access	RW

This parameter provides control of the inter-option module clock synchronization mechanism.

Table 9-114 Inter-option clock synchronization control values

Value	Description
0	Independent. The EtherCAT interface should not try to be come synchronization master to clocks in other EtherCAT interfaces.
1	Master. The EtherCAT interface should try to become synchronization master to clocks in other EtherCAT interfaces.
2	Slave. The EtherCAT interface should become a synchronization slave to clocks in another EtherCAT interfaces.

9.24.8 Option slot indicator

Table 9-115 Option slot indicator

Option slot indicator		
Pr **61.07**	Default	0
	Range	0 to 3
	Access	RO

The parameter displays the number of the option slot on the drive that the EtherCAT interface is connected to. The values for the slots are 1, 2 and 3. The EtherCAT interface is located in slot 3.

9.24.9 Option hardware issue

Table 9-116 Option hardware issue

Option hardware issue		
Pr **61.40**	Default	0
	Range	0 to 255
	Access	RO

The parameter displays the hardware revision number of the The EtherCAT interface.

9.24.10 500 ms Task % free

Table 9-117 500 ms Task % free

500 ms Task % free		
Pr **61.42**	Default	0
	Range	0 to 100
	Access	RO

This parameter indicates what percentage of the 500 ms system task is unused and still available.

9.24.11 External memory % free

Table 9-118 External memory % free.

External memory % free		
Pr **61.43**	Default	0
	Range	0 to 100
	Access	RO

This parameter indicates what percentage of the external memory is unused and still available.

9.24.12 Internal memory % free

Table 9-119 Internal memory % free

Internal memory % free		
Pr **61.44**	Default	0
	Range	0 to 100
	Access	RO

This parameter indicates what percentage of the internal memory is unused and still available.

9.24.13 EtherCAT interface error sub-code

Table 9-120 EtherCAT interface error sub-code

EtherCAT interface error sub-code		
Pr **61.49**	Default	0
	Range	0 to 255
	Access	RO

This parameter provides more detailed information of the cause of the current EtherCAT interface error.

9.24.14 Bootloader software version

Table 9-121 Bootloader software version

Bootloader software version (XX.YY)		
Pr **61.50**	Default	0
	Range	0 to 9999
	Access	RO

9.24.15 Bootloader software sub-version

Table 9-122 Bootloader software sub-version

Bootloader software subversion (ZZ)		
Pr **61.51**	Default	0
	Range	0 to 99
	Access	RO

These parameters provide the XX.YY and ZZ parts of the bootloader firmware version number while the main application is running.

9.25 Advanced cyclic data configuration

This configuration will allow the behavior of the cyclic data handling to be modified; specifically, it will allow the tasks in which cyclic data is handled to be changed.

Table 9-123 Out cyclic data configuration

0x2820	**Out cyclic data configuration**			
Sub-index 0				
Access: RO		**Range**: N/A	**Size**: Unsigned 8	**Unit**: N/A
Default:	2			
Description:	The number of the last sub-index in this object.			
Sub-index 1				
Access: RW		**Range**: 0 to 2	**Size**: Unsigned 8	**Unit**: ms
Default:	0			
Description:	High priority cyclic data task; selects the task in which high priority out (master to slave) cyclic data is copied between the intermediate buffer and the mapped objects, parameters, etc. 0 – Critical task (**default**). This is the first 90 µs of the critical task. 1 – Critical+90 task. This is the task that commences 90µs after the critical task start, and finishes before the next critical task. 2 – Sync Manager task. This is the AL event task which occurs upon a sync manager access.			
Sub-index 2				
Access: RW		**Range**: 0 to 2	**Size**: Unsigned 8	**Unit**: N/A
Default:	2			
Description:	Intermediate buffer copy task. Selects the task in which the high priority out (master to slave) cyclic data is copied into the intermediate buffer. 0 – Critical task. This is the first 90 µs of the critical task. 1 – Critical+90 task. This is the task that commences 90µs after the critical task start, and finishes before the next critical task. 2 – Sync Manager task (**default**). This is the AL event task which occurs upon a sync manager access.			

Table 9-124 In cyclic data configuration

0x2821	**In cyclic data configuration**			
Sub-index 0				
Access: RO	**Range**: N/A	**Size**: Unsigned 8	**Unit:** N/A	
Default:	2			
Description:	The number of the last sub-index in this object.			
Sub-index 1				
Access: RW	**Range**: 0 to 2	**Size**: Unsigned 8	**Unit**: ms	
Default:	1			
Description:	High priority cyclic data task; selects the task in which high priority in (slave to master) cyclic data is copied between the intermediate buffer and the mapped objects, parameters, etc. 0 – Critical task. This is the default task. This is the first 90µs of the critical task. 1_Critical+90 task (**Default**). This is the task that commences 90µs after the critical task start, and finishes before the next critical task. 2 – Sync Manager task (default). This is the AL event task which occurs upon a sync manager access.			
Sub-index 2				
Access: RW	**Range**: 0 to 2	**Size**: Unsigned 8	**Unit**: N/A	
Default:	1			
Description:	Intermediate buffer copy task. Selects the task in which the high priority in (slave to master) cyclic data is copied into the intermediate buffer. 0 – Critical task. This is the first 90µs of the critical task. 1_Critical+90 task (**Default**). This is the task that commences 90µs after the critical task start, and finishes before the next critical task. 2 – Sync Manager task (default). This is the AL event task which occurs upon a sync manager access.			

9.26 Internal shortcuts

Internal shortcuts are provided for very fast operation. It is not possible to read the values non-cyclically; they can only be accessed at certain parts of the cycle in order to read and write correct values.

Table 9-125 Internal position feedback shortcut

0x2830	**Internal position feedback shortcut**			
Sub-index 0				
Access: RO	**Range**: -2^{31} to $+2^{31}-1$	**Size**: Signed 32	**Unit**: Counts	
Default:	0			
Description:	This value is the *drive* feedback source. It consists of the coarse position in the most significant 16 bits and the fine position in the least significant 16 bits. It will then have a number of turns bits shifted into the most significant bits (“pushing” as many fine position bits as required out). This should not be read in the first 90 µs after the RMINT edge, because data skew may result.			

Table 9-126 Internal torque shortcut

0x2831	**Internal torque shortcut**		
Sub-index 0			
Access: RW	**Range**: N/A	**Size**: Signed 16	**Unit**: 0.01 % rated torque
Default:	0		
Description:	This represents the drive internal torque shortcut, scaled to 0.01 % units.		

9.27 Quick reference

Table 9-127 and Table 9-129 list of all the EtherCAT interface set-up objects and parameters that are required to configure the module.

Table 9-127 EtherCAT interface objects reference

Object	Name	Description	Cross reference
0x1000	Device type	Specifies the device profile being used (DSP-402).	Section 9.16.1 on page 76
0x1018	Identity object	Contains the EtherCAT interface specific identity information.	
0x1600	Receive PDO mapping 1	Contains the mapping information for receive PDO mapping 1.	Section 9.16.2 on page 77
0x1601	Receive PDO mapping 2	Contains the mapping information for receive PDO mapping 2.	
0x1605	Receive PDO mapping 6	Contains the mapping information for receive PDO mapping 6.	
0x1615	Receive PDO mapping 22	Contains the mapping information for receive PDO mapping 22.	
0x1A00	Transmit PDO mapping 1	Contains the mapping information for transmit PDO mapping 1.	
0x1A01	Transmit PDO mapping 2	Contains the mapping information for transmit PDO mapping 2.	
0x1A02	Transmit PDO mapping 3	Contains the mapping information for transmit PDO mapping 3.	
0x1A05	Transmit PDO mapping 6	Contains the mapping information for transmit PDO mapping 6.	
0x1A15	Transmit PDO mapping 22	Contains the mapping information for transmit PDO mapping 22.	
0x1C00	Sync manager communication type	This read-only object provides sync manager usage details.	Section 9.16.4 on page 79
0x1C10	Sync manager 0 PDO assignment	This read-only object contains information relating to the non-cyclic receive mailbox.	
0x1C11	Sync manager 1 PDO assignment	This read-only object contains information relating to the non-cyclic send mailbox.	
0x1C12	Sync manager 2 PDO assignment	Contains the currently in use receive PDOs.	
0x1C13	Sync manager 3 PDO assignment	Contains the currently in use transmit PDOs.	
0x2802	Feedback encoder source	Specifies the source position for position controller feedback.	Section 9.16.5 on page 79
0x2803	Homing source	Indicates the configured source of the homing switch used during the homing procedure.	Section 9.22.2 on page 93
0x2804	Freeze object	Used to configure the freeze function that can be used within the Homing mode profile.	
0x2813	Network loss behavior object	Used to configure the network loss trip behavior (watchdog).	Section 14.5 on page 200
0x2820	Out cyclic data configuration	The number of the last sub-index in this object	Section 9.25 on page 96
0x2821	In cyclic data configuration	The number of the last sub-index in this object	
0x2830	Internal position feedback shortcut	This value is the *drive* feedback source. It consists of the coarse position in the most significant 16 bits and the fine position in the least significant 16 bits. It will then have a number of turns bits shifted into the most significant bits (“pushing” as many fine position bits as required out). This should not be read in the first 90 µs after the RMINT edge, because data skew may result.	
0x2831	Internal torque shortcut	This represents the drive internal torque shortcut scaled to 0.01 % units.	Section 9.26 on page 97
0x603F	Error code	Indicates the current drive error code.	Section 14.10 on page 201
0x6040	Controlword	Provides the primary method of controlling the behavior of the drive.	Section 9.18.1 on page 81
0x6041	Statusword	This provides feedback about the current operating state of the drive.	Section 9.18.2 on page 82
0x6042	vl_target_velocity	Used to set the required velocity of the system.	Section 9.20.1 on page 88
0x6043	vl_velocity demand	Provides the instantaneous velocity demand generated by the drive ramp function.	Section 9.20.2 on page 88
0x6044	vl_velocity_actual value	Provides the velocity at the motor spindle or load.	Section 9.20.3 on page 88
0x6046	vl_velocity_min max_amount	This object is used to configure the minimum and maximum velocity.	Section 9.20.4 on page 88
0x6047	vl_velocity_min max	This object is used to configure the minimum and maximum velocity.	Section 9.20.5 on page 88
0x6048	vl_velocity acceleration	This object is used to configure the delta speed and delta time of the slope of the acceleration ramp.	Section 9.20.6 on page 89
0x6049	vl_velocity deceleration	This object is used to configure the delta speed and delta time of the slope of the deceleration ramp.	Section 9.20.7 on page 89
0x604A	vl_velocity_quick stop	This object is used to configure the delta speed and delta time of the slope of the deceleration ramp for quick stop.	Section 9.20.8 on page 89
0x604B	vl_setpoint factor	This object is used to configure the numerator and denominator of the vl_setpoint_factor.	Section 9.20.9 on page 89

Object	Name	Description	Cross reference
0x604C	vl_dimension_factor	This object is used to configure the numerator and denominator of the vl_dimension_factor.	Section 9.20.10 on page 89
0x605A	Quick_stop option_code	Specifies what action is performed in the event of a quick stop function	Section 9.18.4 on page 84
0x605B	Shutdown_option code	Used to control what action is performed if there is a transition from the Operation Enabled state to the Ready To Switch On state.	Section 9.18.5 on page 84
0x605C	Disable operation_optioncode	This object is used to control what action is performed if there is a transition from the Operation Enabled state to the Switched On state.	Section 9.18.6 on page 84
0x605E	Fault_reaction option_code	This object is used to control what action is performed when a fault is detected.	Section 9.18.7 on page 84
0x6060	Modes_of operation	This object is used to request a change in the mode of operation.	Section 9.18.8 on page 84
0x6061	Modes of operation display	This read only object is used to provide the active mode of operation.	Section 9.18.9 on page 84
0x6062	Position_demand value	Used to provide the currently demanded position value.	Section 9.18.17 on page 86
0x6064	Position_actual value	This read only object provides the actual value of the position feedback device.	Section 9.18.18 on page 86
0x6071	Target_torque	This object indicates the configured input value for the torque controller in profile torque mode.	Section 9.21.1 on page 90
0x6075	Motor_rated_current	This object indicates the motor rated current.	Section 9.21.2 on page 90
0x6077	Torque_actual_value	This object provides the actual torque value	Section 9.23.1 on page 94
0x6078	Current_actual_value	This object provides the actual value of the current.	Section 9.21.3 on page 90
0x607A	Target_position	Indicates the command positions that the drive should move to in cyclic sync position mode.	Section 9.23.2 on page 94
0x607C	Home offset	this object indicates the configured difference between the zero position for the application and the machine home position (found during homing).	Section 9.20.7 on page 89
0x6080	Max motor speed	This object indicated the configured maximum allowed speed for the motor in either direction.	Section 9.18.19 on page 86
0x6084	Profile deceleration	Provides the deceleration ramp for the positioning modes	Section 9.18.10 on page 85
0x6085	Quick_stop deceleration	This object is used to configure the deceleration rate used to stop the motor when the quickstop function is activated and the quick stop code object (0x605A) is set to 2 or 6.	Section 9.18.11 on page 85
0x608F	Position_encoder resolution	This read only object indicates the configured encoder increments per number of motor revolutions.	Section 9.18.13 on page 85
0x6091	Gear_ratio	This object is used to apply scaling.	Section 9.18.14 on page 85
0x6092	Feed_constant	This is used to configure a feed constant.	Section 9.18.15 on page 86
0x6098	Homing Method	This object indicates the configured homing method that shall be used.	Table 9-100 on page 93
0x6099	Homing speeds	This object indicated the configured speeds used during the homing procedure.	Table 9-102 on page 93
0x609A	Homing acceleration	Indicates the configured acceleration and deceleration to be used during homing operation.	Table 9-103 on page 94
0x60B1	Velocity_offset	This object provides the value of the velocity offset.	Section 9.23.3 on page 94
0x60F4	Following_error actual_value	This read only object provides the actual value of the following error.	Section 9.18.20 on page 86
0x60FB	Position_control parameter_set object	Used to configure the positional control gains.	Section 9.18.21 on page 86
0x60C0	Interpolation sub-mode_select	Specifies the interpolation type.	Section 9.19.1 on page 87
0x60C1	Interpolation data_record	This object is used to specify the target position.	Section 9.19.2 on page 87
0x60C2	Interpolation time_period	The number of time units between interpolator re-starts.	Section 9.19.3 on page 87

Table 9-128 Virtual parameter reference

Parameter	Default	Description	Cross reference
Pr **61.01**	0	Parameter 1.00 shortcut	Section 9.24.4 on page 95
Pr **61.03**	1	Drive synchronization control	Section 9.24.5 on page 95
Pr **61.04**	1	Inter-option module synchronization control	Section 9.24.6 on page 95
Pr **61.05**	0	Inter-option clock synchronization control	Section 9.24.7 on page 95
Pr **61.07**	0	Option slot indicator	Section 9.24.8 on page 96
Pr **61.40**	0	Option hardware issue	Section 9.24.9 on page 96
Pr **61.42**	0	500 ms Task % free	Section 9.24.10 on page 96
Pr **61.43**	0	External memory % free	Section 9.24.11 on page 96
Pr **61.44**	0	Internal memory % free	Section 9.24.12 on page 96
Pr **61.49**	0	The EtherCAT interface error sub-code	Section 9.24.13 on page 96
Pr **61.50**	0	Bootloader software version - major and minor (XX.YY)	Section 9.24.14 on page 96
Pr **61.51**	0	Bootloader software version -subversion (ZZ)	Section 9.24.15 on page 96

Table 9-129 EtherCAT interface parameter reference

Object	Description	Default	Range	Cross reference
Pr **17.01**	EtherCAT interface ID code	421	- - - -	Section 14.4.1 on page 199
Pr **17.02**	EtherCAT interface firmware - major and minor version	N/A	00.00 to 99.99	Section 14.4.2 on page 199
Pr **17.03**	Node address	0	0 to 65535	Section 9.11 on page 75
Pr **17.04**	EtherCAT interface RUN	1	1 to 8	Section 9.12 on page 75
Pr **17.06**	EtherCAT interface operating status	N/A	-9999 to 9999	Section 14.6 on page 200
Pr **17.10**	EoE - IP address W_{ip}	0	0 to 255	Table 9-30 on page 80
Pr **17.11**	EoE - IP address X_{ip}			Table 9-31 on page 80
Pr **17.12**	EoE - IP address Y_{ip}			Table 9-32 on page 80
Pr **17.13**	EoE - IP address Z_{ip}			Table 9-33 on page 80
Pr **17.14**	EoE - Subnet mask W_{subnet}			Table 9-34 on page 80
Pr **17.15**	EoE - Subnet mask X_{subnet}			Table 9-35 on page 80
Pr **17.16**	EoE - Subnet mask Y_{subnet}			Table 9-36 on page 80
Pr **17.17**	EoE - Subnet mask Z_{subnet}			Table 9-37 on page 80
Pr **17.18**	EoE - Default gateway $W_{gateway}$			Table 9-38 on page 81
Pr **17.19**	EoE - Default gateway $X_{gateway}$			Table 9-39 on page 81
Pr **17.20**	EoE - Default gateway $Y_{gateway}$			Table 9-40 on page 81
Pr **17.21**	EoE - Default gateway $Z_{gateway}$			Table 9-41 on page 81
Pr **17.32**	EtherCAT interface re-initialize	0 (OFF)	0 (OFF) to 1 (ON)	Section 9.12 on page 75
Pr **17.35**	EtherCAT interface serial number	N/A	0 to 16777215	Section 14.9 on page 201
Pr **17.37**	Reduce Drive serial interface priority	OFF	OFF - ON	Section 9.17.4 on page 81
Pr **17.44**	EtherCAT interface temperature	N/A	0 to 255	Section 14.8 on page 201
Pr **17.46**	Critical task % free	N/A	0 to 100	Section 14.12 on page 203
Pr **17.47**	Worst case critical task % free	N/A	0 to 100	
Pr **17.48**	Flash file system % free	N/A	0 to 100	Section 14.14 on page 203
Pr **17.50**	EtherCAT interface error code	N/A	0 to 255	Section 14.10 on page 201
Pr **17.51**	EtherCAT interface firmware - subversion	N/A	0 to 99	Section 14.4.2 on page 199

10 SMARTCARD Operation

10.1 Introduction

This is a standard feature that enables simple configuration of parameters in a variety of ways. The SMARTCARD can be used for:

- Parameter copying between drives
- Saving whole drive parameter sets
- Saving 'differences from default' parameter sets
- Storing Onboard PLC programs
- Automatically saving all user parameter changes for maintenance purposes
- Loading complete motor map parameters

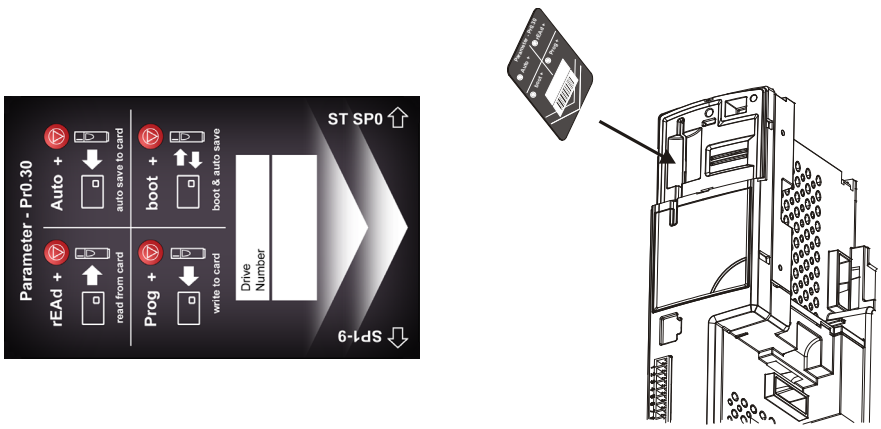
The SMARTCARD is located at the top of the module under the drive display (if installed) on the left-hand side. Ensure the SMARTCARD is inserted as shown on the SMARTCARD.

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

WARNING

Encoder phase angle
The encoder phase angles in Pr **3.25** and Pr **21.20** are copied to the SMARTCARD when using any of the SMARTCARD transfer methods.

Figure 10-1 Installation of the SMARTCARD



NOTE

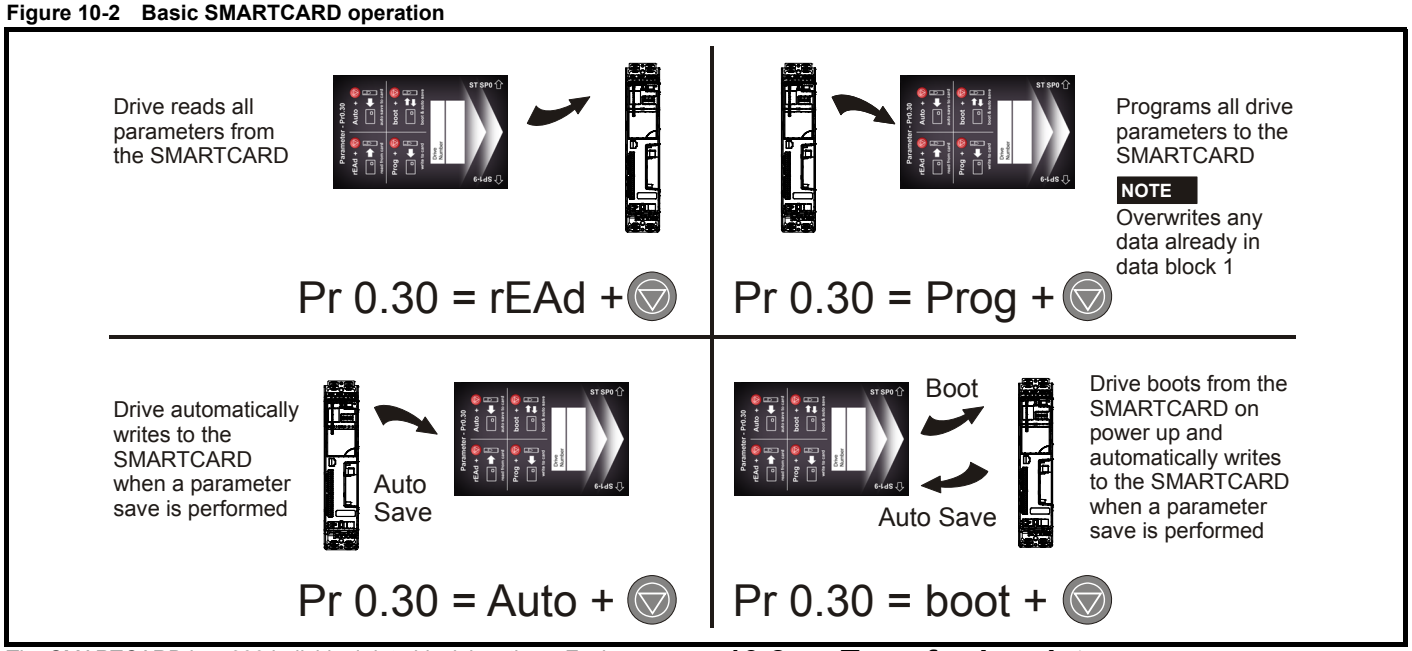
When inserting the SMARTCARD, always ensure that ST SP0 arrow points upwards.

WARNING

Be aware of possible live terminals when inserting the SMARTCARD.

Easy saving and reading

Figure 10-2 Basic SMARTCARD operation



The SMARTCARD has 999 individual data block locations. Each individual location from 1 to 499 can be used to store data until the capacity of the SMARTCARD is used. The drive can support SMARTCARDs with a capacity of between 4kB and 512kB.

The data block locations of the SMARTCARD are arranged to have the following usage:

Table 10-1 SMARTCARD data blocks

Data Block	Type	Example Use
1 to 499	Read / Write	Application set ups
500 to 999	Read Only	Macros

'Differences from default' parameter sets will be much smaller than whole parameter sets and thus take up a lot less memory as most applications only require a few parameters to be changed from the default setting.

The whole card may be protected from writing or erasing by setting the read-only flag as detailed section 10.2.10 *9888 / 9777 - Setting and clearing the SMARTCARD read only flag* on page 104.

Data transfer to or from the SMARTCARD is indicated by one the following:

- Digitax ST: The decimal point after the fourth digit in the upper display will flash.
- SM-Keypad Plus: The symbol 'CC' will appear in the lower left hand corner of the display

The card should not be removed during data transfer, as the drive will produce a trip. If this occurs then either the transfer should be reattempted or in the case of a card to drive transfer, default parameters should be loaded.

10.2 Transferring data

Data transfer, erasing and protecting the information is performed by entering a code in Pr **xx.00** and then resetting the drive as shown in Table 10-2.

Table 10-2 SMARTCARD codes

Code	Action
2001	Transfer drive parameters as difference from defaults to a bootable SMARTCARD block in data block number 001
3yyy	Transfer drive parameters to a SMARTCARD block number yyy
4yyy	Transfer drive data as difference from defaults to SMARTCARD block number yyy
5yyy	Transfer drive Onboard PLC program to SMARTCARD block number yyy
6yyy	Transfer SMARTCARD data block yyy to the drive
7yyy	Erase SMARTCARD data block yyy
8yyy	Compare drive parameters with block yyy
9555	Clear SMARTCARD warning suppression flag
9666	Set SMARTCARD warning suppression flag
9777	Clear SMARTCARD read-only flag
9888	Set SMARTCARD read-only flag
9999	Erase SMARTCARD

Where yyy indicates the block number 001 to 999. See Table 10-1 for restrictions on block numbers.

NOTE

If the read only flag is set then only codes 6yyy or 9777 are effective.

10.2.1 Writing to the SMARTCARD

3yyy - Transfer data to the SMARTCARD

The data block contains the complete parameter data from the drive, i.e. all user save (US) parameters except parameters with the NC coding bit set. Power-down save (PS) parameters are not transferred to the SMARTCARD.

4yyy - Write default differences to a SMARTCARD

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

Six bytes are required for each parameter difference. The data density is not as high as when using the 3yyy transfer method as described in the previous section, but in most cases the number of differences from default is small and the data blocks are therefore smaller. This method can be used for creating drive macros. Power-down save (PS) parameters are not transferred to the SMARTCARD.

All user save (US) parameters including those that do not have a default value (i.e. Pr **3.25** or Pr **21.20** *Encoder phase angle*), but not including those with the NC (Not copied) coding bit set can be transferred to the SMARTCARD. In addition to these parameters all menu 20 parameters (except Pr **20.00**), can be transferred to the SMARTCARD even though they are not user save parameters and have the NC coding bit set.

It is possible to transfer parameters between drives with each of the different formats, however, the data block compare function does not work with data produced by different formats.

Writing a parameter set to the SMARTCARD (Pr 11.42 = Prog (2))

Setting Pr **11.42** to Prog (2) and resetting the drive will save the parameters to the SMARTCARD, i.e. this is equivalent to writing 3001 to Pr **xx.00**. All SMARTCARD trips apply except 'C.Chg'. If the data block already exists it is automatically overwritten. When the action is complete this parameter is automatically reset to nonE (0).

10.2.2 Reading from the SMARTCARD

6yyy - Read default differences from a SMARTCARD

When the data is transferred back to a drive, using 6yyy in Pr **xx.00**, it is transferred to the drive RAM and the drive EEPROM. A parameter save is not required to retain the data after power-down. Set up data for any Solutions Modules installed are stored on the card and are transferred to the destination drive. If the Solutions Modules are different between the source and destination drive, the menus for the slots where the Solutions Module categories are different are not updated from the card and will contain their default values after the copying action. The drive will produce a 'C.Optn' trip if the Solutions Modules installed to the source and destination drive are different or are in different slots. If the data is being transferred to a drive of a different voltage or current rating a 'C.rtg' trip will occur.

The following drive rating dependant parameters (RA coding bit set) will not be transferred to the destination drive by a SMARTCARD when the rating of the destination drive is different from the source drive and the file is a parameter file (i.e. created using the 3yyy transfer method). However drive rating dependent parameters will be transferred if only the current rating is different and the file is a differences from default type file (i.e. created using the 4yyy transfer method). If drive rating dependant parameters are not transferred to the destination drive they will contain their default values.

Pr **2.08** *Standard ramp voltage*
Pr **4.05** to Pr **4.07** and Pr **21.27** to Pr **21.29** *Current limits*
Pr **4.24**, *User current maximum scaling*
Pr **5.07**, Pr **21.07** *Motor rated current*
Pr **5.09**, Pr **21.09** *Motor rated voltage*
Pr **5.10**, Pr **21.10** *Rated power factor*
Pr **5.17**, Pr **21.12** *Stator resistance*
Pr **5.18** *Switching frequency*
Pr **5.23**, Pr **21.13** *Voltage offset*
Pr **5.24**, Pr **21.14** *Transient inductance*
Pr **5.25**, Pr **21.24** *Stator inductance*
Pr **6.06** *DC injection braking current*
Pr **6.48** *Line power supply loss ride through detection level*

Reading a parameter set from the SMARTCARD (Pr 11.42 = rEAd (1))

Setting Pr **11.42** to rEAd (1) and resetting the drive will transfer the parameters from the card into the drive parameter set and the drive EEPROM, i.e. this is equivalent to writing 6001 to Pr **xx.00**. All SMARTCARD trips apply. Once the parameters are successfully copied this parameter is automatically reset to nonE (0). Parameters are saved to the drive EEPROM after this action is complete.

NOTE

This operation is only performed if data block 1 on the card is a full parameter set (3yyy transfer) and not a default difference file (4yyy transfer). If block 1 does not exist a 'C.dAt' trip occurs.

10.2.3 Auto saving parameter changes (Pr 11.42 = Auto (3))

This setting causes the drive to automatically save any changes made to menu 0 parameters on the drive to the SMARTCARD. The latest menu 0 parameter set in the drive is therefore always backed up on the SMARTCARD. Changing Pr **11.42** to Auto (3) and resetting the drive will immediately save the complete parameter set from the drive to the card, i.e. all user save (US) parameters except parameters with the NC coding bit set. Once the whole parameter set is stored only the individual modified menu 0 parameter setting is updated.

Advanced parameter changes are only saved to the card when Pr **xx.00** is set to a 1000 and the drive reset.

All SMARTCARD trips apply, except ‘C.Chg’. If the data block already contains information it is automatically overwritten.

If the card is removed when Pr **11.42** is set to 3 Pr **11.42** is then automatically set to nonE (0).

When a new SMARTCARD is installed Pr **11.42** must be set back to Auto (3) by the user and the drive reset so the complete parameter set is rewritten to the new SMARTCARD if auto mode is still required.

When Pr **11.42** is set to Auto (3) and the parameters in the drive are saved, the SMARTCARD is also updated, therefore the SMARTCARD becomes a copy of the drives stored configuration.

At power up, if Pr **11.42** is set to Auto (3), the drive will save the complete parameter set to the SMARTCARD. The drive will display ‘cArd’ during this operation. This is done to ensure that if a user puts a new SMARTCARD in during power down the new SMARTCARD will have the correct data.

NOTE

When Pr **11.42** is set to Auto (3) the setting of Pr **11.42** itself is saved to the drive EEPROM but NOT to the SMARTCARD.

10.2.4 Booting up from the SMARTCARD on every power up (Pr 11.42 = boot (4))

When Pr **11.42** is set to boot (4) the drive operates the same as Auto mode except when the drive is powered-up. The parameters on the SMARTCARD will be automatically transferred to the drive at power up if the following are true:

- A card is inserted in the drive
- Parameter data block 1 exists on the card
- The data in block 1 is type 1 to 5 (as defined in Pr **11.38**)
- Pr **11.42** on the card set to boot (4)

The drive will display 'boot' during this operation. If the drive mode is different from that on the card, the drive gives a 'C.Typ'. trip and the data is not transferred.

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

If data block 1 contains a bootable parameter set and data block 2 contains an Onboard PLC program (type 17 as defined in Pr **11.38**), then the onboard PLC program will be transferred to the drive at power up along with the parameter set in data block 1.

NOTE

‘Boot’ mode is saved to the card, but when the card is read, the value of Pr **11.42** is not transferred to the drive.

10.2.5 Booting up from the SMARTCARD on every power up (Pr xx.00 = 2001)

It is possible to create a difference from default bootable file by setting Pr **xx.00** to 2001 and resetting the drive. This type of file causes the drive to behave in the same way at power-up as a file created with boot

mode set up with Pr **11.42**. The difference from the default file is that it has the added advantage of including menu 20 parameters.

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

If a data block 2 exists and contains an Onboard PLC program (type 17 as defined in Pr **11.38**), this will also be loaded after the parameters have been transferred

A bootable difference from default file can only be created in one operation and parameters cannot be added as they are saved via menu 0.

10.2.6 8yyy - Comparing the drive full parameter set with the SMARTCARD values

Setting 8yyy in Pr **xx.00**, will compare the SMARTCARD file with the data in the drive. If the compare is successful Pr **xx.00** is simply set to 0. If the compare fails a 'C.cpr' trip is initiated.

10.2.7 7yyy / 9999 - Erasing data from the SMARTCARD

Data can be erased from the SMARTCARD either one block at a time or all blocks in one go.

- Setting 7yyy in Pr **xx.00** will erase SMARTCARD data block yyy.
- Setting 9999 in Pr **xx.00** will erase all SMARTCARD data blocks

10.2.8 SM-Applications Modules And Motion Processors program to/from SMARTCARD transfer system

The following additional codes can be used in Pr **x.00** and will initiate the specified actions when a drive reset occurs.

Value	Action
15yyy	Transfer the user program in the applications module in slot 1 to data block number yyy on a SMARTCARD
16yyy	Transfer the user program in the applications module in slot 2 to data block number yyy on a SMARTCARD
17yyy	Transfer the user program in the SM-Applications Modules And Motion Processors (Digitax ST Plus and Indexer) to data block number yyy on a SMARTCARD
18yyy	Transfer a user program in data block number yyy on a SMARTCARD to the applications module in slot 1
19yyy	Transfer a user program in data block number yyy on a SMARTCARD to the applications module in slot 2
20yyy	Transfer a user program in data block number yyy on a SMARTCARD to the SM-Applications Modules And Motion Processors (Digitax ST Plus and Indexer)

If the action is not possible because there is no applications category module in the requested slot then Pr **x.00** remains at the value set by the user. If the action is not possible for any other reason a C.SLx trip is produced where x is the slot number. The possible reasons are:

1. The data block to be read from the card does not exist or the data block is of the wrong type.
2. Either the data block to be written to the card already exists or the program in the module is identical to that on the SMARTCARD.
3. A failure has occurred within the Solutions Module and it has stopped the transfer process.
4. The data block to be written to the card is not copyable. To resolve this, allow copying within CTSoft or SyPTPro.
5. The SMARTCARD does not have enough free memory. To resolve use an empty SMARTCARD or a high capacity SMARTCARD (64KB).

10.2.9 9666 / 9555 - Setting and clearing the SMARTCARD warning suppression flag

If the Solutions Modules installed to the source and destination drive are different or are in different slots the drive will produce a 'C.Optn' trip. If the data is being transferred to a drive of a different voltage or current rating a 'C.rtg' trip will occur. It is possible to suppress these trips by setting the warning suppression flag. If this flag is set the drive will not trip if the Solutions Module(s) or drive ratings are different between the source and destination drives. The Solutions Module or rating dependent parameters will not be transferred.

- Setting 9666 in Pr **xx.00** will set the warning suppression flag
- Setting 9555 in Pr **xx.00** will clear the warning suppression flag

10.2.10 9888 / 9777 - Setting and clearing the SMARTCARD read only flag

The SMARTCARD may be protected from writing or erasing by setting the read only flag. If an attempt is made to write or erase a data block when the read only flag is set, a 'C.Rdo' trip is initiated. When the read only flag is set only codes 6yyy or 9777 are effective.

- Setting 9888 in Pr **xx.00** will set the read only flag
- Setting 9777 in Pr **xx.00** will clear the read only flag.

10.3 Data block header information

Each data block stored on a SMARTCARD has header information detailing the following:

- A number which identifies the block (Pr **11.37**)
- The type of data stored in the block (Pr **11.38**)
- The drive mode if the data is parameter data (Pr **11.38**)
- The version number (Pr **11.39**)
- The checksum (Pr **11.40**)
- The read-only flag
- The warning suppression flag

The header information for each data block which has been used can be viewed in Pr **11.38** to Pr **11.40** by increasing or decreasing the data block number set in Pr **11.37**.

If Pr **11.37** is set to 1000 the checksum parameter (Pr **11.40**) shows the number of 16 byte pages left on the card.

If Pr **11.37** is set to 1001 the checksum parameter (Pr **11.40**) shows the total capacity of the card in 16 byte pages. Therefore, for a 4 kB card this parameter would show 254.

If Pr **11.37** is set to 1002 the checksum parameter (Pr **11.40**) shows the state of the read-only (bit 0) and warning suppression flags (bit 1).

Software version xx.xx.xx: If Pr **11.37** is set to 1003, the checksum parameter (Pr **11.40**) shows the product identifier (2 = Digitax ST).

If there is no data on the card Pr **11.37** can only have values of 0 or 1000 to 1003.

10.4 SMARTCARD parameters

Table 10-3 Key to parameter table coding

RW	Read / Write	RO	Read only	Uni	Unipolar
Bi	Bi-polar	Bit	Bit parameter	Txt	Text string
FI	Filtered	DE	Destination	NC	Not copied
RA	Rating dependent	PT	Protected	US	User save
PS	Power down save				

11.36 {0.29}	SMARTCARD parameter data previously loaded									
RO	Uni					NC	PT	US		
⇳	0 to 999				⇨	0				

This parameter shows the number of the data block last transferred from a SMARTCARD to the drive.

11.37	SMARTCARD data number									
RW	Uni					NC				
⇳	0 to 1003				⇨	0				

This parameter should have the data block number entered for which the user would like information displayed in Pr **11.38**, Pr **11.39** and Pr **11.40**.

11.38	SMARTCARD data type/mode								
RO	Txt					NC	PT		
⇳	0 to 18				⇨				

Gives the type/mode of the data block selected with Pr **11.37**

Pr 11.38	String	Type/mode	Data stored
0	FrEE	Value when Pr **11.37** = 0, 1000 to 1003	
1		Reserved	
2	3OpEn.LP	Open-loop mode parameters	Data from EEPROM
6 to 8	3Un	Unused	
9		Reserved	
10	4OpEn.LP	Open-loop mode parameters	Defaults last loaded and differences
11	4CL.VECt	Closed-loop vector mode parameters	
14 to 16	4Un	Unused	
17	LAddEr	Onboard PLC program	
18	Option	A Solutions Module file	
19	Opt.Prg	Solutions Module program data block present	

11.39	SMARTCARD data version								
RW	Uni					NC			
⇳	0 to 9,999				⇨	0			

Gives the version number of the data block selected in Pr **11.37**.

11.40	SMARTCARD data checksum								
R0	Uni					NC	PT		
⇳	0 to 65,335				⇨				

Gives the checksum of the data block selected in Pr **11.37**.

11.42 {0.30}	Parameter copying								
RW	Txt					NC		US*	
⇳	0 to 4				⇨	nonE (0)			

NOTE

If Pr **11.42** is equal to 1 or 2, this value is not transferred to the drive or saved to the EEPROM. If Pr **11.42** is set to a 3 or 4 the value is transferred.

nonE (0) = Inactive
rEAd (1) = Read parameter set from the SMARTCARD
Prog (2) = Programming a parameter set to the SMARTCARD
Auto (3) = Auto save
boot (4) = Boot mode

10.5 SMARTCARD trips

After an attempt to read, write or erase data to or from a SMARTCARD a trip may occur if there has been a problem with the command. The following trips indicate various problems as detailed in Table 10-4.

Table 10-4 Trip conditions

Trip	Diagnosis
C.Acc	**SMARTCARD trip: SMARTCARD Read / Write fail**
185	Check SMARTCARD is installed / located correctly Ensure SMARTCARD is not writing data to data location 500 to 999 Replace SMARTCARD
C.boot	**SMARTCARD trip: The menu 0 parameter modification cannot be saved to the SMARTCARD because the necessary file has not been created on the SMARTCARD**
177	A write to a menu 0 parameter has been initiated via the keypad with Pr **11.42** set to auto(3) or boot(4), but the necessary file on the SMARTCARD has not been created Ensure that Pr **11.42** is correctly set and reset the drive to create the necessary file on the SMARTCARD Re-attempt the parameter write to the menu 0 parameter
C.bUSY	**SMARTCARD trip: SMARTCARD can not perform the required function as it is being accessed by a Solutions Module**
178	Wait for the Solutions Module to finish accessing the SMARTCARD and then re-attempt the required function
C.Chg	**SMARTCARD trip: Data location already contains data**
179	Erase data in data location Write data to an alternative data location
C.Cpr	**SMARTCARD trip: The values stored in the drive and the values in the data block on the SMARTCARD are different**
188	Press the red reset button
C.dat	**SMARTCARD trip: Data location specified does not contain any data**
183	Ensure data block number is correct
C.Err	**SMARTCARD trip: SMARTCARD data is corrupted**
182	Ensure the card is located correctly Erase data and retry Replace SMARTCARD
C.Full	**SMARTCARD trip: SMARTCARD full**
184	Delete a data block or use a different SMARTCARD
C.Optn	**SMARTCARD trip: Solutions Modules installed are different between source drive and destination drive**
180	Ensure correct Solutions Modules are installed Ensure Solutions Modules are in the same Solutions Module slot Press the red reset button
C.Prod	**SMARTCARD trip: The data blocks on the SMARTCARD are not compatible with this product**
175	Erase all data on the SMARTCARD by setting Pr **xx.00** to 9999 and pressing the red reset button Replace SMARTCARD
C.Rdo	**SMARTCARD trip: SMARTCARD has the Read only bit set**
181	Enter 9777 in Pr **xx.00** to allow SMARTCARD Read / Write access Ensure card is not writing to data locations 500 to 999
C.SLX	**An error has occurred when attempting to transfer a user program from a Solutions Module to a SMARTCARD and vice versa**
172,173,174	See section 10.2.8 *SM-Applications Modules And Motion Processors program to/from SMARTCARD transfer system* on page 104 for more information.

Table 10-4 Trip conditions

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>C.rtg</td><td>SMARTCARD trip: The voltage and/or current rating of the source and destination drives are different</td></tr>
<tr><td>186</td><td>Drive rating dependent parameters (parameters with the RA coding) are likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will not be transferred to the destination drive by SMARTCARDs when the rating of the destination drive is different from the source drive and the file is a parameter file.
Press the red reset button
Drive rating parameters are:
<table>
<tr><th>Parameter</th><th>Function</th></tr>
<tr><td>2.08</td><td>Standard ramp voltage</td></tr>
<tr><td>4.05/6/7, 21.27/8/9</td><td>Current limits</td></tr>
<tr><td>4.24</td><td>User current maximum scaling</td></tr>
<tr><td>5.07, 21.07</td><td>Motor rated current</td></tr>
<tr><td>5.09, 21.09</td><td>Motor rated voltage</td></tr>
<tr><td>5.10, 21.10</td><td>Rated power factor</td></tr>
<tr><td>5.17, 21.12</td><td>Stator resistance</td></tr>
<tr><td>5.18</td><td>Switching frequency</td></tr>
<tr><td>5.23, 21.13</td><td>Voltage offset</td></tr>
<tr><td>5.24, 21.14</td><td>Transient inductance</td></tr>
<tr><td>5.25, 21.24</td><td>Stator inductance</td></tr>
<tr><td>6.06</td><td>DC injection braking current</td></tr>
<tr><td>6.48</td><td>Line power supply loss ride through detection level</td></tr>
</table>
The above parameters will be set to their default values.</td></tr>
<tr><td>C.Typ</td><td>SMARTCARD trip: SMARTCARD parameter set not compatible with drive</td></tr>
<tr><td>187</td><td>Press the red reset button
Ensure destination drive type is the same as the source parameter file drive type</td></tr>
</table>

Table 10-5 SMARTCARD status indications

Lower display	Description	Lower display	Description
boot	A parameter set is being transferred from the SMARTCARD to the drive during power-up. For further information, please refer to section 10.2.4 *Booting up from the SMARTCARD on every power up (Pr 11.42 = boot (4))* .	**cArd**	The drive is writing a parameter set to the SMARTCARD during power-up. For further information, please refer to section 10.2.3 *Auto saving parameter changes (Pr 11.42 = Auto (3))* .

11 Onboard PLC

11.1 Onboard PLC and SYPTLite

The Digitax ST has the ability to store and execute a 4KB Onboard PLC ladder logic program without the need for additional hardware.

The ladder logic program is written using SYPTLite, a Windows™ based ladder diagram editor allowing the development of programs for execution in Digitax ST.

SYPTLite is designed to be easy to use and to make program development as simple as possible. The features provided are a sub-set of those in the SYPT program editor. SYPTLite programs are developed using ladder logic, a graphical language widely used to program PLCs (IEC61131-3). SYPTLite allows the user to "draw" a ladder diagram representing a program.

SYPTLite provides a complete environment for the development of ladder diagrams. Ladder diagrams can be created, compiled into user programs and downloaded to a Digitax ST for execution, via the RJ45 serial communications port on the front of the drive. The run-time operation of the compiled ladder diagram on the target can also be monitored using SYPTLite and facilities are provided to interact with the program on the target by setting new values for target parameters.

11.2 Benefits

The combination of the Onboard PLC and SYPTLite, means that Digitax ST can replace nano and some micro PLCs in many applications. The Onboard PLC programs can consist of up to a maximum of 50 ladder logic rungs (up to 7 function blocks and 10 contacts per rung). The Onboard PLC program can also be transferred to and from a SMARTCARD for backup or quick commissioning / start-up

In addition to the basic ladder symbols, SYPTLite contains a sub-set of the function from the full version of SYPT. These include,

- Arithmetic blocks
- Comparison blocks
- Timers
- Counters
- Multiplexers
- Latches
- Bit manipulation

Typical applications for the Onboard PLC include,

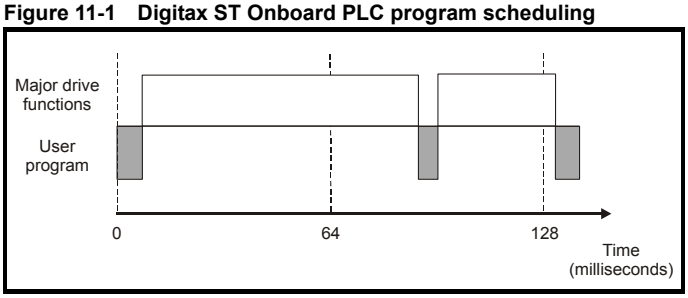
- Interlocking logic
- Sequences routines
- Custom control words.

11.3 Limitations

The Onboard PLC program has the following limitations:

- The maximum program size is 4032 bytes including header and optional source code.
- The Digitax ST is rated for 100 program downloads. This limitation is imposed by the flash memory used to store the program within the drive.
- The user cannot create user variables. The user is only able to manipulate the drive parameter set.
- The program cannot be downloaded or monitored over CTNet. The program is only accessible via the drives RJ45 serial communications port.
- There are no real-time tasks, i.e. the scheduling rate of the program cannot be guaranteed. SM-Applications tasks such as Clock, Event, Pos0 or Speed are not available. The Onboard PLC should not be used for time-critical applications.
- The program runs at a low priority. The Digitax ST provides a single background task in which to run a ladder diagram. The drive is prioritized to perform its major functions first, e.g. motor control, and will use any remaining processing time to execute the ladder diagram as a background activity. As the drive's processor becomes more heavily loaded, less time is spent executing the program.

Figure 11-1 Digitax ST Onboard PLC program scheduling



The user program is scheduled for a short period approximately once every 64 ms. The time for which the program is scheduled will vary between 0.2 ms and 2 ms 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. SYPTLite displays the average execution time calculated over the last 10 scans of the user program.

11.4 Getting started

SYPTLite can be downloaded at: http://www.emersonindustrial.com/en-EN/controltechniques/products/software/programming/syptlite/Pages/default.aspx.

SYPTLite system requirements

- Windows 2000/XP/Vista. **Windows 95/98/98SE/Me/NT4 are not supported**
- Pentium III 500 MHz or better recommended
- 128 MB RAM
- Minimum of 800x600 shield resolution. 1024x768 is recommended
- Adobe Acrobat 5.10 or later (for viewing User Guides)
- Microsoft Internet Explorer V5.0 or later
- RS232 to RS485, RJ45 communications lead to connect the PC to a Digitax ST
- Administrator rights under Windows NT/2000/XP/Vista are required to install the software

See the SYPTLite help file for more information regarding using SYPTLite, creating ladder diagrams and the available function blocks.

11.5 Onboard PLC parameters

The following parameters are associated with the Onboard PLC program.

11.47	Drive Onboard PLC program enable									
RW	Uni								US	
⇳	0 to 2					⇨	2			

This parameter is used to start and stop the drive Onboard PLC program.

Value	Description
0	Halt the drive Onboard PLC program.
1	Run the drive Onboard PLC program (if installed). Any out-of-range parameter writes attempted will be clipped to the maximum / minimum values valid for that parameter before being written.
2	Run the drive Onboard PLC program (if installed). Any out-of-range parameter writes attempted will cause a 'UP ovr' trip.

11.48	Drive Onboard PLC program status								
RO	Bi					NC	PT		
⇳	-128 to +127				⇨				

The drive Onboard PLC program status parameter indicates to the user the actual state of the drive Onboard PLC program.

Value	Description
-n	Onboard PLC program caused a drive trip due to an error condition while running rung n. Note that the rung number is shown on the display as a negative number.
0	Onboard PLC program is not installed.
1	Onboard PLC program is installed but stopped.
2	Onboard PLC program is installed and running.

When an Onboard PLC program is installed and running, the lower display of the drive flashes 'PLC' once every 10 s.

11.49	Drive Onboard PLC programming events								
RO	Uni					NC	PT		PS
⇳	0 to 65,535				⇨				

The drive Onboard PLC programming events parameter holds the number of times an Onboard PLC program download has taken place and is 0 on dispatch from the factory. The Digitax ST is rated for one hundred ladder program downloads. This parameter is not altered when defaults are loaded.

11.50	Drive Onboard PLC program maximum scan time								
RO	Uni					NC	PT		
⇳	0 to 65,535 ms				⇨				

The Onboard PLC program maximum scan time parameter gives the longest scan time within the last ten scans of the drive Onboard PLC program. If the scan time is greater than the maximum value which can be represented by this parameter, the value will be clipped to the maximum value.

11.51	Drive Onboard PLC program first run								
RO	Bit					NC	PT		
⇳	OFF (0) or On (1)				⇨				

The Drive Onboard PLC program first run parameter is set for the duration of program scan from the stopped state. This enables the user to perform any required initialization every time the program is run. This parameter is set every time the program is stopped.

11.6 Onboard PLC trips

The following trips are associated with the Onboard PLC program.

Trip	Diagnosis
UP ACC	**Onboard PLC program: Cannot access Onboard PLC program file on drive**
98	Disable drive - write access is not allowed when the drive is enabled. Another source is already accessing Onboard PLC program - retry once the other action is complete.
UP div0	**Onboard PLC program attempted divide by zero**
90	Check program
UP OFL	**Onboard PLC program variables and function block calls using more than the allowed RAM space (stack overflow)**
95	Check program
UP ovr	**Onboard PLC program attempted out of range parameter write**
94	Check program
UP PAr	**Onboard PLC program attempted access to a non-existent parameter**
91	Check program
UP ro	**Onboard PLC program attempted write to a read-only parameter**
92	Check program
UP So	**Onboard PLC program attempted read of a write-only parameter**
93	Check program
UP udF	**Onboard PLC program undefined trip**
97	Check program
UP uSEr	**Onboard PLC program requested a trip**
96	Check program

11.7 Onboard PLC and the SMARTCARD

The Onboard PLC program in a drive may be transferred from the drive to a SMARTCARD and vice versa.

- To transfer an Onboard PLC program from the drive to a SMARTCARD, set Pr **xx.00** to 5yyy and reset the drive
- To transfer an Onboard PLC program from the SMARTCARD to a drive, set Pr **xx.00** to 6yyy and reset the drive.

(Where yyy is the data block location, see Table 10-1 *SMARTCARD data blocks* on page 102 for restrictions on block numbers).

If an attempt is made to transfer an Onboard PLC program from a drive to the SMARTCARD when the drive contains no program, the block is still created on the SMARTCARD but it will contain no data. If this data block is then transferred to a drive, the destination drive will then have no Onboard PLC program.

The smallest SMARTCARD compatible with Digitax ST has a capacity of 4064 bytes and each block can be up to 4064 bytes in size. The maximum size of a user program is 4032 bytes so it is guaranteed that any Onboard PLC program downloaded to a Digitax ST will fit on to an empty SMARTCARD. A SMARTCARD can contain a number of Onboard PLC programs until the capacity of the card is used.

12 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 *Advanced User Guide* available for download at: http://www.emersonindustrial.com/en-EN/controltechniques/downloads/userguidesandsoftware/Pages/digitaxst.aspx.

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 *Advanced User Guide*.

Table 12-1 Menu descriptions

Menu number	Description
0	Commonly used basic set up parameters for quick / easy programming
1	Speed reference
2	Ramps
3	Speed feedback and 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 and binary sum
10	Status and trips
11	General drive set-up
12	Threshold detectors and variable selectors
13	Position control
14	User PID controller
15, 16	Solutions Module slots
17	Digitax ST indexer/plus parameters
18	Application menu 1
19	Application menu 2
20	Application menu 3
21	Second motor parameters
22	Additional Menu 0 set-up

Default abbreviations:

EUR> European default value (50 Hz AC supply frequency)
USA> USA default value (60 Hz AC supply frequency)

NOTE

Parameter numbers shown in brackets {...} are the equivalent Menu 0 parameters.

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 such parameters.

Table 12-2 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
Bi	Bipolar parameter
Uni	Unipolar parameter
Txt	Text: the parameter uses text strings instead of numbers.
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 not be transferred to the destination drive by SMARTCARDs when the rating of the destination drive is different from the source drive and the file is a parameter file.
NC	Not copied: not transferred to or from SMARTCARDs 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) trip occurs. With software version V01.08.00 and later, power-down save parameters are also saved in the drive when the user initiates a parameter save.

Table 12-3 Feature look-up table

Feature	Parameter number (Pr)												
Acceleration rates	2.10	2.11 to 2.19		2.32	2.33	2.34	2.02						
Analog speed reference 1	1.36	7.10	7.01	7.07	7.08	7.09	7.25	7.26	7.30				
Analog speed reference 2	1.37	7.14	1.41	7.02	7.11	7.12	7.13	7.28	7.31				
Analog I/O	Menu 7												
Analog input 1	7.01	7.07	7.08	7.09	7.10	7.25	7.26	7.30					
Analog input 2	7.02	7.11	7.12	7.13	7.14	7.28	7.31						
Analog input 3	7.03	7.15	7.16	7.17	7.18	7.29	7.32						
Analog output 1	7.19	7.20	7.21	7.33									
Analog output 2	7.22	7.23	7.24										
Application menu	Menu 18		Menu 19		Menu 20								
At speed indicator bit	3.06	3.07	3.09	10.06	10.05	10.07							
Auto reset	10.34	10.35	10.36	10.01									
Autotune	5.12	5.17	5.24										
Binary sum	9.29	9.30	9.31	9.32	9.33	9.34							
Bipolar speed	1.10												
Brake control	12.40 to 12.49												
Braking	10.11	10.10	10.30	10.31	6.01	2.04	2.02	10.12	10.39	10.40			
Copying	11.42	11.36 to 11.40											
Stop mode	6.01												
Comms	11.23 to 11.26												
Cost - per kWh electricity	6.16	6.17	6.24	6.25	6.26	6.40							
Current controller	4.13	4.14											
Current feedback	4.01	4.02	4.17	4.04	4.12	4.20	4.23	4.24	10.08	10.09	10.17		
Current limits	4.05	4.06	4.07	4.18	4.15	4.19	4.16	5.07	10.08	10.09	10.17		
DC bus voltage	5.05	2.08											
Deceleration rates	2.20	2.21 to 2.29		2.04	2.35 to 2.37		2.02	2.04	2.08	6.01	10.30	10.31	10.39
Defaults	11.43	11.46											
Digital I/O	Menu 8												
Digital I/O read word	8.20												
Digital I/O T24	8.01	8.11	8.21	8.31									
Digital I/O T25	8.02	8.12	8.22	8.32									
Digital I/O T26	8.03	8.13	8.23	8.33									
Digital input T27	8.04	8.14	8.24										
Digital input T28	8.05	8.15	8.25	8.39									
Digital input T29	8.06	8.16	8.26	8.39									
Digital lock	13.10	13.01 to 13.09		13.11	13.12	13.16	3.22	3.23	13.19 to 13.23				
Digital output T22	8.08	8.18	8.28										
Direction	10.13	6.30	6.31	1.03	10.14	2.01	3.02	8.03	8.04	10.40			
Display timeout	11.41												
Drive active	10.02	10.40											
Drive derivative	11.28												
Drive ok	10.01	8.27	8.07	8.17	10.36	10.40							
Dynamic performance	5.26												
Electronic nameplate	3.49												
Enable	6.15	8.09	8.10										
Encoder reference	3.43	3.44	3.45	3.46									
Encoder set up	3.33	3.34 to 3.42		3.47	3.48								
External trip	10.32	8.10	8.07										
Fan speed	6.45												
Fast disable	6.29												
Field weakening	5.22	1.06											
Filter change	6.19	6.18											
Speed reference selection	1.14	1.15											
Speed slaving	3.01	3.13	3.14	3.15	3.16	3.17	3.18						
Hard speed reference	3.22	3.23											
Current rating	5.07	11.32											
I/O sequencer	6.04	6.30	6.31	6.32	6.33	6.34	6.42	6.43	6.41				
Inertia compensation	2.38	5.12	4.22	3.18									
Jog reference	1.05	2.19	2.29										
Ke	5.33												
Keypad reference	1.17	1.14	1.43	1.51	6.12	6.13							
Kt	5.32												
Limit switches	6.35	6.36											
Line power supply loss	6.03	10.15	10.16	5.05									
Local position reference	13.20 to 13.23												
Logic function 1	9.01	9.04	9.05	9.06	9.07	9.08	9.09	9.10					
Logic function 2	9.02	9.14	9.15	9.16	9.17	9.18	9.19	9.20					

Feature	Parameter number (Pr)												
Low voltage supply	6.44	6.46											
Marker pulse	3.32	3.31											
Maximum speed	1.06												
Menu 0 set up	11.01 to 11.22		Menu 22										
Minimum speed	1.07	10.04											
Motor map	5.07	5.08	5.09	5.11									
Motor map 2	Menu 21		11.45										
Motorized potentiometer	9.21	9.22	9.23	9.24	9.25	9.26	9.27	9.28					
Offset speed reference	1.04	1.38	1.09										
Onboard PLC	11.47 to 11.51												
Open collector digital outputs	8.30												
Orientation	13.10	13.13 to 13.15											
Output	5.01	5.02	5.03	5.04									
Overspeed threshold	3.08												
Phase angle	3.25	5.12											
PID controller	Menu 14												
Position feedback - drive	3.28	3.29	3.30	3.50									
Positive logic	8.29												
Power up parameter	11.22	11.21											
Precision reference	1.18	1.19	1.20	1.44									
Preset speeds	1.15	1.21 to 1.28		1.16	1.14	1.42	1.45 to 1.48		1.50				
Programmable logic	Menu 9												
Ramp (accel / decel) mode	2.04	2.08	6.01	2.02	2.03	10.30	10.31	10.39					
Rated speed autotune	5.08												
Regenerating	10.10	10.11	10.30	10.31	6.01	2.04	2.02	10.12	10.39	10.40			
Relative jog	13.17 to 13.19												
Relay output	8.07	8.17	8.27										
Reset	10.33	8.02	8.22	10.34	10.35	10.36	10.01						
S ramp	2.06	2.07											
Safe Torque Off input	8.09	8.10											
Sample rates	5.18												
Security code	11.30	11.44											
Serial comms	11.23 to 11.26												
Skip speeds	1.29	1.30	1.31	1.32	1.33	1.34	1.35						
SMARTCARD	11.36 to 11.40		11.42										
Software version	11.29	11.34											
Speed controller	3.10 to 3.17		3.19	3.20	3.21								
Speed feedback	3.02	3.03	3.04										
Speed feedback - drive	3.26	3.27	3.28	3.29	3.30	3.31	3.42						
Speed reference selection	1.14	1.15	1.49	1.50	1.01								
Status word	10.40												
Supply	6.44	5.05	6.46										
Switching frequency	5.18	5.35	7.34	7.35									
Thermal protection - drive	5.18	5.35	7.04	7.05	7.06	7.32	7.35	10.18					
Thermal protection - motor	4.15	5.07	4.19	4.16	4.25	7.15							
Thermistor input	7.15	7.03	10.37										
Threshold detector 1	12.01	12.03 to 12.07											
Threshold detector 2	12.02	12.23 to 12.27											
Time - filter change	6.19	6.18											
Time - powered up log	6.20	6.21	6.28										
Time - run log	6.22	6.23	6.28										
Torque	4.03	5.32											
Torque mode	4.08	4.11	4.09	4.10									
Trip detection	10.37	10.38	10.20 to 10.29										
Trip log	10.20 to 10.29		10.41 to 10.51		6.28								
Under voltage	5.05	10.16	10.15										
Variable selector 1	12.08 to 12.15												
Variable selector 2	12.28 to 12.35												
Velocity feed forward	1.39	1.40											
Voltage controller	5.31												
Voltage mode	5.14	5.17											
Voltage rating	11.33	5.09	5.05										
Voltage supply	6.44	6.46	5.05										
Warning	10.19	10.12	10.17	10.18	10.40								
Zero speed indicator bit	3.05	10.03											

Parameter ranges and variable maximums:

The two values provided define the minimum and maximum values for the given parameter. In some cases the parameter range is variable and dependant on either:

- other parameters
- the drive rating
- drive mode
- or a combination of these

The values given in Table 12-4 are the variable maximums used in the drive.

Table 12-4 Definition of parameter ranges & variable maximums

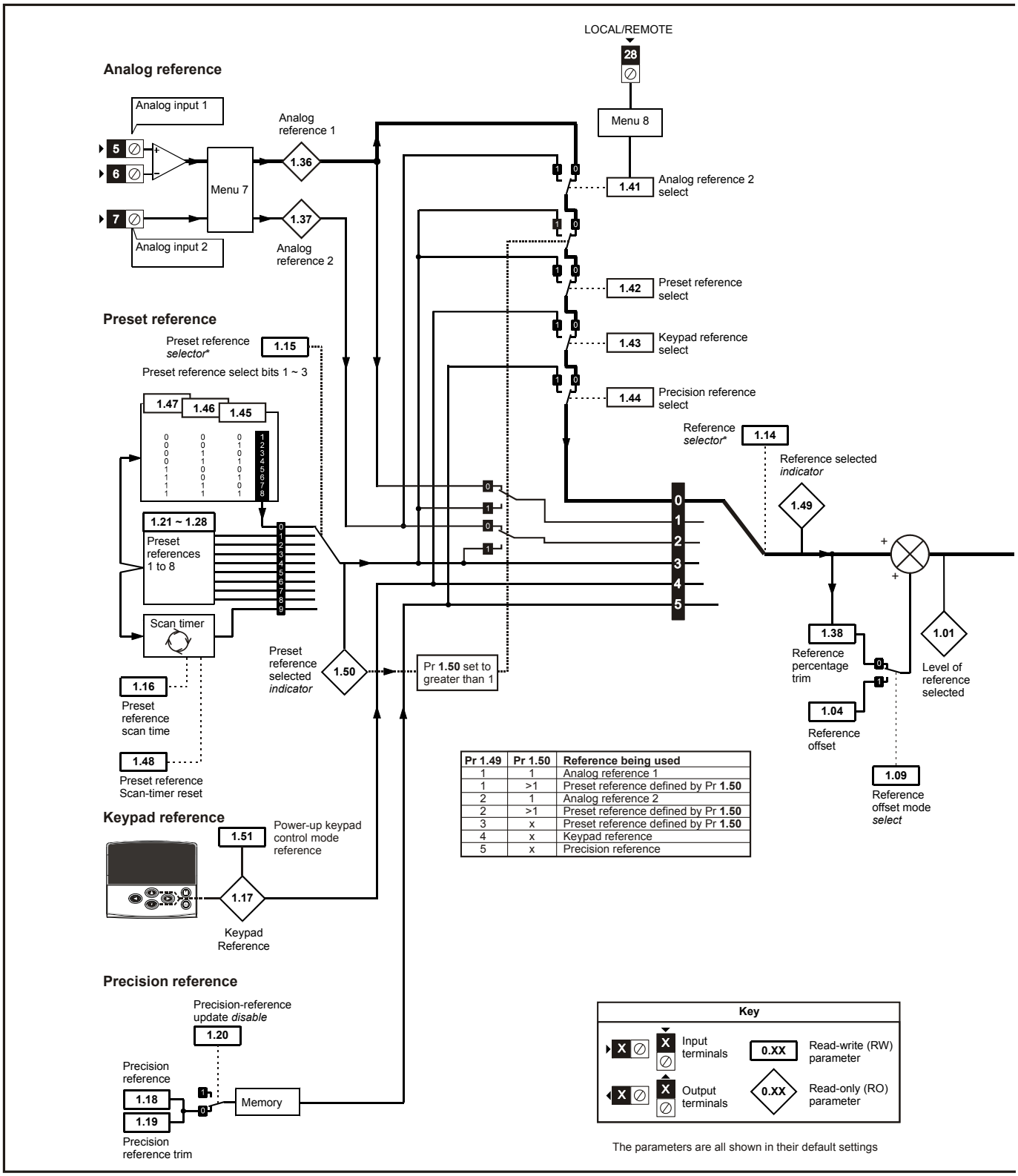
Maximum	Definition
SPEED_REF_MAX [40000.0rpm]	**Maximum speed reference** If Pr **1.08** = 0: SPEED_REF_MAX = Pr **1.06** If Pr **1.08** = 1: SPEED_REF_MAX is Pr **1.06** or – Pr **1.07** whichever is the largest (If the second motor map is selected Pr **21.01** is used instead of Pr **1.06** and Pr **21.02** instead of Pr **1.07**)
SPEED_LIMIT_MAX [40000.0rpm]	**Maximum applied to speed reference limits** A maximum limit may be applied to the speed reference to prevent the nominal encoder frequency from exceeding 500 kHz. The maximum is defined by SPEED_LIMIT_MAX (in rpm) = 500 kHz x 60 / ELPR = 3.0×10^7 / ELPR subject to an absolute maximum of 40,000 rpm. ELPR is equivalent encoder lines per revolution and is the number of lines that would be produced by a quadrature encoder. Quadrature encoder ELPR = number of lines per revolution F and D encoder ELPR = number of lines per revolution / 2 Resolver ELPR = resolution / 4 SINCOS encoder ELPR = number of sine waves per revolution Serial comms encoder ELPR = resolution / 4 This maximum is defined by the device selected with the speed feedback selector (Pr **3.26**) and the ELPR set for the position feedback device.
SPEED_MAX [40000.0rpm]	**Maximum speed** This maximum is used for some speed related parameters in menu 3. To allow headroom for overshoot etc. the maximum speed is twice the maximum speed reference. SPEED_MAX = 2 x SPEED_REF_MAX
DRIVE_CURRENT_MAX [9999.99A]	**Maximum drive current** The maximum drive current is the current at the over current trip level and is given by: DRIVE_CURRENT_MAX = K_C / 0.45
AC_VOLTAGE_SET_MAX [690V]	**Maximum output voltage set-point** Defines the maximum motor voltage that can be selected. 200 V drives: 240 V, 400 V drives: 480 V
AC_VOLTAGE_MAX [930V]	**Maximum AC output voltage** This maximum has been chosen to allow for maximum AC voltage that can be produced by the drive including quasi-square wave operation as follows: AC_VOLTAGE_MAX = 0.78 x DC_VOLTAGE_MAX 200 V drives: 325 V, 400 V drives: 650 V
DC_VOLTAGE_SET_MAX [1150V]	**Maximum DC voltage set-point** 200 V rating drive: 0 to 400 V, 400 V rating drive: 0 to 800 V
DC_VOLTAGE_MAX [1190V]	**Maximum DC bus voltage** The maximum measurable DC bus voltage. 200 V drives: 415 V, 400 V drives: 830 V
MOTOR1_CURRENT_LIMIT_MAX [1000.0%]	Where: $\text{Maximum current limit} = \left[\frac{\text{Maximum current}}{\text{Motor rated current}}\right] \times 100\%$ The Maximum current is either (1.75 x K_C) when the motor rated current set in Pr **5.07** is less than or equal to the maximum Heavy Duty current rating given by Pr **11.32**, otherwise it is (1.1 x Normal Duty rating). Motor rated current is given by Pr **5.07**
MOTOR2_CURRENT_LIMIT_MAX [1000.0%]	**Maximum current limit settings for motor map 2** This maximum current limit setting is the maximum applied to the current limit parameters in motor map 2. The formulae for MOTOR2_CURRENT_LIMIT_MAX are the same for MOTOR1_CURRENT_LIMIT_MAX except that Pr **5.07** is replaced with Pr **21.07** and Pr **5.10** is replaced with Pr **21.10**.
TORQUE_PROD_CURRENT_MAX [1000.0%]	**Maximum torque producing current** This is used as a maximum for torque and torque producing current parameters. It is MOTOR1_CURRENT_LIMIT_MAX or MOTOR2_CURRENT_LIMIT_MAX depending on which motor map is currently active.

Maximum	Definition
USER_CURRENT_MAX [1000.0%]	**Current parameter limit selected by the user** The user can select a maximum for Pr **4.08** (torque reference) and Pr **4.20** (percentage load) to give suitable scaling for analog I/O with Pr **4.24**. This maximum is subject to a limit of MOTOR1_CURRENT_LIMIT_MAX. or MOTOR2_CURRENT_LIMIT_MAX depending on which motor map is currently active. USER_CURRENT_MAX = Pr **4.24**
POWER_MAX [9999.99kW]	**Maximum power in kW** The maximum power has been chosen to allow for the maximum power that can be output by the drive with maximum AC output voltage, maximum controlled current and unity power factor. Therefore POWER_MAX = √3 x AC_VOLTAGE_MAX x DRIVE_CURRENT_MAX

The values given in square brackets indicate the absolute maximum value allowed for the variable maximum.

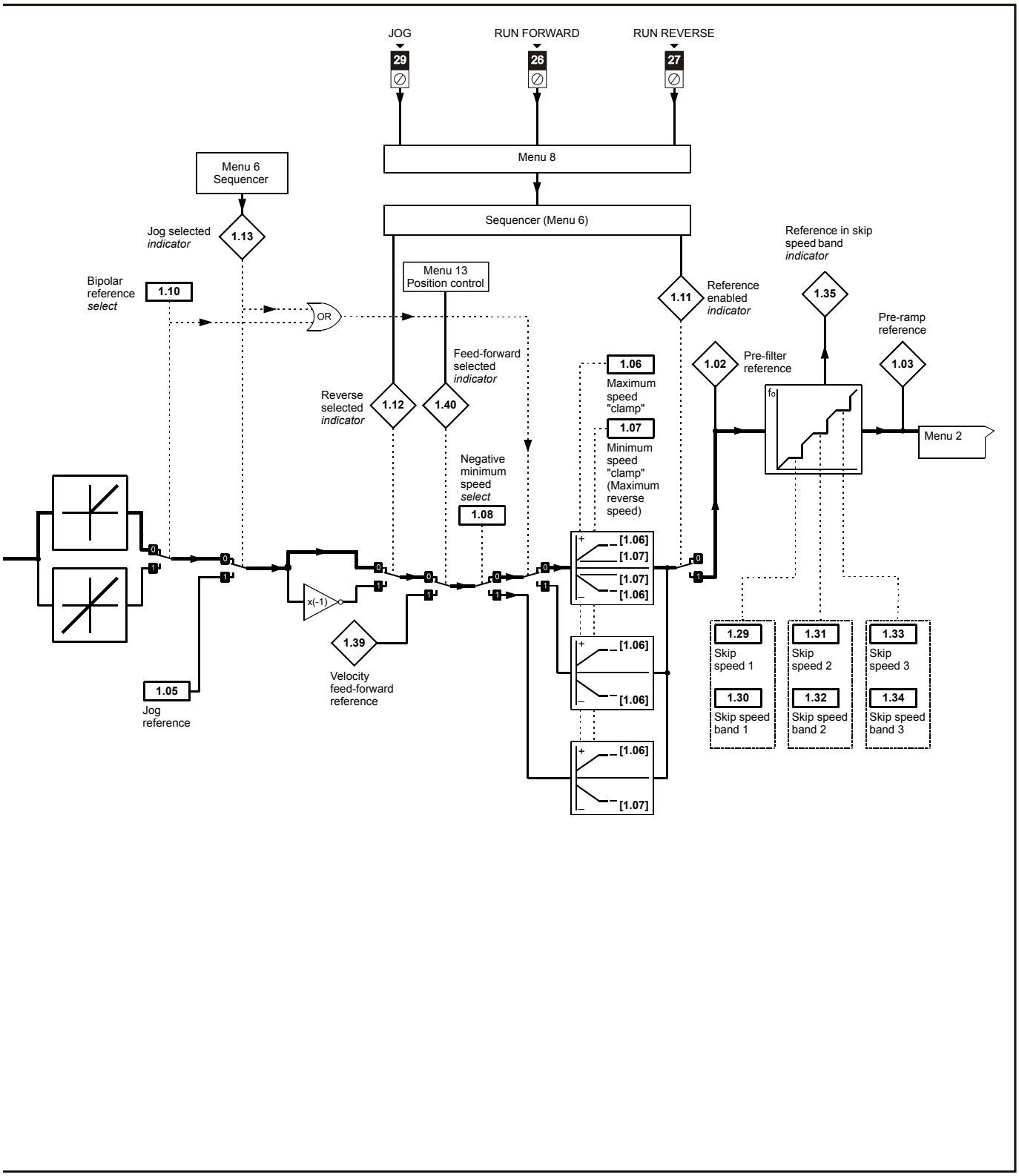
12.1 Menu 1: Speed reference

Figure 12-1 Menu 1 logic diagram



Pr 1.49	Pr 1.50	Reference being used
1	1	Analog reference 1
1	>1	Preset reference defined by Pr **1.50**
2	1	Analog reference 2
2	>1	Preset reference defined by Pr **1.50**
3	x	Preset reference defined by Pr **1.50**
4	x	Keypad reference
5	x	Precision reference

*For more information, refer to section 12.22.1 *Reference modes* on page 166

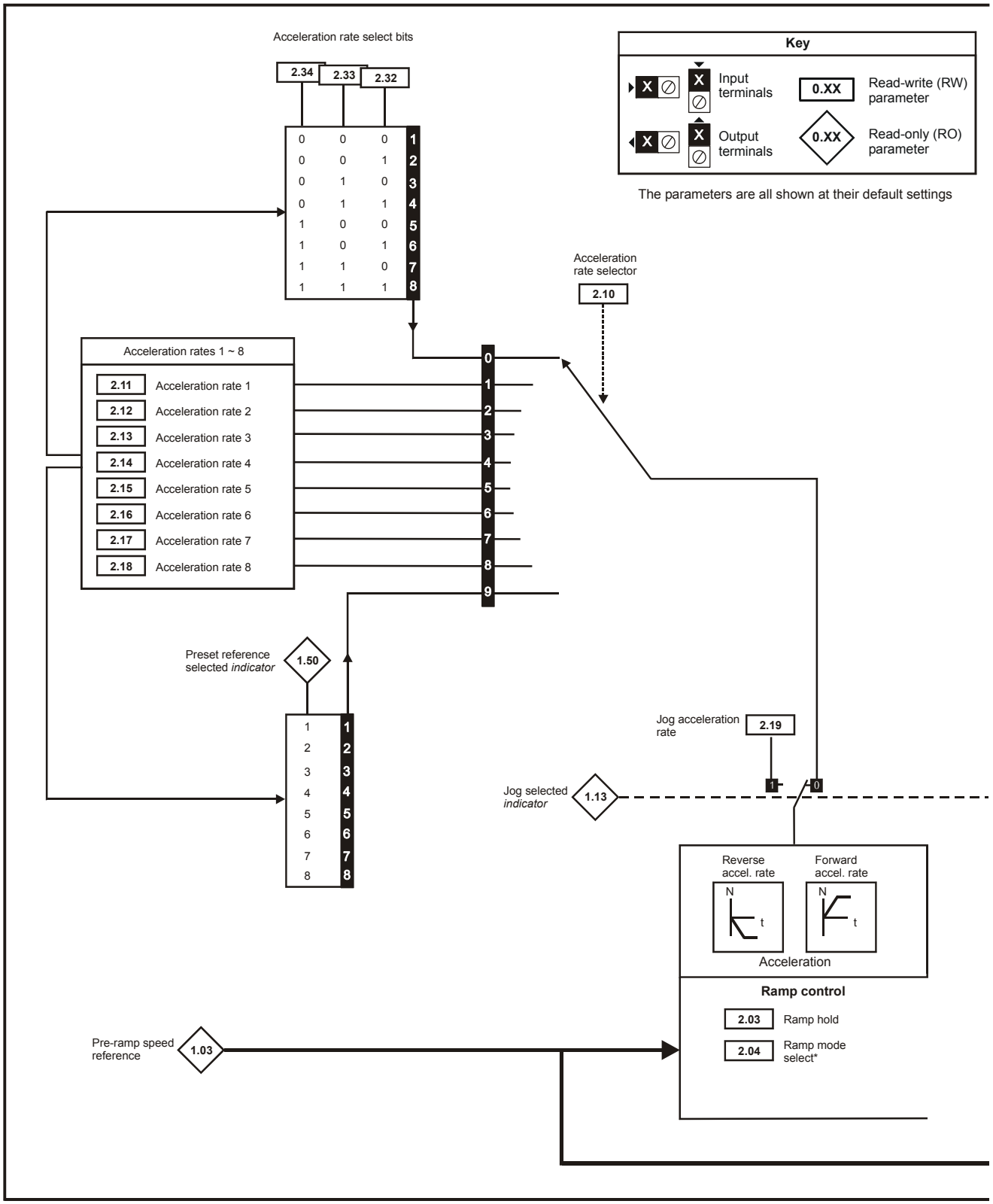

JOG
RUN FORWARD
RUN REVERSE
29
26
27
Menu 8
Sequencer (Menu 6)
Menu 6 Sequencer
Jog selected indicator
1.13
Bipolar reference select
1.10
OR
Menu 13 Position control
1.11
Reference enabled indicator
Reference in skip speed band indicator
1.35
Pre-ramp reference
1.03
1.02
Pre-filter reference
Feed-forward selected indicator
1.40
Reverse selected indicator
1.12
1.06
Maximum speed "clamp"
1.07
Minimum speed "clamp" (Maximum reverse speed)
Negative minimum speed select
1.08
Menu 2
x(-1)
1.39
Velocity feed-forward reference
1.05
Jog reference
[1.06]
[1.07]
1.29
Skip speed 1
1.30
Skip speed band 1
1.31
Skip speed 2
1.32
Skip speed band 2
1.33
Skip speed 3
1.34
Skip speed band 3

Parameter			Range (⇳)	Default (⇨)	Type					
1.01	Speed reference selected		±SPEED_REF_MAX rpm		RO	Bi		NC	PT	
1.02	Pre-skip filter reference		±SPEED_REF_MAX rpm		RO	Bi		NC	PT	
1.03	Pre-ramp reference		±SPEED_REF_MAX rpm		RO	Bi		NC	PT	
1.04	Reference offset		±40,000.0 rpm	0.0	RW	Bi				US
1.05	Jog reference	{**0.23**}	0 to 4,000.0 rpm	0.0	RW	Uni				US
1.06	Maximum reference clamp	{**0.02**}	SPEED_LIMIT_MAX rpm	3,000.0	RW	Uni				US
1.07	Minimum reference clamp	{**0.01**}	±SPEED_LIMIT_MAX rpm	0.0	RW	Bi			PT	US
1.08	Negative minimum reference clamp enable		OFF (0) or On (1)	OFF (0)	RW	Bit				US
1.09	Reference offset select		OFF (0) or On (1)	OFF (0)	RW	Bit				US
1.10	Bipolar reference enable	{**0.22**}	OFF (0) or On (1)	OFF (0)	RW	Bit				US
1.11	Reference enabled indicator		OFF (0) or On (1)		RO	Bit		NC	PT	
1.12	Reverse selected indicator		OFF (0) or On (1)		RO	Bit		NC	PT	
1.13	Jog selected indicator		OFF (0) or On (1)		RO	Bit		NC	PT	
1.14	Reference selector	{**0.05**}	A1.A2 (0), A1.Pr (1), A2.Pr (2), Pr (3), PAd (4), Prc (5)	A1.A2 (0)	RW	Txt				US
1.15	Preset reference selector		0 to 9	0	RW	Uni				US
1.16	Preset reference selector timer		0 to 400.0s	10.0	RW	Uni				US
1.17	Keypad control mode reference		±SPEED_REF_MAX rpm	0.0	RO	Bi		NC	PT	PS
1.18	Precision reference coarse		±SPEED_REF_MAX rpm	0.0	RW	Bi				US
1.19	Precision reference fine		0.000 to 0.099 rpm	0.000	RW	Uni				US
1.20	Precision reference update disable		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
1.21	Preset reference 1	{**0.24**}	±SPEED_REF_MAX rpm	0.0	RW	Bi				US
1.22	Preset reference 2	{**0.25**}	±SPEED_REF_MAX rpm	0.0	RW	Bi				US
1.23	Preset reference 3		±SPEED_REF_MAX rpm	0.0	RW	Bi				US
1.24	Preset reference 4		±SPEED_REF_MAX rpm	0.0	RW	Bi				US
1.25	Preset reference 5		±SPEED_REF_MAX rpm	0.0	RW	Bi				US
1.26	Preset reference 6		±SPEED_REF_MAX rpm	0.0	RW	Bi				US
1.27	Preset reference 7		±SPEED_REF_MAX rpm	0.0	RW	Bi				US
1.28	Preset reference 8		±SPEED_REF_MAX rpm	0.0	RW	Bi				US
1.29	Skip reference 1		0 to 40,000 rpm	0	RW	Uni				US
1.30	Skip reference band 1		0 to 250 rpm	5	RW	Uni				US
1.31	Skip reference 2		0 to 40,000 rpm	0	RW	Uni				US
1.32	Skip reference band 2		0 to 250 rpm	5	RW	Uni				US
1.33	Skip reference 3		0 to 40,000 rpm	0	RW	Uni				US
1.34	Skip reference band 3		0 to 250 rpm	5	RW	Uni				US
1.35	Reference in rejection zone		OFF (0) or On (1)		RO	Bit		NC	PT	
1.36	Analog reference 1		±SPEED_REF_MAX rpm		RO	Bi		NC		
1.37	Analog reference 2		±SPEED_REF_MAX rpm		RO	Bi		NC		
1.38	Percentage trim		±100.00 %	0.00	RW	Bi		NC		
1.39	Velocity feed-forward		±40,000.0 rpm		RO	Bi		NC	PT	
1.40	Velocity feed-forward select		OFF (0) or On (1)		RO	Bit		NC	PT	
1.41	Analog reference 2 select		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
1.42	Preset reference select		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
1.43	Keypad reference select		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
1.44	Precision reference select		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
1.45	Preset reference 1 select		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
1.46	Preset reference 2 select		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
1.47	Preset reference 3 select		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
1.48	Reference timer reset flag		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
1.49	Reference selected indicator		1 to 5		RO	Uni		NC	PT	
1.50	Preset reference selected indicator		1 to 8		RO	Uni		NC	PT	
1.51	Power-up keyboard control mode reference		rESEt (0), LASt (1), PrS1 (2)	rESEt (0)	RW	Txt				US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

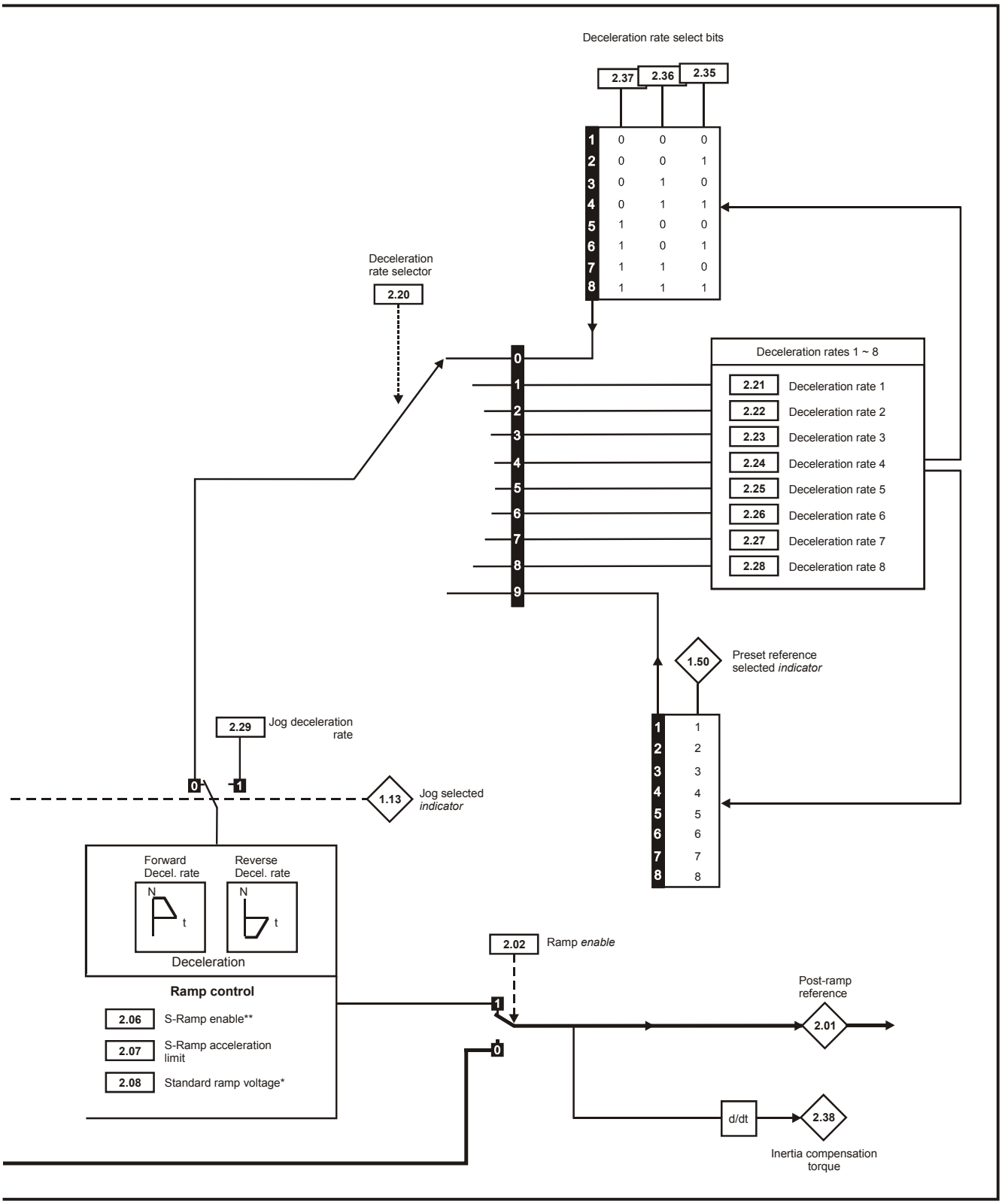
12.2 Menu 2: Ramps

Figure 12-2 Menu 2 logic diagram



*For more information, refer to section 12.22.2 *Braking Modes* on page 167.

**For more information, refer to section 12.22.3 *S ramps* on page 167.

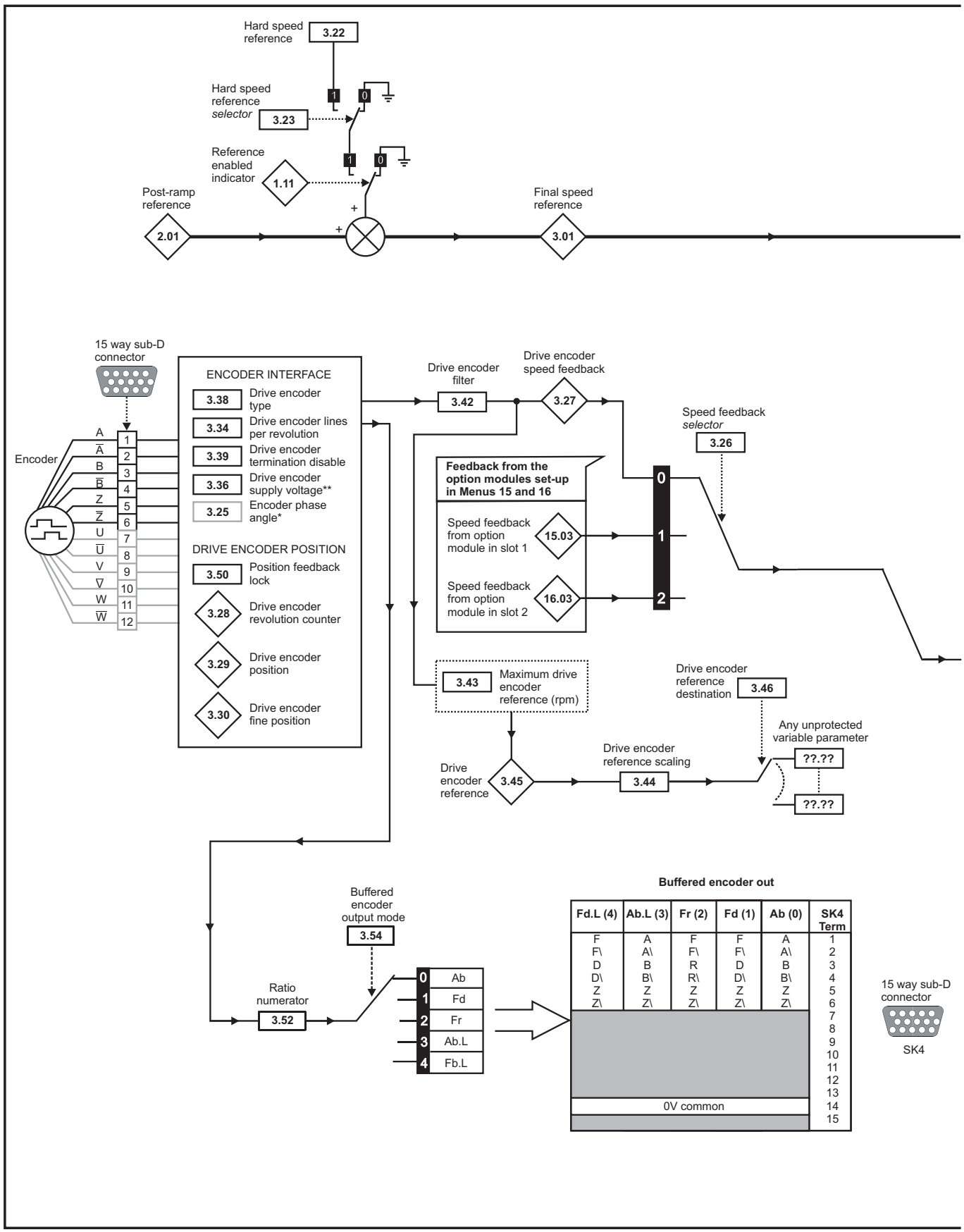

Deceleration rate select bits
2.37
2.36
2.35
1 0 0 0
2 0 0 1
3 0 1 0
4 0 1 1
5 1 0 0
6 1 0 1
7 1 1 0
8 1 1 1
Deceleration rate selector
2.20
0
1
2
3
4
5
6
7
8
9
Deceleration rates 1 ~ 8
2.21 Deceleration rate 1
2.22 Deceleration rate 2
2.23 Deceleration rate 3
2.24 Deceleration rate 4
2.25 Deceleration rate 5
2.26 Deceleration rate 6
2.27 Deceleration rate 7
2.28 Deceleration rate 8
1.50
Preset reference selected *indicator*
1 1
2 2
3 3
4 4
5 5
6 6
7 7
8 8
2.29
Jog deceleration rate
0
1
1.13
Jog selected *indicator*
Forward Decel. rate
Reverse Decel. rate
N
t
Deceleration
Ramp control
2.06 S-Ramp enable**
2.07 S-Ramp acceleration limit
2.08 Standard ramp voltage*
2.02
Ramp *enable*
1
0
Post-ramp reference
2.01
d/dt
2.38
Inertia compensation torque

Parameter			Range (⇳)	Default (⇨)	Type					
2.01	Post ramp reference		±SPEED_REF_MAX rpm		RO	Bi		NC	PT	
2.02	Ramp enable	{**0.16**}	OFF (0) or On (1)	On (1)	RW	Bit				US
2.03	Ramp hold		OFF (0) or On (1)	OFF (0)	RW	Bit				US
2.04	Ramp mode select	{**0.15**}	FASt (0) Std (1)	Std (1)	RW	Txt				US
2.06	S ramp enable		OFF (0) or On (1)	OFF (0)	RW	Bit				US
2.07	S ramp acceleration limit		0.000 to 100.000 s^2/1000 rpm	0.030	RW	Uni				US
2.08	Standard ramp voltage		0 to DC_VOLTAGE_SET_MAX V	200 V drive: 375 400 V drive: EUR> 750 USA> 775	RW	Uni		RA		US
2.10	Acceleration rate selector		0 to 9	0	RW	Uni				US
2.11	Acceleration rate 1	{**0.03**}	0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.12	Acceleration rate 2		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.13	Acceleration rate 3		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.14	Acceleration rate 4		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.15	Acceleration rate 5		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.16	Acceleration rate 6		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.17	Acceleration rate 7		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.18	Acceleration rate 8		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.19	Jog acceleration rate		0.000 to 3,200.000 s/1,000 rpm	0.000	RW	Uni				US
2.20	Deceleration rate selector		0 to 9	0	RW	Uni				US
2.21	Deceleration rate 1	{**0.04**}	0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.22	Deceleration rate 2		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.23	Deceleration rate 3		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.24	Deceleration rate 4		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.25	Deceleration rate 5		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.26	Deceleration rate 6		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.27	Deceleration rate 7		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.28	Deceleration rate 8		0.000 to 3,200.000 s/1,000 rpm	0.200	RW	Uni				US
2.29	Jog deceleration rate		0.000 to 3,200.000 s/1,000 rpm	0.000	RW	Uni				US
2.32	Acceleration select bit 0		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
2.33	Acceleration select bit 1		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
2.34	Acceleration select bit 2		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
2.35	Deceleration select bit 0		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
2.36	Deceleration select bit 1		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
2.37	Deceleration select bit 2		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
2.38	Inertia compensation torque		± 1,000.0 %		RO	Bi		NC	PT	

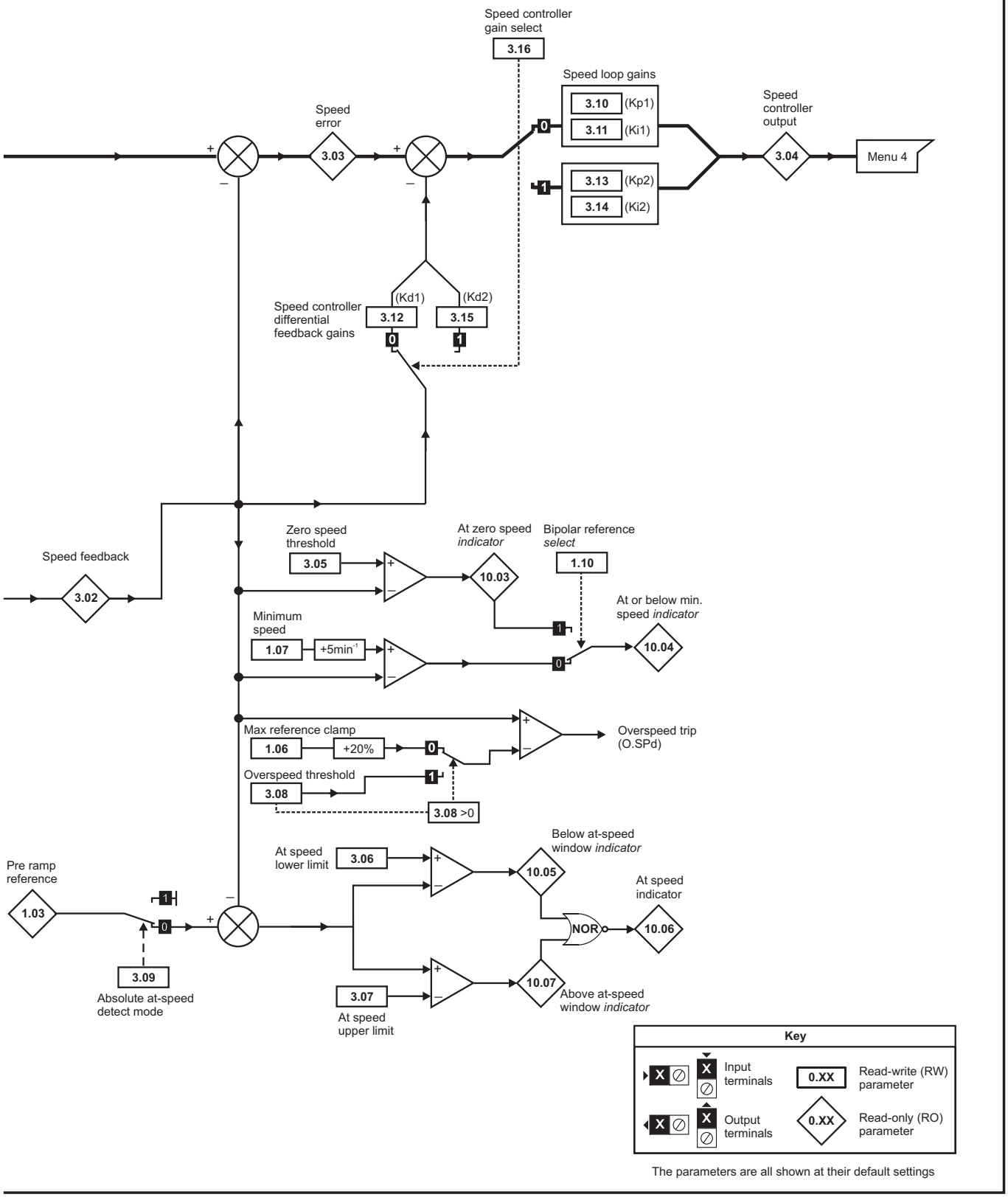
RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.3 Menu 3: Speed feedback and control

Figure 12-3 Menu 3 logic diagram



NOTE **If Ab encoder voltage is greater than 5 V, then the termination resistors must be disabled Pr **3.39** to 0.



The parameters are all shown at their default settings

	Parameter		Range(⇳)	Default(⇨)	Type					
3.01	Final speed reference		±SPEED_MAX rpm		RO	Bi	FI	NC	PT	
3.02	Speed feedback	{**0.10**}	±SPEED_MAX rpm		RO	Bi	FI	NC	PT	
3.03	Speed error		±SPEED_MAX rpm		RO	Bi	FI	NC	PT	
3.04	Speed controller output		±TORQUE_PROD_CURRENT_MAX %		RO	Bi	FI	NC	PT	
3.05	Zero speed threshold		0 to 200 rpm	5	RW	Uni				US
3.06	At speed lower limit		0 to 40,000 rpm	5	RW	Uni				US
3.07	At speed upper limit		0 to 40,000 rpm	5	RW	Uni				US
3.08	Overspeed threshold	{**0.26**}	0 to 40,000 rpm	0	RW	Uni				US
3.09	Absolute 'at speed' detect		OFF (0) or On (1)	OFF (0)	RW	Bit				US
3.10	Speed controller proportional gain (Kp1)	{**0.07**}	0.0000 to 6.5535 1/rad s^{-1}	0.0100	RW	Uni				US
3.11	Speed controller integral gain (Ki1)	{**0.08**}	0.00 to 655.35 s/rad s^{-1}	1.00	RW	Uni				US
3.12	Speed controller differential feedback gain (Kd1)	{**0.09**}	0.00000 to 0.65535 s^{-1}/rad s^{-1}	0.00000	RW	Uni				US
3.13	Speed controller proportional gain (Kp2)		0.0000 to 6.5535 1/rad s^{-1}	0.0100	RW	Uni				US
3.14	Speed controller integral gain (Ki2)		0.00 to 655.35 1/rad	1.00	RW	Uni				US
3.15	Speed controller differential feedback gain (Kd2)		0.00000 to 0.65535 s	0.00000	RW	Uni				US
3.16	Speed controller gain select		OFF (0) or On (1)	OFF (0)	RW	Bit				US
3.17	Speed controller set-up method		0 to 3	0	RW	Uni				US
3.18	Motor and load inertia		0.00010 to 90.00000 kg m^2	0.00000	RW	Uni				US
3.19	Compliance angle		0.0 to 359.9 °	4.0	RW	Uni				US
3.20	Bandwidth		0 to 255 Hz	10	RW	Uni				US
3.21	Damping factor		0.0 to 10.0	1.0	RW	Uni				US
3.22	Hard speed reference		±SPEED_REF_MAX rpm	0.0	RW	Bi				US
3.23	Hard speed reference selector		OFF (0) or On (1)	OFF (0)	RW	Bit				US
3.25	Encoder phase angle*	{**0.43**}	0.0 to 359.9 °	0.0	RW	Uni				US
3.26	Speed feedback selector		drv (0), SLot1 (1), SLot2 (2)	drv (0)	RW	Txt				US
3.27	Drive encoder speed feedback		±40,000.0 rpm		RO	Bi	FI	NC	PT	
3.28	Drive encoder revolution counter		0 to 65,535 revolutions		RO	Uni	FI	NC	PT	
3.29	Drive encoder position	{**0.11**}	0 to 65,535 1/2^{16}ths of a revolution		RO	Uni	FI	NC	PT	
3.30	Drive encoder fine position		0 to 65,535 1/2^{32}nds of a revolution		RO	Uni	FI	NC	PT	
3.31	Drive encoder marker position reset disable		OFF (0) or On (1)	OFF (0)	RW	Bit				US
3.32	Drive encoder marker flag		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
3.33	Drive encoder turn bits / Linear encoder comms to sine wave ratio		0 to 255	16	RW	Uni				US
3.34	Drive encoder lines per revolution	{**0.27**}	0 to 50,000	4096	RW	Uni				US
3.35	Drive encoder single turn comms bits / Linear encoder comms bits / Marker mode		0 to 32 bits	0	RW	Uni				US
3.36	Drive encoder supply voltage**		5 V (0), 8 V (1), 15 V (2)	5V (0)	RW	Txt				US
3.37	Drive encoder comms baud rate		100 (0), 200 (1), 300 (2), 400 (3), 500 (4), 1000 (5), 1500 (6), 2000 (7) kBaud	300 (2)	RW	Txt				US
3.38	Drive encoder type		Ab (0), Fd (1), Fr (2), Ab.SErvo (3), Fd.SErvo (4), Fr.SErvo (5), SC (6), SC.Hiper (7), EndAt (8), SC.EndAt (9), SSI (10), SC.SSI (11)	Ab.SErvo (3)	RW	Txt				US
3.39	Drive encoder termination select / Rotary encoder select / Comms only encoder mode		0 to 2	1	RW	Uni				US
3.40	Drive encoder error detection level		Bit 0 (LSB) = Wire break detect Bit 1 = Phase error detect Bit 2 (MSB) = SSI power supply bit monitor Value is binary sum	1	RW	Uni				US
3.41	Drive encoder auto-configuration / SSI binary format select		OFF (0) or On (1)	OFF (0)	RW	Bit				US
3.42	Drive encoder filter		0 (0), 1 (1), 2 (2), 4 (3), 8 (4), 16 (5) ms	0	RW	Txt				US
3.43	Maximum drive encoder reference		0 to 40,000 rpm	3000	RW	Uni				US
3.44	Drive encoder reference scaling		0.000 to 4.000	1.000	RW	Uni				US
3.45	Drive encoder reference		±100.0 %		RO	Bi	FI	NC	PT	
3.46	Drive encoder reference destination		Pr **0.00** to **21.50**	Pr **0.00**	RW	Uni		DE	PT	US
3.47	Re-initialise position feedback		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
3.48	Position feedback initialised		OFF (0) or On (1)		RO	Bit		NC	PT	
3.49	Full motor object electronic nameplate transfer		OFF (0) or On (1)	OFF (0)	RW	Bit				US
3.50	Position feedback lock		OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
3.52	Encoder simulation ratio numerator		0.0000 to 1.0000	1.0000	RW	Uni				US
3.54	Encoder simulation mode		0 to 4	0	RW	Uni				US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string			
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save	

***Encoder phase angle**

The encoder phase angles in Pr **3.25** and Pr **21.20** are copied to the SMARTCARD when using any of the SMARTCARD transfer methods.

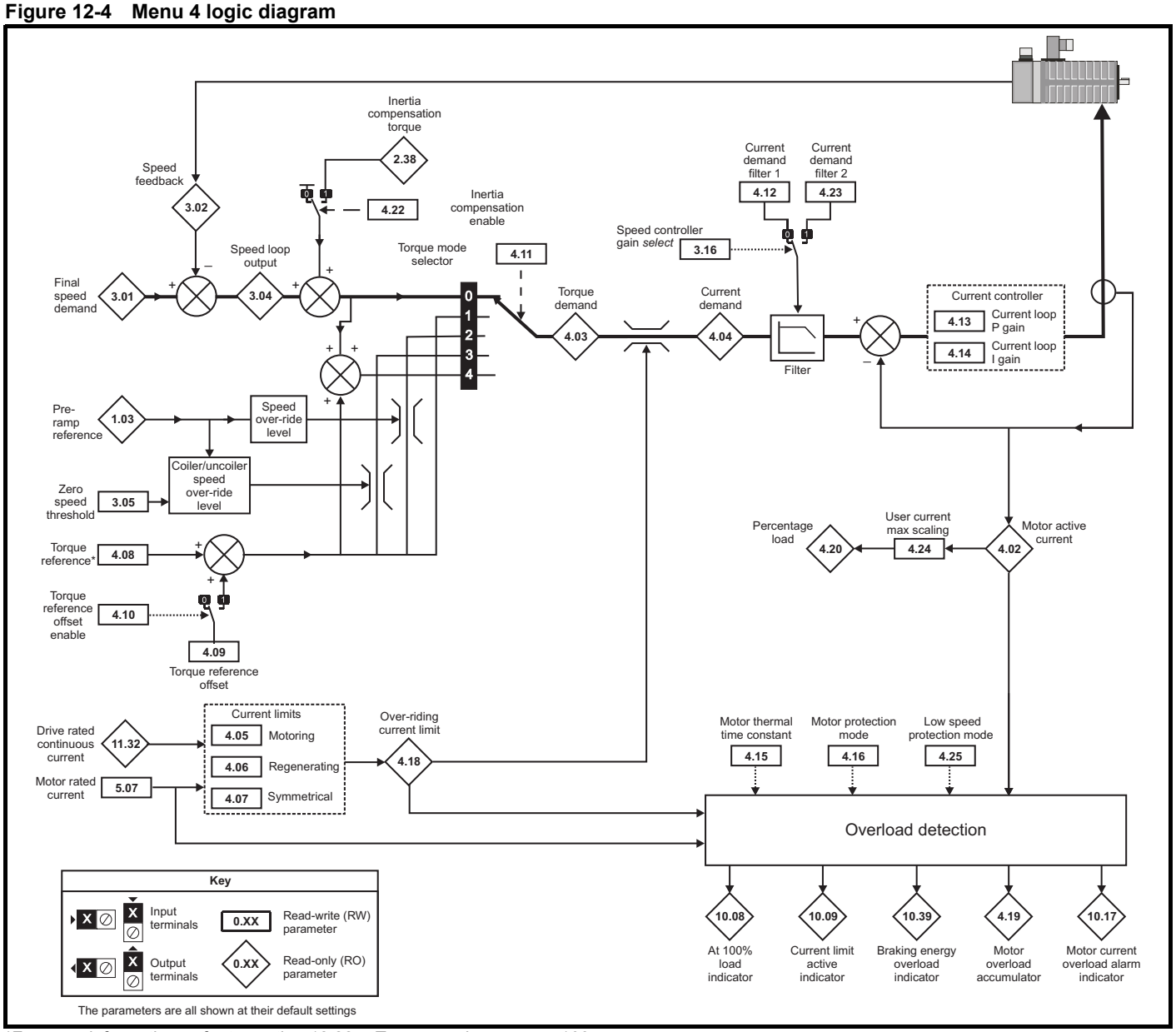
WARNING

NOTE

If Ab encoder voltage is greater than 5 V, then the termination resistors must be disabled Pr **3.39 to 0.

12.4 Menu 4: Torque and current control

Figure 12-4 Menu 4 logic diagram



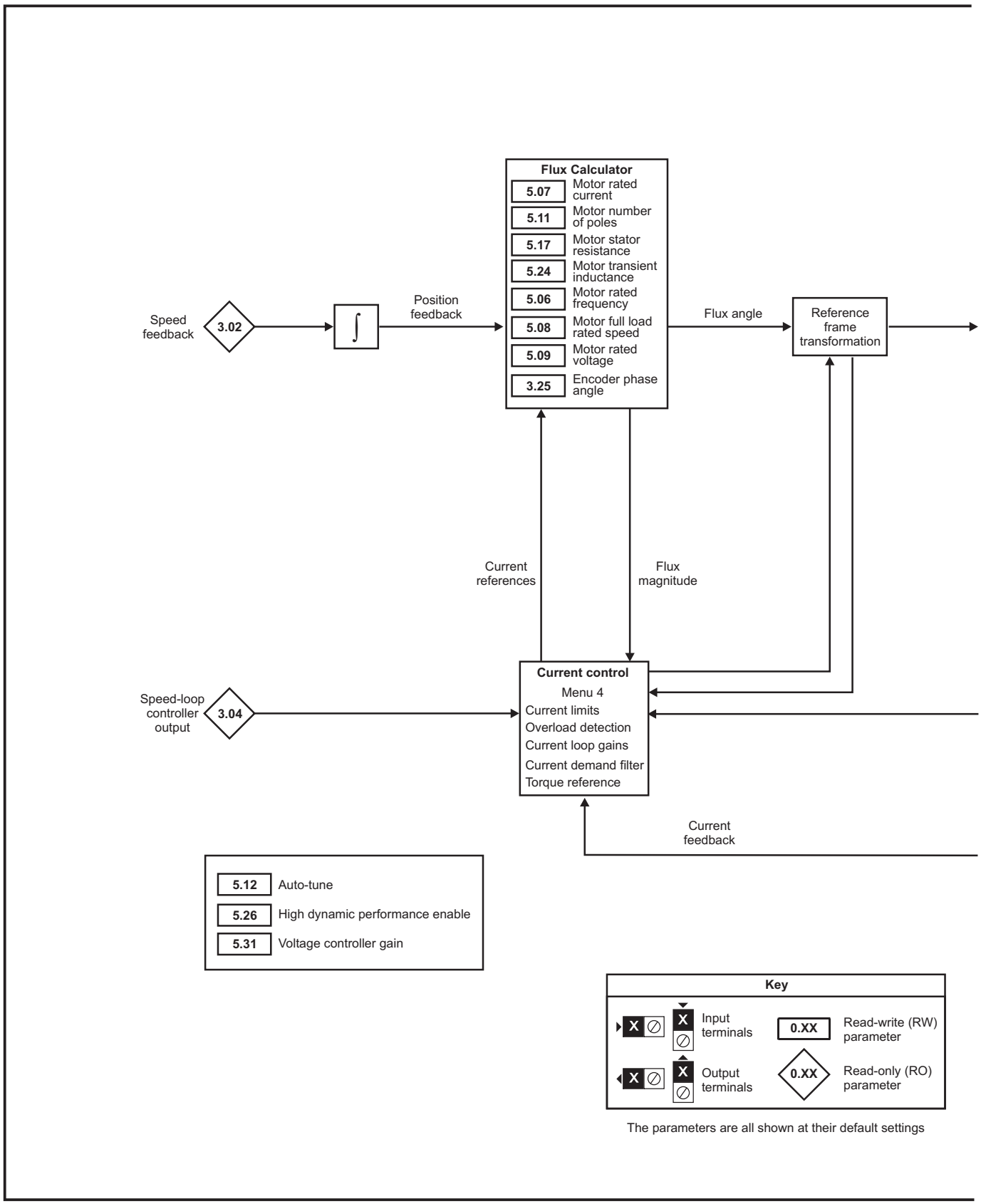
*For more information, refer to section 12.22.4 *Torque modes* on page 168.

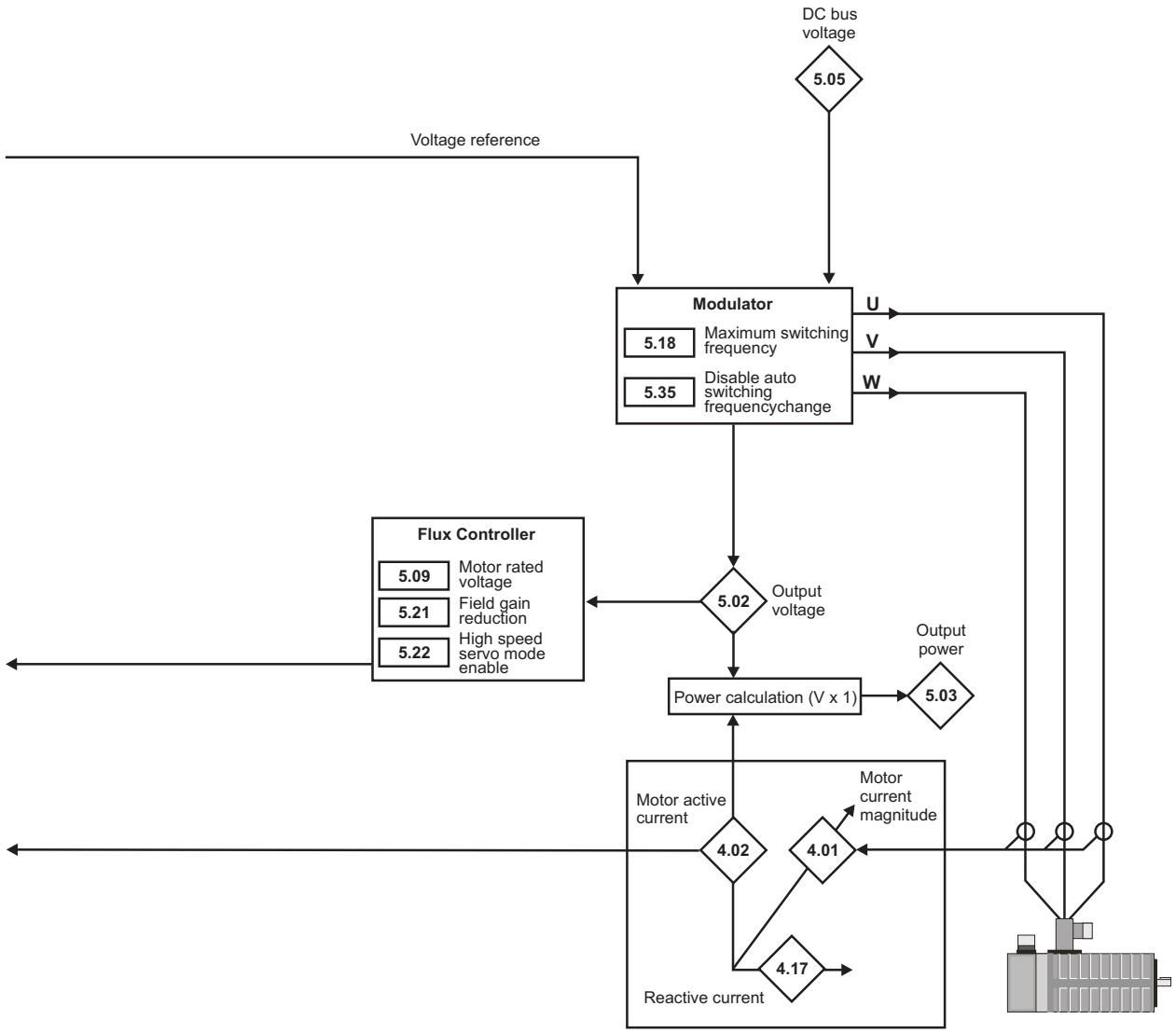
Parameter			Range(⇳)	Default(⇨)	Type					
4.01	Current magnitude	{**0.12**}	0 to DRIVE_CURRENT_MAX A		RO	Uni	FI	NC	PT	
4.02	Active current		±DRIVE_CURRENT_MAX A		RO	Bi	FI	NC	PT	
4.03	Torque demand		±TORQUE_PROD_CURRENT_MAX %		RO	Bi	FI	NC	PT	
4.04	Current demand		±TORQUE_PROD_CURRENT_MAX %		RO	Bi	FI	NC	PT	
4.05	Motoring current limit		0 to MOTOR1_CURRENT_LIMIT_MAX %	300.0	RW	Uni		RA		US
4.06	Regen current limit		0 to MOTOR1_CURRENT_LIMIT_MAX %	300.0	RW	Uni		RA		US
4.07	Symmetrical current limit	{**0.06**}	0 to MOTOR1_CURRENT_LIMIT_MAX %	300.0	RW	Uni		RA		US
4.08	Torque reference		±USER_CURRENT_MAX %	0.00	RW	Bi				US
4.09	Torque offset		±USER_CURRENT_MAX %	0.0	RW	Bi				US
4.10	Torque offset select		OFF (0) or On (1)	OFF (0)	RW	Bit				US
4.11	Torque mode selector	{**0.14**}	0 to 4	0	RW	Uni				US
4.12	Current demand filter 1	{**0.17**}	0.0 to 25.0 ms	0.0	RW	Uni				US
4.13	Current controller Kp gain	{**0.38**}	0 to 30,000	200V drive: 75 400V drive: 150	RW	Uni				US
4.14	Current controller Ki gain	{**0.39**}	0 to 30,000	200V drive: 1000 400V drive: 2000	RW	Uni				US
4.15	Thermal filter	{**0.45**}	0.0 to 3000.0	20.0	RW	Uni				US
4.16	Thermal protection mode		0 to 1	0	RW	Bit				US
4.17	Reactive current		±DRIVE_CURRENT_MAX A		RO	Bi	FI	NC	PT	
4.18	Overriding current limit		±TORQUE_PROD_CURRENT_MAX %		RO	Uni		NC	PT	
4.19	Overload accumulator		0 to 100.0 %		RO	Uni		NC	PT	
4.20	Percentage load		±USER_CURRENT_MAX %		RO	Bi	FI	NC	PT	
4.22	Inertia compensation enable		OFF (0) or On (1)	OFF (0)	RW	Bit				US
4.23	Current demand filter 2		0.0 to 25.0 ms	0.0	RW	Uni				US
4.24	User current maximum scaling		0.0 to TORQUE_PROD_CURRENT_MAX %	300.0	RW	Uni		RA		US
4.25	Low speed thermal protection mode		OFF (0) or On (1)	OFF (0)	RW	Bit				US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.5 Menu 5: Motor control

Figure 12-5 Menu 5 logic diagram



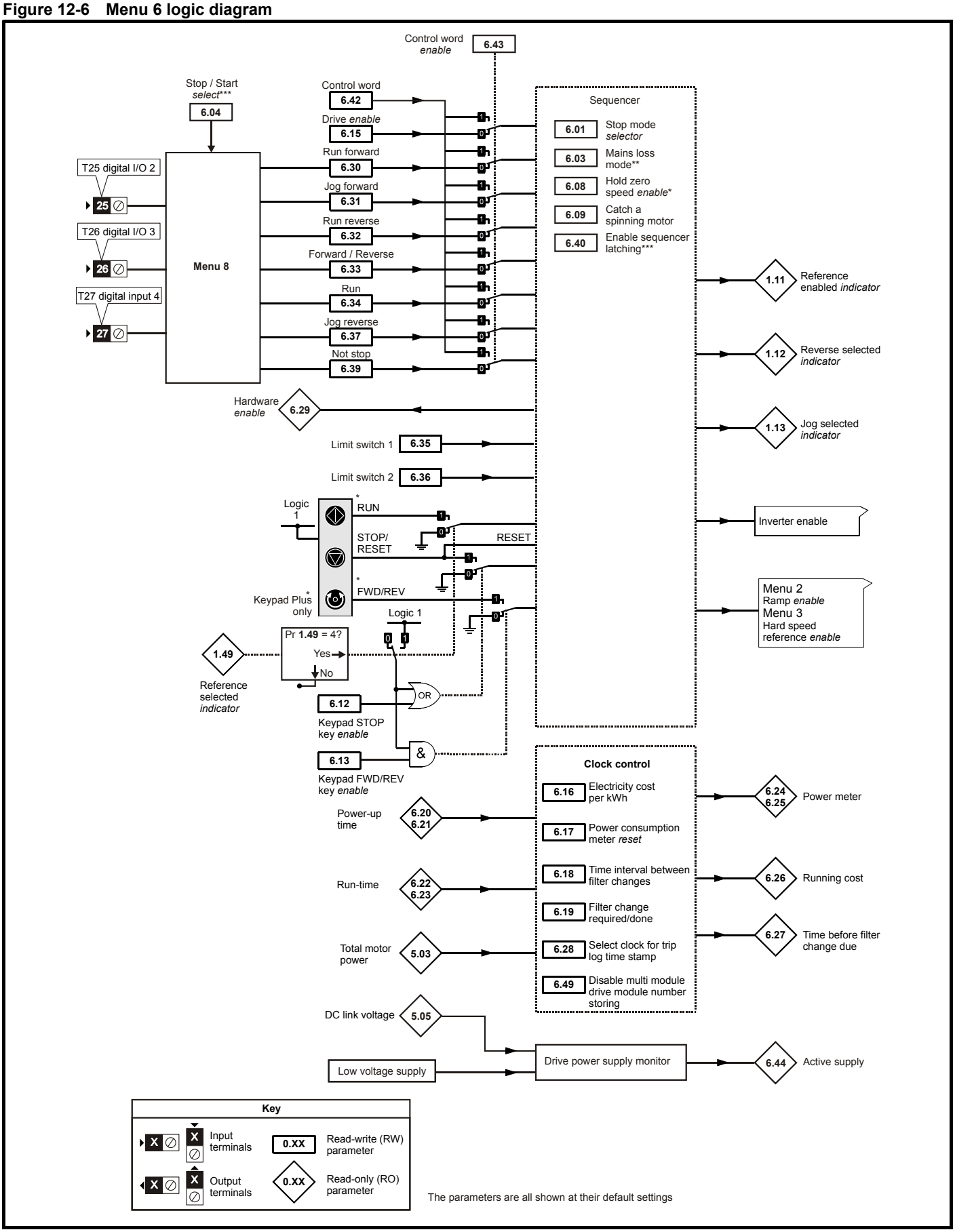

DC bus voltage
5.05
Voltage reference
Modulator
5.18
Maximum switching frequency
5.35
Disable auto switching frequencychange
U
V
W
Flux Controller
5.09
Motor rated voltage
5.21
Field gain reduction
5.22
High speed servo mode enable
5.02
Output voltage
Output power
Power calculation (V x 1)
5.03
Motor active current
Motor current magnitude
4.02
4.01
4.17
Reactive current

Parameter			Range(⇳)	Default(⇨)	Type					
5.01	Output frequency	{**0.11**}	±SPEED_REF_MAX rpm		RO	Bi	FI	NC	PT	
5.02	Output voltage		0 to AC_VOLTAGE_MAX V		RO	Uni	FI	NC	PT	
5.03	Output power		±POWER_MAX kW		RO	Bi	FI	NC	PT	
5.05	D.C bus voltage		0 to +DC_VOLTAGE_MAX V		RO	Uni	FI	NC	PT	
5.07	Motor rated current	{**0.46**}	0 to RATED_CURRENT_MAX A	Drive rated current [**11.32**]	RW	Uni		RA		US
5.08	Rated speed		0.00 to 40,000.00 rpm	3,000.00	RW	Uni				US
5.09	Rated voltage	{**0.44**}	0 to AC_VOLTAGE_SET_MAX V	200 V drive: 230 400 V drive: EUR> 400, USA> 460	RW	Uni		RA		US
5.11	Number of motor poles	{**0.42**}	Auto to 120 Pole (0 to 60)	6 POLE (3)	RW	Txt				US
5.12	Autotune	{**0.40**}	SV> 0 to 6	0	RW	Uni		NC		
5.14	Action on enable		nonE (0), Ph EnL (1), Ph Init (2)	nonE(0)	RW	Txt				US
5.17	Motor stator resistance		0.000 to 65.000 x 10 Ω	0.0	RW	Uni		RA		US
5.18	Maximum switching frequency	{**0.41**}	0 to 4 (3, 4, 6, 8, 12 kHz)	2 (6 kHz)	RW	Txt		RA		US
5.21	Field gain reduction		OFF (0) or On (1)	OFF (0)	RW	Bit				US
5.22	High speed servo mode enable		OFF (0) or On (1)	0	RW	Bit				US
5.24	Transient inductance (σL_s)		0.000 to 500.000 mH	0.000	RW	Uni		RA		US
5.26	High dynamic performance enable		OFF (0) or On (1)	OFF (0)	RW	Bit				US
5.31	Voltage controller gain		0 to 30	1	RW	Uni				US
5.32	Motor torque per amp, K_t		0.00 to 500.00 N m A^{-1}	1.60	RW	Uni				US
5.33	Motor volts per 1,000 rpm, K_e		0 to 10,000 V	98	RW	Uni				US
5.35	Disable auto switching frequency change		OFF (0) or On (1)	OFF (0)	RW	Bit				US
5.36	Motor pole pitch		0 to 655.35 mm	0.00	RW	Uni				US
5.37	Actual switching frequency		3 (0), 4 (1), 6 (2), 8 (3), 12 (4), 16 (5), 6 rEd (6), 12 rEd (7)		RO	Txt		NC	PT	
5.38	Minimal movement phasing test angle		0.0 to 25.5°	5.0	RW	Uni				US
5.39	Minimal movement phasing test pulse length		0 to 3	0	RW	Uni				US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string			
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save	

12.6 Menu 6: Sequencer and clock

Figure 12-6 Menu 6 logic diagram



Parameter		Range(⇳)	Default(⇨)	Type					
6.01	Stop mode	COASt (0), rP (1), no.rP (2)	no.rP (2)	RW	Txt				US
6.03	Line power supply loss mode	diS (0), StoP (1), ridE.th (2)	diS (0)	RW	Txt				US
6.04	Start / stop logic select	0 to 4	4	RW	Uni				US
6.08	Hold zero speed	OFF (0) or On (1)	On (1)	RW	Bit				US
6.09	Catch a spinning motor	0 to 1	1	RW	Uni				US
6.12	Enable stop key	OFF (0) or On (1)	OFF (0)	RW	Bit				US
6.13	Enable forward / reverse key {**0.28**}	OFF (0) or On (1)	OFF (0)	RW	Bit				US
6.15	Drive enable	OFF (0) or On (1)	On (1)	RW	Bit				US
6.16	Electricity cost per kWh	0.0 to 600.0 currency units per kWh	0	RW	Uni				US
6.17	Reset energy meter	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
6.18	Time between filter changes	0 to 30,000 hrs	0	RW	Uni				US
6.19	Filter change required / change done	OFF (0) or On (1)	OFF (0)	RW	Bit			PT	
6.20	Powered-up time: years.days	0 to 9.364 years.days		RW	Uni		NC	PT	
6.21	Powered-up time: hours.minutes	0 to 23.59 hours.minutes		RW	Uni		NC	PT	
6.22	Run time: years.days	0 to 9.364 years.days		RO	Uni		NC	PT	PS
6.23	Run time: hours.minutes	0 to 23.59 hours.minutes		RO	Uni		NC	PT	PS
6.24	Energy meter: MWh	±999.9 MWh		RO	Bi		NC	PT	PS
6.25	Energy meter: kWh	±99.99 kWh		RO	Bi		NC	PT	PS
6.26	Running cost	±32,000		RO	Bi		NC	PT	
6.27	Time before filter change due	0 to 30,000 hrs		RO	Uni		NC	PT	PS
6.28	Select clock for trip log time sampling	OFF (0) or On (1)	OFF (0)	RW	Bit				US
6.29	Hardware enable	OFF (0) or On (1)		RO	Bit		NC	PT	
6.30	Sequencing bit: Run forward	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
6.31	Sequencing bit: Jog forward	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
6.32	Sequencing bit: Run reverse	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
6.33	Sequencing bit: Forward / reverse	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
6.34	Sequencing bit: Run	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
6.35	Forward limit switch	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
6.36	Reverse limit switch	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
6.37	Sequencing bit: Jog reverse	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
6.39	Sequencing bit: Not stop	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
6.40	Enable sequencer latching	OFF (0) or On (1)	OFF (0)	RW	Bit				US
6.41	Drive event flags	0 to 65,535	0	RW	Uni		NC		
6.42	Control word	0 to 32,767	0	RW	Uni		NC		
6.43	Control word enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
6.44	Active supply	OFF (0) or On (1)		RO	Bit		NC	PT	
6.45	Force cooling fan to run at full speed	OFF (0) or On (1)	OFF (0)	RW	Bit				US
6.46	Normal low voltage supply	48 V to 72 V	48	RW	Uni			PT	US
6.47	Disable line power supply/ phase loss detection from input rectifier	OFF (0) or On (1)	OFF (0)	RW	Bit				US
6.48	Line power supply loss ride through detection level	0 to DC_VOLTAGE_SET_MAX V	200 V drive: 205, 400 V drive: 410	RW	Uni		RA		US
6.49	Disable multi-module drive module number storing on trip	OFF (0) or On (1)	OFF (0)	RW	Bit				US
6.50	Drive comms state	drv (0), SLot 1(1), SLot 2 (2)		RO	Txt		NC	PT	
6.51	External rectifier not active	OFF (0) or On (1)	OFF (0)	RW	Bit				

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

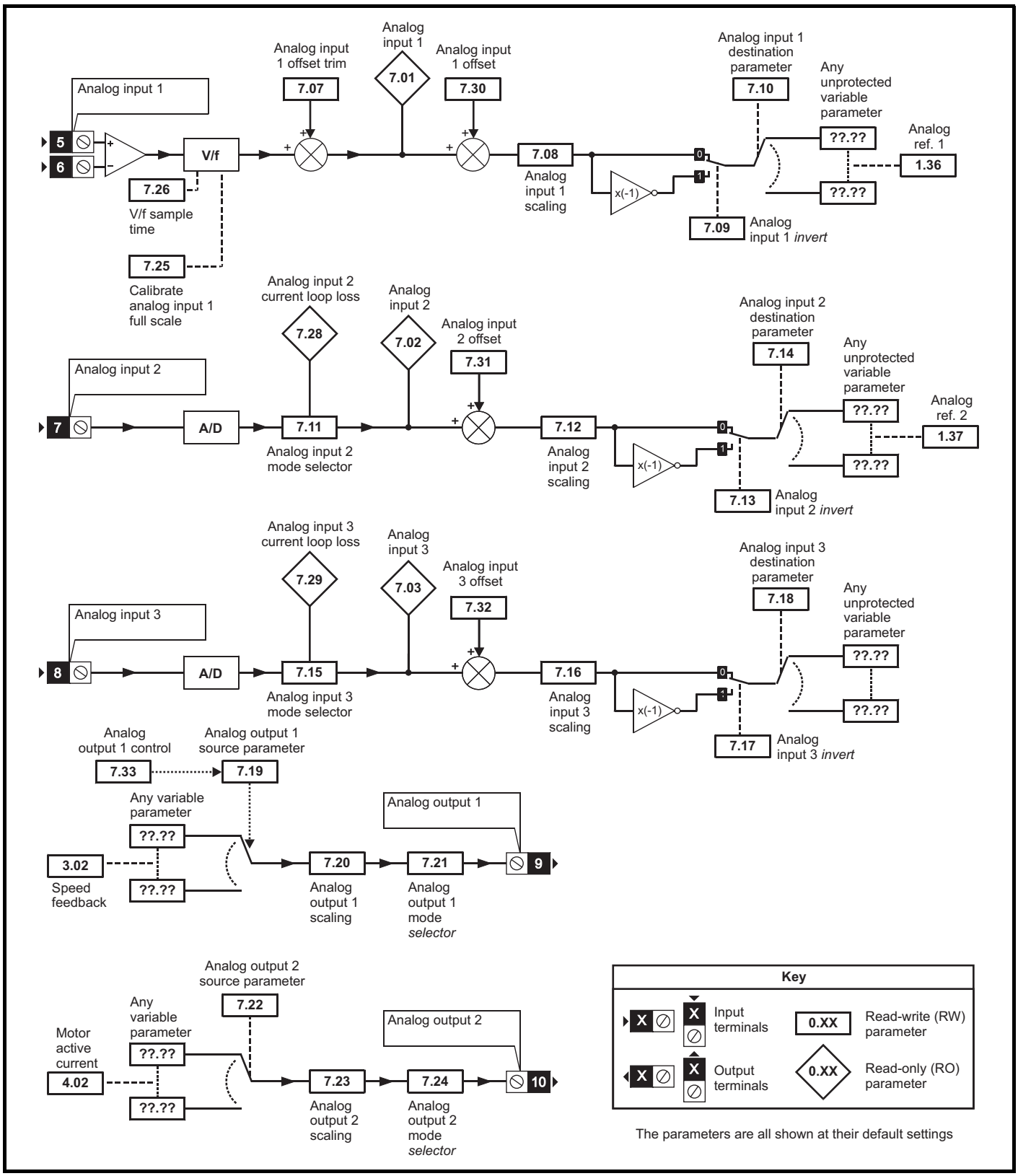
*For more information, refer to section 12.22.5 *Stop modes* on page 169.

**For more information, refer to section 12.22.6 *Line power supply loss modes* on page 169.

***For more information, refer to section 12.22.7 *Start / stop logic modes* on page 170.

12.7 Menu 7: Analog I/O

Figure 12-7 Menu 7 logic diagram

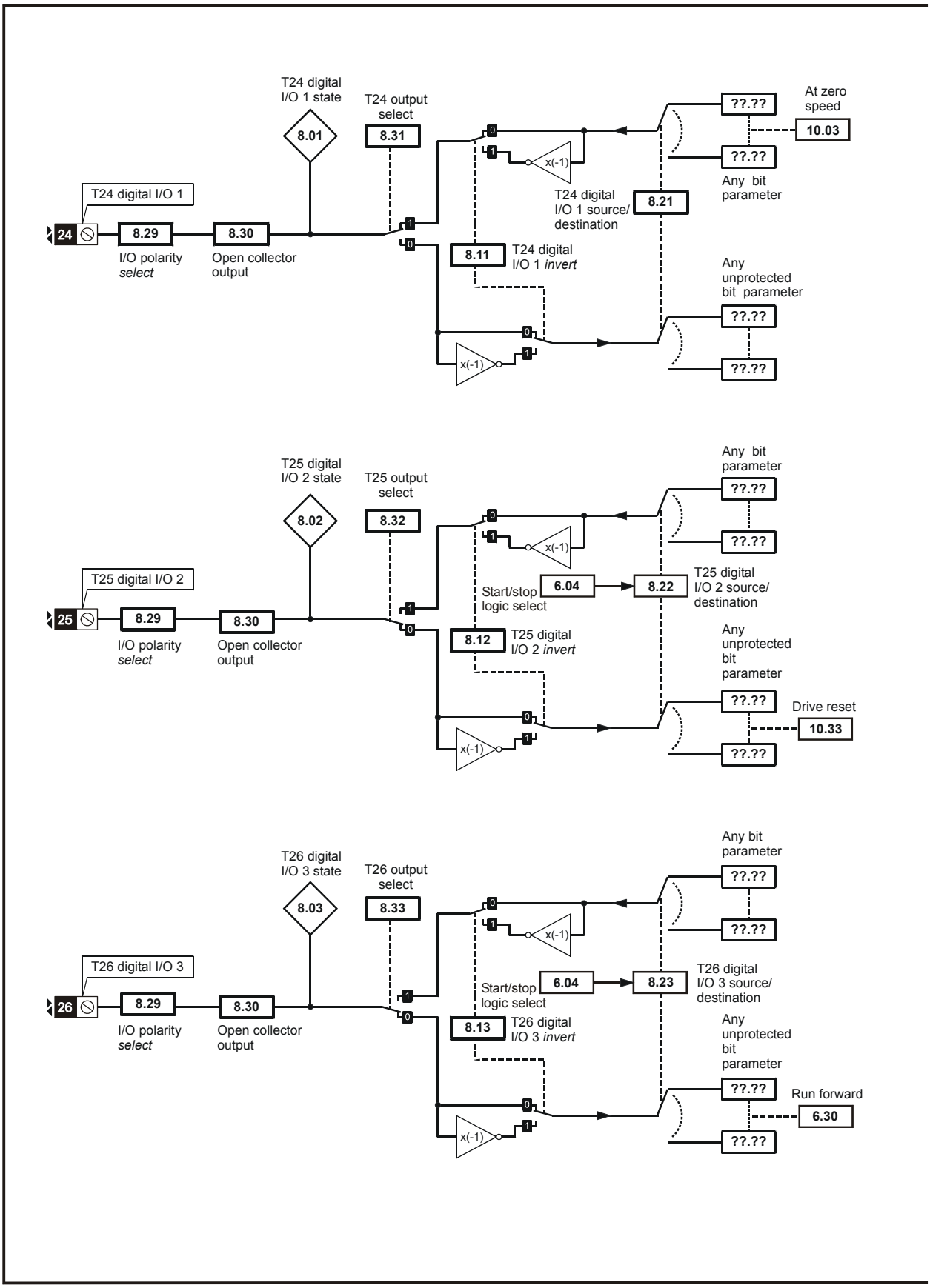


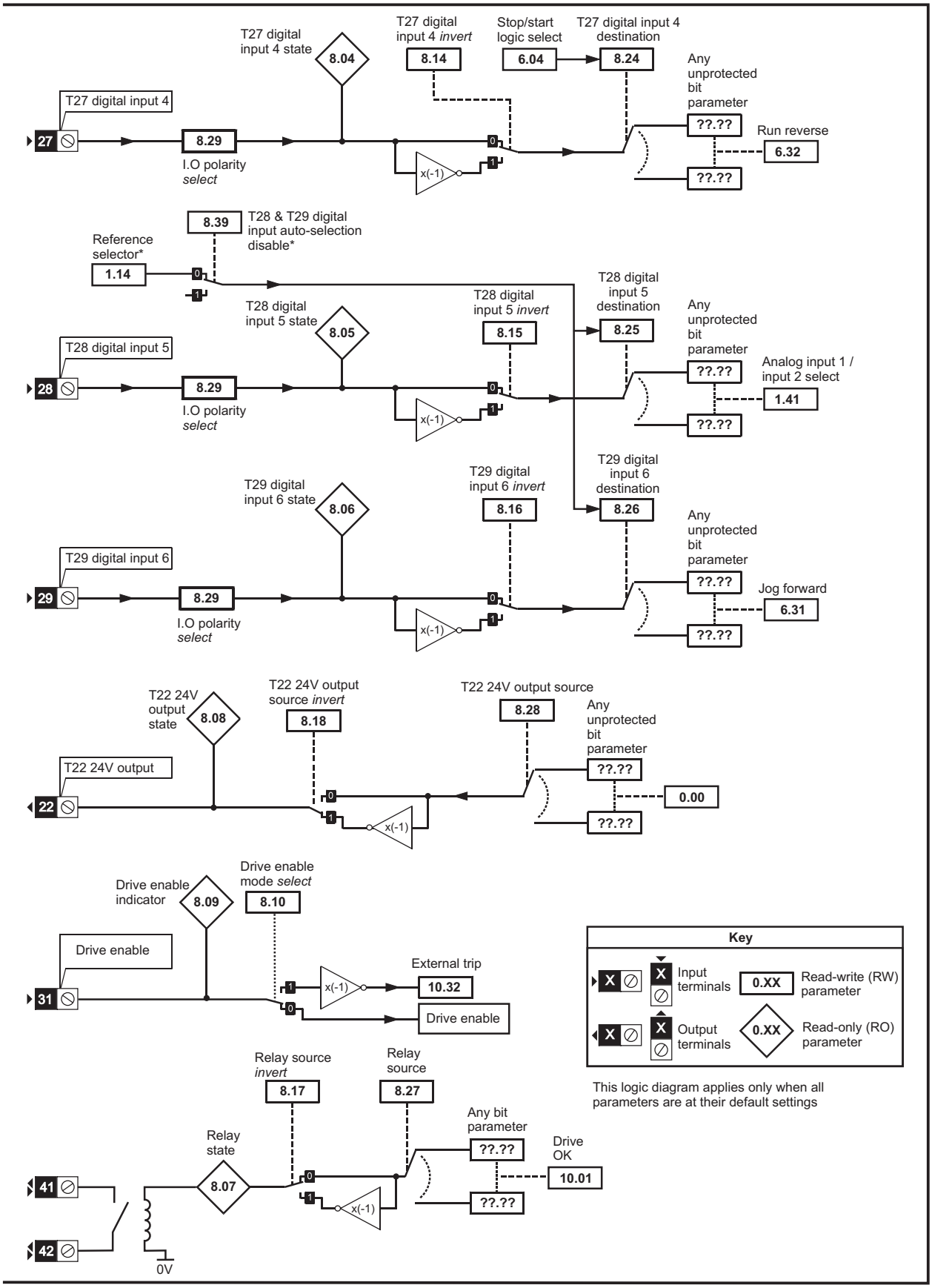
Parameter		Range(⇳)	Default(⇨)	Type					
7.01	T5/6 analog input 1 level	±100.00 %		RO	Bi		NC	PT	
7.02	T7 analog input 2 level	±100.0 %		RO	Bi		NC	PT	
7.03	T8 analog input 3 level	±100.0 %		RO	Bi		NC	PT	
7.04	Power circuit temperature 1 (Highest IGBT)	-128 to 127 °C		RO	Bi		NC	PT	
7.05	Power circuit temperature 2 (Highest SMPS)	-128 to 127 °C		RO	Bi		NC	PT	
7.06	Control board temperature	-128 to 127 °C		RO	Bi		NC	PT	
7.07	T5/6 analog input 1 offset trim {**0.13**}	±10.000 %	0.000	RW	Bi				US
7.08	T5/6 analog input 1 scaling	0 to 4.000	1.000	RW	Uni				US
7.09	T5/6 analog input 1 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
7.10	T5/6 analog input 1 destination	Pr **0.00** to **21.51**	Pr **1.36**	RW	Uni	DE		PT	US
7.11	T7 analog input 2 mode {**0.19**}	0-20 (0), 20-0 (1), 4-20.tr (2), 20-4.tr (3), 4-20 (4), 20-4 (5), VOLt (6)	VOLt (6)	RW	Txt				US
7.12	T7 analog input 2 scaling	0 to 4.000	1.000	RW	Uni				US
7.13	T7 analog input 2 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
7.14	T7 analog input 2 destination {**0.20**}	Pr **0.00** to **21.51**	Pr **1.37**	RW	Uni	DE		PT	US
7.15	T8 analog input 3 mode {**0.21**}	0-20 (0), 20-0 (1), 4-20.tr (2), 20-4.tr (3), 4-20 (4), 20-4 (5), VOLt (6), th.SC (7), th (8), th.diSP (9)	th (8)	RW	Txt				US
7.16	T8 analog input 3 scaling	0 to 4.000	1.000	RW	Uni				US
7.17	T8 analog input 3 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
7.18	T8 analog input 3 destination	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni	DE		PT	US
7.19	T9 analog output 1 source	Pr **0.00** to **21.51**	Pr **3.02**	RW	Uni			PT	US
7.20	T9 analog output 1 scaling	0.000 to 4.000	1.000	RW	Uni				US
7.21	T9 analog output 1 mode	VOLt (0), 0-20 (1), 4-20 (2), H.SPd (3)	VOLt (0)	RW	Txt				US
7.22	T10 analog output 2 source	Pr **0.00** to **21.51**	Pr **4.02**	RW	Uni			PT	US
7.23	T10 analog output 2 scaling	0.000 to 4.000	1.000	RW	Uni				US
7.24	T10 analog output 2 mode	VOLt (0), 0-20 (1), 4-20 (2), H.SPd (3)	VOLt (0)	RW	Txt				US
7.25	Calibrate T5/6 analog input 1 full scale	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
7.26	T5/6 analog input 1 sample time	0 to 8.0 ms	4.0	RW	Uni				US
7.28	T7 analog input 2 current loop loss	OFF (0) or On (1)		RO	Bit		NC	PT	
7.29	T8 analog input 3 current loop loss	OFF (0) or On (1)		RO	Bit		NC	PT	
7.30	T5/6 analog input 1 offset	±100.00 %	0.00	RW	Bi				US
7.31	T7 analog input 2 offset	±100.0 %	0.0	RW	Bi				US
7.32	T8 analog input 3 offset	±100.0 %	0.0	RW	Bi				US
7.33	T9 analog output 1 control	Fr (0), Ld (1), AdV (2)	AdV (2)	RW	Txt				US
7.34	IGBT junction temperature	±200 °C		RO	Bi		NC	PT	
7.35	Drive thermal protection accumulator	0 to 100.0 %		RO	Uni		NC	PT	
7.36	Power circuit temperature 3 (Rectifier)	-128 to 127 °C		RO	Bi		NC	PT	

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.8 Menu 8: Digital I/O

Figure 12-8 Menu 8 logic diagram





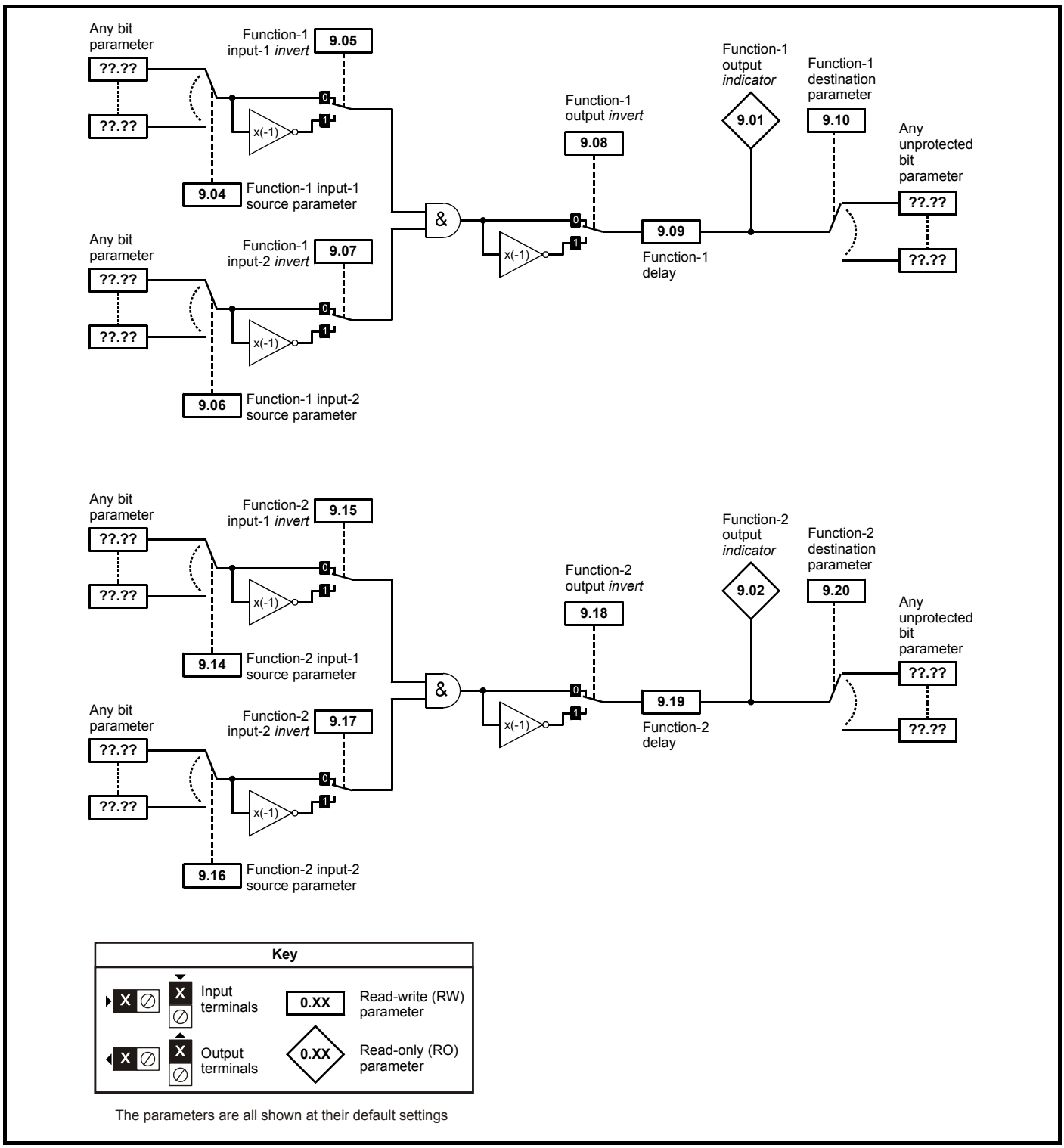
*For more information, please refer to 12.22.1*Reference modes* on page 166.

Parameter		Range(⇳)	Default(⇨)	Type					
8.01	T24 digital I/O 1 state	OFF (0) or On (1)		RO	Bit		NC	PT	
8.02	T25 digital I/O 2 state	OFF (0) or On (1)		RO	Bit		NC	PT	
8.03	T26 digital I/O 3 state	OFF (0) or On (1)		RO	Bit		NC	PT	
8.04	T27 digital input 4 state	OFF (0) or On (1)		RO	Bit		NC	PT	
8.05	T28 digital input 5 state	OFF (0) or On (1)		RO	Bit		NC	PT	
8.06	T29 digital input 6 state	OFF (0) or On (1)		RO	Bit		NC	PT	
8.07	Relay state	OFF (0) or On (1)		RO	Bit		NC	PT	
8.08	T22 24V output state	OFF (0) or On (1)		RO	Bit		NC	PT	
8.09	Drive enable indicator	OFF (0) or On (1)		RO	Bit		NC	PT	
8.10	Drive enable mode select	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.11	T24 digital I/O 1 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.12	T25 digital I/O 2 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.13	T26 digital I/O 3 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.14	T27 digital input 4 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.15	T28 digital input 5 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.16	T29 digital input 6 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.17	Relay source invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.18	T22 24V output source invert	OFF (0) or On (1)	On (1)	RW	Bit				US
8.20	Digital I/O read word	0 to 511		RO	Uni		NC	PT	
8.21	T24 digital I/O 1 source/ destination	Pr **0.00** to **21.51**	Pr **10.03**	RW	Uni	DE		PT	US
8.22	T25 digital I/O 2 source/ destination	Pr **0.00** to **21.51**	Pr **10.33**	RW	Uni	DE		PT	US
8.23	T26 digital I/O 3 source/ destination	Pr **0.00** to **21.51**	Pr **6.30**	RW	Uni	DE		PT	US
8.24	T27 digital input 4 destination	Pr **0.00** to **21.51**	Pr **6.32**	RW	Uni	DE		PT	US
8.25	T28 digital input 5 destination	Pr **0.00** to **21.51**	Pr **1.41**	RW	Uni	DE		PT	US
8.26	T29 digital input 6 destination	Pr **0.00** to **21.51**	Pr **6.31**	RW	Uni	DE		PT	US
8.27	Relay source	Pr **0.00** to **21.51**	Pr **10.01**	RW	Uni			PT	US
8.28	T22 24V output source	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
8.29	Positive logic select {**0.18**}	OFF (0) or On (1)	On (1)	RW	Bit			PT	US
8.30	Open collector output	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.31	T24 digital I/O 1 output select	OFF (0) or On (1)	On (1)	RW	Bit				US
8.32	T25 digital I/O 2 output select	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.33	T26 digital I/O 3 output select	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.39	T28 & T29 digital input auto-selection disable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
8.40	Freeze flag	OFF (0) or On (1)	OFF (0)	RW	Bit			PT	

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

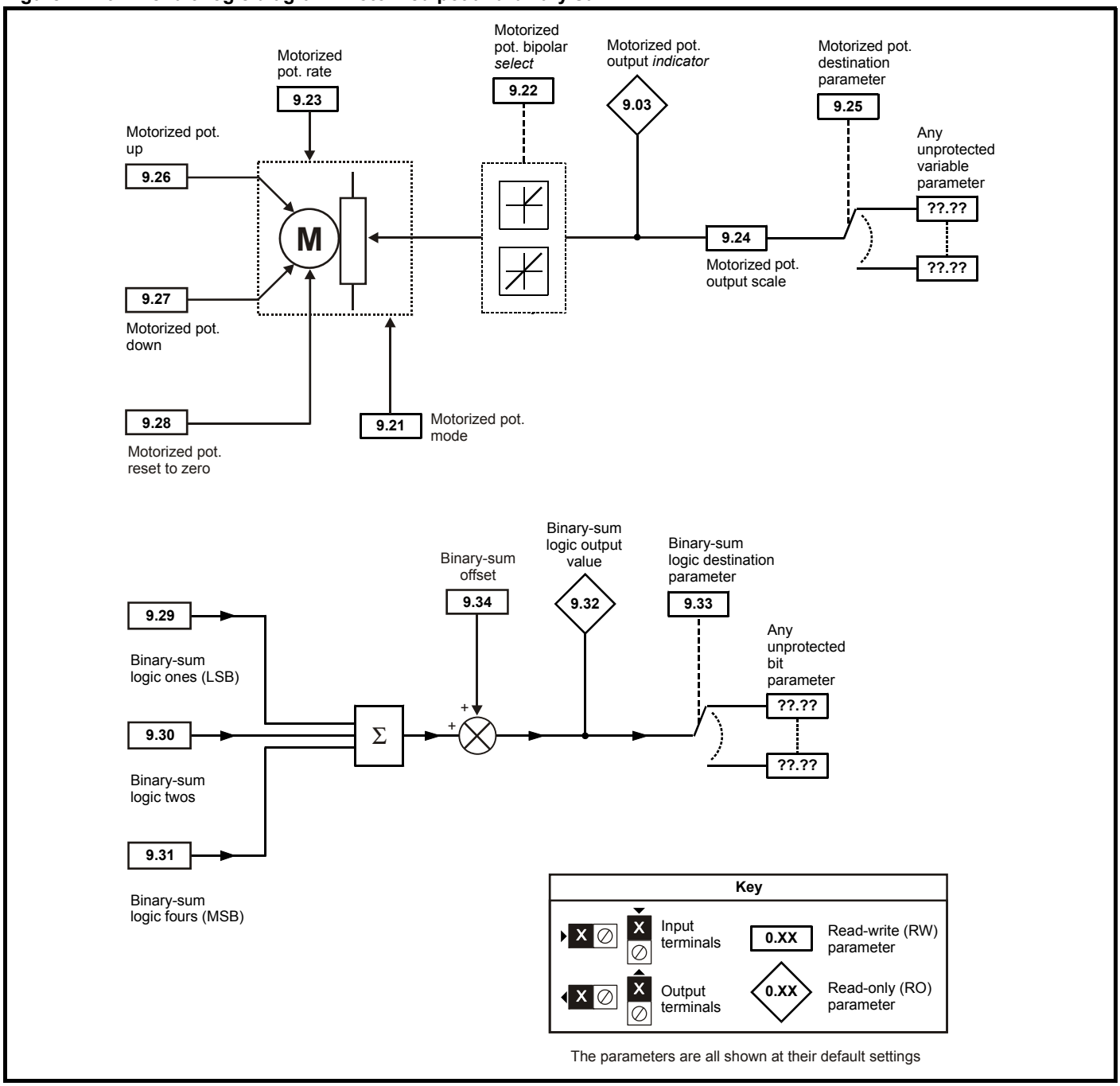
12.9 Menu 9: Programmable logic, motorized pot, binary sum and timers

Figure 12-9 Menu 9 logic diagram: Programmable logic



The parameters are all shown at their default settings

Figure 12-10 Menu 9 logic diagram: Motorized pot and binary sum



The parameters are all shown at their default settings

Parameter		Range(⇳)	Default(⇨)	Type					
9.01	Logic function 1 output	OFF (0) or On (1)		RO	Bit		NC	PT	
9.02	Logic function 2 output	OFF (0) or On (1)		RO	Bit		NC	PT	
9.03	Motorized pot output	±100.00 %		RO	Bi		NC	PT	PS
9.04	Logic function 1 source 1	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
9.05	Logic function 1 source 1 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.06	Logic function 1 source 2	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
9.07	Logic function 1 source 2 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.08	Logic function 1 output invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.09	Logic function 1 delay	±25.0 s	0.0	RW	Bi				US
9.10	Logic function 1 destination	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni	DE		PT	US
9.14	Logic function 2 source 1	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
9.15	Logic function 2 source 1 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.16	Logic function 2 source 2	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
9.17	Logic function 2 source 2 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.18	Logic function 2 output invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.19	Logic function 2 delay	±25.0 s	0.0	RW	Bi				US
9.20	Logic function 2 destination	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni	DE		PT	US
9.21	Motorized pot mode	0 to 3	2	RW	Uni				US
9.22	Motorized pot bipolar select	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.23	Motorized pot rate	0 to 250 s	20	RW	Uni				US
9.24	Motorized pot scale factor	0.000 to 4.000	1.000	RW	Uni				US
9.25	Motorized pot destination	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni	DE		PT	US
9.26	Motorized pot up	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.27	Motorized pot down	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.28	Motorized pot reset	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.29	Binary sum ones input	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.30	Binary sum twos input	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.31	Binary sum fours input	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.32	Binary sum output	0 to 255		RO	Uni		NC	PT	
9.33	Binary sum destination	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni	DE		PT	US
9.34	Binary sum offset	0 to 248	0	RW	Uni				US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.10 Menu 10: Status and trips

Parameter		Range(⇳)	Default(⇨)	Type					
10.01	Drive ok	OFF (0) or On (1)		RO	Bit		NC	PT	
10.02	Drive active	OFF (0) or On (1)		RO	Bit		NC	PT	
10.03	Zero speed	OFF (0) or On (1)		RO	Bit		NC	PT	
10.04	Running at or below minimum speed	OFF (0) or On (1)		RO	Bit		NC	PT	
10.05	Below set speed	OFF (0) or On (1)		RO	Bit		NC	PT	
10.06	At speed	OFF (0) or On (1)		RO	Bit		NC	PT	
10.07	Above set speed	OFF (0) or On (1)		RO	Bit		NC	PT	
10.08	Load reached	OFF (0) or On (1)		RO	Bit		NC	PT	
10.09	Drive output is at current limit	OFF (0) or On (1)		RO	Bit		NC	PT	
10.10	Regenerating	OFF (0) or On (1)		RO	Bit		NC	PT	
10.11	Braking IGBT active	OFF (0) or On (1)		RO	Bit		NC	PT	
10.12	Braking resistor alarm	OFF (0) or On (1)		RO	Bit		NC	PT	
10.13	Direction commanded	OFF (0) or On (1) [0 = FWD, 1 = REV]		RO	Bit		NC	PT	
10.14	Direction running	OFF (0) or On (1) [0 = FWD, 1 = REV]		RO	Bit		NC	PT	
10.15	Line power supply loss	OFF (0) or On (1)		RO	Bit		NC	PT	
10.16	Under voltage active	OFF (0) or On (1)		RO	Bit		NC	PT	
10.17	Overload alarm	OFF (0) or On (1)		RO	Bit		NC	PT	
10.18	Drive over temperature alarm	OFF (0) or On (1)		RO	Bit		NC	PT	
10.19	Drive warning	OFF (0) or On (1)		RO	Bit		NC	PT	
10.20	Trip 0	0 to 230*		RO	Txt		NC	PT	PS
10.21	Trip 1	0 to 230*		RO	Txt		NC	PT	PS
10.22	Trip 2	0 to 230*		RO	Txt		NC	PT	PS
10.23	Trip 3	0 to 230*		RO	Txt		NC	PT	PS
10.24	Trip 4	0 to 230*		RO	Txt		NC	PT	PS
10.25	Trip 5	0 to 230*		RO	Txt		NC	PT	PS
10.26	Trip 6	0 to 230*		RO	Txt		NC	PT	PS
10.27	Trip 7	0 to 230*		RO	Txt		NC	PT	PS
10.28	Trip 8	0 to 230*		RO	Txt		NC	PT	PS
10.29	Trip 9	0 to 230*		RO	Txt		NC	PT	PS
10.30	Full power braking time	0.00 to 400.00 s	See Table 12-5	RW	Uni				US
10.31	Full power braking period	0.0 to 1500.0 s	See Table 12-5	RW	Uni				US
10.32	External trip	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
10.33	Drive reset	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
10.34	No. of auto-reset attempts	0 to 5	0	RW	Uni				US
10.35	Auto-reset delay	0.0 to 25.0 s	1.0	RW	Uni				US
10.36	Hold drive ok until last attempt	OFF (0) or On (1)	OFF (0)	RW	Bit				US
10.37	Action on trip detection	0 to 15	0	RW	Uni				US
10.38	User trip	0 to 255	0	RW	Uni		NC		
10.39	Braking energy overload accumulator	0.0 to 100.0 %		RO	Uni		NC	PT	
10.40	Status word	0 to 32,767		RO	Uni		NC	PT	
10.41	Trip 0 time: years.days	0.000 to 9.365 years.days		RO	Uni		NC	PT	PS
10.42	Module number for trip 0, or, Trip 0 time: hours.minutes	00.00 to 23.59 hours.minutes		RO	Uni		NC	PT	PS
10.43	Module number for trip 1, or, Trip 1 time	0 to 600.00 hours.minutes		RO	Uni		NC	PT	PS
10.44	Module number for trip 2, or, Trip 2 time	0 to 600.00 hours.minutes		RO	Uni		NC	PT	PS
10.45	Module number for trip 3, or, Trip 3 time	0 to 600.00 hours.minutes		RO	Uni		NC	PT	PS
10.46	Module number for trip 4, or, Trip 4 time	0 to 600.00 hours.minutes		RO	Uni		NC	PT	PS
10.47	Module number for trip 5, or, Trip 5 time	0 to 600.00 hours.minutes		RO	Uni		NC	PT	PS
10.48	Module number for trip 6, or, Trip 6 time	0 to 600.00 hours.minutes		RO	Uni		NC	PT	PS
10.49	Module number for trip 7, or, Trip 7 time	0 to 600.00 hours.minutes		RO	Uni		NC	PT	PS
10.50	Module number for trip 8, or, Trip 8 time	0 to 600.00 hours.minutes		RO	Uni		NC	PT	PS
10.51	Module number for trip 9, or, Trip 9 time	0 to 600.00 hours.minutes		RO	Uni		NC	PT	PS

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

*The value given for the range is that obtained via serial communication. For the text string displayed on the drive, see Chapter 14 *Diagnostics* on page 183.

CAUTION

Braking resistor overload protection parameter settings
Failure to observe the following information may damage the resistor.
The drive's software contains an overload protection function for a braking resistor. On Digitax ST this function is enabled at default to protect the internally mounted resistor. Below are the parameter settings.

Table 12-5 Defaults for Pr 10.30 and Pr 10.31

Parameter	Digitax ST	
	200 V drive	400 V drive
	Default	
Pr **10.30** - Full power braking time	0.06	0.01
Pr **10.31** - Full power braking period	2.6	1.7

For more information on the braking resistor software overload protection, see Pr **10.30** and Pr **10.31** full descriptions in the *Advanced User Guide*.

If the internally mounted braking resistor is to be used at more than half of its average power rating then the drive's cooling fan must be at full speed, controlled by setting Pr **6.45** to On (1).

12.11 Menu 11: General drive set-up

Parameter			Range(⇳)	Default(⇨)	Type					
11.01	Parameter 0.11 set up		Pr **1.00** to Pr **21.51**	Pr **3.29**	RW	Uni			PT	US
11.02	Parameter 0.12 set up			Pr **4.01**	RW	Uni			PT	US
11.03	Parameter 0.13 set up			Pr **7.07**	RW	Uni			PT	US
11.04	Parameter 0.14 set up			Pr **4.11**	RW	Uni			PT	US
11.05	Parameter 0.15 set up			Pr **2.04**	RW	Uni			PT	US
11.06	Parameter 0.16 set up			Pr **2.02**	RW	Uni			PT	US
11.07	Parameter 0.17 set up			Pr **4.12**	RW	Uni			PT	US
11.08	Parameter 0.18 set up			Pr **8.29**	RW	Uni			PT	US
11.09	Parameter 0.19 set up			Pr **7.11**	RW	Uni			PT	US
11.10	Parameter 0.20 set up			Pr **7.14**	RW	Uni			PT	US
11.11	Parameter 0.21 set up			Pr **7.15**	RW	Uni			PT	US
11.12	Parameter 0.22 set up			Pr **1.10**	RW	Uni			PT	US
11.13	Parameter 0.23 set up			Pr **1.05**	RW	Uni			PT	US
11.14	Parameter 0.24 set up			Pr **1.21**	RW	Uni			PT	US
11.15	Parameter 0.25 set up			Pr **1.22**	RW	Uni			PT	US
11.16	Parameter 0.26 set up			Pr **3.08**	RW	Uni			PT	US
11.17	Parameter 0.27 set up			Pr **3.34**	RW	Uni			PT	US
11.18	Parameter 0.28 set up			Pr **6.13**	RW	Uni			PT	US
11.19	Parameter 0.29 set up			Pr **11.36**	RW	Uni			PT	US
11.20	Parameter 0.30 set up			Pr **11.42**	RW	Uni			PT	US
11.21	Parameter scaling		0.000 to 9.999	1.000	RW	Uni				US
11.22	Parameter displayed at power-up		Pr **0.00** to **00.50**	Pr **0.10**	RW	Uni			PT	US
11.23	Serial address	{**0.37**}	0 to 247	1	RW	Uni				US
11.24	Serial mode	{**0.35**}	AnSI (0), rtU (1), Lcd (2)	rtU (1)	RW	Txt			PT	US
11.25	Baud rate	{**0.36**}	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8)*, 115200 (9)* *Modbus RTU only	19200 (6)	RW	Txt				US
11.26	Minimum comms transmit delay		0 to 250ms	2	RW	Uni				US
11.28	Drive derivative		0 to 16		RO	Uni		NC	PT	
11.29	Software version	{**0.50**}	1.00 to 99.99		RO	Uni		NC	PT	
11.30	User security code	{**0.34**}	0 to 999	0	RW	Uni		NC	PT	PS
11.32	Maximum current rating	{**0.32**}	0.00 to 9999.99 A		RO	Uni		NC	PT	
11.33	Drive voltage rating	{**0.31**}	200 (0), 400 (1), 575 (2), 690 (3)		RO	Txt		NC	PT	
11.34	Software sub-version		0 to 99		RO	Uni		NC	PT	
11.35	Number of modules		0 to 10	0	RW	Uni			PT	US
11.36	SMARTCARD parameter data previously loaded	{**0.29**}	0 to 999	0	RO	Uni		NC	PT	US
11.37	SMARTCARD data number		0 to 1003	0	RW	Uni		NC		
11.38	SMARTCARD data type / mode		0 to 18		RO	Txt		NC	PT	
11.39	SMARTCARD data version		0 to 9,999	0	RW	Uni		NC		
11.40	SMARTCARD data checksum		0 to 65,335		RO	Uni		NC	PT	
11.41	Status mode timeout		0 to 250s	240	RW	Uni				US
11.42	Parameter copying	{**0.30**}	nonE (0), rEAd (1), Prog (2), AutO (3), boot (4)	nonE (0)	RW	Txt		NC		*
11.43	Load defaults		nonE (0), Eur (1), USA (2)	nonE (0)	RW	Txt		NC		
11.44	Security status	{**0.49**}	L1 (0), L2 (1), Loc (2)		RW	Txt			PT	US
11.45	Select motor 2 parameters		OFF (0) or On (1)	OFF (0)	RW	Bit				US
11.46	Defaults previously loaded		0 to 2000		RO	Uni		NC	PT	US
11.47	Drive Onboard PLC program enable		Halt program (0) Run program: out of range = clip (1) Run program: out of range = trip (2)	Run program: out of range = trip (2)	RW	Uni				US
11.48	Drive Onboard PLC program status		-128 to +127		RO	Bi		NC	PT	
11.49	Drive Onboard PLC programming events		0 to 65,535		RO	Uni		NC	PT	PS
11.50	Drive Onboard PLC program average scan time		0 to 65,535 ms		RO	Uni		NC	PT	
11.51	Drive Onboard PLC program first run		OFF (0) or On (1)		RO	Bit		NC	PT	
11.52	Drive serial number least significant 9 digits		0 to 999999999		RO	Uni		NC	PT	
11.53	Drive serial number most significant digits		0 to 65535		RO	Uni		NC	PT	

* Modes 1 and 2 are not user saved, Modes 0, 3 and 4 are user saved

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.12 Menu 12: Threshold detectors, variable selectors and brake control function

Figure 12-11 Menu 12 logic diagram

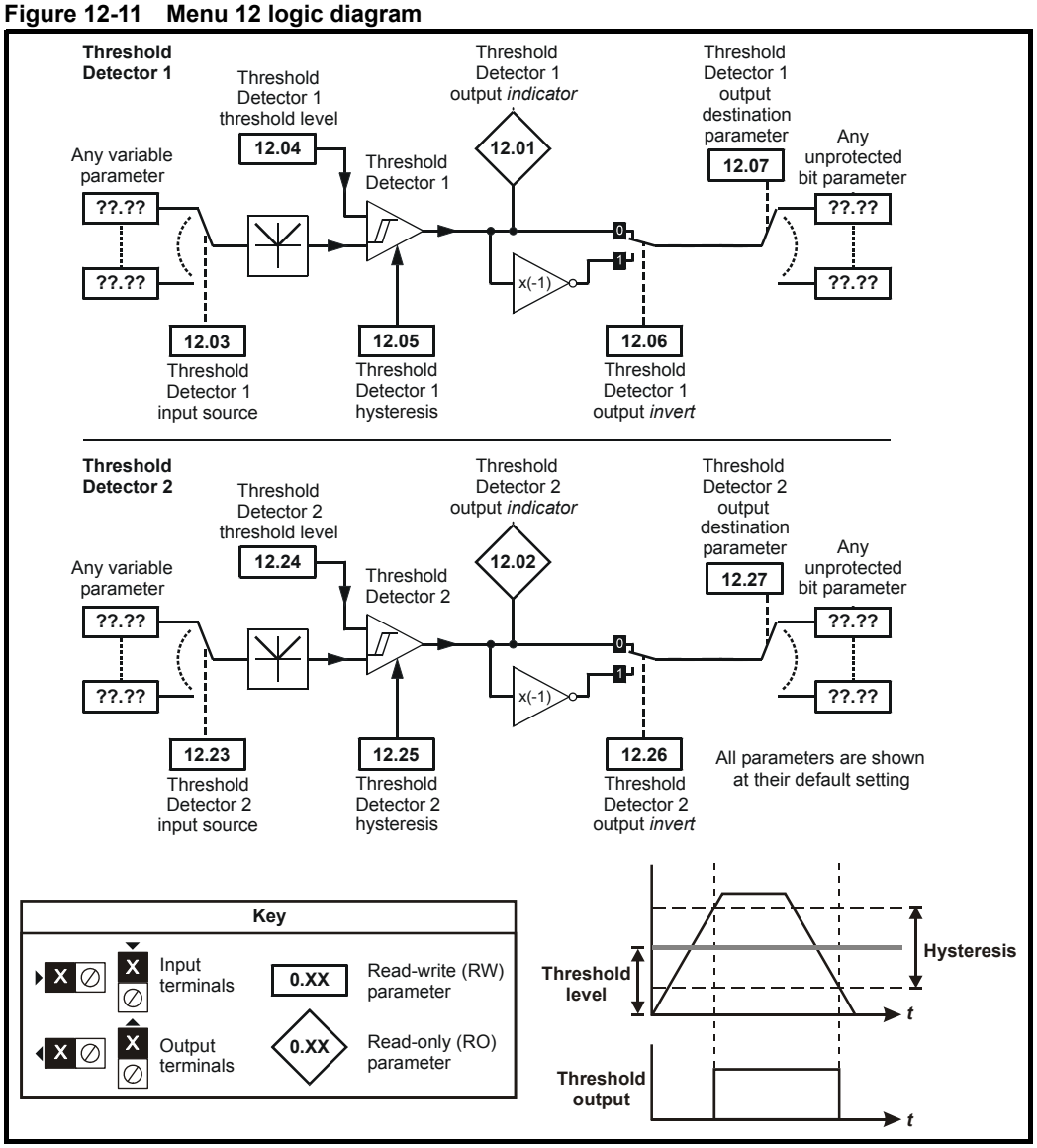
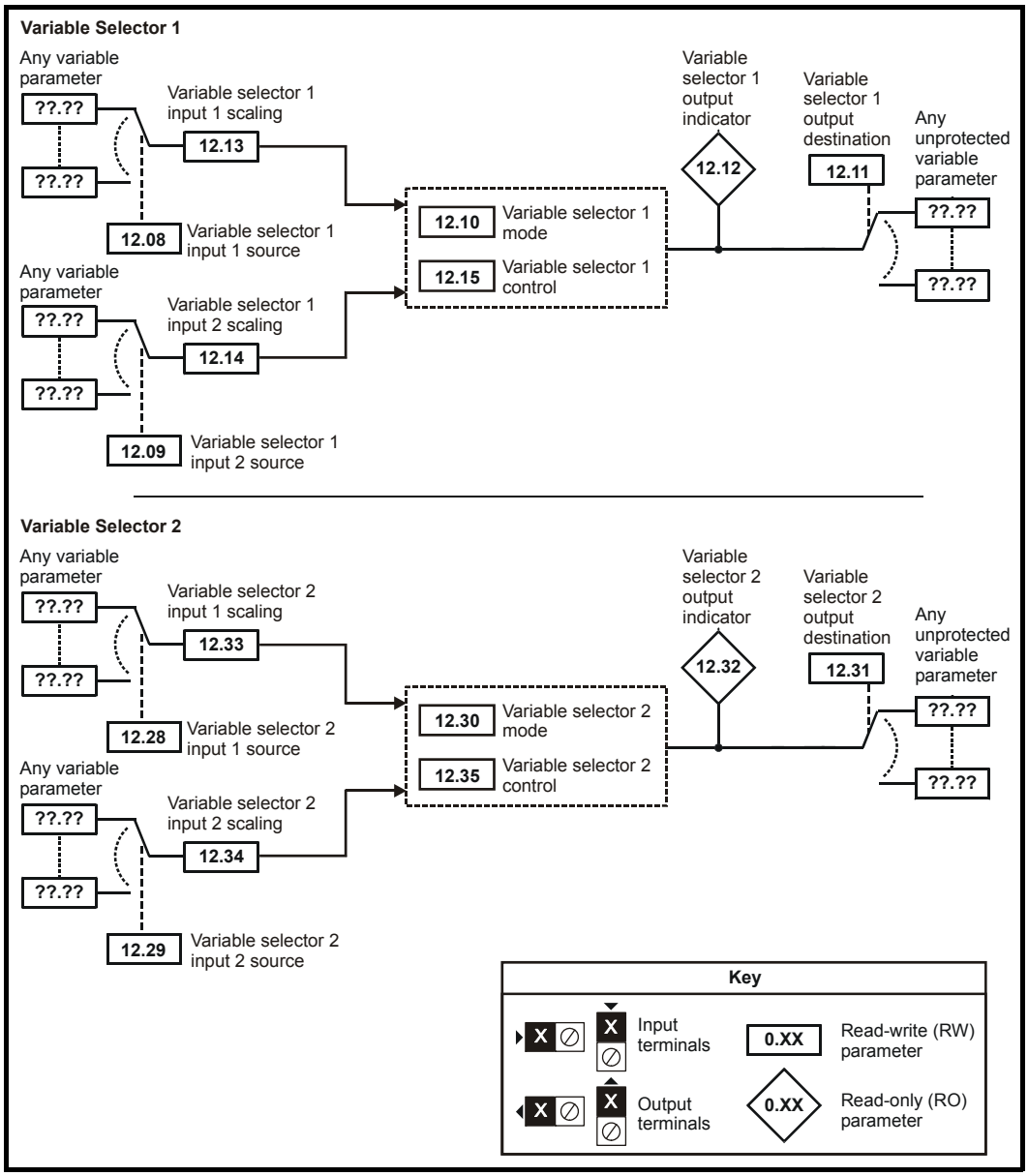


Figure 12-12 Menu 12 logic diagram (continued)



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 a Smartcard in boot mode or an SM-Applications module can ensure drive parameters are immediately programmed to avoid this situation.

Figure 12-13 Brake function

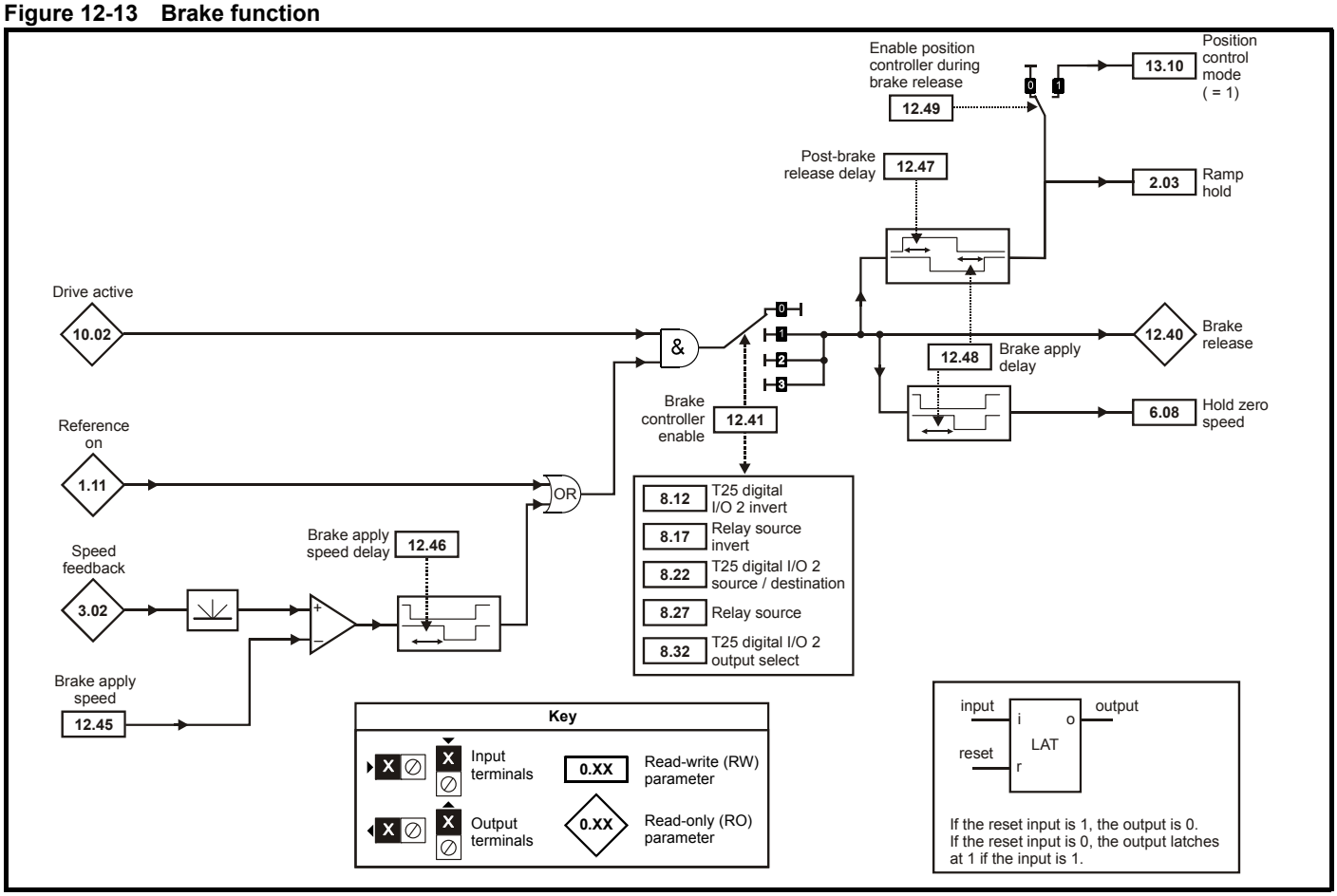
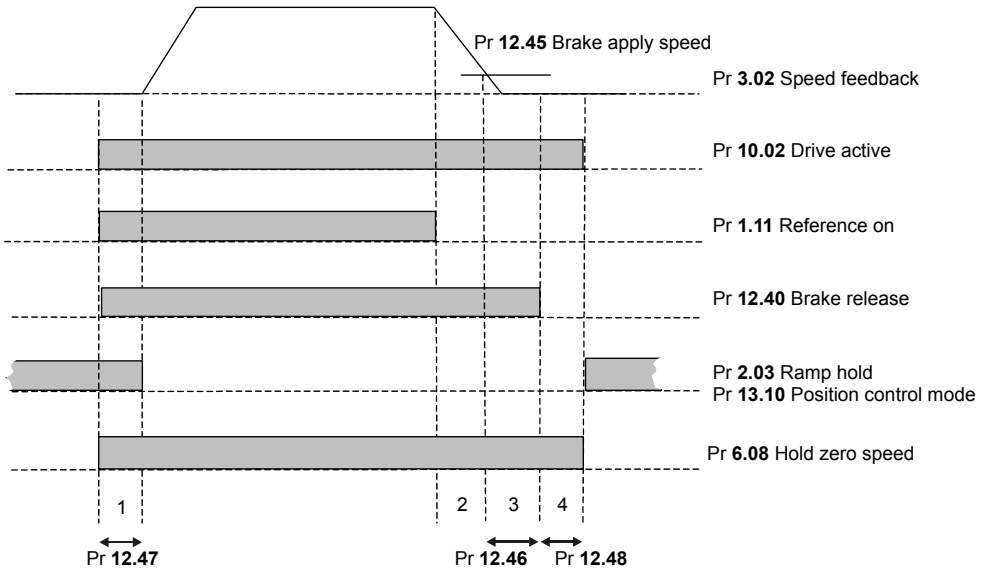


Figure 12-14 Brake sequence



1. Post-brake release delay
2. Wait for speed threshold
3. Wait for brake apply speed delay
4. Brake apply delay

Parameter		Range(⇳)	Default(⇨)	Type					
12.01	Threshold detector 1 output	OFF (0) or On (1)		RO	Bit		NC	PT	
12.02	Threshold detector 2 output	OFF (0) or On (1)		RO	Bit		NC	PT	
12.03	Threshold detector 1 source	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
12.04	Threshold detector 1 level	0.00 to 100.00 %	0.00	RW	Uni				US
12.05	Threshold detector 1 hysteresis	0.00 to 25.00 %	0.00	RW	Uni				US
12.06	Threshold detector 1 output invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
12.07	Threshold detector 1 destination	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni	DE		PT	US
12.08	Variable selector 1 source 1	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
12.09	Variable selector 1 source 2	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
12.10	Variable selector 1 mode	Select input 1 (0), select input 2 (1), add (2), subtract (3), multiply (4), divide (5), filter (6), linear ramp (7), absolute value (8), powers (9), sectional control (10), external rectifier monitor (11)	Select input 1 (0)	RW	Uni				US
12.11	Variable selector 1 destination	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni	DE		PT	US
12.12	Variable selector 1 output	±100.00 %		RO	Bi		NC	PT	
12.13	Variable selector 1 source 1 scaling	±4.000	1.000	RW	Bi				US
12.14	Variable selector 1 source 2 scaling	±4.000	1.000	RW	Bi				US
12.15	Variable selector 1 control	0.00 to 100.00 s	0.00	RW	Uni				US
12.23	Threshold detector 2 source	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
12.24	Threshold detector 2 level	0.00 to 100 .00 %	0.00	RW	Uni				US
12.25	Threshold detector 2 hysteresis	0.00 to 25.00 %	0.00	RW	Uni				US
12.26	Threshold detector 2 output invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
12.27	Threshold detector 2 destination	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni	DE		PT	US
12.28	Variable selector 2 source 1	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
12.29	Variable selector 2 source 2	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
12.30	Variable selector 2 mode	Select input 1 (0), select input 2 (1), add (2), subtract (3), multiply (4), divide (5), filter (6), linear ramp (7), absolute value (8), powers (9), sectional control (10), external rectifier monitor (11)	Select input 1 (0)	RW	Uni				US
12.31	Variable selector 2 destination	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni	DE		PT	US
12.32	Variable selector 2 output	±100.00 %		RO	Bi		NC	PT	
12.33	Variable selector 2 source 1 scaling	±4.000	1.000	RW	Bi				US
12.34	Variable selector 2 source 2 scaling	±4.000	1.000	RW	Bi				US
12.35	Variable selector 2 control	0.00 to 100.00 s	0.00	RW	Uni				US

WARNING

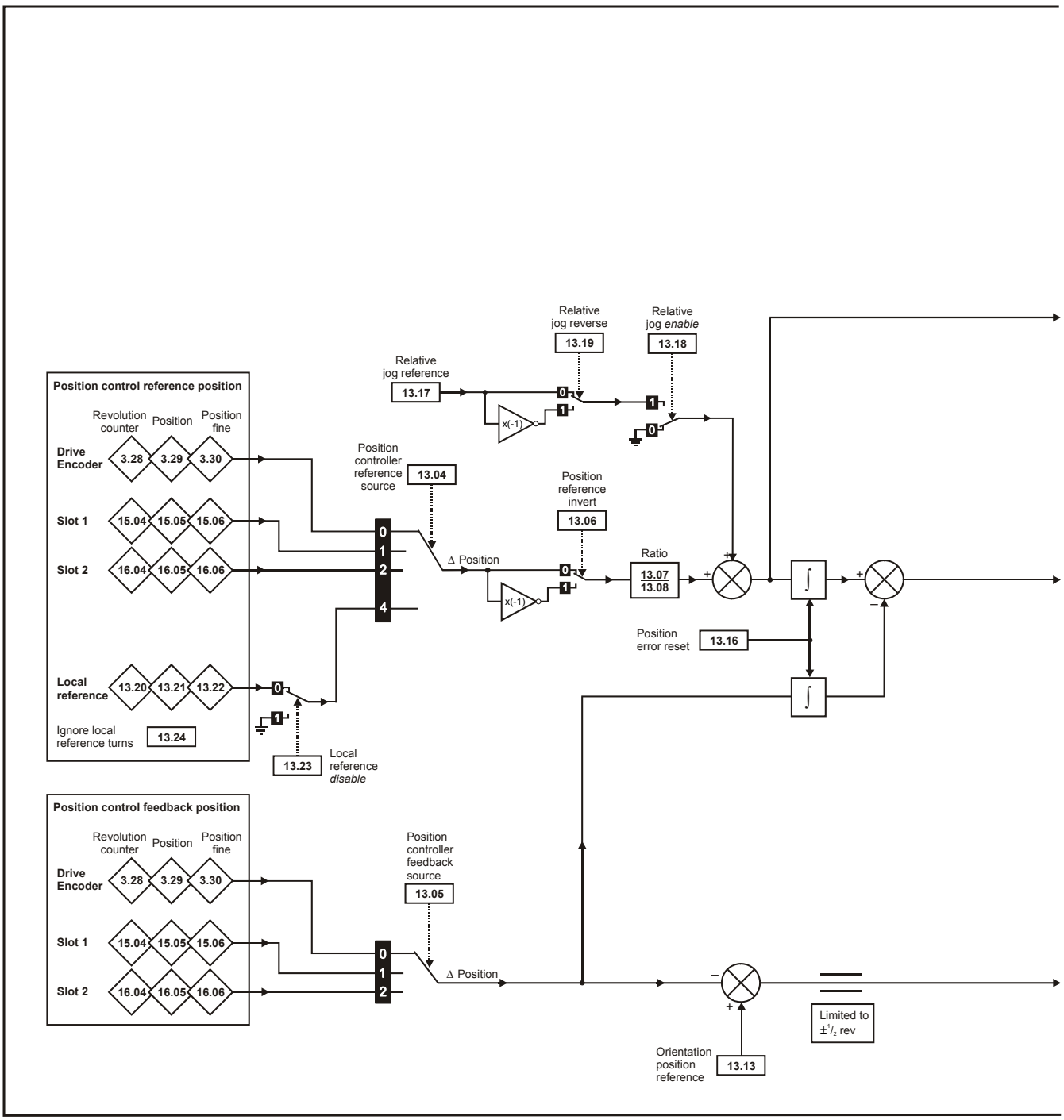
The brake control functions are provided to allow well co-ordinated operation of an external brake with the drive. While both hardware and software are designed to high standards of quality and robustness, they are not intended for use as safety functions, i.e. where a fault or failure would result in 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.

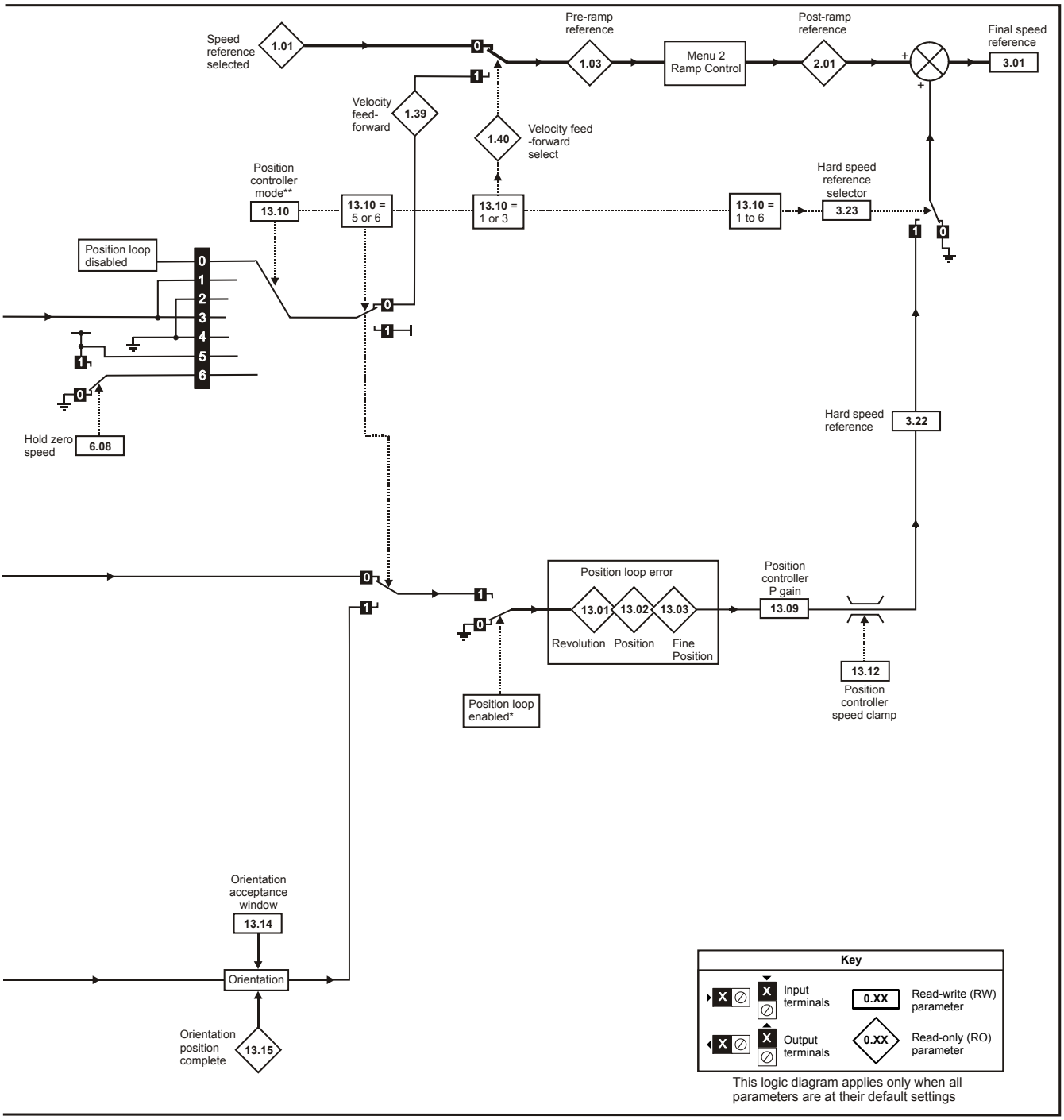
12.40	Brake release indicator	OFF (0) or On (1)		RO	Bit		NC	PT	
12.41	Brake controller enable	dis (0), rEL (1), d IO (2), USEr (3)	dis (0)	RW	Txt				US
12.43	Lower current threshold	0 to 200 %	10	RW	Uni				US
12.45	Brake apply speed	0 to 200 rpm	5	RW	Bit				US
12.46	Brake apply speed delay	0.0 to 25.0 s	1.0	RW	Uni				US
12.47	Post brake release delay	0.0 to 25.0 s	1.0	RW	Uni				US
12.48	Brake apply delay	0.0 to 25.0 s	1.0	RW	Uni				US
12.49	Enable position controller during brake release	OFF (0) or On (1)	OFF (0)	RW	Bit				US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.13 Menu 13: Position control

Figure 12-15 Menu 13 logic diagram





* For more information, refer to section 12.22.9 *Position modes* on page 171.

** The position controller is disabled and the error integrator is also reset under the following conditions:

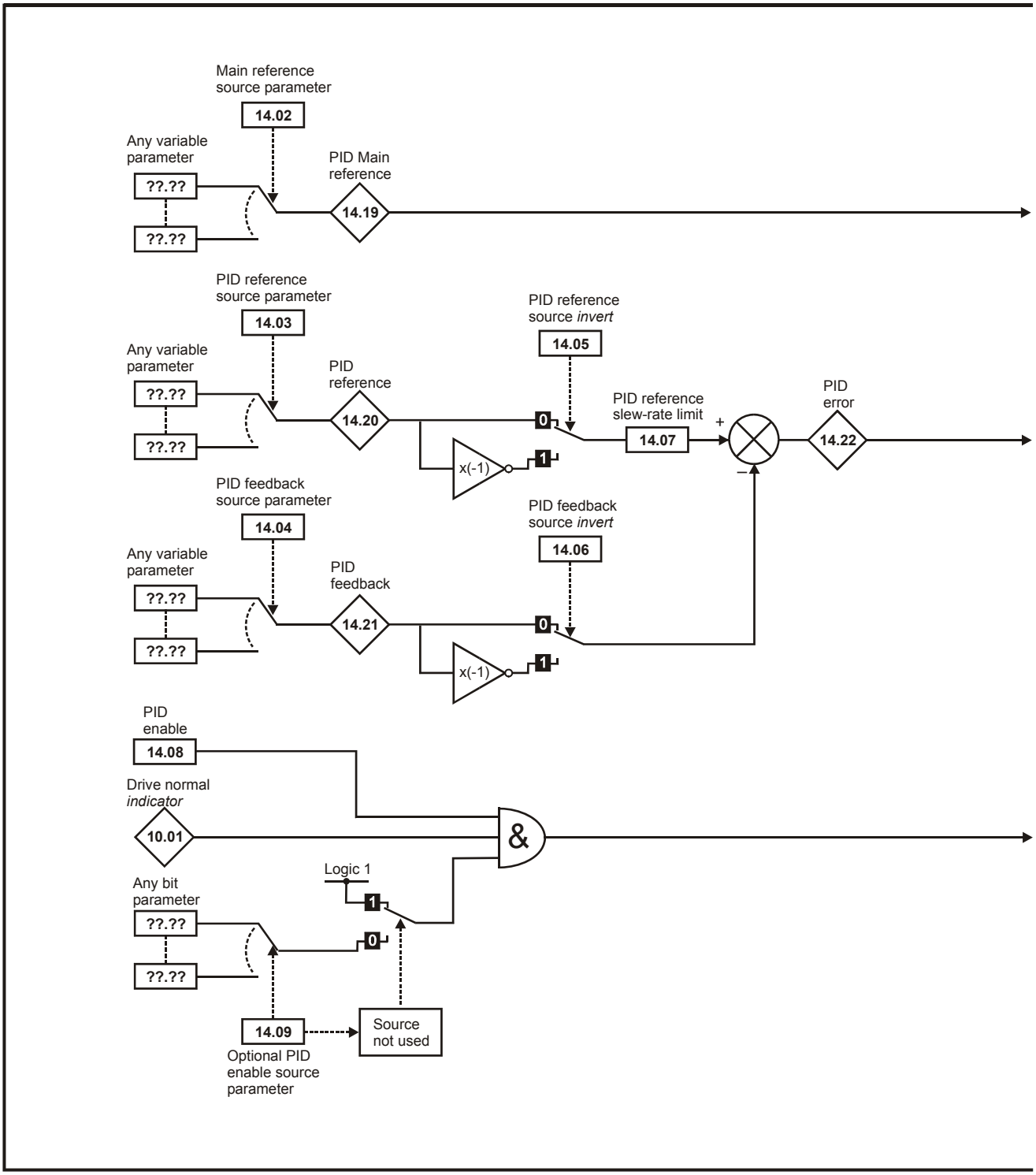
1. If the drive is disabled (i.e. inhibited, ready or tripped)
2. If the position controller mode (Pr **13.10**) is changed. The position controller is disabled transiently to reset the error integrator.
3. The absolute mode parameter (Pr **13.11**) is changed. The position controller is disabled transiently to reset the error integrator.
4. One of the position sources is invalid.
5. The position feedback initialised parameter (Pr **3.48**) is zero.

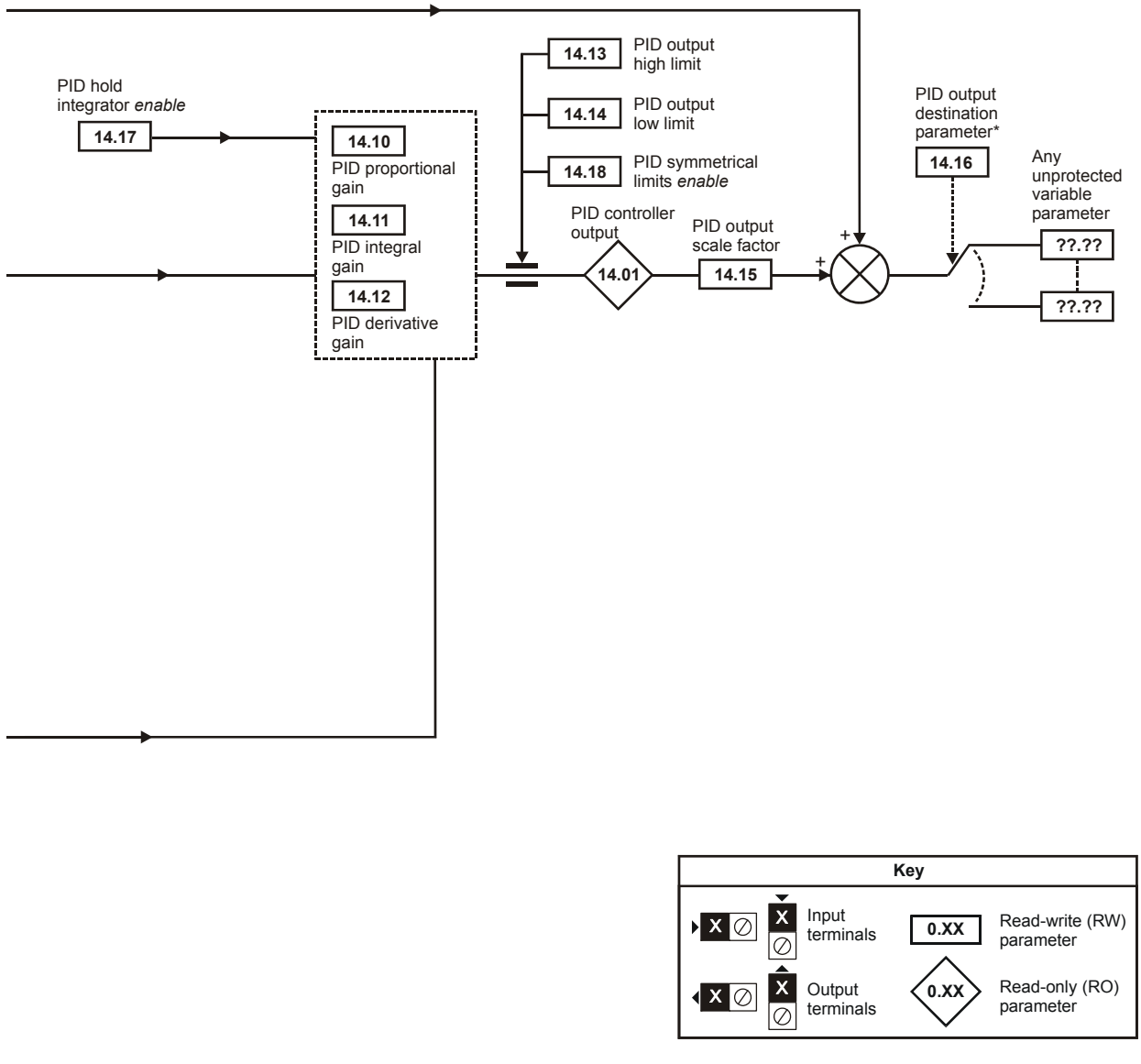
Parameter		Range(⇳)	Default(⇨)	Type					
13.01	Revolutions error	-32,768 to +32,767		RO	Bi		NC	PT	
13.02	Position error	-32,768 to +32,767		RO	Uni		NC	PT	
13.03	Fine position error	-32,768 to +32,767		RO	Uni		NC	PT	
13.04	Position controller reference source	drv (0), Slot1 (1), Slot2 (2), LocAL (4)	drv (0)	RW	Uni				US
13.05	Position controller feedback source	drv (0), Slot1 (1), Slot2 (2)	drv (0)	RW	Uni				US
13.06	Position reference invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
13.07	Ratio numerator	0.000 to 4.000	1.000	RW	Uni				US
13.08	Ratio denominator	0.000 to 1.000	1.000	RW	Uni				US
13.09	Position controller P gain	0.00 to 100.00 rad $s^{-1}/_{rad}$	25.00	RW	Uni				US
13.10	Position controller mode	Position controller disabled (0) Rigid position control - feed fwd (1) Rigid position control (2) Non-rigid position control - feed fwd (3) Non-rigid position control (4) Orientation on stop (5) Orientation on stop and when drive enabled (6)	Position controller disabled (0)	RW	Uni				US
13.11	Absolute mode enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
13.12	Position controller speed clamp	0 to 250	150	RW	Uni				US
13.13	Orientation position reference	0 to 65,535	0	RW	Uni				US
13.14	Orientation acceptance window	0 to 4,096	256	RW	Uni				US
13.15	Orientation position complete	OFF (0) or On (1)		RO	Bit		NC	PT	
13.16	Position error reset	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
13.17	Relative jog reference	0.0 to 4,000.0 rpm	0.0	RW	Uni		NC		
13.18	Relative jog enable	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
13.19	Relative jog reverse	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
13.20	Local reference turns	0 to 65,535	0	RW	Uni		NC		
13.21	Local reference position	0 to 65,535	0	RW	Uni		NC		
13.22	Local reference fine position	0 to 65,535	0	RW	Uni		NC		
13.23	Local reference disable	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
13.24	Ignore local reference turns	OFF (0) or On (1)	OFF (0)	RW	Bit				US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.14 Menu 14: User PID controller

Figure 12-16 Menu 14 Logic diagram





The parameters are all shown at their default settings

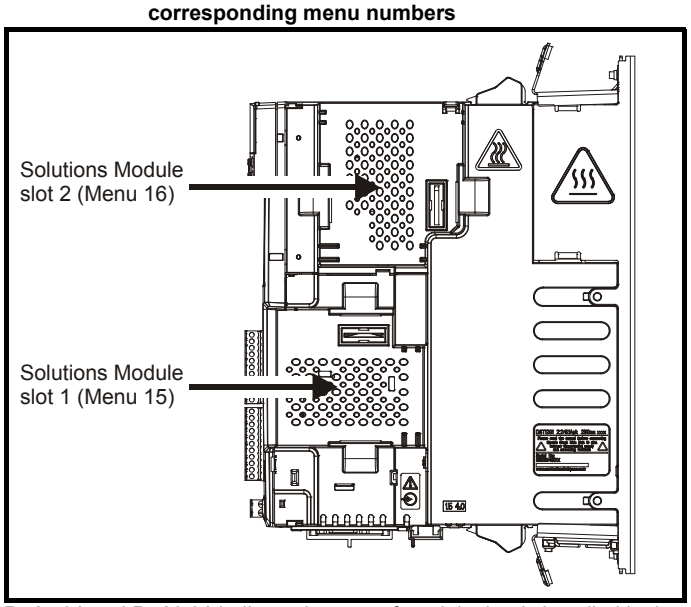
*The PID controller is only enabled if Pr **14.16** is set to a non Pr **xx.00** and unprotected destination parameter.

Parameter		Range(⇳)	Default(⇨)	Type					
14.01	PID control output	±100.00 %		RO	Bi		NC	PT	
14.02	PID main reference source	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
14.03	PID reference source	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
14.04	PID feedback source	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
14.05	PID reference source invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
14.06	PID feedback source invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
14.07	PID reference slew-rate limit	0.0 to 3,200.0 s	0.0	RW	Uni				US
14.08	PID enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
14.09	PID optional enable source	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni			PT	US
14.10	PID proportional gain	0.000 to 4.000	1.000	RW	Uni				US
14.11	PID integral gain	0.000 to 4.000	0.500	RW	Uni				US
14.12	PID derivative gain	0.000 to 4.000	0.000	RW	Uni				US
14.13	PID upper limit	0.00 to 100.00 %	100.00	RW	Uni				US
14.14	PID lower limit	±100.00 %	-100.00	RW	Bi				US
14.15	PID output scaling factor	0.000 to 4.000	1.000	RW	Uni				US
14.16	PID output destination	Pr **0.00** to **21.51**	Pr **0.00**	RW	Uni	DE		PT	US
14.17	PID hold integrator enable	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
14.18	PID symmetrical limits enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
14.19	PID main reference	±100.00 %		RO	Bi		NC	PT	
14.20	PID reference	±100.00 %		RO	Bi		NC	PT	
14.21	PID feedback	±100.00 %		RO	Bi		NC	PT	
14.22	PID error	±100.00 %		RO	Bi		NC	PT	

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.15 Menus 15 and 16: Solutions Module set-up

Figure 12-17 Location of Solutions Module slots and their corresponding menu numbers



Pr **15.01** and Pr **16.01** indicate the type of module that is installed in the corresponding slot.

Solutions Module ID	Module	Category
0	No module installed	
101	SM-Resolver	Feedback
102	SM-Universal Encoder Plus	
104	SM-Encoder Plus / SM-Encoder Output Plus	
201	SM-I/O Plus	Automation (I/O Expansion)
203	SM-I/O Timer	
204	SM-I/O PELV	
205	SM-I/O 24V Protected	
206	SM-I/O 120V	
207	SM-I/O Lite	
208	SM-I/O 32	
301	SM-Applications*	Automation (Applications)
302	SM-Applications Lite*	
303	SM-EZMotion*	
304	SM-Applications Plus*	
305	SM-Applications Lite V2*	
306	SM-Register	
401	SM-LON	Fieldbus
403	SM-PROFIBUS-DP-V1	
404	SM-INTERBUS	
406	SM-CAN	
407	SM-DeviceNet	
408	SM-CANopen	
409	SM-SERCOS	
410	SM-Ethernet	
421	SM-EtherCAT	
501	SM-SLM	SLM

* Features provided by this option are integrated within the product.

Solutions Module software

Most Solutions Modules contain software. The software version of the module can be checked by looking at Pr **x.02** and Pr **x.51**.

The software version takes the form of xx.yy.zz, where Pr **x.02** displays xx.yy and Pr **x.51** displays zz. I.e. for software version 01.01.00, Pr **x.02** would display 1.01 and Pr **x.51** would display 0

The SM-Resolver, SM-Encoder Plus, SM-Encoder Output Plus and SM-I/O Plus modules do not contain any software.

For further information relating to Solution Modules, refer to the appropriate *Solutions Module User Guide*.

12.16 Menu 17: Motion processors

Menu 17 parameter functions are dependant on the Digitax ST variant.

12.16.1 Digitax ST Base

Menu 17 not available.

12.16.2 Digitax ST Indexer

Table 12-6 Digitax ST Indexer

Parameter		Range(⇳)	Default(⇨)	Type					
17.01	Motion processor ID	0 to 599		RO	Uni			PT	US
17.02	Motion processor software version	0.00 to 99.99		RO	Uni		NC	PT	
17.03	DPL program status	None (0), Stop (1), Run (2), Trip (3)		RO	Txt		NC	PT	
17.04	Available system resource	0 to 100		RO	Uni		NC	PT	
17.10	DPL Print Routing	SYPT: OFF (0), RS485: On (1)	SYPT: OFF (0)	RW	Bit				US
17.11	Clock tick time (ms)	0 to 200	10	RW	Uni				US
17.12	Motion engine sample rate	dISAbLEd (0), 0.25 ms (1), 0.5 ms (2), 1 ms (3), 2 ms (4), 4 ms (5), 8 ms (6)	dISAbLEd (0)	RW	Txt				US
17.13	Enable autorun	OFF (0) or On (1)	On (1)	RW	Bit				US
17.14	Global run time trip enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.15	Disable reset on trip cleared	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.16	Encoder data update rate	0 to 3	0	RW	Uni				US
17.17	Enable parameter over range trips	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.18	Watchdog enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.19	Save request	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
17.20	Enable power down save	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.21	Enable menu 20 save and restore	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.37	Reject download if drive enabled	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.38	Do not trip drive on APC run-time error	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.39	Inter-UT70 synchronization status	0 to 3	0	RO	Uni		NC		
17.40	Inter-UT70 master transfer mode	0 to 10	1	RW	Uni				US
17.41	Indexer control	0 to 3	0	RW	Uni		NC		
17.42	Freeze main drive position	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.43	Freeze invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.44	Task priority level	0 to 255	0	RW	Uni				US
17.45	User set-up parameter 1		0	RO	Uni		NC	PT	
17.46	User set-up parameter 2		0	RO	Uni		NC	PT	
17.47	User set-up parameter 3		0	RO	Uni		NC	PT	
17.48	DPL line number in error	0 to 2,147,483,647	0	RO	Uni		NC	PT	
17.49	User program ID	-32,767 to +32,768	0	RO	Bi		NC	PT	
17.50	Motion processor error status*	0 to 255		RO	Uni		NC	PT	
17.51	Motion processor software sub-version	0 to 99		RO	Uni		NC	PT	

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

*See trip SLX.Er, *Automation (I/O Expansion) module category* on page 194.

12.16.3 Digitax ST Plus

Table 12-7 Digitax ST Plus

Parameter		Range(⇳)	Default(⇨)	Type					
17.01	Motion processor ID	0 to 599		RO	Uni			PT	US
17.02	Motion processor software version	0.00 to 99.99		RO	Uni		NC	PT	
17.03	DPL program status	None (0), Stop (1), Run (2), Trip (3)		RO	Txt		NC	PT	
17.04	Available system resource	0 to 100		RO	Uni		NC	PT	
17.05	RS485 address	0 to 255	11	RW	Uni				US
17.06	RS485 mode	0 to 255	1	RW	Uni				US
17.07	RS485 baud rate	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 115200 (9) baud	4800 (4)	RW	Txt				US
17.08	RS485 Turnaround delay	0 to 255 ms	2	RW	Uni				US
17.09	RS485 Tx enable delay	0 to 1 ms	0	RW	Uni				US
17.10	DPL Print Routing	SYPT: OFF (0), RS485: On (1)	SYPT: OFF (0)	RW	Bit				US
17.11	Clock tick time (ms)	0 to 200	10	RW	Uni				US
17.12	Motion engine sample rate	dISAbLEd (0), 0.25 ms (1), 0.5 ms (2), 1 ms (3), 2 ms (4), 4 ms (5), 8 ms (6)	dISAbLEd (0)	RW	Txt				US
17.13	Enable autorun	OFF (0) or On (1)	On (1)	RW	Bit				US
17.14	Global run time trip enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.15	Disable reset on trip cleared	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.16	Encoder data update rate	0 to 3	0	RW	Uni				US
17.17	Enable parameter over range trips	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.18	Watchdog enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.19	Save request	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
17.20	Enable power down save	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.21	Enable menu 20 save and restore	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.22	CTNet Token Ring ID	0 to 255	0	RW	Uni				US
17.23	CTNet node address	0 to 255	0	RW	Uni				US
17.24	CTNet baud rate	5.000 (0), 2.500 (1), 1.250 (2), 0.625 (3)	2.500 (1)	RW	Txt				US
17.25	CTNet sync setup	0,000 to 9,999	0,000	RW	Uni				US
17.26	CTNet easy mode - first cyclic parameter destination node	0 to 25,503	0	RW	Uni				US
17.27	CTNet easy mode - first cyclic source parameter	0 to 9,999	0	RW	Uni				US
17.28	CTNet easy mode - second cyclic parameter destination node	0 to 25,503	0	RW	Uni				US
17.29	CTNet easy mode - second cyclic source parameter	0 to 9,999	0	RW	Uni				US
17.30	CTNet easy mode - third cyclic parameter destination node	0 to 25,503	0	RW	Uni				US
17.31	CTNet easy mode - third cyclic source parameter	0 to 9,999	0	RW	Uni				US
17.32	CTNet easy mode set-up - Transfer slot 1 destination parameter	0 to 9,999	0	RW	Uni				US
17.33	CTNet easy mode set-up - Transfer slot 2 destination parameter	0 to 9,999	0	RW	Uni				US
17.34	CTNet easy mode set-up - Transfer motion processor destination parameter	0 to 9,999	0	RW	Uni				US
17.35	CTNet sync event task ID	Disabled (0), Event (1), Event1 (2), Event2 (3), Event3 (4)	Disabled (0)	RW	Txt				US
17.36	CTNet diagnostic parameter			RO	Uni		NC	PT	
17.37	Reject download if drive enabled	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.38	Do not trip drive on APC run-time error	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.39	Inter-UT70 synchronization status	0 to 3	0	RO	Uni		NC		
17.40	Inter-UT70 master transfer mode	0 to 10	1	RW	Uni				US
17.41	Indexer control	0 to 3	0	RW	Uni		NC		
17.42	Freeze main drive position	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.43	Freeze invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.44	Task priority level	0 to 255	0	RW	Uni				US
17.45	User set-up parameter 1		0	RO	Uni		NC	PT	
17.46	User set-up parameter 2		0	RO	Uni		NC	PT	
17.47	User set-up parameter 3		0	RO	Uni		NC	PT	
17.48	DPL line number in error	0 to 2,147,483,647	0	RO	Uni		NC	PT	
17.49	User program ID	-32,767 to +32,768	0	RO	Bi		NC	PT	
17.50	Solutions Module error status*	0 to 255		RO	Uni		NC	PT	
17.51	Solutions Module software sub-version	0 to 99		RO	Uni		NC	PT	

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

*See trip SLX.Er, *Automation (I/O Expansion) module category* on page 194.

12.16.4 Digitax ST EZMotion

Table 12-8 Digitax ST EZMotion

Parameter		Range(⇳)	Default(⇨)	Type					
17.01	Motion processor code	303	303	RO				PT	US
17.02	Motion processor software version	OFF (0) or On (1)		RO	Bit		NC	PT	
17.13	EZ output 1 status	OFF (0) or On (1)		RO	Bit		NC	PT	
17.14	EZ output 2 status	OFF (0) or On (1)		RO	Bit		NC	PT	
17.17	EZ input 1 status	OFF (0) or On (1)		RO	Bit		NC	PT	
17.18	EZ input 2 status	OFF (0) or On (1)		RO	Bit		NC	PT	
17.19	EZ input 3 status	OFF (0) or On (1)		RO	Bit		NC	PT	
17.20	EZ input 4 status	OFF (0) or On (1)		RO	Bit		NC	PT	
17.48	System status	OFF (0) or On (1)		RO	Bit		NC	PT	
17.50	Motion processor error status	0 to 255		RO			NC	PT	
17.51	Motion processor software sub-version	0 to 99		RO			NC	PT	

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.16.5 Digitax ST EtherCAT

Table 12-9 Digitax ST EtherCAT

Parameter		Range	Default	Type					
17.01	EtherCAT interface ID code		421	RO	Num	ND		PT	US
17.02	EtherCAT interface firmware - major and minor version	00.00 to 99.99	N/A	RO	Num	ND	NC	PT	
17.03	Node address	0 to 65535	0	RW	Num				US
17.04	EtherCAT interface RUN	1 to 8	1	RW	Num				US
17.06	EtherCAT interface operating status	-9999 to 9999	N/A	RO	Num	ND	NC	PT	
17.10	EoE - IP address W_{ip}	0 to 255	0	RW	IP				US
17.11	EoE - IP address X_{ip}	0 to 255	0	RW	IP				US
17.12	EoE - IP address Y_{ip}	0 to 255	0	RW	IP				US
17.13	EoE - IP address Z_{ip}	0 to 255	0	RW	IP				US
17.14	EoE - Subnet mask W_{subnet}	0 to 255	0	RW	Num				US
17.15	EoE - Subnet mask X_{subnet}	0 to 255	0	RW	Num				US
17.16	EoE - Subnet mask Y_{subnet}	0 to 255	0	RW	Num				US
17.17	EoE - Subnet mask Z_{subnet}	0 to 255	0	RW	Num				US
17.18	EoE - Default gateway $W_{gateway}$	0 to 255	0	RW	Num				US
17.19	EoE - Default gateway $X_{gateway}$	0 to 255	0	RW	Num				US
17.20	EoE - Default gateway $Y_{gateway}$	0 to 255	0	RW	Num				US
17.21	EoE - Default gateway $Z_{gateway}$	0 to 255	0	RW	Num				US
17.32	EtherCAT interface re-initialize	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
17.35	EtherCAT interface serial number	0 to 16777215	N/A	RO	Num	ND	NC	PT	
17.37	Reduce Drive serial interface priority	OFF (0) or On (1)	OFF (0)	RW	Bit				US
17.44	EtherCAT interface temperature	0 to 255	N/A	RO	Num	ND	NC	PT	
17.46	Critical task % free	0 to 100	N/A	RO	Num	ND	NC	PT	
17.47	Worst case critical task % free	0 to 100	N/A	RO	Num	ND	NC	PT	
17.48	Flash file system % free	0 to 100	N/A	RO	Num	ND	NC	PT	
17.50	EtherCAT interface error code	0 to 255	N/A	RO	Num	ND	NC	PT	
17.51	EtherCAT interface firmware - subversion	0 to 99	N/A	RO	Num	ND	NC	PT	

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

12.17 Menu 18: Application menu 1

Parameter		Range(⇳)	Default(⇨)	Type					
18.01	Application menu 1 power-down saved integer	-32,768 to +32,767	0	RW	Bi		NC		PS
18.02 to 18.10	Application menu 1 read-only integer	-32,768 to +32,767	0	RO	Bi		NC		
18.11 to 18.30	Application menu 1 read-write integer	-32,768 to +32,767	0	RW	Bi				US
18.31 to 18.50	Application menu 1 read-write bit	OFF (0) or On (1)	0	RW	Bit				US

12.18 Menu 19: Application menu 2

Parameter		Range(⇳)	Default(⇨)	Type					
19.01	Application menu 2 power-down saved integer	-32,768 to +32,767	0	RW	Bi		NC		PS
19.02 to 19.10	Application menu 2 read-only integer	-32,768 to +32,767	0	RO	Bi		NC		
19.11 to 19.30	Application menu 2 read-write integer	-32,768 to +32,767	0	RW	Bi				US
19.31 to 19.50	Application menu 2 read-write bit	OFF (0) or On (1)	0	RW	Bit				US

12.19 Menu 20: Application menu 3

Parameter		Range(⇳)	Default(⇨)	Type					
20.01 to 20.20	Application menu 3 read-write integer	-32,768 to +32,767	0	RW	Bi		NC		
20.21 to 20.40	Application menu 3 read-write long integer	-2^{31} to $2^{31}-1$	0	RW	Bi		NC		

Menu 20 parameters are transferred to the SMARTCARD when a 4yyy transfer is performed. See section 10.2.1 *Writing to the SMARTCARD* on page 102 for more information.

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.20 Menu 21: Second motor parameters

Parameter			Range(⇳)	Default(⇨)	Type					
21.01	Maximum reference clamp	{**0.02**}*	SPEED_LIMIT_MAX rpm	3,000.0	RW	Uni				US
21.02	Minimum reference clamp	{**0.01**}*	±SPEED_LIMIT_MAX rpm	0.0	RW	Bi			PT	US
21.03	Reference selector	{**0.05**}*	A1.A2 (0), A1.Pr (1), A2.Pr (2), Pr (3), PAd (4), Prc (5)	A1.A2 (0)	RW	Txt				US
21.04	Acceleration rate	{**0.03**}*	0.000 to 3,200.000 s/1000rpm	0.200	RW	Uni				US
21.05	Deceleration rate	{**0.04**}*	0.000 to 3,200.000 s/1000rpm	0.200	RW	Uni				US
21.07	Rated current	{**0.46**}*	0 to RATED_CURRENT_MAX A	Drive rated current (Pr **11.32**)	RW	Uni		RA		US
21.08	Rated speed		0.00 to 40,000.00 rpm	3,000.00	RW	Uni				US
21.09	Rated voltage	{**0.44**}*	0 to AC_VOLTAGE_SET_MAX V	200V rating drive: 230V 400V rating drive: EUR> 400V, USA> 460V	RW	Uni		RA		US
21.11	Number of motor poles	{**0.42**}*	Auto to 120 pole (0 to 60)	6 POLE (3)	RW	Txt				US
21.12	Stator resistance		0.000 to 65.000 x 10 Ω	0.0	RW	Uni		RA		US
21.14	Transient inductance ($\sigma L_{s)}$		0.000 to 500.000mH	0.000	RW	Uni		RA		US
21.15	Motor 2 active		OFF (0) or On (1)		RO	Bit		NC	PT	
21.16	Thermal filter	{**0.45**}*	0.0 to 3000.0	20.0	RW	Uni				US
21.17	Speed controller Kp gain	{**0.07**}*	0.000 to 6.5535 rad s^{-1}	0.0100	RW	Uni				US
21.18	Speed controller Ki gain	{**0.08**}*	0.00 to 655.35 s/rad s^{-1}	1.00	RW	Uni				US
21.19	Speed controller Kd gain	{**0.09**}*	0.00000 to 0.65535 s^{-1}/rad s^{-1}	0.00000	RW	Uni				US
21.20	Encoder phase angle**	{**0.43**}*	0.0 to 359.9 ° electrical	0.0	RW	Uni				US
21.21	Speed feedback selector		drv (0), SLot1 (1), SLot2 (2), SLot3 (3)	drv (0)	RW	Txt				US
21.22	Current controller Kp gain	{**0.38**}*	0 to 30,000	200V: 75, 400V: 150,	RW	Uni				US
21.23	Current controller Ki gain	{**0.39**}*	0 to 30,000	200V: 1,000, 400V: 2,000,	RW	Uni				US
21.27	Motoring current limit		0 to MOTOR2_CURRENT_LIMIT_MAX %	300.0	RW	Uni		RA		US
21.28	Regen current limit		0 to MOTOR2_CURRENT_LIMIT_MAX %	300.0	RW	Uni		RA		US
21.29	Symmetrical current limit	{**0.06**}*	0 to MOTOR2_CURRENT_LIMIT_MAX %	300.0	RW	Uni		RA		US
21.30	Motor volts per 1,000 rpm, K_e		SV> 0 to 10,000 V	98	RW	Uni				US
21.31	Motor pole pitch		0.00 to 655.35 mm	0.00	RW	Uni				US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

* The menu 0 references are only valid when the second motor map parameters have been made active by setting Pr **11.45** to 1. (The second motor map only becomes effective when the output stage of the drive is not enabled, i.e. inh, rdY, or trip states.)

When the second motor map parameters are active, the symbol 'Mot2' will appear in the lower left hand corner of the LCD display or the decimal point that is second from the right on the first row of the LED display is lit.

****Encoder phase angle**

The encoder phase angles in Pr **3.25** and Pr **21.20** are copied to the SMARTCARD when using any of the SMARTCARD transfer methods.

12.21 Menu 22: Additional Menu 0 set-up

Parameter		Range(⇳)	Default(⇨)	Type					
22.01	Parameter **0.31** set-up	Pr **1.00** to Pr **21.51**	Pr **11.33**	RW	Uni			PT	US
22.02	Parameter **0.32** set-up	Pr **1.00** to Pr **21.51**	Pr **11.32**	RW	Uni			PT	US
22.03	Parameter **0.33** set-up	Pr **1.00** to Pr **21.51**	Pr **0.00**	RW	Uni			PT	US
22.04	Parameter **0.34** set-up	Pr **1.00** to Pr **21.51**	Pr **11.30**	RW	Uni			PT	US
22.05	Parameter **0.35** set-up	Pr **1.00** to Pr **21.51**	Pr **11.24**	RW	Uni			PT	US
22.06	Parameter **0.36** set-up	Pr **1.00** to Pr **21.51**	Pr **11.25**	RW	Uni			PT	US
22.07	Parameter **0.37** set-up	Pr **1.00** to Pr **21.51**	Pr **11.23**	RW	Uni			PT	US
22.10	Parameter **0.40** set-up	Pr **1.00** to Pr **21.51**	Pr **5.12**	RW	Uni			PT	US
22.11	Parameter **0.41** set-up	Pr **1.00** to Pr **21.51**	Pr **5.18**	RW	Uni			PT	US
22.18	Parameter **0.48** set-up	Pr **1.00** to Pr **21.51**	Pr **11.31**	RW	Uni			PT	US
22.20	Parameter **0.50** set-up	Pr **1.00** to Pr **21.51**	Pr **11.29**	RW	Uni			PT	US
22.21	Parameter **0.51** set-up	Pr **1.00** to Pr **21.51**	Pr **10.37**	RW	Uni			PT	US
22.22	Parameter **0.52** set-up	Pr **1.00** to Pr **21.51**	Pr **0.00**	RW	Uni			PT	US
22.23	Parameter **0.53** set-up	Pr **1.00** to Pr **21.51**	Pr **0.00**	RW	Uni			PT	US
22.24	Parameter **0.54** set-up	Pr **1.00** to Pr **21.51**	Pr **0.00**	RW	Uni			PT	US
22.25	Parameter **0.55** set-up	Pr **1.00** to Pr **21.51**	Pr **0.00**	RW	Uni			PT	US
22.26	Parameter **0.56** set-up	Pr **1.00** to Pr **21.51**	Pr **0.00**	RW	Uni			PT	US
22.27	Parameter **0.57** set-up	Pr **1.00** to Pr **21.51**	Pr **0.00**	RW	Uni			PT	US
22.28	Parameter **0.58** set-up	Pr **1.00** to Pr **21.51**	Pr **0.00**	RW	Uni			PT	US
22.29	Parameter **0.59** set-up	Pr **1.00** to Pr **21.51**	Pr **0.00**	RW	Uni			PT	US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

12.22 Advanced features

This section gives information on some of the advanced functions of the drive. For additional information see the *Advanced User Guide*.

Reference modes	Pr **1.14**, Pr **1.15** and Pr **8.39**
Braking modes	Pr **2.04** and Pr **2.08**
S ramps	Pr **2.06** and Pr **2.07**
Torque modes	Pr **4.08** and Pr **4.11**
Stop modes	Pr **6.01** and Pr **6.08**
Main loss modes	Pr **6.03**, Pr **6.48**, Pr **4.13** and Pr **4.14**
Start/stop logic modes	Pr **6.04** and Pr **6.40**
Position loop modes	Pr **13.10**
Fast disable	Pr **6.29**

12.22.1 Reference modes

1.14	**Reference selector**									
RW	Txt					NC		US		
⇳	A1.A2 (0), A1.Pr (2), A2.Pr (2), Pr (3), PAd (4), Prc (5)			⇨	A1.A2 (0)					

1.15	**Preset reference selector**									
RW	Uni					NC		US		
⇳	0 to 9				⇨	0				

8.39	**T28 and T29 auto-selection disable**									
RW	Bit							US		
⇳	OFF (0) or On (1)				⇨	OFF (0)				

If Pr **8.39** is set to OFF (0), then the setting of Pr **1.14** automatically changes the operation of digital inputs T28 and T29 by configuring the destination parameters Pr **8.25** and Pr **8.26**. To allow Pr **8.25** and Pr **8.26** to be changed manually by the user, the automatic set-up must be disabled by setting Pr **8.39** to 1.

If Pr **8.39** is 0 and Pr **1.14** is changed, then a drive reset is required before the function of terminal T28 or T29 will become active.

Table 12-10 Active reference

Pr 1.14	Pr 1.15	Digital Input T28		Digital Input T29		Pr 1.49	Pr 1.50	Active Reference
		State	Function	State	Function			
A1.A2 (0)	0 or 1	0	Local Remote		Jog forward**	1	1	Analog input 1
		1				2	1	Analog input 2
	2 to 8		No function			1 or 2	2 to 8	Preset reference 2 to 8
	9 *	0	Local Remote			1	1	Analog input 1
		1				2	1	Analog input 2
			No function			1 or 2	2 to 8	Preset reference 2 to 8
A1.Pr (1)	0	0	Preset select bit 0	0	Preset select bit 1	1	1	Analog input 1
		1					2	Preset reference 2
		0		1			3	Preset reference 3
		1					4	Preset reference 4
	1		No function		No function		1	Analog input 1
	2 to 8						2 to 8	Preset reference 2 to 8
	9 *						1	Analog input 1
							2 to 8	Preset reference 2 to 8
A2.Pr (2)	0	0	Preset select bit 0	0	Preset select bit 1	2	1	Analog input 2
		1					2	Preset reference 2
		0		1			3	Preset reference 3
		1					4	Preset reference 4
	1		No function		No function		1	Analog input 2
	2 to 8						2 to 8	Preset reference 2 to 8
	9 *						1	Analog input 2
							2 to 8	Preset reference 2 to 8
Pr (3)	0	0	Preset select bit 0	0	Preset select bit 1	3	1	Preset reference 1
		1					2	Preset reference 2
		0		1			3	Preset reference 3
		1					4	Preset reference 4
	1 to 8		No function		No function		1 to 8	Preset reference 1 to 8
	9 *						1 to 8	Preset reference 1 to 8
PAd (4)			No function		No function	4		Keypad reference
Prc (5)			No function		No function	5		Precision reference

* Setting Pr **1.15** to 9 enables the Preset reference scan timer. With the scan timer enabled the preset references are selected automatically in turn. Pr **1.16** defines the time between each change.

** Jog forward can only be selected when the drive is in either the ready (rdy), inhibit (inh) or trip states.

Preset references
Preset references 1 to 8 are contained in Pr **1.21** to Pr **1.28**.

Keypad reference
If Keypad reference is selected the drive sequencer is controlled directly by the keypad keys and the keypad reference parameter (Pr **1.17**) is selected. The sequencing bits, Pr **6.30** to Pr **6.34**, and Pr **6.37** have no effect and jog is disabled.

Precision reference
If Precision reference is selected the speed reference is given Pr **1.18** and Pr **1.19**.

12.22.2 Braking Modes

2.04		Ramp mode select		
RW	Txt			US
OL	⇳	FASt (0), Std (1), Std.hV (2)	⇨	Std (1)
CL		FASt (0), Std (1)		

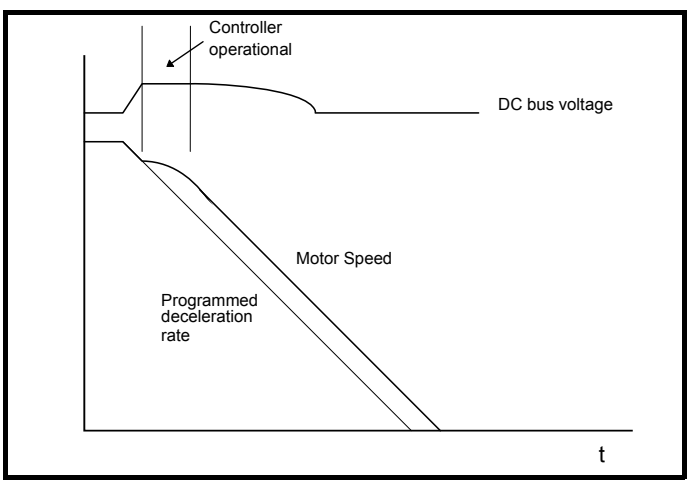
This parameter does not affect the acceleration ramp, as the ramp output always rises at the programmed acceleration rate subject to the current limits. It is possible in under some unusual circumstances in open-loop mode (i.e. highly inductive supply) for the motor to reach a low speed in standard ramp mode, but not completely stop. It is also possible if the drive attempts to stop the motor with an overhauling load in any mode that the motor will not stop when standard ramp mode or fast ramp mode is used. If the drive is in the deceleration state the rate of the fall of speed is monitored. If this does not fall for 10 seconds the drive forces the speed reference to zero. This only applies when the drive is in the deceleration state and not when the reference is simply set to zero.

0: Fast ramp

Fast ramp is used where the deceleration follows the programmed deceleration rate subject to current limits.

1: Standard ramp

Standard ramp is used. During deceleration, if the voltage rises to the standard ramp level (Pr **2.08**) it causes a controller to operate, the output of which changes the demanded load current in the motor. As the controller regulates the DC bus voltage, the motor deceleration increases as the speed approaches zero speed. When the motor deceleration rate reaches the programmed deceleration rate the controller ceases to operate and the drive continues to decelerate at the programmed rate. If the standard ramp voltage (Pr **2.08**) is set lower than the nominal DC bus level the drive will not decelerate the motor, but it will coast to rest. The output of the ramp controller (when active) is a current demand that is fed to the torque producing current controller modes. The gain of these controllers can be modified with Pr **4.13** and Pr **4.14**.



2: Standard ramp with motor voltage boost

This mode is the same as normal standard ramp mode except that the motor voltage is boosted by 20 %. This increases the losses in the motor giving faster deceleration.

2.08		Standard ramp voltage		
RW	Uni	RA		US
⇳	0 to DC_VOLTAGE_SET_MAX V	⇨	200 V drive: 375 400 V drive: EUR> 750 USA> 775	

This voltage is used as the control level for standard ramp mode. If this parameter is set too low the machine will coast to rest, and if it is set too high and no braking resistor is used the drive may give an over-volt 'OV' trip. The minimum level should be greater than the voltage produced on the DC bus by the highest supply voltage. Normally the DC bus voltage will be approximately the rms supply line voltage x √2.

WARNING

Care should be taken in the setting of this parameter. It is recommended that the setting should be at least 50V higher than the maximum expected level of the DC bus voltage. If this is not done, the motor may fail to decelerate on a STOP command.

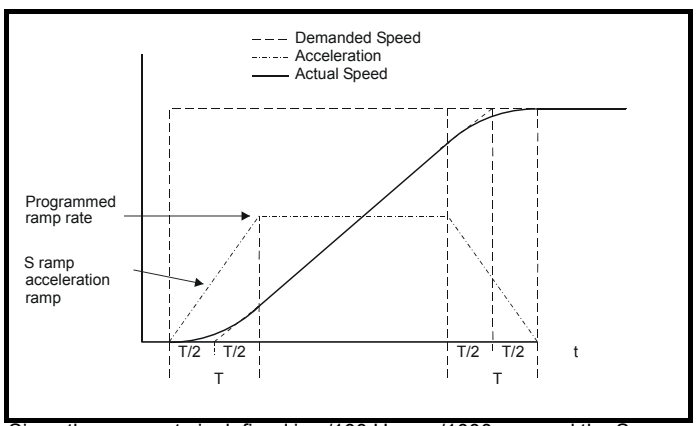
12.22.3 S ramps

2.06		S ramp enable		
RW	Bit			US
⇳	OFF (0) or On (1)	⇨	OFF (0)	

Setting this parameter enables the S ramp function. S ramp is disabled during deceleration using standard ramp. When the motor is accelerated again after decelerating in standard ramp the acceleration ramp used by the S ramp function is reset to zero.

2.07		S ramp acceleration limit		
RW	Uni			US
⇳	0.000 to 100.000 s^2/1000 rpm	⇨	0.030	

This parameter defines the maximum rate of change of acceleration/ deceleration. The default values have been chosen such that for the default ramps and maximum speed, the curved parts of the S will be 25 % of the original ramp if S ramp is enabled.



Since the ramp rate is defined in s/100 Hz or s/1000 rpm and the S ramp parameter is defined in s^2/100 Hz or s^2/1000 rpm, the time T for the 'curved' part of the S can be determined from:

T = S ramp rate of change / Ramp rate

Enabling S ramp increases the total ramp time by the period T since an additional T/2 is added to each end of the ramp in producing the S.

12.22.4 Torque modes

4.08	Torque reference								
RW	Bi							US	
⇳	±USER_CURRENT_MAX %				⇨	0.00			

Parameter for main torque reference. The normal update rate for the torque reference is 4ms. However if analog inputs 2 or 3 on the drive are used as the source of the reference, the drive is in closed-loop vector or servo mode and the analog inputs are in voltage mode with zero offset, the sample time is reduced to 250 µs.

4.11	Torque mode selector								
RW	Uni							US	
⇳	0 to 4				⇨	0			

When this parameter is set to 1, 2 or 3 the ramps are not active while the drive is in the run state. When the drive is taken out of the run state, but not disabled, the appropriate stopping mode is used. It is recommended that coast stopping or stopping without ramps are used. However, if ramp stop mode is used the ramp output is pre-loaded with the actual speed at the changeover point to avoid unwanted jumps in the speed reference.

0: Speed control mode

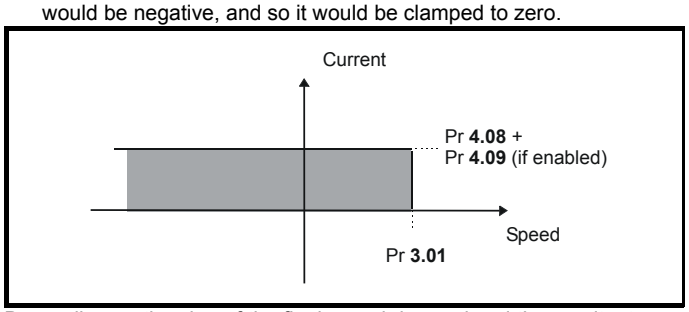
The torque demand is equal to the speed loop output.

1: Torque control

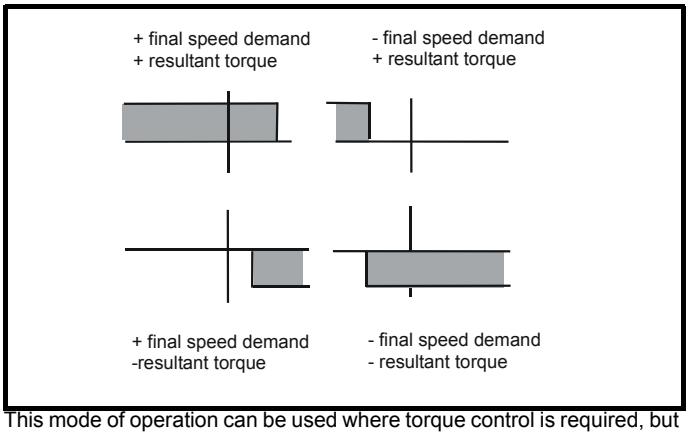
The torque demand is given by the sum of the torque reference and the torque offset, if enabled. The speed is not limited in any way, however, the drive will trip at the overspeed threshold if runaway occurs.

2: Torque control with speed override

The output of the speed loop defines the torque demand, but is limited between 0 and the resultant torque reference (Pr **4.08** and Pr **4.09** (if enabled)). The effect is to produce an operating area as shown below if the final speed demand and the resultant torque reference are both positive. The speed controller will try and accelerate the machine to the final speed demand level with a torque demand defined by the resultant torque reference. However, the speed cannot exceed the reference because the required torque would be negative, and so it would be clamped to zero.



Depending on the sign of the final speed demand and the resultant torque the four areas of operation shown below are possible.



This mode of operation can be used where torque control is required, but the maximum speed must be limited by the drive.

3: Coiler/uncoiler mode

Positive final speed demand:

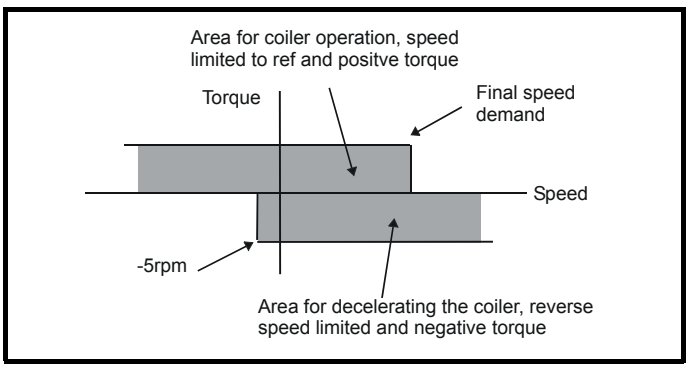
A positive resultant torque will give torque control with a positive speed limit defined by the final speed demand. A negative resultant torque will give torque control with a negative speed limit of -5 rpm.

Negative final speed demand:

A negative resultant torque will give torque control with a negative speed limit defined by the final speed demand. A positive resultant torque will give torque control with a positive speed limit of +5 rpm.

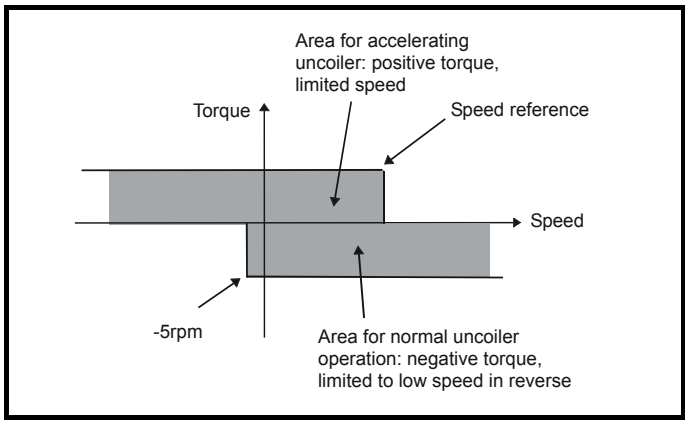
Example of coiler operation:

This is an example of a coiler operating in the positive direction. The final speed demand is set to a positive value just above the coiler reference speed. If the resultant torque demand is positive the coiler operates with a limited speed, so that if the material breaks the speed does not exceed a level just above the reference. It is also possible to decelerate the coiler with a negative resultant torque demand. The coiler will decelerate down to -5 rpm until a stop is applied. The operating area is shown in the following diagram.



Example of uncoiler operation:

This is an example for an uncoiler operating in the positive direction. The final speed demand should be set to a level just above the maximum normal speed. When the resultant torque demand is negative the uncoiler will apply tension and try and rotate at 5 rpm in reverse, and so take up any slack. The uncoiler can operate at any positive speed applying tension. If it is necessary to accelerate the uncoiler a positive resultant torque demand is used. The speed will be limited to the final speed demand. The operating area is the same as that for the coiler and is shown overleaf:



4: Speed control with torque feed-forward
The drive operates under speed control, but a torque value may be added to the output of the speed controller. This can be used to improve the regulation of systems where the speed loop gains need to be low for stability.

12.22.5 Stop modes

6.01	Stop mode								
RW	Txt							US	
⇳	COASt (0), rP (1), no.rP (2)				⇨	no.rP (2)			

Only one stopping phases exists and the ready state is entered as soon as the single stopping action is complete.

Stopping Mode	Action
0: Coast	Inhibits the inverter
1: Ramp	Stop with ramp
2: No ramp	Stop with no ramp

The motor can be stopped with position orientation after stopping. This mode is selected with the position controller mode parameter (Pr **13.10**). When this mode is selected Pr **6.01** has no effect.

6.08	Hold zero speed								
RW	Bit							US	
⇳	OFF (0) or On (1)				⇨	On (1)			

When this bit is set the drive remains active even when the run command has been removed and the motor has reached standstill.

12.22.6 Line power supply loss modes

6.03	Line power supply loss mode								
RW	Txt							US	
⇳	diS (0), StoP (1), ridE.th (2)				⇨	diS (0)			

0: diS
There is no line power supply loss detection and the drive operates normally only as long as the DC bus voltage remains within specification (i.e. >Vuu). Once the voltage falls below Vuu an under-voltage 'UV' trip occurs. This will reset itself if the voltage rises above Vuu Restart, as stated in the table below.

1: StoP
The speed reference is set to zero and the ramps are disabled allowing the drive to decelerate the motor to a stop under current limit. If the line power supply is re-applied while the motor is stopping any run signal is ignored until the motor has stopped. If the current limit value is set very low level the drive may trip UV before the motor has stopped.

2: ridE.th
The drive detects line power supply loss when the DC bus voltage falls below Vml_1. The drive then enters a mode where a closed-loop controller attempts to hold the DC bus level at Vml_1. This causes the motor to decelerate at a rate that increases as the speed falls. If the line power supply is re-applied it will force the DC bus voltage above the detection threshold Vml_3 and the drive will continue to operate normally. The output of the line power supply loss controller is a current demand that is fed into the current control system and therefore the gain Pr **4.13** and Pr **4.14** must be set up for optimum control. See parameters Pr **4.13** and Pr **4.14** for set-up details.

The following table shows the voltage levels used by drives with each voltage rating.

Voltage level	200 V drive	400 V drive
Vuu	175	330
Vml_1	205*	410*
Vml_2	Vml_1 - 10V	Vml_1 - 20V
Vml_3	Vml_1 + 10V	Vml_1 + 15V
Vuu Restart	215	425

* Vml_1 is defined by Pr **6.48**. The values in the table above are the default values.

6.48	Line power supply loss ride through detection level								
RW	Uni					RA		US	
⇳	0 to DC_VOLTAGE_SET_MAX V				⇨	200 V drive: 205 400 V drive: 410			

The line power supply loss detection level can be adjusted using this parameter. If the value is reduced below the default value, the default value is used by the drive. If the level is set too high, so that the line power supply loss detection becomes active under normal operating conditions, the motor will coast to a stop.

4.13	Current loop P gain								
RW	Uni							US	
⇳	0 to 30,000				⇨	200V drive: 75 400V drive: 150			

4.14	Current loop I gain								
RW	Uni							US	
⇳	0 to 30,000				⇨	200V drive: 1,000 400V drive: 2,000			

The Kp and Ki gains are used in the voltage based current controller. The default values give satisfactory operation with most motors. However it may be necessary to change the gains to improve the performance. The proportional gain (Pr **4.13**) is the most critical value in controlling the performance. Either the value can be set by auto-tuning (see Pr **5.12**) or it can be set by the user so that

Pr **4.13** = Kp = (L / T) x (I_{fs} / V_{fs}) x (256 / 5)

Where:

T is the sample time of the current controllers. The drive compensates for any change of sample time, and so it should be assumed that the sample time is equivalent to the lowest sample rate of 167 µs.

L is the motor inductance. For a servo motor this is half the phase to phase inductance that is normally specified by the manufacturer. For an induction motor this is the per phase transient inductance (σL_s). This is the inductance value stored in Pr **5.24** after the autotune test

is carried out. If σL_s cannot be measured it can be calculated from the steady state per-phase equivalent circuit of the motor as follows:

$$\sigma L_s = L_s - \left(\frac{L_m^2}{L_r}\right)$$

I_{fs} is the peak full scale current feedback = $K_C \times \sqrt{2} / 0.45$. Where K_C is defined in Pr **11.32**.

V_{fs} is the maximum DC bus voltage.

Therefore:

Pr **4.13** = Kp = (L / 167 µs) x (K_C x √2 / 0.45 / V_{fs}) x (256 / 5)

= K x L x K_C

Where:

K = [√2 / (0.45 x V_{fs} x 167µs)] x (256 / 5)

Drive voltage rating	Vfs	K
200 V	415V	2322
400 V	830V	1161

This set-up will give a step response with minimum overshoot after a step change of current reference. The approximate performance of the current controllers will be as given below. The proportional gain can be increased by a factor of 1.5 giving a similar increase in bandwidth, however, this gives at step response with approximately 12.5 % overshoot.

Switching frequency kHz	Current control sample time µs	Gain bandwidth Hz	Phase delay µs
3	167	TBA	1160
4	125	TBA	875
6	83	TBA	581
8	125	TBA	625
12	83	TBA	415

The integral gain (Pr **4.14**) is less critical and should be set so that

Pr **4.14** = Ki = Kp x 256 x T / τ_m

Where:

τ_m is the motor filter (L / R).

R is the per phase stator resistance of the motor (i.e. half the resistance measured between two phases).

Therefore

Pr **4.14** = Ki = (K x L x K_C) x 256 x 167µs x R / L

= 0.0427 x K x R x K_C

The above equation gives a conservative value of integral gain. 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 closed-loop induction motor applications) the integral gain may need to have a significantly higher value.

12.22.7 Start / stop logic modes

6.04	Start / stop logic select									
RW	Uni								US	
⇳	0 to 4				⇨	0				

This parameter is provided to allow the user to select several predefined digital input routing macros to control the sequencer. When a value between 0 and 3 is selected the drive processor continuously updates the destination parameters for digital I/O T25, T26 and T27, and the enable sequencer latching bit (Pr **6.40**). When a value of 4 is selected the destination parameters for these digital I/O and Pr **6.40** can be modified by the user.

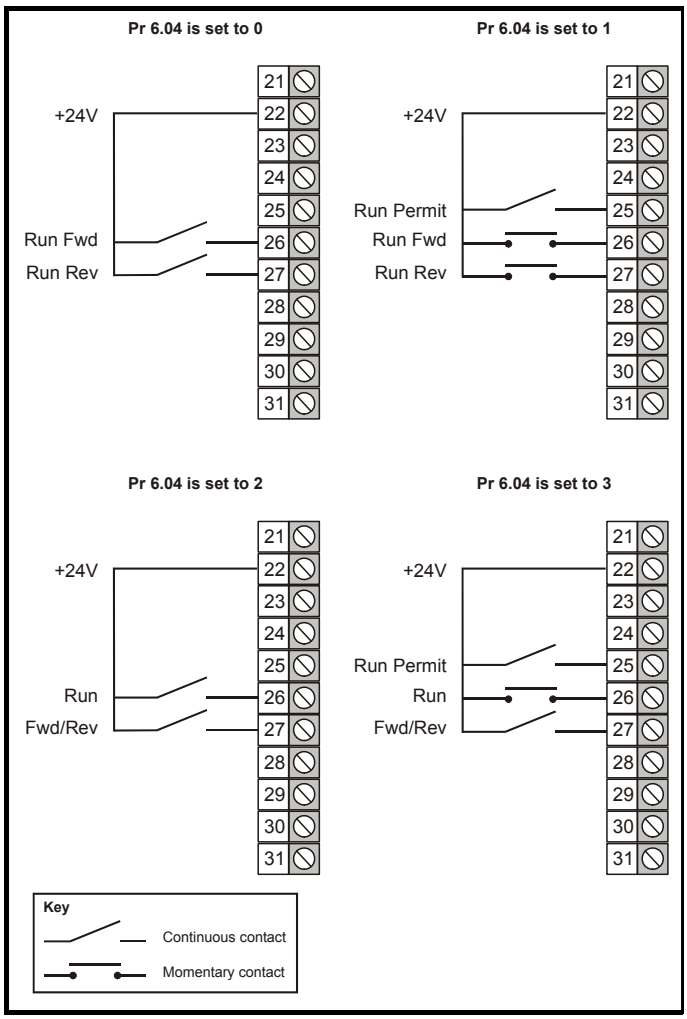
If Pr **6.04** is changed then a drive reset is required before the function of T25, T26 or T27 will become active.

Pr 6.04	T25 (Pr 8.22)	T26 (Pr 8.23)	T27 (Pr 8.24)	Pr 6.40
0	Pr **6.29** (Fast Disable)	Pr **6.30** (Run Forward)	Pr **6.32** (Run Reverse)	0 (Non Latching)
1	Pr **6.39** (Run Permit)	Pr **6.30** (Run Forward)	Pr **6.32** (Run Reverse)	1 (Latching)
2	Pr **6.29** (Fast Disable)	Pr **6.34** (Run)	Pr **6.33** (Fwd/Rev)	0 (Non Latching)
3	Pr **6.39** (Run Permit)	Pr **6.34** (Run)	Pr **6.33** (Fwd/Rev)	1 (Latching)
4	User programmable	User programmable	User programmable	User programmable

If Pr **6.04** has been set to a value of 0 to 3, then setting Pr **6.04** to 4 does not automatically reconfigure terminals T25, T26 and T27 to their default functions. To return terminals T25, T26 and T27 to their default functions, one of the following operations should be performed.

- Drive defaults should be restored. See section 5.6.6 *Restoring parameter defaults* on page 46 for details.
- Manually set Pr **6.04** to 4, Pr **6.40** to 0, Pr **8.22** to 10.33, Pr **8.23** to 6.30, and Pr **8.24** to 6.32.

Figure 12-18 Digital input connections when Pr 6.04 is set to 0 to 3



6.40	Enable sequencer latching									
RW	Bit								US	
⇳	OFF (0) or On (1)				⇨	OFF (0)				

This parameter enables sequencer latching. When sequencer latching is used, a digital input must be used as a run permit or not stop input. The digital input should write to Pr **6.39**. The run permit or not stop input must be made active to allow the drive to run. Making the run permit or not stop input inactive resets the latch and stops the drive.

12.22.8 Catch a spinning motor

6.09	Catch a spinning motor								
RW	Uni							US	
⇳	0 to 1				⇨	1			

When the drive is enabled with this bit at zero, the post ramp reference (Pr **2.01**) starts at zero and ramps to the required reference. When the drive is enabled with this bit at one, the post ramp reference is set to the motor speed.

When closed-loop vector mode is used without position feedback, and catch a spinning motor is not required, this parameter should be set to zero as this avoids unwanted movement of the motor shaft when zero speed is required. When closed-loop vector mode without position feedback is used with larger motors it may be necessary to increase Pr **5.40** *Spin start boost* from its default value of 1.0 for the drive to successfully detect the motor speed.

12.22.9 Position modes

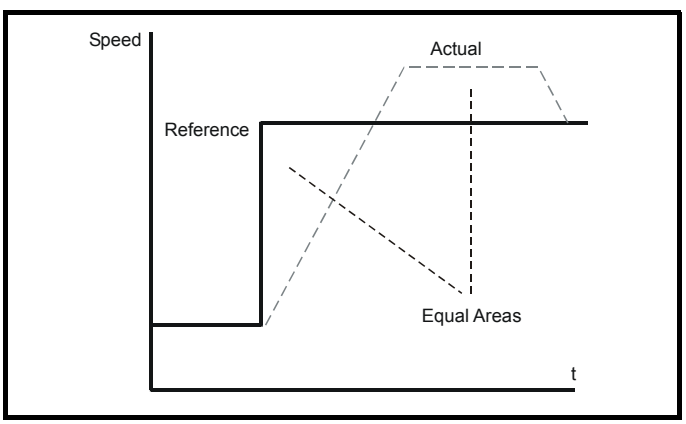
13.10	Position controller mode								
RW	Uni							US	
⇳	0 to 6				⇨	0			

This parameter is used to set the position controller mode as shown in the table below.

Parameter value	Mode	Feed forward active
0	Position controller disabled	
1	Rigid position control	✓
2	Rigid position control	
3	Non-rigid position control	✓
4	Non-rigid position control	
5	Orientation on stop	
6	Orientation on stop and when drive enabled	

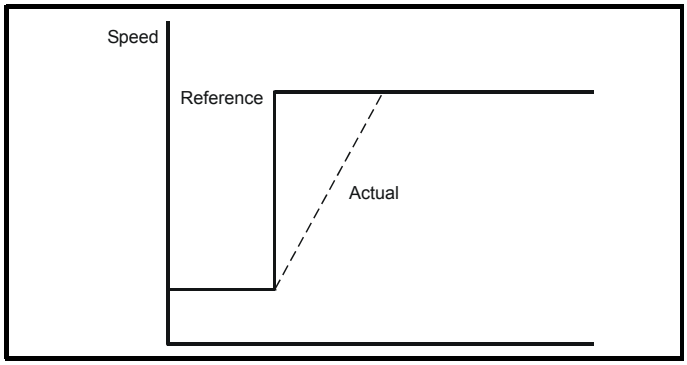
Rigid position control

In rigid position control the position error is always accumulated. This means that, if for example, the slave shaft is slowed down due to excessive load, the target position will eventually be recovered by running at a higher speed when the load is removed.



Non-rigid position control

In non-rigid position control the position loop is only active when the 'At Speed' condition is met (see Pr **3.06**). This allows slippage to occur while the speed error is high.



Velocity feed forward

The position controller can generate a velocity feed forward value from the speed of the reference encoder. The feed-forward value is passed to menu 1, and so ramps may be included if required. Because the position controller only has a proportional gain, it is necessary to use velocity feed-forward to prevent a constant position error that would be proportional to the speed of the reference position.

If for any reason the user wishes to provide the velocity feed forward from a source other than the reference position, the feed forward system can be made inactive, i.e. Pr **13.10** = 2 or 4. The external feed forward can be provided via Menu 1 from any of the speed references. However, if the feed forward level is not correct a constant position error will exist.

Relative jogging

If relative jogging is enabled the feedback position can be made to move relative the reference position at the speed defined by Pr **13.17**.

Orientation

If Pr **13.10** is 5 the drive orientates the motor following a stop command. If hold zero speed is enabled (Pr **6.08** = 1) the drive remains in position control when orientation is complete and hold the orientation position. If hold zero speed is not enabled the drive is disabled when orientation is complete.

If Pr **13.10** is 6 the drive orientates the motor following a stop command and whenever the drive is enabled provided that hold zero speed is enabled (Pr **6.08** = 1). This ensures that the spindle is always in the same position following the drive being enabled.

When orientating from a stop command the drive goes through the following sequence:

1. The motor is decelerated or accelerated to the speed limit programmed in Pr **13.12**, using ramps if these are enabled, in the direction the motor was previously running.
2. When the ramp output reaches the speed set in Pr **13.12**, ramps are disabled and the motor continues to rotate until the position is found to be close to the target position (i.e. within 1/32 of a revolution). At this point the speed demand is set to 0 and the position loop is closed.
3. When the position is within the window defined by Pr **13.14**, the orientation complete indication is given in Pr **13.15**.

The stop mode selected by Pr **6.01** has no effect if orientation is enabled.

12.22.10 Fast Disable

6.29	Hardware enable								
RO	Bit					NC	PT		
⇳	OFF (0) or On (1)				⇨				

This bit is a duplicate of parameter Pr **8.09** and reflects the state of the enable input. With software V01.10.00 and later, if the destination of one of the drive digital I/O (Pr **8.21** to Pr **8.26**) is set to Pr **6.29** and the I/O is set as an input, the state of the input does not affect the value of this parameter as it is protected, however, it does provide a fast disable function.

The Safe Torque Off input to the drive (T31) disables the drive in hardware by removing the gate drive signals from the inverter IGBTs and also disables the drive via the software system. When the drive is disabled by de-activating the Safe Torque Off input (T31) there can be a delay of up to 20 ms (typically 8 ms) before the drive is disabled. However, if a digital I/O is set up to provide the fast disable function it is possible to disable the drive within 600 µs of de-activating the input. To do this an enable signal should be given to both the Safe Torque Off input (T31) and to the digital I/O selected for the fast disable function. The state of the digital I/O including the effect of its associated invert parameter is ANDed with the Safe Torque Off (T31) to enable the drive.

If the safety function of the Safe Torque Off input is required then there must not be a direct connection between the Safe Torque Off input (T31) and any other digital I/O on the drive. If the safety function of the Safe Torque Off input and the fast disable function is required then the drive should be given two separate independent enable signals. A safety related enable from a safe source connected to the Safe Torque Off input on the drive. A second enable connected to the digital I/O on the drive selected for the fast disable function. The circuit must be arranged so that a fault which causes the fast input to be forced high cannot cause the Safe Torque Off input to be forced high, including the case where a component such as a blocking diode has failed.

13 Technical Data

13.1 Drive technical data

13.1.1 Power and current ratings (Derating for switching frequency)

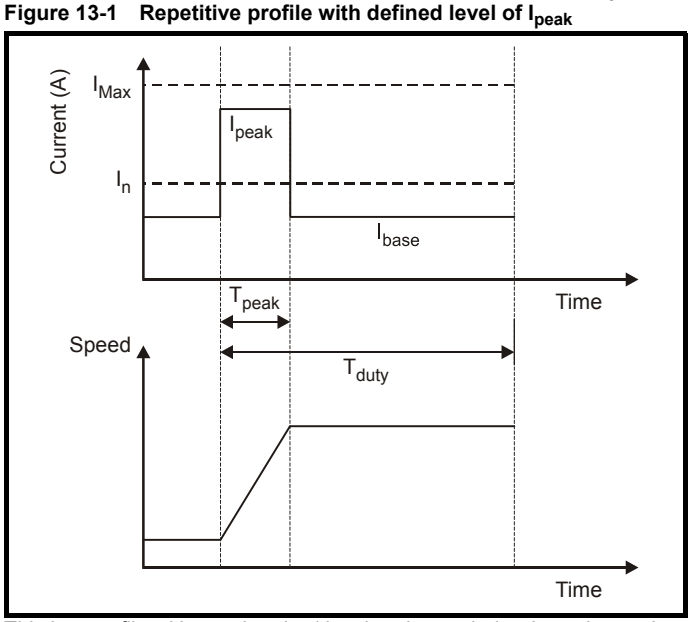
13.1.2 Typical pulse duty

The following tables give examples of load profiles that indicate the performance of the drive.

The profiles simulate the drive accelerating from standstill to full speed.

13.1.3 Repetitive profile with defined level of I_{peak}

Figure 13-1 Repetitive profile with defined level of I_{peak}



This is a profile with acceleration/deceleration periods where the peak output current from the drive (I_{peak}) is given as a proportion of the nominal current (I_n) for a defined period of time. (T_{peak}).

For example accelerating/decelerating for 10 s with a current of 2.0 x I_n.

The ratio between accelerating/decelerating period (T_{peak}) and the total profile period (T_{duty}) is always 1:10.

The profile shows the level of current that can be provided during the running/stopped period when the maximum peak current is used for accelerating/decelerating.

I_{base} is the drive output current during the constant speed segment of the profile.

Table 13-1 Repetitive profile with defined level of I_{peak} at 6 kHz switching frequency, ≤230 Vac supply for DST120X and ≤400 Vac supply for DST140X

Model	I_n	Overloads									
		1.5 x I_n for 60 s		1.75 x I_n for 40 s		2.0 x I_n for 10 s		2.5 x I_n for 2 s		3.0 x I_n for 0.25 s	
		I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}
	A										
DST1201	1.7	1.7	2.6	1.7	3.0	1.7	3.4	1.7	4.3	1.7	5.1
DST1202	3.8	3.8	5.7	3.8	6.7	3.8	7.6	3.8	9.5	3.8	11.4
DST1203	5.4	5.4	8.1	5.4	9.5	5.4	10.8	5.4	13.5	5.4	16.2
DST1204	7.6	7.6	11.4	7.6	13.3	7.6	15.2	7.6	19.0	7.6	22.8
DST1401	1.5	1.5	2.3	1.5	2.6	1.5	3.0	1.5	3.8	1.5	4.5
DST1402	2.7	2.7	4.1	2.7	4.7	2.7	5.4	2.7	6.8	2.7	8.1
DST1403	4.0	4.0	6.0	4.0	7.0	4.0	8.0	4.0	10.0	4.0	12.0
DST1404	5.9	5.9	8.9	5.9	10.3	5.9	11.8	5.9	14.8	5.9	17.7
DST1405	8.0	6.5	12.0	8.0	14.0	8.0	16.0	8.0	20.0	8.0	24.0

Table 13-2 Repetitive profile with defined level of I_{peak} at 8kHz switching frequency, ≤230 Vac supply for DST120X and ≤400 Vac supply for DST140X

Model	I_n	Overloads									
		1.5 x I_n for 60 s		1.75 x I_n for 40 s		2.0 x I_n for 10 s		2.5 x I_n for 2 s		3.0 x I_n for 0.25 s	
		I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}
	A										
DST1201	1.7	1.7	2.6	1.7	3.0	1.7	3.4	1.7	4.3	1.7	5.1
DST1202	3.8	3.8	5.7	3.8	6.7	3.8	7.6	3.8	9.5	3.8	11.4
DST1203	5.4	5.4	8.1	5.4	9.5	5.4	10.8	5.4	13.5	5.4	16.2
DST1204	7.6	7.6	11.4	7.6	13.3	7.6	15.2	7.6	19.0	7.6	22.8
DST1401	1.5	1.5	2.3	1.5	2.6	1.5	3.0	1.5	3.8	1.5	4.5
DST1402	2.7	2.7	4.1	2.7	4.7	2.7	5.4	2.7	6.8	2.7	8.1
DST1403	4.0	4.0	6.0	4.0	7.0	4.0	8.0	4.0	10.0	4.0	12.0
DST1404	5.9	5.9	8.9	5.7	10.3	5.9	11.8	5.9	14.8	5.9	17.7
DST1405	8.0	4.1	12.0	4.3	14.0	8.0	16.0	8.0	20.0	7.8	24.0

Table 13-3 Repetitive profile with defined level of I_{peak} at 6 kHz switching frequency, ≤240 Vac supply for DST120X and ≤480 Vac supply for DST140X

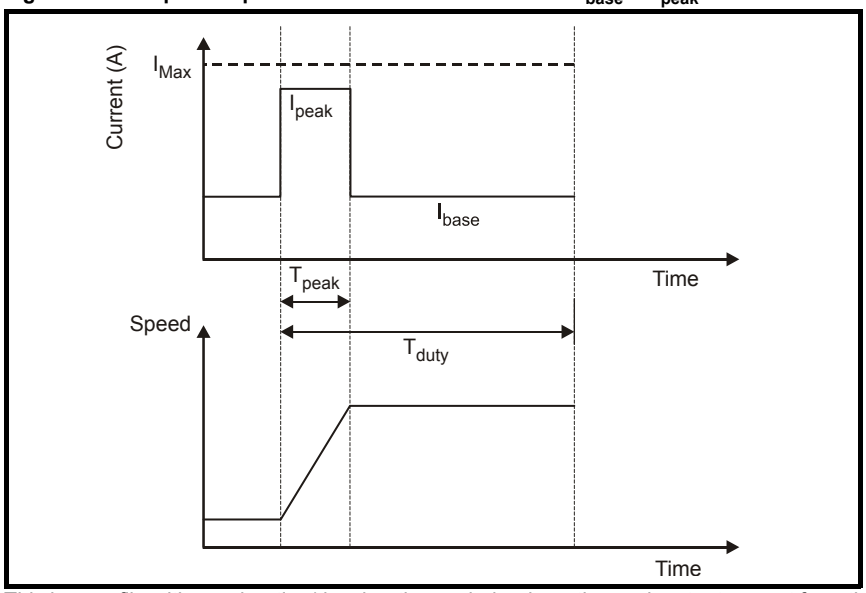
Model	I_n	Overloads									
		1.5 x I_n for 60 s		1.75 x I_n for 40 s		2.0 x I_n for 10 s		2.5 x I_n for 2 s		3.0 x I_n for 0.25 s	
		I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}
	A										
DST1201	1.7	1.7	2.6	1.7	3.0	1.7	3.4	1.7	4.3	1.7	5.1
DST1202	3.8	3.8	5.7	3.8	6.7	3.8	7.6	3.8	9.5	3.8	11.4
DST1203	5.4	5.4	8.1	5.4	9.5	5.4	10.8	5.4	13.5	5.4	16.2
DST1204	7.6	7.6	11.4	7.6	13.3	7.6	15.2	7.6	19.0	7.6	22.8
DST1401	1.5	1.5	2.3	1.5	2.6	1.5	3.0	1.5	3.8	1.5	4.5
DST1402	2.7	2.7	4.1	2.7	4.7	2.7	5.4	2.7	6.8	2.7	8.1
DST1403	4.0	4.0	6.0	4.0	7.0	4.0	8.0	4.0	10.0	4.0	12.0
DST1404	5.9	5.9	8.9	5.9	10.3	5.9	11.8	5.9	14.8	5.9	17.7
DST1405	8.0	8.0	12.0	8.0	14.0	8.0	16.0	8.0	20.0	8.0	24.0

Table 13-4 Repetitive profile with defined level of I_{peak} at 8 kHz switching frequency, ≤240 Vac supply for DST120X and ≤480 Vac supply for DST140X

Model	I_n	Overloads									
		1.5 x I_n for 60 s		1.75 x I_n for 40 s		2.0 x I_n for 10 s		2.5 x I_n for 2 s		3.0 x I_n for 0.25 s	
		I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}
	A										
DST1201	1.7	1.7	2.6	1.7	3.0	1.7	3.4	1.7	4.3	1.7	5.1
DST1202	3.8	3.8	5.7	3.8	6.7	3.8	7.6	3.8	9.5	3.8	11.4
DST1203	5.4	5.4	8.1	5.4	9.5	5.4	10.8	5.4	13.5	5.4	16.2
DST1204	7.6	7.6	11.4	7.6	13.3	7.6	15.2	7.6	19.0	7.6	22.8
DST1401	1.5	1.5	2.3	1.5	2.6	1.5	3.0	1.5	3.8	1.5	4.5
DST1402	2.7	2.7	4.1	2.7	4.7	2.7	5.4	2.7	6.8	2.7	8.1
DST1403	4.0	4.0	6.0	4.0	7.0	4.0	8.0	4.0	10.0	4.0	12.0
DST1404	5.9	5.5	8.9	5.0	10.3	5.9	11.8	5.9	14.8	5.9	17.7
DST1405	8.0	3.6	12.0	3.8	14.0	7.2	16.0	7.3	20.0	6.9	24.0

13.1.4 Repetitive profile with defined ratio between I_{base} to I_{peak}

Figure 13-2 Repetitive profile with defined ratio between I_{base} to I_{peak}



This is a profile with acceleration/deceleration periods where the peak output current from the drive (I_{peak}) is given as a proportion of the base current (I_{base}) for a defined period of time. (T_{peak}).

For example accelerating/decelerating for 10 s with a current of 2.0 x I_{base}.

The ratio between accelerating/decelerating period (T_{peak}) and the total profile period (T_{duty}) is always 1:10.

The profile shows the highest I_{base} ratings possible for the given I_{peak}/I_{base} ratio.

Table 13-5 Repetitive profile with defined ratio between I_{base} to I_{peak} at 6 kHz switching frequency, ≤230 Vac supply for DST120X and ≤400 Vac supply for DST140X

Model	I_n	Overloads									
		1.5 x I_{base} for 60 s		1.75 x I_{base} for 40 s		2.0 x I_{base} for 10 s		2.5 x I_{base} for 2 s		3.0 x I_{base} for 0.25 s	
		I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}
	A										
DST1201	1.7	1.7	2.6	1.7	3.0	1.7	3.4	1.7	4.3	1.7	5.1
DST1202	3.8	3.8	5.7	3.8	6.7	3.8	7.6	3.8	9.5	3.8	11.4
DST1203	5.4	5.4	8.1	5.4	9.5	5.4	10.8	5.4	13.5	5.4	16.2
DST1204	7.6	7.6	11.4	7.6	13.3	7.6	15.2	7.6	19.0	7.6	22.8
DST1401	1.5	1.5	2.3	1.5	2.6	1.5	3.0	1.5	3.8	1.5	4.5
DST1402	2.7	2.7	4.1	2.7	4.7	2.7	5.4	2.7	6.8	2.7	8.1
DST1403	4.0	4.0	6.0	4.0	7.0	4.0	8.0	4.0	10.0	4.0	12.0
DST1404	5.9	5.9	8.9	5.9	10.3	5.9	11.8	5.9	14.8	5.9	17.7
DST1405	8.0	8.0	12.0	8.0	14.0	8.0	16.0	8.0	20.0	8.0	24.0

Table 13-6 Repetitive profile with defined ratio between I_{base} to I_{peak} at 8 kHz switching frequency, ≤230 Vac supply for DST120X and ≤400 Vac supply for DST140X

Model	I_n	Overloads									
		1.5 x I_{base} for 60 s		1.75 x I_{base} for 40 s		2.0 x I_{base} for 10 s		2.5 x I_{base} for 2 s		3.0 x I_{base} for 0.25 s	
		I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}
	A										
DST1201	1.7	1.7	2.6	1.7	3.0	1.7	3.4	1.7	4.3	1.7	5.1
DST1202	3.8	3.8	5.7	3.8	6.7	3.8	7.6	3.8	9.5	3.8	11.4
DST1203	5.4	5.4	8.1	5.4	9.5	5.4	10.8	5.4	13.5	5.4	16.2
DST1204	7.6	7.6	11.4	7.6	13.3	7.6	15.2	7.6	19.0	7.6	22.8
DST1401	1.5	1.5	2.3	1.5	2.6	1.5	3.0	1.5	3.8	1.5	4.5
DST1402	2.7	2.7	4.1	2.7	4.7	2.7	5.4	2.7	6.8	2.7	8.1
DST1403	4.0	4.0	6.0	4.0	7.0	4.0	8.0	4.0	10.0	4.0	12.0
DST1404	5.9	5.9	8.9	5.9	10.3	5.9	11.8	5.9	14.8	5.9	17.7
DST1405	8.0	7.2	10.8	7.2	12.6	8.0	16.0	8.0	20.0	8.0	24.0

Table 13-7 Repetitive profile with defined ratio between I_{base} to I_{peak} at 6 kHz switching frequency, ≤240 Vac supply for DST120X and ≤480 Vac supply for DST140X

Model	I_n	Overloads									
		1.5 x I_{base} for 60 s		1.75 x I_{base} for 40 s		2.0 x I_{base} for 10 s		2.5 x I_{base} for 2 s		3.0 x I_{base} for 0.25 s	
		I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}
	A										
DST1201	1.7	1.7	2.6	1.7	3.0	1.7	3.4	1.7	4.3	1.7	5.1
DST1202	3.8	3.8	5.7	3.8	6.7	3.8	7.6	3.8	9.5	3.8	11.4
DST1203	5.4	5.4	8.1	5.4	9.5	5.4	10.8	5.4	13.5	5.4	16.2
DST1204	7.6	7.6	11.4	7.6	13.3	7.6	15.2	7.6	19.0	7.6	22.8
DST1401	1.5	1.5	2.3	1.5	2.6	1.5	3.0	1.5	3.8	1.5	4.5
DST1402	2.7	2.7	4.1	2.7	4.7	2.7	5.4	2.7	6.8	2.7	8.1
DST1403	4.0	4.0	6.0	4.0	7.0	4.0	8.0	4.0	10.0	4.0	12.0
DST1404	5.9	5.9	8.9	5.9	10.3	5.9	11.8	5.9	14.8	5.9	17.7
DST1405	8.0	8.0	12.0	8.0	14.0	8.0	16.0	8.0	20.0	8.0	24.0

Table 13-8 Repetitive profile with defined ratio between I_{base} to I_{peak} at 8 kHz switching frequency, ≤240 Vac supply for DST120X and ≤480 Vac supply for DST140X

Model	I_n	Overloads									
		1.5 x I_{base} for 60 s		1.75 x I_{base} for 40 s		2.0 x I_{base} for 10 s		2.5 x I_{base} for 2 s		3.0 x I_{base} for 0.25 s	
		I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}	I_{base}	I_{peak}
	A										
DST1201	1.7	1.7	2.6	1.7	3.0	1.7	3.4	1.7	4.3	1.7	5.1
DST1202	3.8	3.8	5.7	3.8	6.7	3.8	7.6	3.8	9.5	3.8	11.4
DST1203	5.4	5.4	8.1	5.4	9.5	5.4	10.8	5.4	13.5	5.4	16.2
DST1204	7.6	7.6	11.4	7.6	13.3	7.6	15.2	7.6	19.0	7.6	22.8
DST1401	1.5	1.5	2.3	1.5	2.6	1.5	3.0	1.5	3.8	1.5	4.5
DST1402	2.7	2.7	4.1	2.7	4.7	2.7	5.4	2.7	6.8	2.7	8.1
DST1403	4.0	4.0	6.0	4.0	7.0	4.0	8.0	4.0	10.0	4.0	12.0
DST1404	5.9	5.9	8.9	5.6	9.8	5.9	11.8	5.9	14.8	5.9	17.7
DST1405	8.0	7.2	10.8	6.8	11.9	7.6	15.2	7.6	19.0	7.6	22.8

13.1.5 Continuous rating

Table 13-9 Continuous rating with no overload, ≤230 Vac supply for DST120X and ≤400 Vac supply for DST140X

Model	I_n	6kHz		8kHz		12kHz	
		I_{cont} at 150 Hz	I_{cont} at 0 Hz	I_{cont} at 150 Hz	I_{cont} at 0 Hz	I_{cont} at 150 Hz	I_{cont} at 0 Hz
	A						
DST1201	1.7	1.7					
DST1202	3.8	3.8					
DST1203	5.4	5.4					
DST1204	7.6	7.6					
DST1401	1.5	1.5					
DST1402	2.7	2.7					
DST1403	4.0	4.0					
DST1404	5.9	5.9					4.2
DST1405	8.0	8.0		7.0		7.9	5.0

Table 13-10 Continuous rating with no overload, ≤240 Vac supply for DST120X and ≤480 Vac supply for DST140X

Model	I_n	6kHz		8kHz		12kHz	
		I_{cont} at 150 Hz	I_{cont} at 0 Hz	I_{cont} at 150 Hz	I_{cont} at 0 Hz	I_{cont} at 150 Hz	I_{cont} at 0 Hz
	A						
DST1201	1.7	1.7					
DST1202	3.8	3.8					
DST1203	5.4	5.4					
DST1204	7.6	7.6					
DST1401	1.5	1.5					
DST1402	2.7	2.7					
DST1403	4.0	4.0					3.4
DST1404	5.9	5.9			5.4		3.4
DST1405	8.0	8.0	7.5	8.0	6.2	6.4	4.0

NOTE

The power available from a rectifier may limit these figures.

The drive will automatically reduce the output switching frequency so that the highest possible output current can be supported without a thermal trip.

This allows the drive to support the highest possible current at standstill while operating at a higher switching frequency under normal running conditions.

This feature can be disabled using drive Pr **5.35**, see the *Advanced User Guide* for further details.

13.1.6 Maximum power ratings

For the models shown, the protection systems limit the output rating of the drive.

The ratings are based on the following operating conditions:

- Ambient temperature = 40 °C
- Altitude = 1000 m

Table 13-11 Maximum rectifier power, ≤230 Vac supply for DST120X and ≤400 Vac supply for DST140X

Model	No. of Input phases	Power at supply voltage	
		Without line reactor	With line reactor
		kW	kW
DST1201	1	0.329	
DST1202	1	0.714	
DST1203	1	0.864	
DST1204	1	1.391	
DST1201	3	0.51	
DST1202	3	1.13	
DST1203	3	1.61	
DST1204	3	1.77	1.98
DST1401	3	0.77	
DST1402	3	1.36	
DST1403	3	2.04	
DST1404	3	2.93	2.99
DST1405	3	2.77	3.05

Table 13-12 Maximum rectifier power, ≤240 Vac supply for DST120X and ≤480 Vac supply for DST140X

Model	No. of Input phases	Power at supply voltage	
		Without line reactor	With line reactor
		kW	kW
DST1201	1	0.394	
DST1202	1	0.857	
DST1203	1	1.03	
DST1204	1	1.66	
DST1201	3	0.609	
DST1202	3	1.35	
DST1203	3	1.92	
DST1204	3	2.12	2.38
DST1401	3	0.924	
DST1402	3	1.63	
DST1403	3	2.44	
DST1404	3	3.51	3.58
DST1405	3	3.32	3.65

13.1.7 Power dissipation

Table 13-13 Maximum drive losses

Model	6 kHz	8 kHz	12 kHz
	W	W	W
DST1201	64	65	69
DST1202	79	82	88
DST1203	102	109	122
DST1204	107	110	118
DST1401	79	87	101
DST1402	77	81	90
DST1403	124	142	177
DST1404	127	143	175
DST1405	150	169	207

13.1.8 Supply requirements

Table 13-14 Supply requirements

Model	Voltage	Frequency range
DST120X	200 V to 240 V ±10 % single phase	48 Hz to 65 Hz
DST120X	200 V to 240 V ±10 % three phase*	48 Hz to 65 Hz
DST140X	380 V to 480 V ±10 % three phase*	48 Hz to 65 Hz

*Maximum supply in-balance: 2 % negative phase sequence (equivalent to 3 % voltage in-balance between phases).

Frequency range: 48 to 65 Hz

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

13.1.9 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 imbalance 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
- Direct-on-line 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.

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

Continuous current:

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

Repetitive peak current:

Not less than three times the continuous input current rating of the drive.

13.1.10 Input inductor calculation

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

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

Where:

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

13.1.11 Motor requirements

No. of phases: 3

Maximum voltage:
Digitax ST (200 V): 240 V
Digitax ST (400 V): 480 V

13.1.12 Temperature, humidity and cooling method

Ambient temperature operating range:
0 °C to 50 °C (32 °F to 122 °F).
Output current derating must be applied at ambient temperatures >40 °C (104 °F).

Minimum temperature at power-up:
-15 °C (5 °F), the supply must be cycled when the drive has warmed up to 0 °C (32 °F).

Cooling method: Forced convection

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

13.1.13 Storage

-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.

13.1.14 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 (9,900ft) the output current of the drive would have to be de-rated by 20 %.

13.1.15 IP / UL Rating

The drive is rated to IP20 pollution degree 2 (dry, non-conductive contamination only) (NEMA 1).

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 13-15.

Table 13-15 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 > 1 mm (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 13-16 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.

13.1.16 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.

13.1.17 RoHS compliance

The drive meets EU directive 2002-95-EC for RoHS compliance.

13.1.18 Vibration

Maximum recommended continuous vibration level 0.14 g r.m.s. broad-band 5 to 200 Hz.

NOTE

This is the limit for broad-band (random) vibration. Narrow-band vibration at this level which coincides with a structural resonance could result in premature failure.

Bump Test

Testing in each of three mutually perpendicular axes in turn.
Referenced standard:IEC 60068-2-29: Test Eb:
Severity: 18 g, 6 ms, 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: 2* to 500 Hz
Severity: 3.5 mm peak displacement from 2* to 9 Hz
10 m/s² peak acceleration from 9 to 200 Hz
15 m/s² peak acceleration from 200 to 500 Hz
Sweep rate: 1 octave/minute
Duration: 15 minutes in each of 3 mutually perpendicular axes.

* Or lowest achievable on an electromagnetic shaker.

13.1.19 Starts per hour

By electronic control: unlimited

By interrupting the AC supply: ≤60 (equally spaced)

13.1.20 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:: 4 s

13.1.21 Output speed range

0 to 40,000 rpm

13.1.22 Accuracy and resolution

Speed:

The absolute speed accuracy depends on the accuracy of the crystal used with the drive microprocessor. The accuracy of the crystal is 100 ppm, and so the absolute speed accuracy is 100 ppm (0.01%) of the reference, when a preset speed 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.

Preset speed reference: 0.1 rpm
Precision speed reference: 0.001 rpm
Analog input 1: 16 bit plus sign
Analog input 2: 10 bit plus sign

Current:

The resolution of the current feedback is 10 bit plus sign.

Accuracy: typical 2 %
worst case 5 %

13.1.23 Acoustic noise

The heatsink fan generates the majority of the acoustic noise produced by the drive. The heatsink fan is a dual 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.

Fan at high speed: 65 dB
Fan at low speed: 53 dB

13.1.24 Overall dimensions

H Height including surface mounting brackets
W Width
D Projection forward of panel when surface mounted

Table 13-17 Overall drive dimensions

Dimension		
H	**W**	**D**
322 mm (12.677in)	62 mm (2.441in)	226 mm (8.898in)

13.1.25 Weight

2.1 kg (4.6 lb)

13.1.26 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 13-18.

Table 13-18 Supply fault current used to calculate maximum input currents

Model	Symmetrical fault level (kA)
All	100

Fuses

WARNING

The AC supply to the drive must be installed with suitable protection against overload and short-circuits. Table 13-19 shows recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

Table 13-19 Fuse ratings and cable sizes

Model	No of input phases	Typical input current A	Maximum continuous input current A	Fuse rating		Cable size			
				IEC class gG	Class CC	Input		Output	
						mm^2	AWG	mm^2	AWG
DST1201	1		4.0	6	10	0.75	16	0.75	24
DST1202	1		7.6	10	10	1	16	0.75	22
DST1203	1		9.0	16	15	2.5	14	0.75	20
DST1204	1		13.4	16	20	2.5	12	0.75	18
DST1201	3	3.1	3.5	6	10	0.75	16	0.75	24
DST1202	3	6.4	7.3	10	10	1	16	0.75	22
DST1203	3	8.6	9.4	16	15	2.5	14	0.75	20
DST1204	3	11.8	13.4	16	20	2.5	12	0.75	18
DST1401	3	2.6	2.8	4	10	0.75	16	0.75	24
DST1402	3	4.2	4.3	6	10	0.75	16	0.75	24
DST1403	3	5.9	6.0	8	10	0.75	16	0.75	22
DST1404	3	7.9	8.0	10	10	1	16	0.75	20
DST1405	3	9.9	9.9	12	15	1.5	14	0.75	18
Control cable						≥0.5	20		

NOTE

PVC insulated cable should be used.

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

B1 - Separate cables in conduit.
B2 - Multicore cable in conduit
C - Multicore cable in free air.

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).

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

The recommended cable sizes above 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.

NOTE

The recommended 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.

NOTE

UL listing is dependent on the use of the correct type of UL-listed fuse, and applies when symmetrical short-circuit current does not exceed 100 kA. See Chapter 15 *UL listing information* on page 204 for sizing information.

An MCB (miniature circuit breaker) may be used in place of fuses under the following conditions:

- The fault-clearing capacity must be sufficient for the installation
- The I^2T rating of the MCB must be less than or equal to that of the fuse rating listed above.

A fuse or other protection must be included in all live connections to the AC supply.
For a parallel DC bus system the maximum AC input fusing is shown in Table 13-20 below.

Table 13-20 Maximum AC input fusing

Model	Fuse rating IEC class gG	Fuse rating class CC	Input cable size	
	A	A	mm^2	AWG
All	20	20	4.0	12

NOTE

Refer to the supplier of your drive for further information regarding DC bus paralleling.

Inrush current

The drive will have an inrush current during power-up, the peak inrush is limited to the value shown below:

DST120X 18 A peak

DST140X 35 A peak

NOTE

The inrush current for all drives after a brown-out can be larger than the power-up inrush.

13.1.27 Motor cable size and maximum 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 13-21.

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
- When operating in ambient >45 °C UL 75 °C cable should be used.

Cable sizes are given for guidance only and may be changed depending on the application and the method of installation of the cables.

The mounting and grouping of cables affect their current capacity, in some cases a larger cable is required to avoid excessive temperature or voltage drop.

Input cable sizes should generally be regarded as a minimum, since they have been selected for co-ordination with the recommended fuses.

Output cable sizes assume that the maximum motor 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.

- 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 6 kHz.

The drive power terminals are designed for a maximum cable size of $4.0mm^2$ (minimum 0.2mm / 24 AWG).

Where more than one cable per terminal is used the combined diameters should not exceed the maximum.

The terminals are suitable for both solid and stranded wires.

Table 13-21 Motor cable size and maximum lengths

Model	Output cable		6kHz	8kHz	12kHz
	mm^2	AWG	m	m	m
DST1201	0.75	24	50		
DST1202		22			
DST1203		20			
DST1204		18			
DST1401		24			
DST1402					
DST1403		22			
DST1404		20			
DST1405		18			

13.1.28 Braking resistor values

Table 13-22 Minimum resistance and power ratings

Model	Minimum resistance*	Peak power rating	Continuous power rating	Average power for 0.25s
	Ω	kW	kW	kW
DST1201	23	6.6	0.5	1.6
DST1202			1.2	3.5
DST1203			1.6	4.9
DST1204	16	9.3	2.3	7.0
DST1401	111	5.5	0.8	2.3
DST1402			1.4	4.1
DST1403	75	8.1	2.0	6.1
DST1404	28	21.7	3.0	9.0
DST1405			4.1	12.2

* Resistor tolerance: ±10 %

13.1.29 Terminal torque settings

Table 13-23 Torque settings

Terminals	Torque setting*
Power terminals	1.0 N m (12.1 lb in)
Control terminals	0.2 N m (1.7 lb in)
Status relay terminals	0.5 N m (4.5 lb in)
Ground terminals	4 N m (35 lb in)
Small ground terminal screws	2 N m (17.7 lb in)

*Torque tolerance = 10 %

Table 13-24 Plug-in terminal block maximum cable sizes

Model size	Terminal block description	Max cable size
All	11 way control connectors	1.5 mm^2 (16 AWG)
All	2 way relay connector	2.5 mm^2 (12 AWG)

13.1.30 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 13-25 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	10V/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	Level 2
IEC61000-4-6 EN61000-4-6	Conducted radio frequency	10 V 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
EN 61800-3:2004 IEC61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

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 13-26 DST120X (200 V) emission compliance (single and three phase drives

Motor cable length (m)	Switching frequency (kHz)				
	3	4	6	8	12
Using internal filter:					
0 to 7	E2U				
7 to 9	E2U				E2R
9 to 11	E2U		E2R		
>11	E2R				
Using external filter:					
0 to 20	R			I	
20 to 100	I				

Table 13-27 DST140X (400 V) emission compliance

Motor cable length (m)	Switching frequency (kHz)				
	3	4	6	8	12
Using internal filter:					
0 to 6	E2U			E2R	
6 to 12	E2U		E2R		
12 to 14	E2U	E2R			
>14	E2R				
Using external filter:					
0 to 20	R			I	
20 to 70	I				
70 to 100	I	Do not use			

Key to Table 13-26 and Table 13-27

(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 properties 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.

13.2 Optional external EMC filters

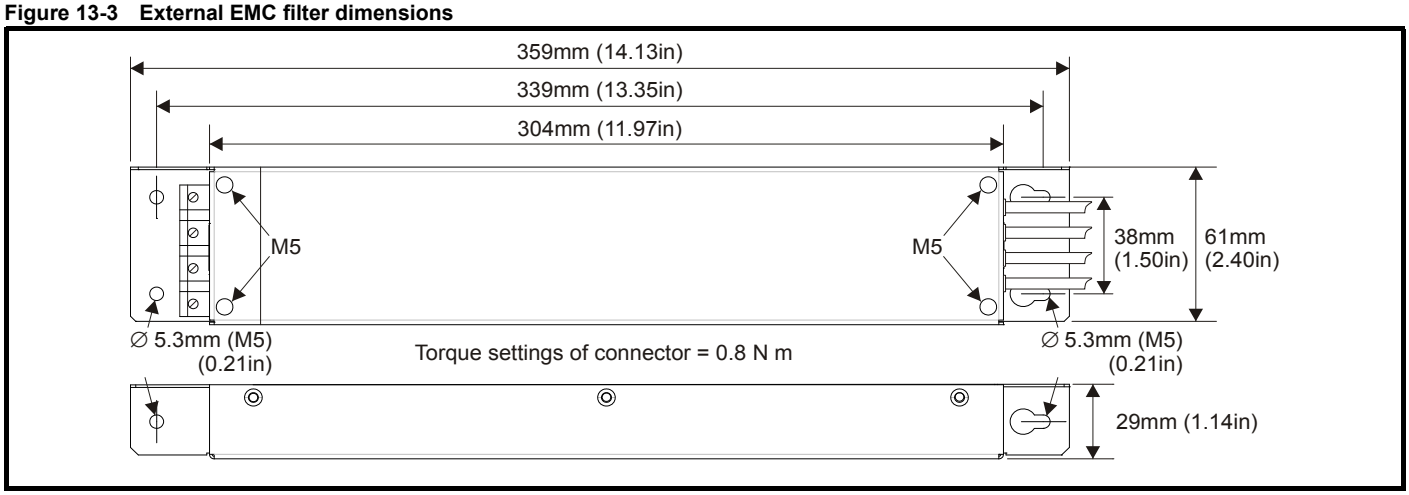
13.2.1 EMC filter ratings

Table 13-28 External EMC filter ratings

Used with	Number of phases	Filter part number		Maximum continuous current		Power losses at rated current	IP rating	Weight		Operational leakage current	Worst case leakage current	Filter terminal tightening torque	
		CT	Schaffner	@40°C (104°F) A	@50°C (122°F) A	W		Kg	lb	mA	mA	Nm	lb ft
DST120X	1	4200-6000	FS23072-19-07	19	17.3	11	20	1.2	2.64	29.5	56.9	0.8	0.6
DST120X	3	4200-6001	FS23073-17-07	17	15.5	13		1.2	2.64	8	50	0.8	0.6
DST140X	3	4200-6002	FS23074-11-07	11	10	10		1.2	2.64	16	90	0.8	0.6

13.3 Overall EMC filter dimensions

Figure 13-3 External EMC filter dimensions



14 Diagnostics

The display on the drive gives various information about the status of the drive. These fall into three 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.

14.1 Trip indications

If the drive trips, the output of the drive is disabled so that the drive stops controlling the motor. The upper display indicates that a trip has occurred and the lower display shows the trip. If this is a multi-module drive and a power module has indicated a trip, then the lower display will alternate between the trip string and the module number.

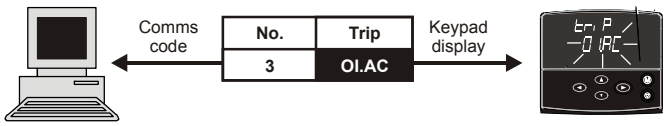
Trips are listed alphabetically in Table 14-1 based on the trip indication shown on the drive display. Refer to Figure 14-1.

If a display is not used, the drive LED Status indicator will flash if the drive has tripped. Refer to Figure 14-2.

The trip indication can be read in Pr **10.20** providing a trip number. Trip numbers are listed in numerical order in Table 14-2 so the trip indication can be cross referenced and then diagnosed using Table 14-1.

Example

1. Trip code 3 is read from Pr **10.20** via serial communications.
2. Checking Table 14-2 shows Trip 3 is an OI.AC trip.



3. Look up OI.AC in Table 14-1.

Perform checks detailed under *Diagnosis*.

Figure 14-1 Keypad status modes

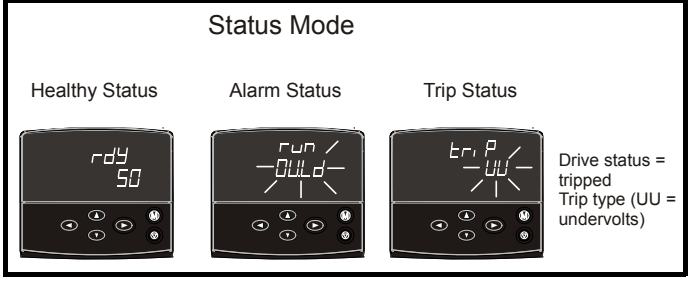
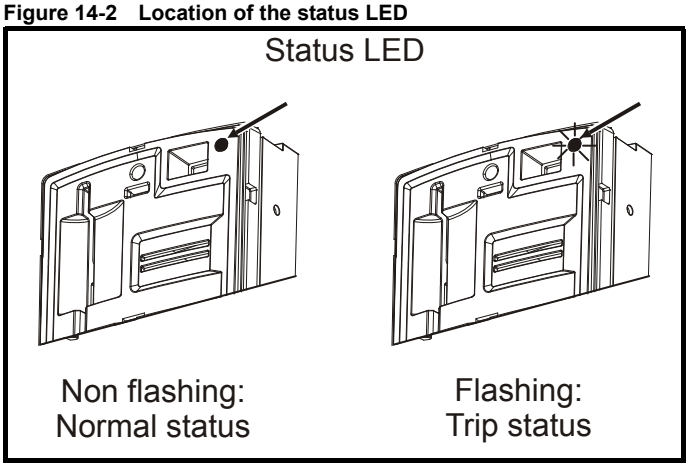


Figure 14-2 Location of the status LED



Trip	Diagnosis
OI.AC	**Instantaneous output over current detected**
3	Over current threshold is Kc/0.45 (see the *Digitax ST Advanced User Guide* for Kc values) Acceleration /deceleration rate is too short. If seen during autotune reduce voltage boost Pr **5.15** Check for short circuit on output cabling Check integrity of motor insulation Check feedback device wiring Check feedback device mechanical coupling Check feedback signals are free from noise Is motor cable length within limits Reduce the values in speed loop gain parameters – Pr **3.10**, Pr **3.11** and Pr **3.12** Has offset measurement test been completed? Reduce the values in current loop gain parameters - Pr **4.13** and Pr **4.14**

Table 14-1 Trip indications

Trip	Diagnosis
br.th	**Braking resistor thermistor temperature monitoring fail**
10	If no brake resistor is installed, set Pr **0.51** (or Pr **10.37**) to 8 to disable this trip. If a brake resistor is installed: Ensure that the braking resistor thermistor is connected correctly Ensure that the fan in the drive is working correctly Replace the braking resistor
C.Acc	**SMARTCARD trip: SMARTCARD Read / Write fail**
185	Check SMARTCARD is installed / located correctly Ensure SMARTCARD is not writing data to data location 500 to 999 Replace SMARTCARD
C.boot	**SMARTCARD trip: The menu 0 parameter modification cannot be saved to the SMARTCARD because the necessary file has not been created on the SMARTCARD**
177	A write to a menu 0 parameter has been initiated via the keypad with Pr **11.42** set to auto(3) or boot(4), but the necessary file on the SMARTCARD has not bee created Ensure that Pr **11.42** is correctly set and reset the drive to create the necessary file on the SMARTCARD Re-attempt the parameter write to the menu 0 parameter
C.bUSY	**SMARTCARD trip: SMARTCARD can not perform the required function as it is being accessed by a Solutions Module**
178	Wait for the Solutions Module to finish accessing the SMARTCARD and then re-attempt the required function
C.Chg	**SMARTCARD trip: Data location already contains data**
179	Erase data in data location Write data to an alternative data location
C.cPr	**SMARTCARD trip: The values stored in the drive and the values in the data block on the SMARTCARD are different**
188	Press the red reset button
C.dAt	**SMARTCARD trip: Data location specified does not contain any data**
183	Ensure data block number is correct
C.Err	**SMARTCARD trip: SMARTCARD data is corrupted**
182	Ensure the card is located correctly Erase data and retry Replace SMARTCARD
C.Full	**SMARTCARD trip: SMARTCARD full**
184	Delete a data block or use different SMARTCARD
cL2	**Analog input 2 current loss (current mode)**
28	Check analog input 2 (terminal 7) current signal is present (4-20 mA, 20-4 mA)
cL3	**Analog input 3 current loss (current mode)**
29	Check analog input 3 (terminal 8) current signal is present (4-20 mA, 20-4 mA)
CL.bit	**Trip initiated from the control word (Pr 6.42)**
35	Disable the control word by setting Pr **6.43** to 0 or check setting of Pr **6.42**
C.OPtn	**SMARTCARD trip: Solutions Modules installed are different between source drive and destination drive**
180	Ensure correct Solutions Modules are installed Ensure Solutions Modules are in the same Solutions Module slot Press the red reset button
C.Prod	**SMARTCARD trip: The data blocks on the SMARTCARD are not compatible with this product**
175	Erase all data on the SMARTCARD by setting Pr **xx.00** to 9999 and pressing the red reset button Replace SMARTCARD
C.Rdo	**SMARTCARD trip: SMARTCARD has the Read Only bit set**
181	Enter 9777 in Pr **xx.00** to allow SMARTCARD Read / Write access Ensure card is not writing to data locations 500 to 999

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>C.rtg</td><td>SMARTCARD trip: The voltage and/or current rating of the source and destination drives are different</td></tr>
<tr><td>186</td><td>Drive rating dependent parameters (parameters with the RA coding) are likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will not be transferred to the destination drive by SMARTCARDs when the rating of the destination drive is different from the source drive and the file is a parameter file. Drive rating dependent parameters will be transferred if only the current rating is different and the file is a differences from default type file.
Press the red reset button
Drive rating parameters are:
<table>
<tr><th>Parameter</th><th>Function</th></tr>
<tr><td>2.08</td><td>Standard ramp voltage</td></tr>
<tr><td>4.05/6/7, 21.27/8/9</td><td>Current limits</td></tr>
<tr><td>4.24</td><td>User current maximum scaling</td></tr>
<tr><td>5.07, 21.07</td><td>Motor rated current</td></tr>
<tr><td>5.09, 21.09</td><td>Motor rated voltage</td></tr>
<tr><td>5.17, 21.12</td><td>Stator resistance</td></tr>
<tr><td>5.18</td><td>Switching frequency</td></tr>
<tr><td>5.23, 21.13</td><td>Voltage offset</td></tr>
<tr><td>5.24, 21.14</td><td>Transient inductance</td></tr>
<tr><td>6.48</td><td>Line power supply loss ride through detection level</td></tr>
</table>
The above parameters will be set to their default values.</td></tr>
<tr><td>C.SLX</td><td>An error has occurred when attempting to transfer a user program from a Solutions Module to a SMARTCARD and vice versa</td></tr>
<tr><td>172,173,174</td><td>See section 10.2.8 SM-Applications Modules And Motion Processors program to/from SMARTCARD transfer system on page 104 for more information.</td></tr>
<tr><td>C.TyP</td><td>SMARTCARD trip: SMARTCARD parameter set not compatible with drive</td></tr>
<tr><td>187</td><td>Press the reset button
Ensure destination drive type is the same as the source parameter file drive type</td></tr>
<tr><td>dESt</td><td>Two or more parameters are writing to the same destination parameter</td></tr>
<tr><td>199</td><td>Set Pr xx.00 = 12001 check all visible parameters in the menus for duplication</td></tr>
<tr><td>EEF</td><td>EEPROM data corrupted - Serial comms will timeout with remote keypad on the drive RS485 comms port.</td></tr>
<tr><td>31</td><td>This trip can only be cleared by loading default parameters and saving parameters</td></tr>
<tr><td>EnC1</td><td>Drive encoder trip: Encoder power supply overload</td></tr>
<tr><td>189</td><td>Check encoder power supply wiring and encoder current requirement
Maximum current = 200 mA @ 15 V, or 300 mA @ 8 V and 5 V</td></tr>
<tr><td>EnC2</td><td>Drive encoder trip: Wire break (Drive encoder terminals 1 & 2, 3 & 4, 5 & 6)</td></tr>
<tr><td>190</td><td>Check cable continuity
Check encoder cable is plugged into the encoder input port and not the buffered encoder output port (see Figure 2-3 Features of the drive on page 10).
Check wiring of feedback signals is correct
Check encoder power is set correctly
Replace feedback device
If wire break detection on the main drive encoder input is not required, set Pr 3.40 = 0 to disable the Enc2 trip</td></tr>
<tr><td>EnC3</td><td>Drive encoder trip: Phase offset incorrect While running</td></tr>
<tr><td>191</td><td>Check the encoder signal for noise
Check encoder shielding
Check the integrity of the encoder mechanical mounting
Repeat the offset measurement test</td></tr>
<tr><td>EnC4</td><td>Drive encoder trip: Feedback device comms failure</td></tr>
<tr><td>192</td><td>Ensure encoder power supply is correct
Ensure baud rate is correct
Check encoder wiring
Replace feedback device</td></tr>
<tr><td>EnC5</td><td>Drive encoder trip: Checksum or CRC error</td></tr>
<tr><td>193</td><td>Check the encoder signal for noise
Check the encoder cable shielding
With EnDat encoders, check the comms resolution and/or carry out the auto-configuration Pr 3.41
SSI not ready at start of position transfer (i.e. data input not one)</td></tr>
</table>

Trip	Diagnosis
EnC6	**Drive encoder trip: Encoder has indicated an error**
194	Replace feedback device With SSI encoders, check the wiring and encoder supply setting
EnC7	**Drive encoder trip: Initialization failed**
195	Re-set the drive Check the correct encoder type is entered into Pr **3.38** Check encoder wiring Check encoder power supply is set correctly Carry out the auto-configuration Pr **3.41** Replace feedback device
EnC8	**Drive encoder trip: Auto configuration on power up has been requested and failed**
196	Change the setting of Pr **3.41** to 0 and manually enter the drive encoder turns (Pr **3.33**) and the equivalent number of lines per revolution (Pr **3.34**) Check the comms resolution
EnC9	**Drive encoder trip: Position feedback selected is selected from a Solutions Module slot which does not have a speed / position feedback Solutions Module installed**
197	Check setting of Pr **3.26** (or Pr **21.21** if the second motor parameters have been enabled)
EnC10	**Drive encoder trip: Phasing failure because encoder phase angle (Pr 3.25 or Pr 21.20) is incorrect**
198	Check the encoder wiring. Perform an autotune to measure the encoder phase angle or manually enter the correct phase angle into Pr **3.25** (or Pr **21.20**). Spurious Enc10 trips can be seen in very dynamic applications. This trip can be disabled by setting the overspeed threshold in Pr **3.08** to a value greater than zero. Caution should be used in setting the over speed threshold level as a value which is too large may mean that an encoder fault will not be detected.
Enc11	**Drive encoder trip: A failure has occurred during the alignment of the analog signals of a SINCOS encoder with the digital count derived from the sine and cosine waveforms and the comms position (if applicable). This fault is usually due to noise on the sine and cosine signals.**
161	Check encoder cable shield. Examine sine and cosine signals for noise.
Enc12	**Drive encoder trip: Hiperface encoder - The encoder type could not be identified during auto-configuration**
162	Check encoder type can be auto-configured. Check encoder wiring. Enter parameters manually.
Enc13	**Drive encoder trip: EnDat encoder - The number of encoder turns read from the encoder during auto-configuration is not a power of 2**
163	Select a different type of encoder.
Enc14	**Drive encoder trip: EnDat encoder - The number of comms bits defining the encoder position within a turn read from the encoder during auto-configuration is too large.**
164	Select a different type of encoder. Faulty encoder.
Enc15	**Drive encoder trip: The number of periods per revolution calculated from encoder data during auto-configuration is either less than 2 or greater than 50,000.**
165	Linear motor pole pitch / encoder ppr set up is incorrect or out of parameter range i.e. Pr **5.36** = 0 or Pr **21.31** = 0. Faulty encoder.
Enc16	**Drive encoder trip: EnDat encoder - The number of comms bits per period for a linear encoder exceeds 255.**
166	Select a different type of encoder. Faulty encoder.
Enc17	**Drive encoder trip: The periods per revolution obtained during auto-configuration for a rotary SINCOS encoder is not a power of two.**
167	Select a different type of encoder. Faulty encoder.
ENP.Er	**Data error from electronic nameplate stored in selected position feedback device**
176	Replace feedback device

Trip	Diagnosis
Et	**External trip from input on terminal 31**
6	Check terminal 31 signal Check value of Pr **10.32** Enter 12001 in Pr **xx.00** and check for parameter controlling Pr **10.32** Ensure Pr **10.32** or Pr **10.38** (=6) are not being controlled by serial comms
HF01	**Data processing error: CPU address error**
	Hardware fault - return drive to supplier
HF02	**Data processing error: DMAC address error**
	Hardware fault - return drive to supplier
HF03	**Data processing error: Illegal instruction**
	Hardware fault - return drive to supplier
HF04	**Data processing error: Illegal slot instruction**
	Hardware fault - return drive to supplier
HF05	**Data processing error: Undefined exception**
	Hardware fault - return drive to supplier
HF06	**Data processing error: Reserved exception**
	Hardware fault - return drive to supplier
HF07	**Data processing error: Watchdog failure**
	Hardware fault - return drive to supplier
HF08	**Data processing error: Level 4 crash**
	Hardware fault - return drive to supplier
HF09	**Data processing error: Heap overflow**
	Hardware fault - return drive to supplier
HF10	**Data processing error: Router error**
	Hardware fault - return drive to supplier
HF11	**Data processing error: Access to EEPROM failed**
	Hardware fault - return drive to supplier
HF12	**Data processing error: Main program stack overflow**
	Hardware fault - return drive to supplier
HF13	**Data processing error: Software incompatible with hardware**
	Hardware or software fault - return drive to supplier
HF17	**Multi-module system thermistor short circuit or open circuit**
217	Hardware fault - return drive to supplier
HF18	**Multi-module system interconnect cable error**
218	Hardware fault - return drive to supplier
HF19	**Temperature feedback multiplexing failure**
219	Hardware fault - return drive to supplier
HF20	**Power stage recognition: serial code error**
220	Hardware fault - return drive to supplier
HF21	**Power stage recognition: unrecognized frame size**
221	Hardware fault - return drive to supplier
HF22	**Power stage recognition: multi module frame size mismatch**
222	Hardware fault - return drive to supplier
HF23	**Power stage recognition: multi module voltage rating mismatch**
223	Hardware fault - return drive to supplier
HF24	**Power stage recognition: unrecognized drive size**
224	Hardware fault - return drive to supplier

Trip	Diagnosis
HF25	**Current feedback offset error**
225	Hardware fault - return drive to supplier
HF26	**Soft start relay failed to close, soft start monitor failed or braking IGBT short circuit at power up**
226	Hardware fault - return drive to supplier
HF27	**Power stage thermistor 1 fault**
227	Hardware fault - return drive to supplier
HF29	**Control board thermistor fault**
229	Hardware fault - return drive to supplier
HF30	**DCCT wire break trip from power module**
230	Hardware fault - return drive to supplier
It.AC	**Output current overload timed out (I^2t) - accumulator value can be seen in Pr 4.19**
20	Ensure the load is not jammed / sticking Ensure that the motor rated current is not set to zero Check the load on the motor has not changed If seen during an autotune in servo mode, ensure that the motor rated current Pr **0.46** (Pr **5.07**) or Pr **21.07** is current rating of the drive Tune the rated speed parameter Check feedback device signal for noise Check the feedback device mechanical coupling
It.br	**Braking resistor overload timed out (I^2t) – accumulator value can be seen in Pr 10.39**
19	Ensure the values entered in Pr **10.30** and Pr **10.31** are correct Increase the power rating of the braking resistor and change Pr **10.30** and Pr **10.31** If an external thermal protection device is being used and the braking resistor software overload is not required, set Pr **10.30** or Pr **10.31** to 0 to disable the trip
O.CtL	**Drive control board over temperature**
23	Check enclosure / drive fans are still functioning correctly Check enclosure ventilation paths Check enclosure door filters Check ambient temperature Reduce drive switching frequency
O.ht1	**Power device over temperature based on thermal model**
21	Reduce drive switching frequency Reduce duty cycle Decrease acceleration / deceleration rates Reduce motor load
O.ht2	**Heatsink over temperature**
22	Check enclosure / drive fans are still functioning correctly Check enclosure ventilation paths Check enclosure door filters Increase ventilation Decrease acceleration / deceleration rates Reduce drive switching frequency Reduce duty cycle Reduce motor load
O.ht3	**Drive over-temperature based on thermal model**
27	The drive will attempt to stop the motor before tripping. If the motor does not stop in 10s the drive trips immediately. Check DC bus ripple Decrease acceleration / deceleration rates Reduce duty cycle Reduce motor load

Trip	Diagnosis
OI.AC	**Instantaneous output over current detected**
3	Over current threshold is Kc/0.45 (see the *Digitax ST Advanced User Guide* for Kc values) Acceleration /deceleration rate is too short. If seen during autotune reduce voltage boost Pr **5.15** Check for short circuit on output cabling Check integrity of motor insulation Check feedback device wiring Check feedback device mechanical coupling Check feedback signals are free from noise Is motor cable length within limits Reduce the values in speed loop gain parameters – Pr **3.10**, Pr **3.11** and Pr **3.12** Has offset measurement test been completed? Reduce the values in current loop gain parameters - Pr **4.13** and Pr **4.14**
OI.br	**Braking transistor over-current detected: short circuit protection for the braking transistor activated**
4	Check braking resistor wiring Check braking resistor value is greater than or equal to the minimum resistance value Check braking resistor insulation
O.Ld1	**Digital output overload: total current drawn from 24 V supply and digital outputs exceeds 200 mA**
26	Check total load on digital outputs (terminals 24,25,26) and +24 V rail (terminal 22)
O.SPd	**Motor speed has exceeded the over speed threshold**
7	Increase the over speed trip threshold in Pr **3.08** Reduce the speed loop P gain (Pr **3.10**) to reduce the speed overshoot
OV	**DC bus voltage has exceeded the peak level or the maximum continuous level for 15 seconds**
2	Increase deceleration ramp (Pr **0.04**) Decrease 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 – voltage overshoot after supply recovery from a notch induced by DC drives. Check motor insulation **Drive voltage rating** / **Peak voltage** / **Maximum continuous voltage level (15 s)** 200 / 415 / 400 400 / 830 / 800 If the drive is operating in low voltage DC mode the overvoltage trip level is 1.45 x Pr **6.46**.
PAd	**Keypad has been removed when the drive is receiving the speed reference from the keypad**
34	Install the keypad and reset Change speed reference selector to select speed reference from another source
PH	**AC voltage input phase loss or large supply imbalance detected**
32	Ensure all three phases are present and balanced Check input voltage levels are correct (at full load) **NOTE** Load level must be between 50 and 100 % for the drive to trip under phase loss conditions. The drive will attempt to stop the motor before this trip is initiated.
PS	**Internal power supply fault**
5	Remove any Solutions Modules and reset Hardware fault - return drive to supplier
PS.10V	**10 V user power supply current greater than 10 mA**
8	Check wiring to terminal 4 Reduce load on terminal 4
PS.24V	**24V internal power supply overload**
9	The total user load of the drive and Solutions Modules has exceeded the internal 24 V power supply limit. The user load consists of the drive's digital outputs, the SM-I/O Plus digital outputs, the drive's main encoder supply and the SM-Universal Encoder Plus encoder supply. • Reduce load and reset • Provide an external 24 V >50 W power supply • Remove any Solutions Modules and reset
PSAVE.Er	**Power down save parameters in the EEPROM are corrupt**
37	Indicates that the power was removed when power down save parameters were being saved. The drive will revert back to the power down parameter set that was last saved successfully. Perform a user save (Pr **xx.00** to 1000 or 1001 and reset the drive) or power down the drive normally to ensure this trip does not occur the next time the drive is powered up.

Trip	Diagnosis
rS	**Failure to measure resistance during autotune**
33	Check motor power connection continuity
SAVE.Er	**User save parameters in the EEPROM are corrupt**
36	Indicates that the power was removed when user parameters were being saved. The drive will revert back to the user parameter set that was last saved successfully. Perform a user save (Pr **xx.00** to 1000 or 1001 and reset the drive) to ensure this trip does not occur the next time the drive is powered up.
SCL	**Drive RS485 serial comms loss to remote keypad**
30	Re-instal the cable between the drive and keypad Check cable for damage Replace cable Replace keypad
SLX.dF	**Solutions Module slot X trip: Solutions Module type installed in slot X changed**
204,209	Save parameters and reset

Trip	Diagnosis
SLX.Er	**Solutions Module slot X trip: Solutions Module in slot X has detected a fault**
202,207,212	**Feedback module category** Check value in Pr **15**/**16.50**. The following table lists the possible error codes for the SM-Universal Encoder Plus, SM-Encoder Plus and SM-Resolver. See the *Diagnostics* section in the relevant Solutions Module User Guide for more information.

Error code	Module	Trip Description	Diagnostic
0	All	No trip	No fault detected
1	SM-Universal Encoder Plus	Encoder power supply overload	Check encoder power supply wiring and encoder current requirement Maximum current = 200 mA @ 15 V, or 300 mA @ 8 V and 5 V
	SM-Resolver	Excitation output short circuit	Check the excitation output wiring.
2	SM-Universal Encoder Plus & SM-Resolver	Wire break	Check cable continuity Check wiring of feedback signals is correct Check supply voltage or excitation output level Replace feedback device
3	SM-Universal Encoder Plus	Phase offset incorrect while running	Check the encoder signal for noise Check encoder shielding Check the integrity of the encoder mechanical mounting Repeat the offset measurement test
4	SM-Universal Encoder Plus	Feedback device communications failure	Ensure encoder power supply is correct Ensure baud rate is correct Check encoder wiring Replace feedback device
5	SM-Universal Encoder Plus	Checksum or CRC error	Check the encoder signal for noise Check the encoder cable shielding
6	SM-Universal Encoder Plus	Encoder has indicated an error	Replace encoder
7	SM-Universal Encoder Plus	Initialisation failed	Check the correct encoder type is entered into Pr **15**/**16**/**17.15** Check encoder wiring Check supply voltage level Replace feedback device
8	SM-Universal Encoder Plus	Auto configuration on power up has been requested and failed	Change the setting of Pr **15**/**16**/**17.18** and manually enter the number of turns (Pr **15**/**16**/**17.09**) and the equivalent number of lines per revolution (Pr **15**/**16**/**17.10**)
9	SM-Universal Encoder Plus	Motor thermistor trip	Check motor temperature Check thermistor continuity
10	SM-Universal Encoder Plus	Motor thermistor short circuit	Check motor thermistor wiring Replace motor / motor thermistor
11	SM-Universal Encoder Plus	Failure of the sincos analog position alignment during encoder initialization	Check encoder cable shield. Examine sine and cosine signals for noise.
	SM-Resolver	Poles not compatible with motor	Check that the correct number of resolver poles has been set in Pr **15**/**16**/**17.15**.
12	SM-Universal Encoder Plus	Encoder type could not be identified during auto-configuration	Check encoder type can be auto-configured. Check encoder wiring. Enter parameters manually.
13	SM-Universal Encoder Plus	Number of encoder turns read from the encoder during auto-configuration is not a power of 2	Select a different type of encoder.
14	SM-Universal Encoder Plus	Number of comms bits defining the encoder position within a turn read from the encoder during auto-configuration is too large.	Select a different type of encoder. Faulty encoder.
15	SM-Universal Encoder Plus	The number of periods per revolution calculated from encoder data during auto-configuration is either <2 or >50,000.	Linear motor pole pitch / encoder ppr set up is incorrect or out of parameter range i.e. Pr **5.36** = 0 or Pr **21.31** = 0. Faulty encoder.
16	SM-Universal Encoder Plus	The number of comms bits per period for a linear encoder exceeds 255.	Select a different type of encoder. Faulty encoder.
74	All	Solutions Module has overheated	Check ambient temperature Check enclosure ventilation

Trip	Diagnosis
SLX.Er	**Solutions Module slot X trip: Solutions Module in slot X or Digitax ST Plus/Indexer has detected a fault**
202,207,212	**Automation (Applications) module category** Check value in Pr **17.50**. The following table lists the possible error codes for the Digitax ST Plus and Digitax ST Indexer. See the *Diagnostics* section in the SM-Applications Modules and Motion Processors manual for more information.

Error Code	Trip Description
39	User program stack overflow
40	Unknown error - please contact supplier
41	Parameter does not exist
42	Attempt to write to a read-only parameter
43	Attempt to read from a write-only parameter
44	Parameter value out of range
45	Invalid synchronisation modes
46	Unused
47	Synchronisation lost with CTSync Master
48	RS485 not in user mode
49	Invalid RS485 configuration
50	Maths error - divide by zero or overflow
51	Array index out of range
52	Control word user trip
53	DPL program incompatible with target
54	DPL task overrun
55	Unused
56	Invalid timer unit configuration
57	Function block does not exist
58	Flash PLC Storage corrupt
59	Drive rejected application module as Sync master
60	CTNet hardware failure. Please contact your supplier
61	CTNet invalid configuration
62	CTNet invalid baud-rate
63	CTNet invalid node ID
64	Digital Output overload
65	Invalid function block parameter(s)
66	User heap too large
67	RAM file does not exist or a non-RAM file id has been specified
68	The RAM file specified is not associated to an array
69	Failed to update drive parameter database cache in Flash memory
70	User program downloaded while drive enabled
71	Failed to change drive mode
72	Invalid CTNet buffer operation
73	Fast parameter initialisation failure
74	Over-temperature
75	Hardware unavailable
76	Module type cannot be resolved. Module is not recognized.
77	Inter-Solutions Module comms error with module in slot 1
78	Inter-Solutions Module comms error with module in slot 2
79	Inter-Solutions Module comms error with module in slot 3
80	Inter-Solutions Module comms error with module unknown slot
81	APC internal error
82	Communications to drive faulty

Trip	Diagnosis
SLX.Er	**Solutions Module slot X trip: Solutions Module in slot X or Digitax ST EZMotion has detected a fault**
202,207,212	**Automation (EZMotion) module category** Check value in Pr **17.50**. The following table lists the possible error codes for the Digitax ST EZMotion. See the *Advanced parameter section in the Digitax ST Advanced User Guide for more information.*

Error Code	Trip Description
41	Digitax ST parameter access error - Parameter does not exist
42	Digitax ST parameter access error - Parameter is read-only
43	Digitax ST parameter access error - Parameter is write-only
44	Digitax ST parameter access error - Written value out of range
73	Digitax ST database set-up error
74	Module overheat error
101	Invalid configuration error
102	NVM invalid error
103	Power up test failure error
104	Following error
105	Travel limit plus
106	Travel limit minus
107	No program error
108	Motion trajectory error
109	Trajectory update overrun error
120	File corruption error - Consult factory
121	
122	
123	Program error - Buffer overrun
124	Program error - Call stack overflow
125	File corruption error - Consult factory
126	
127	Flash error
128	File corruption error - Consult factory
129	Program error - illegal command
130	File corruption error - Consult factory
131	
132	
133	
134	
135	Program error - Math addition overflow
136	Program error - Math divide by zero
137	Program error - Math divide operand too large
138	Program error - Math multiplication normalization failed
139	Program error - Math divide operand too large
140	Program error - Overflow
141	Program error - Math subtraction overflow
142	Program error - Math stack overflow
143	File corruption error - Consult factory
144	
145	
146	
147	Program error - Flash memory size exceeded
148	Program error - RAM memory size exceeded
153	File corruption error - Consult factory
154	
155	
156	Program error - Too many wait for instructions
157	File corruption error - Consult factory
158	
159	
160	
161	
162	
163	
164	
165	
166	Program error - EZMotion parameter write out of range
171	Invalid slot 1 selection
172	Invalid slot 2 selection
173	Invalid motion processor
174	File corruption error - Consult factory
175	Module output overload

Trip	Diagnosis
SLX.Er	**Solutions Module slot X trip: Solutions Module in slot X has detected a fault**
202,207,212	**Automation (I/O Expansion) module category** Check value in Pr **15/16.50**. The following table lists the possible error codes for the SM-I/O Plus, SM-I/O Lite, SM-I/O Timer, SM-I/O PELV, SM-I/O 120 V and SM-I/O 24 V Protected. See the *Diagnostics* section in the relevant Solutions Module User Guide for more information.

Error code	Module	Reason for fault
0	All	No errors
1	All	Digital output overload
2	SM-I/O Lite, SM-I/O Timer	Analog input 1 current input too high (>22 mA) or too low (<3 mA)
	SM-I/O PELV, SM-I/O 24V Protected	Digital input overload
3	SM-I/O PELV, SM-I/O 24V Protected	Analog input 1 current input too low (<3 mA)
	SM-I/O 24V Protected	Communications error
4	SM-I/O PELV	User power supply absent
5	SM-I/O Timer	Real time clock communication error
74	All	Module over temperature

Trip	Diagnosis
SLX.Er	**Solutions Module slot X trip: Solutions Module in slot X has detected a fault**
202,207,212	**Fieldbus module category** Check value in Pr **15**/**16.50**. The following table lists the possible error codes for the Fieldbus modules. See the *Diagnostics* section in the relevant Solutions Module User Guide for more information.

Error code	Module	Trip Description
0	All	No trip
52	SM-PROFIBUS-DP-V1, SM-Interbus, SM-DeviceNet, SM-CANOpen	User control word trip
61	SM-PROFIBUS-DP-V1, SM-Interbus, SM-DeviceNet, SM-CANOpen, SM-SERCOS	Configuration error
64	SM-DeviceNet	Expected packet rate timeout
65	SM-PROFIBUS-DP-V1, SM-Interbus, SM-DeviceNet, SM-CANOpen, SM-SERCOS	Network loss
66	SM-PROFIBUS-DP-V1	Critical link failure
	SM-CAN, SM-DeviceNet, SM-CANOpen	Bus off error
69	SM-CAN	No acknowledgement
70	All (except SM-Ethernet)	Flash transfer error
	SM-Ethernet	No valid menu data available for the module from the drive
74	All	Solutions module over temperature
75	SM-Ethernet	The drive is not responding
76	SM-Ethernet	The Modbus connection has timed out
80	All (except SM-SERCOS)	Inter-option communications error
81	All (except SM-SERCOS)	Communications error to slot 1
82	All (except SM-SERCOS)	Communications error to slot 2
83	All (except SM-SERCOS)	Communications error to slot 3
84	SM-Ethernet	Memory allocation error
85	SM-Ethernet	File system error
86	SM-Ethernet	Configuration file error
87	SM-Ethernet	Language file error
98	All	Internal watchdog error
99	All	Internal software error

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>SLX.Er</td><td>Solutions Module slot X trip: Solutions Module in slot X has detected a fault</td></tr>
<tr><td>202,207,212</td><td>SLM module category
Check value in Pr 15/16.50. The following table lists the possible error codes for the SM-SLM. See the Diagnostics section in the SM-SLM User Guide for more information.
<table>
<tr><th>Error Code</th><th>Trip Description</th></tr>
<tr><td>0</td><td>No fault detected</td></tr>
<tr><td>1</td><td>Power supply overloaded</td></tr>
<tr><td>2</td><td>SLM version is too low</td></tr>
<tr><td>3</td><td>DriveLink error</td></tr>
<tr><td>4</td><td>Incorrect switching frequency selected</td></tr>
<tr><td>5</td><td>Feedback source selection incorrect</td></tr>
<tr><td>6</td><td>Encoder error</td></tr>
<tr><td>7</td><td>Motor object number of instances error</td></tr>
<tr><td>8</td><td>Motor object list version error</td></tr>
<tr><td>9</td><td>Performance object number of instances error</td></tr>
<tr><td>10</td><td>Parameter channel error</td></tr>
<tr><td>11</td><td>Drive operating mode incompatible</td></tr>
<tr><td>12</td><td>Error writing to the SLM EEPROM</td></tr>
<tr><td>13</td><td>Motor object type incorrect</td></tr>
<tr><td>14</td><td>Digitax ST object error</td></tr>
<tr><td>15</td><td>Encoder object CRC error</td></tr>
<tr><td>16</td><td>Motor object CRC error</td></tr>
<tr><td>17</td><td>Performance object CRC error</td></tr>
<tr><td>18</td><td>Digitax ST object CRC error</td></tr>
<tr><td>19</td><td>Sequencer timeout</td></tr>
<tr><td>74</td><td>Solutions module over temperature</td></tr>
</table></td></tr>
<tr><td>SLX.HF</td><td>Solutions Module slot X trip: Solutions Module X hardware fault</td></tr>
<tr><td>200,205,210</td><td>Ensure Solutions Module is installed correctly
Return Solutions Module to supplier</td></tr>
<tr><td>SLX.nF</td><td>Solutions Module slot X trip: Solutions Module has been removed</td></tr>
<tr><td>203,208,213</td><td>Ensure Solutions Module is installed correctly
Re-instal Solutions Module
Save parameters and reset drive</td></tr>
<tr><td>SL.rtd</td><td>Solutions Module trip: Drive mode has changed and Solutions Module parameter routing is now incorrect</td></tr>
<tr><td>215</td><td>Press reset.
If the trip persists, contact the supplier of the drive.</td></tr>
<tr><td>SLX.tO</td><td>Solutions Module slot X trip: Solutions Module watchdog timeout</td></tr>
<tr><td>201,206,211</td><td>Press reset.
If the trip persists, contact the supplier of the drive.</td></tr>
<tr><td>t010</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>10</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
<tr><td>t038</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>38</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
<tr><td>t040 to t089</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>40 to 89</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
<tr><td>t099</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>99</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
<tr><td>t101</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>101</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
<tr><td>t112 to t160</td><td>User trip defined in 2nd processor Solutions Module code</td></tr>
<tr><td>112 to 160</td><td>SM-Applications program must be interrogated to find the cause of this trip</td></tr>
</table>

Trip	Diagnosis
t168 to t171	**User trip defined in 2nd processor Solutions Module code**
168 to 171	SM-Applications program must be interrogated to find the cause of this trip
t216	**User trip defined in 2nd processor Solutions Module code**
216	SM-Applications program must be interrogated to find the cause of this trip
th	**Motor thermistor trip**
24	Check motor temperature Check thermistor continuity Set Pr **7.15** = VOLt and reset the drive to disable this function
thS	**Motor thermistor short circuit**
25	Check motor thermistor wiring Replace motor / motor thermistor Set Pr **7.15** = VOLt and reset the drive to disable this function
tunE*	**Autotune stopped before completion**
18	The drive has tripped out during the autotune The red stop key has been pressed during the autotune The Safe Torque Off signal (terminal 31) was active during the autotune procedure
tunE1*	**The position feedback did not change or required speed could not be reached during the inertia test (see Pr 5.12)**
11	Ensure the motor is free to turn i.e. brake was released. Check feedback device wiring is correct Check feedback parameters are set correctly Check encoder coupling to motor
tunE2*	**Position feedback direction incorrect or motor could not be stopped during the inertia test (see Pr 5.12)**
12	Check motor cable wiring is correct. Check feedback device wiring is correct Swap any two motor phases
tunE3*	**Drive encoder commutation signals connected incorrectly or measured inertia out of range (see Pr 5.12)**
13	Check motor cable wiring is correct. Check feedback device U,V and W commutation signal wiring is correct
tunE4*	**Drive encoder U commutation signal fail during an autotune**
14	Check feedback device U phase commutation wires continuity Replace encoder
tunE5*	**Drive encoder V commutation signal fail during an autotune**
15	Check feedback device V phase commutation wires continuity Replace encoder
tunE6*	**Drive encoder W commutation signal fail during an autotune**
16	Check feedback device W phase commutation wires continuity Replace encoder
tunE7*	**Motor number of poles set incorrectly**
17	Check lines per revolution for feedback device Check the number of poles in Pr **5.11** is set correctly
UP ACC	**Onboard PLC program: cannot access Onboard PLC program file on drive**
98	Disable drive - write access is not allowed when the drive is enabled Another source is already accessing Onboard PLC program - retry once other action is complete
UP div0	**Onboard PLC program attempted divide by zero**
90	Check program
UP OFL	**Onboard PLC program variables and function block calls using more than the allowed RAM space (stack overflow)**
95	Check program
UP ovr	**Onboard PLC program attempted out of range parameter write**
94	Check program
UP PAr	**Onboard PLC program attempted access to a non-existent parameter**
91	Check program
UP ro	**Onboard PLC program attempted write to a read-only parameter**
92	Check program
UP So	**Onboard PLC program attempted read of a write-only parameter**
93	Check program

Trip	Diagnosis
UP udF	**Onboard PLC program un-defined trip**
97	Check program
UP uSEr	**Onboard PLC program requested a trip**
96	Check program
UV	**DC bus under voltage threshold reached**
1	Check AC supply voltage level **Drive voltage rating (Vac)** / **Under voltage threshold (Vdc)** / **UV reset voltage (Vdc)** 200 / 175 / 215 400 / 330 / 425

*If a tunE through tunE7 trip occurs, then after the drive is reset the drive cannot be made to run unless it is disabled via the Safe Torque Off input (terminal 31), drive enable parameter (Pr **6.15**) or the control word (Pr **6.42** and Pr **6.43**).

Table 14-2 Serial communications look-up table

No.	Trip	No.	Trip	No.	Trip
1	UV	90	UP div0	181	C.Rdo
2	OV	91	UP PAr	182	C.Err
3	OI.AC	92	UP ro	183	C.dAt
4	OI.br	93	UP So	184	C.FULL
5	PS	94	UP ovr	185	C.Acc
6	Et	95	UP OFL	186	C.rtg
7	O.SPd	96	UP uSEr	187	C.TyP
8	PS.10V	97	UP udF	188	C.cPr
9	PS.24V	98	UP ACC	189	EnC1
10	br.th	99	t099	190	EnC2
11	tunE1	100	Reserved	191	EnC3
12	tunE2	101	t101	192	EnC4
13	tunE3	102	Reserved	193	EnC5
14	tunE4	103	Reserved	194	EnC6
15	tunE5	104	Reserved	195	EnC7
16	tunE6	105	Reserved	196	EnC8
17	tunE7	106	Reserved	197	EnC9
18	tunE	107	Reserved	198	EnC10
19	It.br	108	Reserved	199	dESt
20	It.AC	109	Reserved	200	SL1.HF
21	O.ht1	110	Reserved	201	SL1.tO
22	Reserved	111	Reserved	202	SL1.Er
23	Reserved	112 to 160	t112 to t160	203	SL1.nF
24	th	161	Enc11	204	SL1.dF
25	thS	162	Enc12	205	SL2.HF
26	O.Ld1	163	Enc13	206	SL2.tO
27	O.ht3	164	Enc14	207	SL2.Er
28	cL2	165	Enc15	208	SL2.nF
29	cL3	166	Enc16	209	SL2.dF
30	SCL	167	Enc17	210	SL3.HF
31	EEF	168 to 171	t168 to t171	211	SL3.tO
32	PH	172	C.SL1	212	SL3.Er
33	rS	173	C.SL2	213	SL3.nF
34	PAd	174	C.SL3	214	SL3.dF
35	CL.bit	175	C.Prod	215	SL.rtd
36	SAVE.Er	176	EnP.Er	216	t216
37	PSAVE.Er	177	C.boot	217 to 232	HF17 to HF232
38	t038	178	C.bUSY		
39	Reserved	179	C.Chg		
40 to 89	t040 to t089	180	C.OPtn		

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 14-3 Trip categories

Priority	Category	Trips	Comments
1	Hardware faults	HF01 to HF16	These indicate serious internal problems and cannot be reset. The drive is inactive after one of these trips and the display shows HFxx.
2	Non-resetable trips	HF17 to HF32, SL1.HF, SL2.HF, SL3.HF	Cannot be reset.
3	EEF trip	EEF	Cannot be reset unless a code to load defaults is first entered in Pr **x.00** or Pr **11.43**.
4	SMARTCARD trips	C.Boot, C.Busy, C.Chg, C.Optn, C.Rdo, C.Err, C.dat, C.FULL, C.Acc, C.rtg, C.Typ, C.cpr, C.Prod	SMARTCARD trips have priority 5 during power up.
4	Encoder power supply trips	PS.24V, EnC1	These trips can only override the following priority 5 trips: EnC2 - EnC8 or Enc11 - En17
5	Normal trips with extended reset	OI.AC, OI.br, OIAC.P, OIbr.P, OidC.P	Can be reset after 10.0s
5	Normal trips	All other trips not included in this table	Can be reset after 1.0s
5	Non-important trips	Old1, cL2, cL3, SCL	If bit 0 of Pr **10.37** is 1 the drive will stop before tripping.
5	Phase loss	PH	The drive attempts to stop before tripping.
5	Drive over-heat based on thermal model	O.ht3	The drive attempts to stop before tripping, but if it does not stop within 10s the drive will automatically trip.
6	Self resetting trips	UV	Under voltage trip cannot be reset by the user, but is automatically reset by the drive when the supply voltage is with specification.

Unless otherwise stated, trips cannot be reset until 1.0 s after the trip has been accepted by the drive.

Although the UV trip operates in a similar way to all other trips, all drive functions can still operate but the drive cannot be enabled. The following differences apply to the UV trip:

1. Power-down save user parameters are saved when UV trip is activated except when the main high voltage supply is not active (i.e. operating in Low Voltage DC Supply Mode, Pr **6.44** = 1).
2. The UV trip is self-resetting when the DC bus voltage rises above the drive restart voltage level. If another trip is active instead of UV at this point, the trip is not reset.
3. The drive can change between using the main high voltage supply and low voltage DC supply only when the drive is in the under voltage condition (Pr **10.16** = 1). The UV trip can only be seen as active if another trip is not active in the under voltage condition.
4. When the drive is first powered up a UV trip is initiated if the supply voltage is below the restart voltage level and another trip is not active. This does not cause save power down save parameters to be saved at this point.

14.2 Alarm indications

In any mode an alarm flashes alternately with the data displayed when one of the following conditions occur. If action is not taken to eliminate any alarm except "Autotune", "Lt" and "PLC" the drive may eventually trip. Alarms flash once every 640 ms except "PLC" which flashes once every 10 s. Alarms are not displayed when a parameter is being edited.

Table 14-4 Alarm indications

Lower display	Description
br.rS	Braking resistor overload
Braking resistor I^2t accumulator (Pr **10.39**) in the drive has reached 75.0 % of the value at which the drive will trip and the braking IGBT is active.	
Hot	Heatsink or control board or inverter IGBT over temperature alarms are active
• The drive heatsink temperature has reached a threshold and the drive will trip O.ht2 if the temperature continues to rise (see the O.ht2 trip). Or • The ambient temperature around the control PCB is approaching the over temperature threshold (see the O.CtL trip).	
OVLd	Motor overload
The motor I^2t accumulator (Pr **4.19**) in the drive has reached 75 % of the value at which the drive will be tripped and the load on the drive is >100 %	
Auto tune	Autotune in progress
The autotune procedure has been initialised. 'Auto' and 'tunE' will flash alternatively on the display.	
Lt	Limit switch is active
Indicates that a limit switch is active and that it is causing the motor to be stopped (i.e. forward limit switch with forward reference etc.)	
PLC	Onboard PLC program is running
An Onboard PLC program is installed and running. The lower display will flash 'PLC' once every 10 s.	

Drive cooling fan

The drive cooling fan is controlled by the temperature from monitoring points and other actions as follows:

If the "hot" alarm is active or the IGBT temperature (Pr **7.34**) is greater than the upper threshold then the fan will run at full speed. It will continue to run at full speed until the IGBT temperature is below the lower threshold. See the table below for the upper and lower thresholds.

Model	Upper threshold	Lower threshold
DST1201 to DST1204 DST1401 to DST1404	120 ºC	75 ºC
DST1405	145 ºC	90 ºC

If a Solutions Module indicates that it is too hot the fan runs at full speed. The fan will continue to run at full speed for 10 seconds after the Solutions Module has cooled down.

The fan can still be forced to run at full speed at all times if Pr **6.45** is set to one. The fan will continue to run at full speed for 10 seconds after Pr **6.45** has been set to zero.

For all other conditions the fan runs at low speed.

14.3 Status indications

Table 14-5 Status indications

Upper display	Description	Drive output stage
ACUU	AC Supply loss The drive has detected that the AC supply has been lost and is attempting to maintain the DC bus voltage by decelerating the motor.	Enabled
dc	DC applied to the motor The drive is applying DC injection braking.	Enabled
dEC	Decelerating The drive is decelerating the motor.	Enabled
inh	Inhibit The drive is inhibited and cannot be run. The drive enable signal is not applied to terminal 31 or Pr **6.15** is set to 0.	Disabled
POS	Positioning The drive is positioning/orientating the motor shaft.	Enabled
rdY	Ready The drive is ready to be run.	Disabled
run	Running The drive is running.	Enabled
SCAn	Scanning Regen> The drive is enabled and is synchronising to the line.	Enabled
StoP	Stop or holding zero speed The drive is holding zero speed.Regen> The drive is enabled but the AC voltage is too low, or the DC bus voltage is still rising or falling.	Enabled
triP	Trip condition The drive has tripped and is no longer controlling the motor. The trip code appears on the lower display.	Disabled

Table 14-6 Solutions Module and SMARTCARD status indications at power-up

Lower display	Description
boot	A parameter set is being transferred from the SMARTCARD to the drive during power-up. For further information, refer to the *User Guide*.
cArd	The drive is writing a parameter set to the SMARTCARD during power-up. For further information, refer to the *User Guide*.
loAding	The drive is writing information to a Solutions Module.

14.4 EtherCAT Diagnostics

14.4.1 EtherCAT interface ID code

Table 14-7 EtherCAT interface ID code

EtherCAT interface ID code		
Pr **17.01**	Default	421 (EtherCAT)
	Range	-
	Access	RO

This parameter is useful for checking the The EtherCAT interface is of the correct type.

14.4.2 EtherCAT interface firmware version

Table 14-8 EtherCAT interface firmware version - (major and minor)

EtherCAT interface firmware version - (major and minor) (xx.yy)		
Pr **17.02**	Default	N/A
	Range	00.00 to 99.99
	Access	RO

Table 14-9 EtherCAT interface firmware version - (subversion)

EtherCAT interface firmware version (subversion) (zz)		
Pr **17.51**	Default	N/A
	Range	0 to 99
	Access	RO

The software version of the EtherCAT interface can be identified by looking at Pr **17.02** and Pr **17.51**.

The software version takes the form of xx.yy.zz, where Pr **17.02** displays xx.yy and Pr **17.51** displays zz, for software version 01.01.00, Pr **17.02** will display 1.01 and Pr **17.51** will display 0.

The full version of the EtherCAT interface firmware can be assembled by combining the major version (xx.yy) and the minor version (zz) as follows: xx.yy.zz.

14.5 Network configuration objects

14.5.1 EtherCAT interface network loss trip

Table 14-10 Network loss behavior object

0x2813	**Network loss behavior**		
Sub-index 0:			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default:	2		
Description:	The number of sub-indices in this object.		
Sub-index 1: Maximum time interval			
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: ms
Default:	0 (by default the network loss behavior is disabled).		
Description:	The maximum time, in ms, allowed between accesses to PDOs (read or write). If no PDO access occurs for this period, the option will start network loss handling. If a value of zero is set, no network loss handling will occur.		
Sub-index 2: Trip type			
Access: RW	Range: 0 to 2	Size: 1 byte	Unit: N/A
Default:	0		
Description:	Network loss trip type. If this value is set to 0, a network loss trip will never occur; however, a network loss will still be handled by stopping the drive and indicating a warning as previously described. If this value is set to 1, the network loss trip will occur only after the motor has been stopped according to the Fault reaction option code. If the value is set to 2, the network loss trip will occur immediately on network loss (this implies that the motor will coast).		

The EtherCAT interface resets an internal timer when a valid message is received from the EtherCAT network. The network loss trip is triggered when no new messages are received before the timer times out. The EtherCAT interface will trip the drive and the EtherCAT interface error code parameter (Pr **17.50**) will show 120.

After power-up or reset the network loss trip is not armed until one of the following events occur:

- SYNC message is received
- RxPDO is received

Once the trip has been armed, a minimum of one of the above messages must be received or transmitted in each time period set in sub-index 2 of the Network loss behavior object (0x2813).

14.6 Diagnostic parameters

Table 14-11 EtherCAT interface operating status

EtherCAT interface operating status		
Pr **17.06**	Default	N/A
	Range	-9999 to 9999
	Access	RO

14.6.1 Running states

Table 14-12 Diagnostic information - running states

Pr **17.06**	Meaning	Description
0	Link established	A link has been established but no frames are being transmitted or received.
>0	Handled messages per second	The number of cyclic PDO messages that the active EtherCAT is handling per second.

Table 14-13 Diagnostic information - application

Pr **17.06**	Meaning	Description
-99	Application started	The main application has been launched.
-70	Initializing file system	The file system is initializing.
-50	Initializing databases	The databases are initializing.
-30	Initializing fieldbus	The fieldbus is initializing.
-25	Starting fieldbus	The fieldbus is starting.
-1	Initialization complete	The EtherCAT interface has initialized correctly but no network communication is taking place. i.e. no EtherCAT frames have been transmitted or received.

Table 14-14 Diagnostic information - bootloader

Pr **17.06**	Meaning	Description
-199	Boot loader start	The bootloader is starting up.
-180	Initializing memory	The memory manager is being initialized.
-150	Initializing file system	The file system handler is being initialized.
-149	Format file system	The file system is being formatted.
-148	Verify file system	The file system is being verified.
-130	Check boot mode	The required boot mode is being checked.
-110	Loading application	The requested application image is being copied from the file system to memory.
-101	Launching application	The application is being launched.
-100	Default mode	The bootloader has finished but no application was launched.

14.7 Drive trip display codes

If the EtherCAT interface detects an error during operation, it will force a trip on the drive. However, the trip code displayed on the drive will only indicate which slot initiated the trip. The exact reason for the trip will be indicated in the EtherCAT interface error code parameter, Pr **17.50**.

Table 14-15 shows the possible trip codes that will be displayed on the drive when a problem is detected with EtherCAT interface or when EtherCAT interface initiates a trip.

Table 14-15 Drive trip display codes

Trip Code	Fault	Description
SL3.HF/	Hardware fault	The drive has detected that the EtherCAT interface is present, but is unable to communicate with it. If this occurs, please contact your supplier or local Emerson Industrial Automation Centre.
SL3.Er/	Error	Error trip generated by EtherCAT interface
SL3.nF/	Not installed	This trip will occur if the EtherCAT interface has been removed from the drive.
SL3.dF/	Different module installed	The slot configuration parameters stored in the drive are not valid EtherCAT interface configuration parameters.

14.8 EtherCAT interface temperature

Table 14-16 EtherCAT interface temperature

EtherCAT interface temperature		
Pr **17.44**	Default	N/A
	Range	0 - 255
	Access	RO

This parameter shows the EtherCAT interface temperature reading in degrees Celsius.

14.9 EtherCAT interface serial number

Table 14-17 EtherCAT interface serial number

EtherCAT interface serial number		
Pr **17.35**	Default	N/A
	Range	0 - 16777215
	Access	RO

The serial number is loaded into the EtherCAT interface during manufacture and cannot be changed. It contains the last eight digits of the 10-digit serial number of the label.

14.10 EtherCAT interface error codes

Table 14-18 EtherCAT interface error codes

EtherCAT interface error codes		
Pr **17.50**	Default	N/A
	Range	0 to 255
	Access	RO

If an error is detected during operation the EtherCAT interface will force a trip on the drive and update the error code parameter (Pr **17.50**). Table 14-19 shows the EtherCAT interface error codes.

Table 14-19 EtherCAT interface error codes

Error code	Fault
1	No fieldbus mode has been selected
2	Critical task over-run
3	Invalid feedback source
4	Unknown drive type
5	Unsupported drive type
10	Invalid or missing application
62	Database Initialization error
63	File system Initialization error
64	Error initializing fieldbus stack
74	The EtherCAT interface has overheated
75	The drive is not responding
76	The Modbus connection has timed out
80	Inter-option communication failure
81	Inter-option communication to slot 1 timeout
82	Inter-option communication to slot 2 timeout
83	Inter-option communication to slot 3 timeout
84	Memory allocation error
85	File system error
86	Configuration file error
98	The EtherCAT interface background task has not been completed
99	Software fault
120	Network loss trip

14.11 Error handling

The following objects are provided to indicate an error condition

Table 14-20 Error handling objects

Index	Name
0x1001	Error_register
0x603F	Error_code

14.11.1 Error register

Table 14-21 Error register

0x1001	Error register			
Access: RO		Range: 0 to 255	Size: Unsigned 8	Unit: N/A
Default:	0			
Description:	A non-zero value in this object indicates that an error has occurred. The bit(s) set indicate the type of error present. The following bits are supported: 0: Generic error 1: Current 2: Voltage 3: Temperature When an error is indicated in this object, the particular error code will be contained in object 0x603F (Error code).			

14.11.2 Error code

Table 14-22 Error code

0x603F	Error code			
Access: RO		Range: 0 to 0xFFFF	Size: Unsigned 16	Unit: N/A
Default:	0			
Description:	A non-zero value in this object indicates that an error has occurred. The value will be one of the codes described in Table 14-23 *Error codes* on page 202.			

Table 14-23 Error codes

Error Code	Meaning	Corresponding Drive Trip Code
0x0000	Error reset / No error	0 – No trip
0x1000	Generic error	(Any trip code not elsewhere in table)
0x2200	Internal current	109 - OIdC.P
0x2300	Current, device output side	3 – OI.AC 20 – It.AC 104 - OIAC.P
0x3000	Voltage	8 – PS.10V
0x3130	Phase failure	32 – PH 107 – PH.P
0x3200	Voltage inside the device	1 – UU 2 – OU 5 – PS 9 – PS.24V 108 – PS.P
0x3210	dc bus over-voltage	106 - OV.P
0x4200	Temperature device	21 – O.ht1 22 – O.ht2 23 – O.CtL 27 – O.ht3 102 – Oht4.P 105 – Oht2.P
0x5000	Device hardware	200 – SL1.HF, 201 – SL1.t0, 202 – SL1.Er, 203 – SL1.nF, 204 – SL1.dF 205 – SL2.HF, 206 – SL2.t0, 207 – SL2.Er, 208 – SL2.nF, 209 – SL2.dF 210 – SL3.HF, 211 – SL3.t0, 212 – SL3.Er, 213 – SL3.nF, 214 – SL3.dF 215 – SL.rtd, 217 – HF17, 218 – HF18, 219 – HF19, 220-232 – HF20-HF32
0x5530	Data Storage (Non-volatile data memory)	31 – EEF 36 – SAVE.Er 37 – PSAVE.Er
0x6200	Device Software (User Software)	10 – t010 32 – t038 40 to 89 – t040 to t089 90 to 99 – UP --- / t090 to t099 101 – t101 112 to 160 – t112 to t160 168 to 174 – t168 to t174 216 – t216
0x6320	Parameter Error	199 - dESt
0x7112	Brake Chopper (Over current brake chopper)	4 – OI.br 19 – It.br 103 – OIbr.P
0x7200	Measurement Circuit	33 – rS
0x7300	Sensor	14 – tunE4 15 – tunE5 16 – tunE6 161 to 167 – Enc11 to Enc17 176 – EnP.Er 189 – Enc1 (SP Only) 190 to 198 – Enc2 to Enc10
0x7510	Communication (Serial Interface 1)	30 – SCL
0x7600	Additional Modules (Data storage)	175 – C.Prod 177 – C.boot 178 – c.bUSY 179 – C.Chg 180 – C.OPtn 181 – C.RdO 182 – C.Err 183 – C.dAt 184 – C.FULL 185 – C.Acc 186 – C.rtg 187 – C.TyP 188 – C.cPr
0x9000	External Error	6 – Et

14.12 Critical task % free

Table 14-24 EtherCAT interface critical task % free

EtherCAT interface critical task % free		
Pr **17.46**	Default	N/A
	Range	0 to 100
	Access	RO

Table 14-25 Worst case critical task % free

EtherCAT interface worst case critical task % free		
Pr **17.47**	Default	N/A
	Range	0 to 100
	Access	RO

Pr **17.46** and Pr **17.47** indicate how much of the cycle time allocated to the critical task is remaining and available for other the EtherCAT interface tasks.

14.13 SDO abort codes

SDO messages use a request-response mechanism and the EtherCAT master will always expect a response from the slave device. If an error occurs with an SDO transfer the EtherCAT interface will return an SDO abort code to indicate the reason for the failure, the SDO abort codes are listed in Table 14-26.

Table 14-26 SDO abort codes

Abort code (in hex.)	Description
0x05030000	Toggle bit not alternated
0x05040000	SDO protocol timed out
0x05040001	Client/server command specifier not valid or unknown
0x05040002	Invalid block size (block mode only)
0x05040003	Invalid sequence number (block mode only)
0x05040004	CRC error (block mode only)
0x05040005	Out of memory
0x06010000	Unsupported access to an object
0x06010001	Attempt to read a write only object
0x06010002	Attempt to write a read only object
0x06020000	Object does not exist in the object dictionary
0x06040041	Object cannot be mapped to the PDO
0x06040042	The number and length of the objects to be mapped would exceed PDO length
0x06040043	General parameter incompatibility
0x06040047	General internal incompatibility in the device
0x06060000	Access failed due to a hardware error
0x06070010	Data type does not match, length of service parameter does not match
0x06070012	Data type does not match, length of service parameter too high
0x06070013	Data type does not match, length of service parameter too low
0x06090011	Sub-index does not exist
0x06090030	Value range of parameter exceeded (only for write access)
0x06090031	Value of parameter written too high
0x06090032	Value of parameter written too low
0x06090036	Maximum value is less than minimum value
0x08000000	General error
0x08000020	Data cannot be transferred or stored to the application
0x08000021	Data cannot be transferred or stored to the application because of local control
0x08000022	Data cannot be transferred or stored to the application because of the present device state
0x08000023	Object dictionary dynamic generation fails or no object dictionary is present

14.14 FLASH file system % free

Table 14-27 EtherCAT interface FLASH file system % free

EtherCAT interface FLASH file system % free		
Pr **17.48**	Default	N/A
	Range	0 to 100
	Access	RO

Indicates what percentage of the flash based file system is unused and still available.

15 UL listing information

Digitax ST drives have been assessed to comply with both ULus and cUL requirements.

The Control Techniques UL file number is E171230. Confirmation of UL listing can be found on the UL website: www.ul.com.

15.1 Common UL information

Conformity: The drive conforms to UL listing requirements only when the following are observed:

- Class 1 60/75 °C (140/167 °F) copper wire only is used in the installation.
- The surrounding air temperature does not exceed 45 °C (113 °F) when the drive is operating.
- The terminal tightening torques specified in section 3.7 *Terminal torque settings* on page 20 are used.
- The drive is installed in a type 1 enclosure, or better, as defined by UL50. The drive has a UL 'opentype' enclosure rating.
- The correct UL listed class CC fast acting fuses e.g. Bussman Limitron KTK series, Gould Amp-Trap ATM series or equivalent are used in the AC supply. The drive does not comply with UL if MCBs are used in place of fuses.
- If the drive control stage is supplied by an external power supply (+24 V), the external power supply must be a UL Class 2 power supply.

Motor overload protection

All models incorporate an internal overload protection model for the motor load that does not require the use of an external or remote overload protection device. Overload protection is provided at 105 % the FLA of the device. The duration of the overload is dependent on the motor's thermal filter (a value up to 3000 seconds that is able to be entered into the drive - default value is 89 seconds). Refer to 'Menu 4 advanced parameter descriptions' in the *Digitax ST Advanced User Guide* for further information.

Overspeed protection

The drive provides overspeed protection. However, it does not provide the level of protection afforded by an independent high integrity overspeed protection device.

15.2 AC supply specification

The drive is suitable for use in a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes at 264 Vac RMS maximum (200 V drives), 528 Vac RMS maximum (400 V drives).

15.3 Maximum continuous output current

The drive models are listed as having the maximum continuous output currents (FLC) shown in Table 15-1 and Table 15-2.

Table 15-1 Maximum continuous output current (200 V drives)

Model	FLC (A)
DST1201	1.7
DST1202	3.8
DST1203	5.4
DST1204	7.6

Table 15-2 Maximum continuous output current (400 V drives)

Model	FLC(A)
DST1401	1.5
DST1402	2.7
DST1403	4.0
DST1404	5.9
DST1405	8.0

15.4 Common DC bus

The drive can also be used with common DC bus for UL applications as follows: -

Drives can be connected so as to have a common DC bus from a single feed. The power rating of the main fed drive shall not be exceeded. Fusing is not required between the DC bus fed drives, only the main supplied drive is required to be fused. The maximum capacitance to be connected together for the 480 Vac drives is 880 μF and for the 230 Vac drives is 2200 μF (the capacitance includes the mains supplied drive).

15.5 DC Supplied drive

The drive can also have DC feed for UL applications as follows: -

Supply connected to -DC and +DC terminals.

Table 15-3 DC fusing

Model	Volts DC nominal	Fuse current rating	R/C JFHR2 fuse manufacturer, type, Amps	
DST1201	340	25	Ferraz, 6,9xx CP GRC, 25	Siba URZ14x51 gR 690, 25
DST1202	340	32	Ferraz, 6,9xx CP GRC, 32	Siba URZ14x51 gR 690, 40
DST1203	340	40	Ferraz, 6,9xx CP GRC, 40	Siba URZ14x51 gR 690, 40
DST1204	340	50	Ferraz, 6,9xx CP GRC, 50	Siba URZ14x51 gR 690, 50
DST1401	680	25	Ferraz, 6,9xx CP GRC, 25	Siba URZ14x51 gR 690, 25
DST1402	680	25	Ferraz, 6,9xx CP GRC, 25	Siba URZ14x51 gR 690, 25
DST1403	680	25	Ferraz, 6,9xx CP GRC, 25	Siba URZ14x51 gR 690, 25
DST1404	680	25	Ferraz, 6,9xx CP GRC, 25	Siba URZ14x51 gR 690, 25
DST1405	680	25	Ferraz, 6,9xx CP GRC, 25	Siba URZ14x51 gR 690, 25

NOTE

In the table above, Ferraz xx may be 00 (fuse with no trip indicator installed) or 21 (fuse installed with trip indicator).

15.6 UL listed accessories

- Digitax ST Keypad
- Digitax ST Braking resistor
- SM-Keypad Plus
- SM-I/O Plus
- SM-Ethernet
- SM-CANopen
- SM-Universal Encoder Plus
- SM-Resolver
- SM-Encoder Plus
- SM-I/O Lite
- SM-I/O 120V
- SM-LON
- SM-Applications Plus
- 15-way D-type converter
- SM-Encoder Output Plus
- SM-LON
- SM-PROFIBUS-DP-V1
- SM-DeviceNet
- SM-I/O Timer
- SM-CAN
- SM-INTERBUS
- SM-Applications Lite
- SM-Applications Lite V2
- SM-SLM
- SM-Applications
- SM-I/O PELV
- SM-I/O 24V Protected
- SM-I/O 32
- SM-SERCOS
- SM-I/O Timer
- SM-EtherCAT

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