Nidec

All for dreams

User Guide

SI-Encoder V2

Compliance Information

Manufacturer: Nidec Control Techniques Limited ("we", "our")
Registered office: The Gro, Newtown, Powys, SY16 3BE United Kingdom
Registered in: England and Wales, company registration number 01236886
Manufacturer's EU Authorised Representative: Nidec Netherlands B.V., Kubus 155, 3364 DG Sliedrecht, the Netherlands, registered at the Dutch Trade Register under number 33213151; Tel. +31 (0)184 420 555, info.nl@mail.nidec.com

Original instructions

With reference to the UK Supply of Machinery (Safety) Regulations 2008 and the EU Machinery Directive 2006/42/EC, the English version of this Manual constitutes the original instructions. Manuals published in other languages are translations of the original instructions and the English language version of this Manual prevails over any other language version in the event of inconsistency.

Documentation and user software tools

Manuals, datasheets and software that we make available to users of our products can be downloaded from: http://www.drive-setup.com.

Warranty and liability

The contents of this Manual are presented for information purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. All sales are governed by our terms and conditions, which are available on request. We reserve the right to modify or improve the designs, specifications or performance of our products at any time without notice. For full details of the warranty terms applicable to the product, contact the supplier of the product.

In no event and under no circumstances shall we be liable for damages and failures due to misuse, abuse, improper installation, or abnormal conditions of temperature, dust, or corrosion, or failures due to operation outside the published ratings for the product, nor shall we be liable for consequential and incidental damages of any kind.

Environmental management

We operate an Environmental Management System which complies with the requirements of ISO 14001:2015. Further information on our Environmental Statement can be found at: **http://www.drive-setup.com/environment**.

Restriction and control of hazardous substances

The products covered by this Manual comply with the following legislation and regulations on the restriction and control of hazardous substances:

UK Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
UK REACH etc. (Amendment etc.) (EU Exit) Regulations 2020, European Union REACH Regulation EC 1907/2006
EU restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) - Directive 2011/65/EU
EC Regulation 1907/2006 on the Registration, Evaluation, authorisation, and restriction of Chemicals (REACH)
Chinese Administrative Measures for Restriction of Hazardous Substances in Electrical and Electronic Products 2016/07/01
U.S. Environmental Protection Agency ("EPA") regulations under the Toxic Substances Control Act ("TSCA")
MEPC 68/21 / Add.1, Annex 17, Resolution MEPC.269(68) 2015 Guidelines for the development of the inventory of hazardous materials

The products covered by this Manual do not contain asbestos.

Further information on REACH and RoHS can be found at: **http://www.drive-setup.com/environment**.

Conflict minerals

With reference to the Conflict Minerals (Compliance) (Northern Ireland) (EU Exit) Regulations 2020, the U.S. Dodd-Frank Wall Street Reform and Consumer Protection Act and Regulation (EU) 2017/821 of the European Parliament and of the European Council:

We have implemented due diligence measures for responsible sourcing, we conduct conflict minerals surveys of relevant suppliers, we continually review due diligence information received from suppliers against company expectations and our review process includes corrective action management. We are not required to file an annual conflict minerals disclosure. Nidec Control Techniques Limited is not an issuer as defined by the U.S. SEC.

Disposal and recycling (WEEE)

The products covered by this Manual fall within the scope of the UK Waste Electrical and Electronic Equipment Regulations 2013, EU Directive 2012/19/EU amended by EU Directive 2018/849 (EU) on Waste Electrical and Electronic Equipment (WEEE).

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

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

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Contents

1 Safety information

1.1 Warnings, Cautions and Notes

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

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

NOTE

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

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

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

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

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

1.3 Responsibility

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

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

1.4 Compliance with regulations

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

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

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

2006/42/EC Safety of machinery.

2014/30/EU: Electromagnetic Compatibility.

1.5 Electrical hazards

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

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

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

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

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

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

1.6 Stored electrical charge

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

1.7 Mechanical hazards

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

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

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

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

1.8 Access to equipment

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

1.9 Environmental limits

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

1.10   Hazardous environments

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

1.11   Motor

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

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

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

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

1.12   Mechanical brake control

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

1.13   Adjusting parameters

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

1.14   Electromagnetic compatibility (EMC)

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

2 Introduction

2.1 Module information

The SI-Encoder V2 module provides a position feedback interface for the following feedback device types:

- Quadrature AB incremental encoder without marker pulse
- Tamagawa SMART-ABS/SMART-INC absolute multi-turn and single turn encoders
- Sankyo absolute multi-turn and single turn encoders

2.2 Compatible drive models

The SI-Encoder V2 module provides an encoder interface for the following drives.

Drive type	High performance drives	General purpose drives
Drive Model	Unidrive M600 & M70x Digitax HD	Commander C200/C300 Unidrive M200 to M400
Recommended firmware	V01.08.00 or later (V01.22.00 or later recommended if the electronic nameplate is used)	V01.05.06 or later

2.3 Set-up parameters

All parameters associated with the option module can be found in either menu 15, 16, or 17 depending on which option slot on the drive the module is fitted to.

Option Slot	Menu
1	15
2	16
3	17

In this user guide parameter references contain "mm" as a reference to the menu number. "mm" can be replaced by the menu number based on the option slot the module is fitted in. For example, a reference to *Device Type* (mm.038) for the module fitted in slot 3 would refer to parameter *Device Type* (17.038).

2.4 Compatible encoders

The following encoder types are supported

Device Type (mm.038)	Encoder features
AB (0)	Incremental encoders with no marker connection giving incremental position feedback which is initialised to zero at power-up and when the position feedback interface is initialised.
SMART-ABS (1)	Tamagawa SMART-ABS encoders which give multi-turn absolute position feedback using a battery to retain the multi-turn position. These encoders can be used without a battery, but the multi-turn position will not be retained after power-down. This option should also be selected for Tamagawa SMART-INC which give single turn absolute position feedback. Throughout this user guide these encoders are include in the descriptions related to SMART-ABS encoders unless any difference is specifically mentioned. Example devices: TS5700N8401 - SMART-ABS (16 bit turns, 23 bit position within one turn) TS5711N240 - SMART-INC (17 bit position within one turn) Tamagawa SMART-ABS/INC encoders support an electronic nameplate for up to 124 drive parameters.
Sankyo (2)	Sankyo AP05001 multi-turn absolute encoder as used on the S-Flag 2 range of servo motors, which gives multi-turn position feedback using a battery to retain the multi-turn position. This encoder can be used without a battery, but the multi-turn position will not be retained after power-down. Sankyo encoders support an electronic nameplate for up to 16 drive parameters.

When the module is fitted to a General Purpose drive only the incremental AB encoder is supported, for use as a reference encoder input only.

When the module is fitted to a High Performance drive any of the supported encoder types can be used for motor control feedback in RFC-A and RFC-S modes, or as a reference encoder input. If an incremental AB encoder is used for motor control feedback in RFC-S mode then a phasing test must be performed each time the encoder initialised such as at power-up, after the configuration is changed, or after a module trip has been reset.

It should be noted that the position returned by SMART-ABS and Sankyo encoders increases when the encoder rotates in the counter-clockwise direction, unlike other position feedback devices supported by Control Techniques drives. The SI-Encoder V2 module reverses the direction of rotation of these encoders so that with default settings, the motor on which the encoder is fitted will rotate in the clockwise direction when viewed from the motor shaft end with a positive (forward) speed reference.

2.5 Electronic Nameplate

Tamagawa and Sankyo encoders provide some internal memory that can be used for storing drive parameter data as an electronic nameplate. If the encoder contains electronic nameplate data, this can be read from the encoder into the drive by setting Parameter mm.000 to 110S1 and resetting the drive, where S defines the slot number in which the SI-Encoder V2 module is fitted.

2.6 Position Freeze

The SI-Encoder V2 module does not have a freeze input terminal but the position of the connected feedback device can be captured by a freeze input on the drive or another option module (i.e. SI-Applications Plus/Compact or SI-Universal Encoder modules). The position of the connected feedback device can be captured on a rising or falling edge of the freeze signals and the delay of the sensor used to trigger the freeze can also be compensated for.

3   Mechanical Installation

> ⚠️ **WARNING**
>
> Before installing or removing an option module from any drive, ensure the AC supply has been disconnected for at least 10 minutes and refer to section 1 *Safety information* on page 4. If using a DC bus supply ensure this is fully discharged before working on any drive or option module.

3.1   General installation

For information on the installation of the SI-Encoder V2 option module please refer to the installation sheet provided with the option module.

NOTE

Option modules can only be installed on drives that have the option module slot functionality.

4 Electrical Installation

4.1 Terminal descriptions

Figure 4-1 Module connections

Multi-turn SMART-ABS and Sankyo encoders have battery connections. These are not connected to the option module but should be connected to an external battery if required.
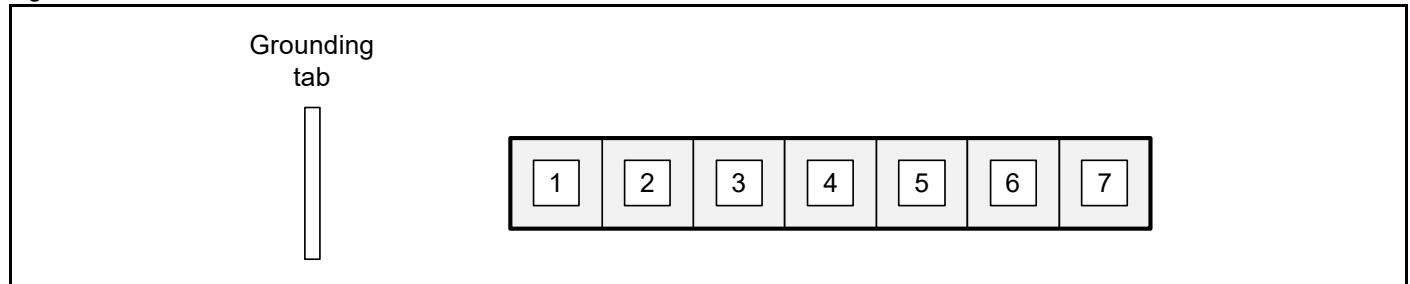
Terminal	Encoder		
	AB	**SMART-ABS**	**SANKYO**
1	A	Data	Data
2	A\	Data\	Data\
3	B		
4	B\		
5	+V (Encoder power supply output)		
6	0V		
7	Shield connection (not connected to 0V)		

For best noise immunity the grounding tab should be connected to ground using the minimum length of cable with the largest cross-sectional area possible, and the encoder cable shield should be connected to the dedicated shield connection (terminal 7).

> ⚠ **WARNING**
>
> For Unidrive M and Commander C drives the control circuits are isolated from the power circuits in the drive by basic insulation only, as specified in IEC60664-1. The installer must ensure that the external control circuits are insulated from human contact by at least one layer of insulation rated for use at the AC supply voltage.
>
> If the module is to be used with Unidrive M or Commander C drives and the control circuits are to be connected to other circuits classified as Safety Extra Low Voltage (SELV) (e.g. to a personal computer), then an additional isolating barrier must be included in order to maintain the SELV classification.

4.2 Terminal specifications

1,2	Channel A, Data
3,4	**Channel B**

AB (0) encoders	
Maximum frequency	500 kHz
Line terminations	120 Ω (switchable)
SMART-ABS (1) and SANKYO (2) encoders	
Maximum Frequency	2.5 MHz
Line terminations	120 Ω (fixed)
Common to all	
Type	EIA 485 different receivers
Line loading	<2 units loads
Working common mode range	+12 Vdc to -7 Vdc
Absolute maximum applied voltage relative to 0V	+14 Vdc to -9 Vdc

4	Encoder power supply output
Supply voltage	5.15 V ±4 %, 8 V ±5 % or 15 V ±6 %
Maximum output current	300 mA for 5 V and 8 V 200 mA for 15 V

6	0V common

7	Shield connection

The maximum input frequency for an AB encoder is 500 kHz. The maximum speed in rpm for an AB encoder is given by,

Maximum speed = 500kHz x 60 / Lines per revolution

For example, the maximum speed for a 4096 line encoder would be 7324 rpm.

For details of the maximum speed of a SMART-ABS or Sankyo encoder, refer to the relevant encoder datasheet.

4.3   Wiring, Shield connections

Shielding considerations are important for PWM drive installations due to the high voltages and currents present in the output circuit with a very wide frequency spectrum, typically from 0 to 20 MHz. Encoder inputs are liable to be disturbed if careful attention is not given to managing the cable shields.

A grounding tab is present on the module and in the following cases this must be connected to the closest possible grounding point (for example, the drive's heatsink) using the minimum length of cable with the largest cross-sectional area possible.

• A communications encoder (Tamagawa SMART-ABS or Sankyo) is used
• The module is fitted to a Commander C200/300 or Unidrive M200-M400

This improves the noise immunity of the module.

To ensure correct operation, observe the following

• Use a cable with the correct impedance
• Use a cable with an overall shield
• For the SI-Encoder V2 module do not connect the cable shields to 0V at the module/drive nor at the encoder.
• Directly clamp the shield to the encoder body (no pigtail) and to the drive grounding bracket. The shield can be terminated at terminal 7 at the module if required. Terminal 7 is not connected to 0V.
• The cable should preferably not be interrupted. If interruptions are unavoidable, ensure the absolute minimum length of "pigtail" in the shield connections at each interruption. Preferably, use a connection method which provides substantial metallic clamps for the cable shield terminations.
• Clamp the overall shield to grounded metallic surfaces at both the encoder and the drive, as illustrated in Figure 4-2.

NOTE

The recommendations of the encoder manufacturer must also be adhered to for the encoder connections.

Figure 4-2 illustrates the preferred method of clamping. The outer sheath of the cable should be stripped back enough to allow the clamp to be installed. The shield must not be broken or opened at this point. The clamps should be installed close to the drive or encoder, with the ground connections made to a ground plate or similar metallic ground surface.

Figure 4-2   Encoder cable connections
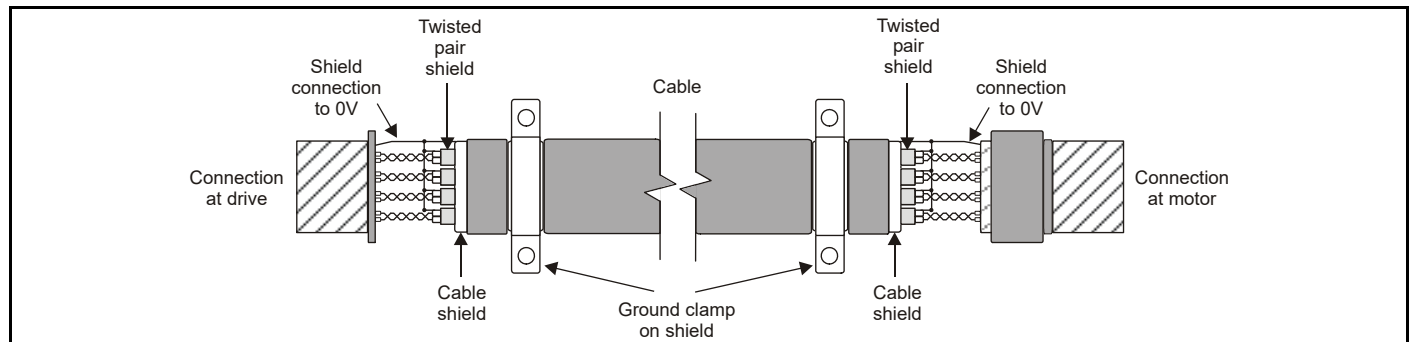
5 Getting Started

When setting up the SI-Encoder V2 the host drive should be disabled by removing the Safe Torque Off (STO) or enable signals to the drive.

5.1 Auto-identification and auto-configuration

When fitted to a high performance drive and with default parameter settings, then at each power up the SI-Encoder V2 module will attempt to automatically identify the connected encoder, and in the event of it detecting a Tamagawa SMART-ABS/INC or Sankyo encoder, it will auto-configure the necessary module parameters listed below and make the encoder ready for use without any further action.

- *Device Type* (mm.038)
- *Additional Configuration* (mm.074)

If a quadrature AB encoder is connected or auto-configuration fails then *Device Type* (mm.038) will be set to AB (0). *Lines Per Revolution* (mm.034) for an AB encoder cannot be determined automatically from the encoder and must be configured manually.

5.2 Manual setup

5.2.1 AB incremental encoder setup

Follow the steps below to manually setup a quadrature incremental encoder.

Quadrature AB Incremental encoder	
Device Type (mm.038)	**AB** (0)
Supply Voltage (mm.036)	**5V** (0), **8V** (1) or **15V** (2) **NOTE** If output voltage from the encoder is >5 V, then the termination resistors must be disabled by setting *Termination Select* (mm.039) to 0
Lines Per Revolution (mm.034)	Set to the number of lines or pulses per revolution of the encoder
Termination Select (mm.039)	**1** = Terminations enabled on both the A and B channels **0** = Terminations disabled on both the A and B channels Unless there is a specific need to disable termination resistors such as if the encoder output voltage is greater than 5V or if the encoder signals are daisy chained to more than one encoder input, then it is recommended to leave them in the default condition of enabled.
Auto-configuration Select (mm.041)	It is not necessary to change this parameter, but it can be set **Disabled** (0) to prevent the module attempting to auto-identify a SMART-ABS or Sankyo encoder.

5.2.2 Tamagawa SMART-ABS and Sankyo encoder setup (high performance drives only)

Follow the steps below to manually setup a SMART-ABS or Sankyo encoder.

Tamagawa SMART-ABS/INC communications encoder Sankyo communications encoder	
Device Type (mm.038)	**AB** (0)
Supply Voltage (mm.036)	5V (0) **NOTE** All Tamagawa SMART-ABS/INC and Sankyo encoders require a 5V power supply
Auto-configuration Select (mm.041)	**Disabled** (0):Use this setting for full manual setup with no auto-identification or auto-configuration of the encoder (*Device Type* (mm.038) and *Additional Configuration* (mm.074) must be set manually). **Full** (1):Use this setting for full auto-identification of the encoder type and auto-configuration of the encoder settings. This is the default setting. **Partial** (2):Use this setting for auto-configuration of the encoder settings but no auto-identification of the encoder type (*Device Type* (mm.038) must be set manually).
Additional Configuration (mm.074)	This parameter includes 2 fields as shown below. | Decimal Digits	2	1-0
---	---	---
Description	Single Turn	Position Padding	 **Position Padding** The encoder position within a turn from the encoder is a 24 bit value, however the actual data may not completely fill all 24 bits. This padding value gives the number of left (most significant) padding bits between 0 and 23 **Single Turn** Set this to 1 if the encoder is a single turn device, otherwise set to 0. Examples: A single turn encoder with position padding of 4 bits would have the value of 104 A multi-turn encoder with a position padding of 1 bit would have the value of 1.

Error Detection (mm.040)	Enable or disable the required error detection features by setting the relevant bits as detailed below. | Bit	Function	Device Type | |---|---|---| | 0 | N/A | N/A | | 1 | Disable multi-turn counter overflow detection | SMART-ABS | | 2 | Disable over-temperature detection | SMART-ABS or Sankyo | | 3 | Disable multi-turn error detection | SMART-ABS or Sankyo | | 4 | Disable low battery detection | SMART-ABS or Sankyo | | 5 | Disable over-speed detection | SMART-ABS or Sankyo | | 6 | Disable low resolution indication | SMART-ABS | Errors detected and latched in the encoder are not removed by drive reset. If the encoder is indicating an error then the appropriate mode in *Encoder Initialisation Mode* (mm.076) should be set.
Encoder Initialisation Mode (mm.076)	**No Error Reset** (0): No error indications are cleared within the encoder. If errors indicated by the encoder are causing a trip (i.e. Low battery) and the trip has not been disabled then when the drive is reset it will trip again. **Error Reset Only** (1): Clear error indications within the encoder. The multi-turn position is not affected. **Multi-turn Reset** (2): Clear error indications within the encoder and reset the multi-turn position.

5.3   Selecting the module for motor control feedback (high performance drives only)

If the SI-Encoder V2 module is required to be the source of control feedback for the drive then *Motor Control Feedback Select* (03.026) on the drive should be set to one of the following settings depending on which option slot the module is installed in.

Option Slot	Setting for *Motor Control Feedback Select* (03.026) on the drive
1	P1 Slot 1 (2)
2	P1 Slot 2 (4)
3	P1 Slot 3 (6)

6   Parameters

6.1   Logic diagram

Figure 6-1   SI-Encoder V2 logic diagram
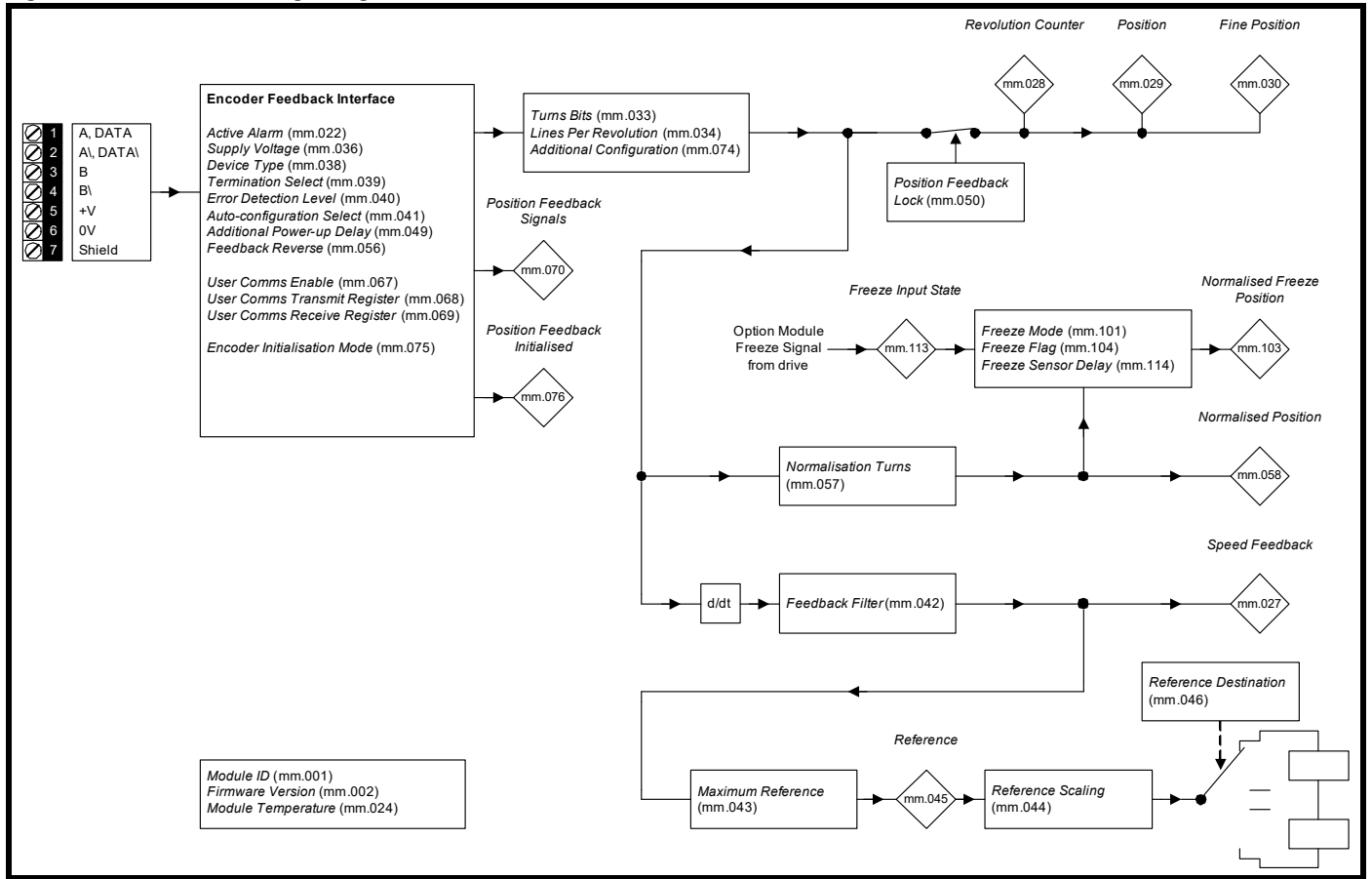
6.2 Single line descriptions

Parameter		Range	Default	Type					
mm.001	Module ID	0 to 999	105	RO	Num	ND	NC	PT	
mm.002	Firmware Version	0 to 99999999		RO	Num	ND	NC	PT	
mm.022	Active alarm	None (0), Low Battery (1)		RO	Txt	ND	NC	PT	
mm.024	Module Temperature	-50 to 175 °C		RO	Num	ND	NC	PT	
mm.027	Speed Feedback	±50000.0		RO	Num	ND	NC	PT	FI
mm.028	Revolution Counter	0 to 65535		RO	Num	ND	NC	PT	
mm.029	Position	0 to 65535		RO	Num	ND	NC	PT	
mm.030	Fine Position	0 to 65535		RO	Num	ND	NC	PT	
mm.033	Turn Bits	0 to 16	16	RW	Num				US
mm.034	Lines Per Revolution	1 to 100000	4096	RW	Num				US
mm.036	Supply Voltage	5 V (0), 8 V (1), 15 V (2)	5 V (0)	RW	Txt				US
mm.038	Device type	AB (0), SMART ABS (1), Sankyo (2)	AB (0)	RW	Txt				US
mm.039	Termination Select	0 to 1	1	RW	Num				US
mm.040	Error Detection Level	0000000 to 1111111	1100111	RW	Bin				US
mm.041	Auto configuration Select	Disabled (0), Full (1), Partial (2)	Full (1)	RW	Txt				US
mm.042	Feedback Filter	Disabled (0), 1 ms (1), 2 ms (2), 4 ms (3), 8 ms (4), 16 ms (5)	Disabled (0)	RW	Txt				US
mm.043	Maximum Reference	0 to 50000	3000	RW	Num				US
mm.044	Reference Scaling	0.000 to 4.000	1.000	RW	Num				US
mm.045	Reference	±100.0 %		RO	Num	ND	NC	PT	FI
mm.046	Reference Destination	0.000 to 59.999	0.000	RW	Num	DE		PT	US
mm.049	Additional Power up Delay	0.0 to 25.0	0.0 s	RW	Num				US
mm.050	Position Feedback Lock	Off (0) or On (1)	Off (0)	RW	Bit				US
mm.056	Feedback Reverse	Off (0) or On (1)	Off (0)	RW	Bit				US
mm.057	Normalisation Turns	0 to 16	16	RW	Num				US
mm.058	Normalised Position	-2147483648 to 2147483647		RO	Num	ND	NC	PT	
mm.067	User Comms Enable	Off (0) or On (1)	Off (0)	RW	Bit		NC	PT	
mm.068	User Comms Transmit Register	0 to 65535	0	RW	Num		NC	PT	
mm.069	User Comms Receive Register	0 to 65535	0	RW	Num		NC	PT	
mm.070	Position Feedback Signals	000000000 to 111111111		RO	Bin	ND	NC	PT	
mm.074	Additional Configuration	0 to 123	1	RW	Num				US
mm.075	Encoder Initialisation Mode	No Error Reset (0), Error Reset Only (1), Multi turn Reset (2), Position Reset (3)		RW	Txt	ND	NC	PT	
mm.076	Position Feedback Initialised	Off (0) or On (1)		RO	Bit	ND	NC	PT	
mm.101	Freeze Mode	Rising 1st (0), Falling 1st (1), Rising all (2), Falling all (3)	Rising 1st (0)	RW	Txt				US
mm.103	Normalised Freeze Position	-2147483648 to 2147483647		RO	Num	ND	NC	PT	
mm.104	Freeze Flag	Off (0) or On (1)		RW	Bit	ND	NC	PT	
mm.113	Freeze Input State	Off (0) or On (1)		RO	Bit	ND	NC	PT	
mm.114	Freeze Sensor Delay	0.0 to 250.0 µs	0 µs	RW	Num				US

RW	Read / Write	RO	Read-only	Bit	Bit parameter	Txt	Text String
Num	Number parameter	Bin	Binary parameter	DE	Destination	ND	No default value
NC	Non-copyable	PT	Protected	FI	Filtered	US	User save

6.3   Parameter descriptions

mm.001	Module ID				
Minimum	0	**Maximum**	999	**Default**	105
Decimal places	0	**Units**		**Update rate**	Power-up write
Type	16 Bit Volatile	**Display format**	Standard	**Coding**	RO, ND, NC, PT

This parameter displays the ID number for the option module. For the SI-Encoder V2 module this is 105.

mm.002	Firmware Version				
Minimum	0	**Maximum**	99999999	**Default**	
Decimal places	0	**Units**		**Update rate**	Power-up Write
Type	32 Bit Volatile	**Display format**	Version	**Coding**	RO, ND, NC, PT

mm.022	Active Alarm				
Minimum	0	**Maximum**	1	**Default**	
Decimal places	0	**Units**		**Update rate**	Background Write
Type	8 Bit Volatile	**Display format**	Standard	**Coding**	RO, TE, ND, NC, PT

Value	Text	Description
0	None	No active alarm.
1	Low Battery	Encoder battery voltage is below the allowed threshold.

This parameter shows the currently active alarm. If this option module is not indicating an alarm this parameter shows *None* (0).

mm.024	Module Temperature				
Minimum	-50	**Maximum**	175	**Default**	
Decimal places	0	**Units**	°C	**Update rate**	Background Write
Type	16 Bit Volatile	**Display format**	Standard	**Coding**	RO, ND, NC, PT

Displays the temperature measured on the module printed circuit board. The module will initiate an *Overheated* (106) trip if the measured temperature exceeds 90 °C.

mm.027	Speed Feedback				
Minimum	-50000.0	**Maximum**	50000.0	**Default**	
Decimal places	0	**Units**		**Update rate**	4 ms write (High performance drive), 20 ms write (General purpose drive)
Type	32 Bit Volatile	**Display format**	Standard	**Coding**	RO, FI, ND, ND, PT

Provided the set-up parameters for the encoder connected to this module are correct this parameter shows the speed derived from the feedback in rpm. The value shown is measured over a 16 ms sliding window period.

mm.028	Revolution Counter					
mm.029	Position					
mm.030	Fine Position					
Minimum	0	Maximum	65535	Default		
Decimal places	0	Units		Update rate	4 ms write (High performance drive), 20 ms write (General purpose drive)	
Type	16 Bit Volatile	Display format	Standard	Coding	RO, ND, NC, PT, BU	

Revolution Counter (mm.028), *Position* (mm.029) and *Fine Position* (mm.030) combined give the encoder position with a resolution of $1/2^{32}$ of a revolution as a 48 bit number.

47	32	31	16	15	0
Revolution Counter		Position		Fine Position	

Provided the encoder set-up parameters are correct, the position is always converted to units of $1/2^{32}$ of a revolution, but some parts of the value may not be relevant depending on the resolution of the feedback device. For example, a 1024 line quadrature encoder produces 4096 counts per revolution. This is represented by 12 bits of information shown in the shaded area below.

47	32	31	20	19	16	15	0
Revolution Counter		Position				Fine Position	

Device Type (mm.038): AB

At power-up and each time the encoder is subsequently initialised the whole position represented by these three parameters is reset to zero. When the position feedback moves by more than one revolution the *Revolution Counter* (mm.028) increments or decrements in the form of a sixteen bit roll-over counter. If required the *Revolution Counter* (mm.028) can be masked to remove the most significant part by defining the number of turns with *Turns Bits* (mm.033).

Device Type (mm.038): SMART-ABS, Sankyo

At power-up, and each time the encoder is subsequently initialised, the whole position represented by these three parameters is set to the absolute position of the encoder. This will then change as the encoder position changes using the difference between the position at each sample. This gives a full 48 bit counter that will roll over the zero boundary without a discontinuity. If required *Turns Bits* (mm.033) can be used to mask the most significant part of the revolution counter, so that the maximum value is equal to the number of turns from the encoder. For example, if a SMART-INC encoder is used, which gives no turns information, *Turns Bits* (mm.033) can be set to zero so that *Revolution Counter* (mm.028) is always zero.

mm.033	Turn Bits				
Minimum	0	Maximum	16	Default	16
Decimal places	0	Units		Update rate	Background read
Type	8 Bit User Save	Display format	Standard	Coding	RW

It is sometimes desirable to mask off the most significant bits of *Revolution Counter* (mm.028), but this does not have to be done for the drive to function correctly. If *Turns Bits* (mm.033) = 0 the whole of *Revolution Counter* (mm.028) is held at zero. If *Turns Bits* (mm.033) has any other value it indicates the number of bits in *Revolution Counter* (mm.028) that are not held at zero. For example, if *Turns Bits* (mm.033) = 5, then *Revolution Counter* (mm.028) counts up to 31 before being reset.

mm.034	Lines Per Revolution				
Minimum	1	Maximum	100000	Default	4096
Decimal places	0	Units		Update rate	Background read
Type	32 Bit User Save	Display format	Standard	Coding	RW

Device Type (mm.038): AB
This parameter must be set to the number of lines per revolution for the encoder connected to this module.

Device Type (mm.038): SMART-ABS, Sankyo
This parameter has no effect.

mm.035	Supply Voltage				
Minimum	5 V (0)	Maximum	15 V (2)	Default	5 V (0)
Decimal places	0	Units		Update rate	Background read
Type	8 Bit User Save	Display format	Standard	Coding	RW, TE

Value	Text
0	5 V
1	8 V
2	15 V

This parameter sets the level for the encoder power supply output voltage on terminal 5. To ensure that the maximum voltage for the position feedback device is not accidentally exceeded, the device should be disconnected from the module when the level is being adjusted.

If the output voltage is set to greater than 5 V and the signals from the encoder are also greater than 5V then the input terminations should be disabled, by setting *Termination Select* (mm.039) to 0, to prevent *PSU Overload* (102) trips or overloading of the termination resistors. If standby mode is enabled in the drive, i.e. *Standby Mode Enable* (06.060) = 1 and the appropriate mask bit set in *Standby Mode Mask* (06.061), the power supply output is turned off when standby mode becomes active.

mm.038	Device Type				
Minimum	AB (0)	Maximum	Sankyo (2)	Default	AB (0)
Decimal places	0	Units		Update rate	Background read
Type	8 Bit User Save	Display format	Standard	Coding	RW, TE

Value	Text
0	AB
1	SMART-ABS
2	Sankyo

This parameter should be set up to match the device connected to the option module. If *Auto-configuration Select* (mm.041) = *Full* (1) an attempt will be made to automatically detect the encoder that is connected to this option module. See *Auto-configuration Select* (mm.041) for more details.

NOTE

If this option module is fitted to a general purpose drive it can only be used with an AB type encoder. If a SMART-ABS or Sanko encoder is selected then a *Compatibility* (117) trip is initiated and the interface for an AB type encoder will remain active.

AB

This is an incremental encoder, and only the A and B quadrature signals can be connected. The position is zero at power-up (or encoder re-initialisation) and accumulates the change of position from that point on, and so the position is incremental and not absolute. These devices are suitable for motor control in RFC-A mode. They can also be used for RFC-S mode, but some form of phasing auto-tune is required each time the position feedback is initialised.

SMART-ABS

This setting should be used for both Tamagawa SMART-ABS and SMART-INC encoders. SMART-ABS encoders use digital communications to provide absolute multi-turn position feedback using a back-up battery to retain the turns information. SMART-INC encoders operate in the same way, but do not use battery back-up and only provide absolute position within one turn. These encoders use an identification byte (ENID) so that the option module can automatically detect which device is connected during auto-configuration. The table below gives the identification bytes that can be recognised and the format of the device.

ENID	Type	Turns	Resolution within a turn	Example devices
0x06	SMART-INC	Single	23	
0x17	SMART-ABS	16	23	TS5700N8401
0x00	SMART-INC	Single	17	TS5711N240
0x11	SMART-ABS	16	17	

For these encoders to function correctly *Additional Configuration* (mm.074) must be set up to indicate if the encoder is single or multi-turn, and to give the position padding related to the resolution. If *Auto-configuration Select* (mm.041) is left at its default value of Full (1) or set to Partial (2) then this parameter is set-up automatically for a supported device on power-up and each time the device is re-initialised when one of the supported devices is connected.

Sankyo

Sankyo AP05001 communication encoder provides absolute multi-turn position feedback using battery back-up to retain the turns information. The ENID value for this device is 0x00. *Additional Configuration* (mm.074) must be set up to indicate this is a multi-turn device, and to give the position padding related to the resolution. If *Auto-configuration Select* (mm.041) is left at its default value of Full (1) or set to Partial (2) then this parameter is set-up automatically if an AP05001 encoder is connected on power-up and each time the device is re-initialised.

mm.039	Termination Select				
Minimum	0	**Maximum**	1	**Default**	1
Decimal places	0	**Units**		**Update rate**	Background read
Type	8 Bit User Save	**Display format**	Standard	**Coding**	RW

Device Type (mm.038): AB

This parameter is used to enable or disable the terminations on the position feedback interface inputs. The table below shows the functionality of this parameter.

Terminal	Input	*Termination Select* (mm.039) = 0	*Termination Select* (mm.039) = 1
1/2 & 3/4	A & B	Disabled	Enabled

If the termination resistors are disabled, the wire break system will not operate regardless of the setting in *Error Detection Level* (mm.040). If the output voltage in *Supply Voltage* (mm.036) is set to greater than 5V and the signals from the encoder are greater than 5V, then the input terminations should be disabled by setting *Termination Select* (mm.039) to 0, to prevent *PSU Overload* trips or overloading of the termination resistors.

Device Type (mm.038): SMART-ABS, Sankyo

This parameter has no effect, and the terminations cannot be disabled.

mm.040	Error Detection Level				
Minimum	000 0000 (0)	**Maximum**	111 1111 (127)	**Default**	110 0111 (103)
Decimal places	0	**Units**		**Update rate**	Background read
Type	8 Bit User Save	**Display format**	Binary	**Coding**	RW

This parameter can be used to enable or disable position feedback trip functions as follows:

Bit	Function	*Device Type (mm.038)	Default
0	Enabled wire break detection	AB (0)	1
1	Disable multi-turn counter overflow detection	SMART-ABS (1)	1
2	Disable over-temperature detection	SMART-ABS (1) or Sankyo (2)	1
3	Disable multi-turn error detection	SMART-ABS (1) or Sankyo (2)	0
4	Disable low battery detection	SMART-ABS (1) or Sankyo (2)	0
5	Disable over-speed detection	SMART-ABS (1) or Sankyo (2)	1
6	Disable low resolution indication	SMART-ABS (1)	1

*Each bit is only active for the range of encoder types shown.

Bit 0: Enable wire break detection (1 as default)

It may be important to detect a break in the connections between the module and the encoder. This is accomplished with hardware detectors on the A and B signals that detect a wire break. This is enabled by setting Bit 0 to 1. NOTE: if the termination resistors are not enabled in *Termination Select* (mm.039), the wire break system will not operate.

Bit 1: Disable multi-turn counter overflow detection (1 as default)

Multi-turn counter overflow detection occurs if the multi-turn position crosses the 32767 -32768 boundary and initiates a *Counter Overflow* trip. This trip can be disabled by setting Bit 1 to 1.

Bit 2: Disable encoder over-temperature detection (1 as default)

If the internal encoder temperature rises above the detection threshold defined within the encoder then an *Encoder Temp* trip is initiated. This trip can be disabled by setting Bit 2 to 1.

Bit 3: Disable multi-turn error detection

If the encoder detects a multi-turn error a *Multi-turn Error* trip is initiated. This trip can be disabled by setting Bit 3 to 1.

Bit 4: Disable low battery detection

If the battery voltage falls below the detection threshold of the encoder when the encoder is powered down then a *Low Battery* trip is initiated when the drive powers up again. This trip can be disabled by setting Bit 4 to 1. Setting this bit to 1 also disables the alarm that indicates the battery is below the allowed threshold when the encoder is powered up.

Bit 5: Disable over-speed detection (1 as default)

If this bit is set then the over-speed detection from the encoder is ignored, and *Over-Speed* trip is disabled. This is disabled as default in case the encoder is being operated with no battery as this can result in incorrect detection of over-speed. During over-speed conditions the multi-turn data can become incorrect. If a battery is being used then this trip can be enabled if required.

Bit 6: Disable low resolution indication (1 as default)

If this bit is set then the low resolution indication from the encoder is ignored, and *Low Resolution* trip is disabled.

See section 7 *Diagnostics* on page 27 on page for a list of the trips that can be initiated by this option module.

mm.041	**Auto-configuration Select**				
Minimum	0	Maximum	2	Default	1
Decimal places	0	Units		Update rate	Background read
Type	8 Bit User save	Display format	Standard	Coding	RW, TW, BU

If this parameter is left at its default value of Full (1) then the following procedure is carried out to detect the type of position feedback device connected to the module.

1. If this option module is fitted to a general purpose drive *Device Type* (mm.038) is set to AB (0) and the detection process is terminated.
2. If the terminations are disabled (i.e. *Termination Select* (mm.039) = 0) then *Device Type* (mm.038) is set to AB (0) and the detection process is terminated.
3. The wire break detection on both the A and B inputs for an AB incremental encoder is checked and if this shows that either input is connected to an encoder output it is assumed an AB encoder is connected. Therefore, *Device Type* (mm.038) is set to AB (0) and the detection process is terminated. (If only one input is connected the drive will initiate a *Wire break A* or *Wire break B* trip because the drive will be set up for an AB encoder, but one input is not connected.)
4. The drive will wait for the time defined by *Additional Power-up Delay* (mm.049) plus 1.5s.
5. The auto-detection system attempts to communicate with a SMART-ABS and then a Sankyo encoder connected to the A input of the option module. If this is not successful *Device Type* (mm.038) is set to AB (0) and the detection process is terminated. Otherwise, *Device Type* (mm.038) is set to SMART-ABS (1) or Sankyo (2) depending on the type of encoder detected.
6. If the encoder is a SMART-ABS or Sankyo encoder the drive attempts to read the identifier and uses this information to set up *Additional Configuration* (mm.074). If the identifier cannot be obtained these parameters are left at their default values and an *Encoder ID Error* trip is initiated.

The action for each of the values of this parameter is given below.

Auto-configuration Select (mm.041)	**Action**
Disabled (0)	No auto-configuration is attempted.
Full (1)	Full auto-configuration as defined above.
Partial (2)	No attempt is made to determine the type of encoder and *Device Type* (mm.038) is not modified. Step 6 above is performed if *Device Type* (mm.038) > 0.

mm.042	**Feedback Filter**				
Minimum	Disabled (0)	Maximum	16 ms (5)	Default	Disabled (0)
Decimal places	0	Units		Update rate	Background read
Type	8 Bit User Save	Display format	Standard	Coding	RW, TE

Value	*Text*
0	Disabled
1	1 ms
2	2 ms
3	4 ms
4	8 ms
5	16 ms

This parameter defines the time period for a sliding window filter that can be applied to the feedback. This is particularly useful in applications where the encoder is used to give speed feedback for the speed controller and where the load includes a high inertia, and so the speed controller gains are very high. Under these conditions, without a filter on the feedback, it is possible for the speed loop output to change constantly from one current limit to the other and lock the integral term of the speed controller.

mm.043	Maximum Reference				
Minimum	0	**Maximum**	50000	**Default**	3000
Decimal places	0	**Units**		**Update rate**	Background read
Type	16 Bit User Save	**Display format**	Standard	**Coding**	RW, BU

The speed feedback from the position feedback interface can be used as a source to control a parameter. The speed feedback is scaled to give a value as a percentage of *Maximum Reference* (mm.043) in 0.1 % units which is displayed in *Reference* (mm.045). The value is then scaled by *Reference Scaling* (mm.044) and routed to the destination defined by *Reference Destination* (mm.046). The destination target parameter is updated every 250μs in a high performance drive, or every 20ms in a general purpose drive. Although *Reference Destination* (mm.046) can be changed at any time, the destination target is only updated on drive reset. In a general purpose drive the speed feedback is filtered over 16ms before being used and the resolution applied to the destination parameter is 0.1% of the maximum value. In a high performance drive the output of the speed feedback filter defined by *Feedback Filter* (mm.042) is used so that the filter time constant can be defined. The resolution is limited by the resolution of the destination parameter or the internal representation of speed (55.9×10^{-6} rpm) whichever is the larger.

mm.044	Reference Scaling				
Minimum	0.000	**Maximum**	4.000	**Default**	1.000
Decimal places	3	**Units**		**Update rate**	Background read
Type	16 Bit User Save	**Display format**	Standard	**Coding**	RW

See *Maximum Reference* (mm.043).

mm.045	Reference				
Minimum	-100.0	**Maximum**	100.0	**Default**	
Decimal places	1	**Units**		**Update rate**	4 ms write (High performance drive), 20 ms write (General purpose drive)
Type	16 Bit User Save	**Display format**	Standard	**Coding**	RO, FI, ND, NC, PT

See *Maximum Reference* (mm.043).

mm.046	Reference Destination				
Minimum	0.000	**Maximum**	59.999	**Default**	0.000
Decimal places	3	**Units**		**Update rate**	Read on drive reset
Type	16 Bit User Save	**Display format**	Standard	**Coding**	RW, DE, PT, BU

See *Maximum Reference* (mm.043).

mm.049	Additional Power-up Delay				
Minimum	0.0	**Maximum**	25.0	**Default**	0.0
Decimal places	1	**Units**	s	**Update rate**	Background read
Type	8 Bit User Save	**Display format**	Standard	**Coding**	RW, BU

When the position feedback is initialised, at power-up or at any other time, a delay is included before the information from the feedback device is used or any attempt is made to communicate with the device. The minimum delays are shown in the table below. This parameter defines an additional delay that is added to the minimum delay.

Device Type (mm.038)	Minimum delay
AB (0)	100 ms
SMART-ABS (1)	1.5 s
Sankyo (2)	500 ms

mm.050	Position Feedback Lock				
Minimum	0	Maximum	1	Default	0
Decimal places	0	Units		Update rate	Background read
Type	1 Bit User Save	Display format	Standard	Coding	RW

If *Position Feedback Lock* (mm.050) = 1 then *Revolution Counter* (mm.028), *Position* (mm.029) and *Fine Position* (mm.030) are not updated. If *Position Feedback Lock* (mm.050) = 0 then these parameters are updated normally.

mm.056	Feedback Reverse				
Minimum	0	Maximum	1	Default	0
Decimal places	0	Units		Update rate	Background read
Type	1 Bit User Save	Display format	Standard	Coding	RW

If *Feedback Reverse* (mm.056) = 1 the direction of the encoder feedback is reversed.

mm.057	Normalisation Turns				
Minimum	0	Maximum	16	Default	16
Decimal places	0	Units		Update rate	Background read
Type	8 Bit User Save	Display format	Standard	Coding	RW

The combination of *Revolution Counter* (mm.028), *Position* (mm.029) and *Fine Position* (mm.030) give the position feedback as a 48 bit value. This position cannot be read atomically without locking the position feedback (*Position Feedback Lock* (mm.050) = 1) and it cannot be used directly by the Advanced Motion Controller in the drive. It is useful to be able to create 32 bit position values that can be held by a single parameter as this value can be accessed atomically and can be used directly by the Advanced Motion Controller. This parameter defines the number of turns bits included in the *Normalised Position* (mm.058).

mm.058	Normalisation Position				
Minimum	-2147483648	Maximum	2147483647	Default	
Decimal places	0	Units		Update rate	250 µs write (High performance drive), 20 ms write (General purpose drive)
Type	32 Bit Volatile	Display format	Standard	Coding	RO, ND, NC, PT

See *Normalisation Turns* (mm.057).

mm.064	Encoder Identifier				
Minimum	0	Maximum	255	Default	
Decimal places	0	Units		Update rate	Background write
Type	8 Bit Volatile	Display format	Standard	Coding	RO, ND, NC, PT, BU

This parameter shows the encoder identifier byte (ENID) given by SMART-ABS or Sankyo encoders in their communications responses. See *Device Type* (mm.038) for the ENID of supported devices. If *Device Type* (mm.038) = AB (0) then this parameter always shows zero.

mm.067	User Comms Enable				
Minimum	0	Maximum	1	Default	0
Decimal places	0	Units		Update rate	Background read
Type	1 Bit Volatile	Display format	Standard	Coding	RW, NC, PT

Device Type (mm.038): AB
User communications is not supported by this type of encoder, and so writing to *User Comms Transmit Register* (mm.068) has no effect and the value read from *User Comms Receive Register* (mm.069) will indicate there is no data.

Device Type (mm.038): SMART-ABS, Sankyo
If this parameter is set to one it is possible to use *User Comms Transmit Register* (mm.068) and *User Comms Receive Register* (mm.069) to communicate with the encoder. The following should be noted:

1. The user comms system is disabled if the position feedback device is not initialised.
2. The user comms system exchange will replace a message that is used to obtain position feedback, and so the position feedback from the previous exchange will be used for two samples. To minimise the disturbance the user comms system exchange will not be placed in the exchange that is carried out every 250 µs to obtain the position used to derive the speed feedback and *Normalised Position* (mm.058). However, if the encoder is being used as feedback for motor control there could be a disturbance in the position used to align the current controllers. This could give a small transient in the torque applied to the motor and will become worse as the drive output frequency increases. Although the user comms system can be used when the drive is enabled, to avoid any possible transients the user comms system should be used when the drive is disabled.

This system only allows reading or writing the internal memory within the encoder. The messages sent and received are processed by the option module before they are sent to the encoder and the response is processed before it is put into the receive buffer. This allows the option module to prevent access to areas of memory that are not allowed. To send a message to the encoder the required message must be written to the transmit register (*User Comms Transmit Register* (mm.068)). The message is stored into an internal buffer by writing a series of 16 bit values into *User Comms Transmit Register* (mm.068). The least significant byte of each value contains the message, and the most significant byte contains control bits described in the table below. When the option module sees a non-zero value in *User Comms Transmit Register* (mm.068) it reads it and then clears *User Comms Transmit Register* (mm.068) to zero.

Bit	Function
15	Should always be written as one to indicate data to be read by the option module.
14	This should be one when the last byte of the message is written.
13	This should be one when the first byte of the message is written to the transmit register. Setting this bit will reset the pointer to the start of the internal buffer.

Once the message is sent to the encoder (triggered by setting bit 14 in the transmit message) the option module stores the response in an internal buffer. The response can be read from *User Comms Receive Register* (mm.069). This parameter can be read at any time. The least significant byte of the value contains the message bytes and the most significant byte contains the status bits described in the table below. When *User Comms Receive Register* (mm.069) has been read it should be written as zero, so that the option module knows to write to this parameter again.

Bit	Function
15	There is still data in the receive buffer.
14	This is the last byte from the receive message.
13	There is no data in the receive buffer and the LS byte is the comms system status. This bits in the comms status remains set until a new exchange is started by writing to *User Comms Transmit Register* (mm.068).

The table below gives the meaning of the system status bits. Unlike the continuous message exchange that is used to give the position feedback the message exchanges via the user comms system do not initiate a trip if an error occurs.

Bit	Function
0	An attempt has been made to send a message with the incorrect number of bytes.
1	Not used.
2	An attempt has been made to send a message with an unsupported control field.
3	Cannot communicate because the encoder is not initialised or the encoder does not support communications.
4	An attempt has been made to access an address that is not allowed. This includes trying to write to a read-only address.
5	The encoder continued to indicate it was in the busy state (i.e. writing) after the 100ms allowed timeout.

The following sequence should always be followed to ensure that the received data is read correctly.

1. Check that *User Comms Receive Register* (mm.069) is not zero.
2. Check that *User Comms Transmit Register* (mm.068) is zero.
3. Write each word of the transmit message to *User Comms Transmit Register* (mm.068) in turn, waiting each time for the drive to return *User Comms Transmit Register* (mm.068) back to zero before writing the next word.
4. Once the whole transmit message has been written, write zero to *User Comms Receive Register* (mm.069).
5. Read *User Comms Receive Register* (mm.069). When it is non-zero this parameter has been updated with a value from the internal receive buffer.
6. Store the non-zero value and then write zero to *User Comms Receive Register* (mm.069) and if the end of the receive message has not been reached go to step 5 above to wait for this parameter to be updated again.

The above sequence must be followed to obtain the correct data in the receive message. It is not essential that any or all of the receive message is read before sending a new transmit message, and so steps 4 to 6 can be omitted if required provided step 1 is not ignored.

To read a memory address the transmit and receive messages contain the following bytes:

Transmit:	0x0D	Page	Address	Any value
Receive:	0x0D	Page	Address	Data

To write a memory address the transmit and receive messages contain the following bytes:

Transmit:	0x06	Page	Address	Data
Receive:	0x06	Page	Address	Data

If an error occurs there will still be a receive message in the buffer. In response to a read command the data will be zero. When the message has been read *User Comms Receive Register* (mm.069) will show the status and the status bits will indicate the reason for the error.

The following addresses are allowed in each type of encoder:

SMART-ABS

Page	Address	Function	Read/write
0 to 5	0x00 to 0x7E	Read/write memory	Read/write
7	0x04	Over temperature threshold	Read/write
7	0x05	Encoder temperature	Read only

Sankyo

Page	Address	Function	Read/write
0	0x00 to 0x6F	Read/write memory	Read/write
0	0x7E	Over temperature threshold	Read/write
0	0x7F	Low voltage threshold	Read/write

mm.068	User Comms Transmit Register				
mm.069	**User Comms Receive Register**				
Minimum	0	**Maximum**	65535	**Default**	0
Decimal places	0	**Units**		**Update rate**	Background read/write
Type	16 Bit Volatile	**Display format**	Standard	**Coding**	RW, NC, PT, BU

Device Type (mm.038): AB
These parameters have no effect.

Device Type (mm.038): SMART-ABS, Sankyo
See *User Comms Enable* (mm.067).

mm.070	Position Feeedback Signals				
Minimum	000000000 (0)	**Maximum**	111111111 (511)	**Default**	
Decimal places	0	**Units**		**Update rate**	Background write
Type	16 Bit Volatile	**Display format**	Binary	**Coding**	RO, ND, NC, PT

This parameter shows the state of the signals from the position feedback device as given in the table below. This parameter is intended as a debugging aid.

Device Type (mm.038): AB

Position Feedback Signals (mm.070) Bits	Signals
0	A
1	B

Device Type (mm.038): SMART-ABS, Sankyo

The only signal connection between the drive and the encoder is the communications link which changes too fast to be viewed in a parameter. To assist with debugging this parameter shows the error status byte from the encoder. The tables below show the meaning of each bit.

SMART-ABS

Bit	Meaning	Trip number	*Encoder Initialisation Mode* (mm.075) value required to reset encoder trip indication
0	Over-speed	107	1 or 2
1	Low resolution	108	
2	Counting error	109	1 or 2
3	Counter overflow	110	1 or 2
4	Encoder temperature	111	1 or 2
5	Multi-turn error	112	2
6	Low battery	113	2
7	Battery alarm. The battery is below the allowed threshold while the encoder is powered up.		
8	Bits 0 to 7 are being updated. If this bit is zero then Bits 0 to 7 show the value the last time the data was read from the encoder.		

Sankyo

Bit	Meaning	Trip number	*Encoder Initialisation Mode* (mm.075) value required to reset encoder trip indication
0	Over-speed	107	1 or 2
1	Sensor error	118	1 or 2
2	Position error	109	1 or 2
3	Memory error	119	1 or 2
4	Encoder temperature	111	
5	Multi-turn error	112	2
6	Low battery	113	2
7	Battery alarm. The battery is below the allowed threshold while the encoder is powered up.		
8	Bits 0 to 7 are being updated. If this bit is zero then Bits 0 to 7 show the value the last time the data was read from the encoder.		

mm.074	Additional Configuration				
Minimum	0	**Maximum**	123	**Default**	1
Decimal places	0	**Units**		**Update rate**	Background read
Type	32 Bit User Save	**Display format**	Standard	**Coding**	RW

This parameter provides additional configuration not covered by other set up parameters.

Device Type (mm.038): AB

This parameter has no effect.

Device Type (mm.038): SMART-ABS, Sankyo

This parameter includes 2 fields as shown below. The option module attempts to set this parameter automatically on power-up and encoder initialisation if *Auto-configuration Select* (mm.041) > 0.

Decimal Digits	2	1-0
Description	Single Turn	Position Padding
Default	0	01

Position Padding

The encoder position within a turn from the encoder is a 24 bit value, however the actual data may not completely fill all 24 bits. This padding value gives the number of left (most significant) padding bits between 0 and 23 (if the value is larger than 23 it is assumed to be 1). The default value of 01 gives one padding bit as the most significant bit.

Single Turn

If the encoder is a single turn device then this field should be set to 1.

mm.075	Encoder Initialisation Mode				
Minimum	0	**Maximum**	3	**Default**	
Decimal places	0	**Units**		**Update rate**	Background read
Type	8 Bit Volatile	**Display format**	Standard	**Coding**	RW, TE, ND, NC, PT

Value	*Text*	*Description*
0	No Error Reset	Internal encoder errors are not reset.
1	Error Reset Only	Internal encoder errors are reset.
2	Multi-turn Reset	Internal encoders errors and the multi-turn position are reset.
3	Position Reset	No errors are reset, but the position within one turn is reset.

Device Type (mm.038): AB

This parameter has no effect.

Device Type (mm.038): SMART-ABS, Sankyo

Errors detected by the encoder are shown in *Position Feedback Signals* (mm.070). Most of these errors are latched and require a special reset to remove them. It is important that these errors are not simply removed by a normal drive reset without further user intervention because the multi-turn position may be incorrect. To remove the detected error indication from within the encoder and clear the trip this parameter must be set to either 1 or 2 and the drive should be reset to clear the trip and re-initialise the encoder. Alternatively, this parameter can be set to 1 or 2 and the encoder can be initialised with *Initialise Position Feedback Devices* (03.075), but this will only internally reset the encoder and initialise it, and not clear the trip. The type of reset performed is given in the table below.

Encoder Initialisation Mode (mm.075)	Encoder Reset
No Error Reset (0)	No error indications are cleared within the encoder. If errors indicated by the encoder are causing a trip (i.e. Low battery) and the trip has not been disabled then when the drive is reset it will trip again.
Error Reset Only (1)	Clear error indications within the encoder. The multi-turn position is not affected.
Multi-turn Reset (2)	Clear error indications within the encoder and reset the multi-turn position.
Position Reset (3)	Reset the single turn position only. **NOTE** This changes the zero position of the encoder within one turn and should only be used if the zero position needs to be changed.

mm.076	Position Feedback Initialised				
Minimum	0	**Maximum**	1	**Default**	
Decimal places	0	**Units**		**Update rate**	Background read
Type	1 Bit Volatile	**Display format**	Standard	**Coding**	RO, ND, NC, PT

This parameter contains a flag that represents the initialisation state of the encoder connected to the option module. When this parameter is "On" it indicates that any power-up sequence for the device has been completed and the device is operating normally and providing position feedback. This is also reflected in parameter *Position Feedback Initialised* (03.076) in the drive which shows the initialisation state of all available position feedback devices in the drive and option modules. The encoder is initialised at power-up, when the drive is reset and the encoder is uninitialised and when position feedback initialisation is specifically requested. The encoder becomes uninitialised if the encoder configuration is changed or the module initiates a trip.

mm.101	*Freeze Mode*				
Minimum	Rising 1st (0)	**Maximum**	Falling all (3)	**Default**	Rising 1st (0)
Decimal places	0	**Units**		**Update rate**	Background read
Type	8 Bit User Save	**Display format**	Standard	**Coding**	RW, TE

Value	*Text*
0	Rising 1st
1	Falling 1st
2	Rising all
3	Falling all

With a high performance drive the drive freeze inputs can be routed to the freeze system of this option module. There are no freeze inputs on a general purpose drive, and so the freeze system cannot be used. This parameter defines the edges of the freeze signal used to trigger freeze events.

0: Rising 1st

Freeze events are produced on the rising edge of the freeze signal. If the *Freeze Flag* (mm.104) is 0 then the first rising edge causes the freeze position to be stored and *Freeze Flag* (mm.104) to be set to 1. No further freeze events are possible until *Freeze Flag* (mm.104) has been cleared by the user.

1: Falling 1st

As for Rising 1st, but the falling edge is used to trigger freeze events.

2: Rising All

Freeze events are produced on the rising edge of the freeze signal. If *Freeze Flag* (mm.104) is 0 then the first rising edge causes the freeze position to be stored and *Freeze Flag* (mm.104) to be set to 1. If further rising edges occur the freeze position is updated.

3: Falling All

As for Rising All, but the falling edge is used to trigger freeze events.

mm.103	Normalisation Freeze Position				
Minimum	-2147483648	**Maximum**	2147483647	**Default**	
Decimal places	0	**Units**		**Update rate**	250 µs write
Type	32 Bit Volatile	**Display format**	Standard	**Coding**	RO, ND, NC, PT

When a freeze event occurs the encoder position is stored and can be accessed as a 32 bit normalised value in *Normalised Freeze Position* (mm.103). This position is normalised in the same way as *Normalised Position* (mm.058). For AB encoders the position is captured at the freeze event using a hardware system. For SMART-ABS or Sankyo encoders the time of the freeze event is captured with hardware and then interpolation, based on the change of position during the previous 250 µs period, is used to estimate the position at the freeze event.

mm.104	Freeze Flag				
Minimum	0	**Maximum**	1	**Default**	
Decimal places	0	**Units**		**Update rate**	250 µs write
Type	1 bit Volatile	**Display format**	Standard	**Coding**	RW, ND, NC, PT

The freeze flag is set when a freeze event occurs. If 0 is written to *Freeze Flag* (mm.104) the freeze flag is cleared.

mm.113	Freeze Input State				
Minimum	0	**Maximum**	1	**Default**	
Decimal places	0	**Units**		**Update rate**	4 ms write
Type	1 Bit Volatile	**Display format**	Standard	**Coding**	RO, ND, NC, PT

This parameter shows the state of the freeze signal from the drive.

mm.114	Freeze Sensor Delay				
Minimum	0.0	**Maximum**	250.0	**Default**	0.0
Decimal places	1	**Units**	µs	**Update rate**	Background read
Type	16 Bit User Save	**Display format**	Standard	**Coding**	RW

Any delay in the sensor used to trigger a freeze event will cause the freeze position to advance (giving a larger freeze position) in the forward direction or retard (giving a smaller freeze position) in the reverse direction compared to the actual physical position. This effect becomes worse as the speed is increased. The error is given by:

$$\text{Freeze Error} = (\text{Speed (rpm)} / 60) \times 2^{\text{Normalised Position Bits}} \times \text{Sensor Time Delay}$$

Normalised Position Bits is the number of bits representing one turn given by:

$$\text{Normalised Position Bits} = 32 - \textit{Normalisation Turns} \text{ (mm.057)}$$

The time delay due to the drive and option module electronics is less than 500 ns for either the digital I/O or the marker inputs. However, external sensors can significantly increase the delay. *Freeze Sensor Delay* (mm.114) can be used to cancel the effect of the sensor delay and prevent unwanted advancing or retarding to the freeze position at higher speeds.

Key to parameter coding

RW	Read write	RO	Read-only	TE	Text string
ND	No default value	NC	Not cloneable	PT	Protected
BU	Unipolar or bit parameter with default of 1	RA	Voltage rating dependent	FI	Filtered
VM	Variable maximum	DE	Destination parameter	PR	Pseudo read-only

7 Diagnostics

7.1 Alarms

This option module can provide the following alarm. If an alarm is active it will be shown in *Active Alarm* (mm.022), and the alarm string will be shown on the drive's keypad display.

Table 7-1 Module alarms

Alarm	Reason	Solution
Low Battery	The encoder has reported that its backup battery is low. The multi-turn data from the encoder may not be correct. This alarm is only applicable to SMART-ABS and Sankyo encoders.	Check that the backup battery supply to the encoder is connected and has sufficient voltage. Replace the battery if necessary. If a battery is not being used then this alarm can be disabled with Bit 4 in *Error Detection Level* (mm.040). This will also disable the *Low Battery* trip.

7.2 Trips

The following are all the possible trips that can be initiated by this option module. The drive produces a *SlotX Error* trip, where X is the slot number where the module is fitted, with a sub-trip which indicates the reason for the trip. Possible trips depend on the type of encoder selected

Table 7-2 Module trips

Trip	Reason for trip	Solution
Comms Error 115	A SMART-ABS or Sankyo encoder has detected a communications error, or the communications response has failed its CRC check.	If this trip occurs check the encoder wiring arrangement as the communications is probably being disturbed by electrical noise.
Comms Loss 114	The response from a SMART-ABS or Sankyo encoder contained no data or not enough data. It is likely that the encoder is not connected, or not connected correctly.	Check the encoder wiring.
Compatibility 117	A SMART-ABS or Sankyo encoder has been selected, but the option module has been fitted to a general purpose drive.	Select an AB type encoder or use a high performance drive.
Config Changed 105	One of the following parameters has been changed: *Turns Bits* (mm.033) *Lines Per Revolution* (mm.034) *Device Type* (mm.038) *Auto-configuration Select* (mm.041) *Feedback Reverse* (mm.056) *Additional Configuration* (mm.074) The position feedback device has been un-initialised, but if the drive is reset it will be re-initialised.	Reset the drive to re-initialise the encoder.
Counter Overflow [1] 110	The multi-turn position for a SMART-ABS encoder has crossed the 32767-32768 boundary in either direction. This trip is only produced by multi-turn encoders. Indicated by Bit 3 of *Position Feedback Signals* (mm.070).	This trip is disabled by default but can be enabled if required by clearing Bit 1 in *Error Detection Level* (mm.040).
Counting Error [1] 109	Internal encoder error for a SMART-ABS or Sankyo encoder that gives an incorrect position. Indicated by Bit 2 of *Position Feedback Signals* (mm.070).	The encoder is indicating a fault and may need to be replaced.
Encoder ID Error 116	A SMART-ABS or Sankyo encoder has responded with an unknown identifier during auto-configuration.	If the encoder identifier cannot be recognised disable auto-configuration and set up the drive parameters manually.
Encoder Temp [1] 111	An internal encoder over-temperature has been detected in a SMART-ABS or Sankyo encoder. Indicated by Bit 4 of *Position Feedback Signals* (mm.070).	The internal temperature detector level can be changed by modifying a parameter in the encoder. To prevent this trip either modify the threshold or disable the trip by setting Bit 2 in *Error Detection Level* (mm.040).
Low Battery [1] 113	The external encoder battery voltage to a SMART-ABS or Sankyo encoder has fallen below the allowed threshold when the encoder power from the drive was off. The battery is used to maintain the multi-turn position while the encoder is not powered. Therefore, the multi-turn position may be incorrect if this trip occurs. Indicated by Bit 6 of *Position Feedback Signals* (mm.070).	If this trip occurs the battery voltage was below the allowed threshold when the encoder power was not present. If a battery is being used then replace the battery. If a battery is not being used then disable this trip with Bit 4 in *Error Detection Level* (mm.040).

Low Resolution 108	A SMART-INC single turn encoder may give a low resolution indication on power-up depending on the initial position. After some encoder movement the encoder resolution is automatically increased to the required level and the indication is removed. A SMART-ABS multi-turn encoder will give this indication if the encoder was rotating above 100rpm at power-up because this causes the position resolution to be reduced. If the speed is reduced below 100rpm the encoder resolution is automatically increased to the required level and the indication is removed Indicated by Bit 1 of *Position Feedback Signals* (mm.070).	Single turn encoder: The trip associated with this indication is disabled by default. Low resolution only occurs for the first small movement, and so this trip does not need to be enabled. Multi-turn encoder: The trip associated with this indication is disabled by default as it is only required when there is a possibility that the encoder could be rotating above 100rpm at power-up. If this is possible then the trip should be enabled by clearing bit Bit 6 in *Error Detection Level* (mm.040). If the trip is enabled and a trip occurs, reduce the speed of the encoder to below 100rpm and reset the trip.
Memory Error [1] 119	An error has been detected in the memory within the Sankyo encoder. Indicated by Bit 3 of *Position Feedback Signals* (mm.070).	The encoder is indicating a fault and may need to be replaced.
Multi-turn Error [1] 112	The multi-turn position may be incorrect because the SMART-ABS or Sankyo encoder has detected a possible error. Indicated by Bit 5 of *Position Feedback Signals* (mm.070).	If multi-turn position is not being used then this trip can be disabled by setting Bit 3 in *Error Detection Level* (mm.040).
Overheated 106	The temperature detected on the module PCB has exceeded 90°C.	Review the ambient temperature and drive cooling configuration.
Over-Speed [1] 107	The maximum allowed speed for SMART-ABS and Sankyo encoders when powered up or operating with battery back-up is 6000rpm. In RFC-A and RFC-S modes the drive speed references are limited to 6000rpm if this option module is used for motor control and a SMART-ABS or Sankyo encoder is selected. However, if the encoder is operated at speeds in excess of 6000rpm this trip may be initiated indicating that the encoder position is unreliable. This trip is also produced by a Sankyo encoder if it is rotating at more than 200rpm when the encoder is powered up. Indicated by Bit 0 of *Position Feedback Signals* (mm.070).	Do not operate outside the allowed range for the encoder. Ensure that the encoder is stationary at power-up. This trip is disabled by setting Bit 5 in *Error Detection Level* (mm.040).
PSU Overload 102	The encoder power supply output has been overloaded.	Check the encoder connections. Check that *Supply Voltage* (mm.036) is not set to a value that is too high for the connected encoder.
Sensor Error [1] 118	A problem has been detected with the sensor within the Sankyo encoder. Indicated by Bit 1 of *Position Feedback Signals* (mm.070).	The encoder is indicating a fault and may need to be replaced.
Wire break A 100	Wire break has been detected on the encoder A channel inputs of an AB encoder.	Check the encoder connections.
Wire break B 101	Wire break has been detected on the encoder B channel inputs of an AB encoder.	Check the encoder connections.

[1] These trips are indicated by the encoder. The internal indication is not cleared unless the appropriate mode in *Encoder Initialisation Mode* (mm.075) is set. If the internal indication is not reset it will not be possible to clear the trip. See section 7.2.1 below.

Table 7-3   Module trips in numerical order by sub-trip number

Sub-trip	Keypad String	Applicable Device Type
100	Wire break A	AB
101	Wire break B	AB
102	PSU Overload	All
105	Config Changed	All
106	Overheated	All
107	Over-Speed	SMART-ABS, Sankyo
108	Low Resolution	SMART-ABS
109	Counting Error	SMART-ABS, Sankyo
110	Counter Overflow	SMART-ABS
111	Encoder Temp	SMART-ABS, Sankyo
112	Multi-turn Error	SMART-ABS, Sankyo
113	Low Battery	SMART-ABS, Sankyo
114	Comms Loss	SMART-ABS, Sankyo
115	Comms Error	SMART-ABS, Sankyo
116	Encoder ID Error	SMART-ABS, Sankyo
117	Compatibility	SMART-ABS, Sankyo
118	Sensor Error	Sankyo
119	Memory Error	Sankyo

7.2.1   Resetting encoder internal error indications

Errors detected and latched in the encoder are not removed by drive reset. If the encoder is indicating an error then set the appropriate mode in *Encoder Initialisation Mode* (mm.076) and reset the drive.

Encoder Initialisation Mode (mm.076)	Description
No Error Reset (0):	No error indications are cleared within the encoder. If errors indicated by the encoder are causing a trip (i.e. Low battery) and the trip has not been disabled then the trip will reoccur when the drive is reset.
Error Reset Only (1)	Clear error indications within the encoder. The multi-turn position is not affected. Use this setting to clear encoder error indications such as a Low Battery trip.
Multi-turn Reset (2)	Clear error indications within the encoder and reset the multi-turn position.

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