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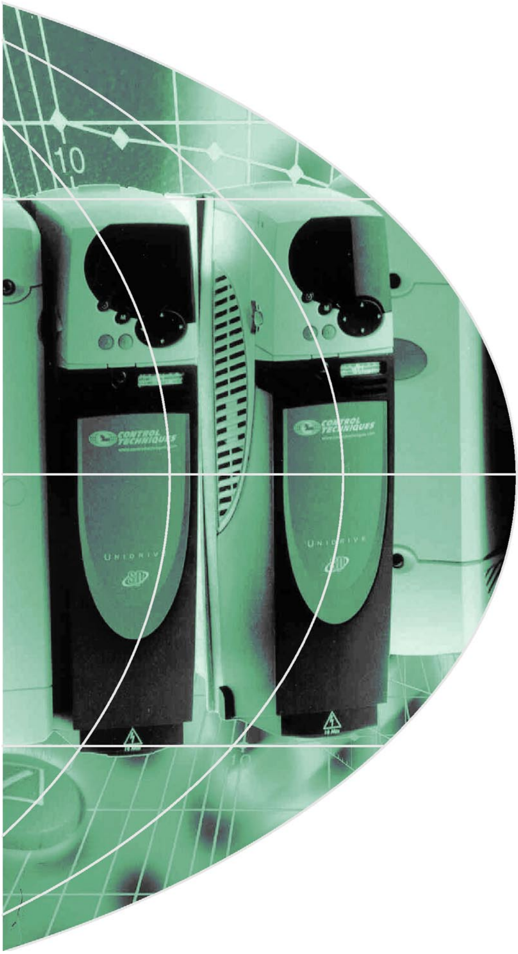


User Guide

SM-Universal Encoder Plus

Solutions module for
Unidrive SP

Part Number: 0471-0005
Issue Number: 1

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 this guide, without notice.

Drive software version

The SM-Universal Encoder Plus option module can only be used with drive software version 00.11.00 onwards.

Issue Code: 1

Contents

1 How to use this guide

1.1 Intended personnel

This guide is intended for personnel who have the necessary training and experience in system design, installation, commissioning and maintenance.

1.2 Information

This guide contains information covering the identification of the Solutions Module, terminal layout for installation, fitting of the Solutions Module to the drive, parameter details and diagnosis information. Additional to the aforementioned are the specifications of the Solutions Module.

1.3 List of headings

The main areas covered by this guide are as follows:

Safety

Introduction, features and functions

Installation

Commissioning

Parameters

Diagnostics

Specifications

2 Safety Information

2.1 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.

2.2 Electrical safety - general warning

The voltages used in the drive can cause severe electrical shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to the drive.

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

2.3 System design and safety of personnel

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

The drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control equipment which can cause injury.

Close attention is required to the electrical installation and the system design to avoid hazards either in normal operation or in the event of equipment malfunction. System design, installation, commissioning and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this User Guide carefully.

The STOP and SECURE DISABLE 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 SECURE DISABLE 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 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.

The SECURE DISABLE function has been approved[1] as meeting the requirements of EN954-1 category 3 for the prevention of unexpected starting of the drive. It 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]Independent approval pending

2.4 Environmental limits

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

2.5 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 earth (ground) connections.

The *Unidrive SP User Guide* contains instruction for achieving compliance with specific EMC standards.

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

97/37/EC: Safety of machinery.

89/336/EEC: Electromagnetic Compatibility.

2.6 Motor

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

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

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

The values of the motor parameters set in the drive affect the protection of the motor. The default values in the drive should not be relied upon.

It is essential that the correct value is entered in parameter **0.46** motor rated current. This affects the thermal protection of the motor.

2.7 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.

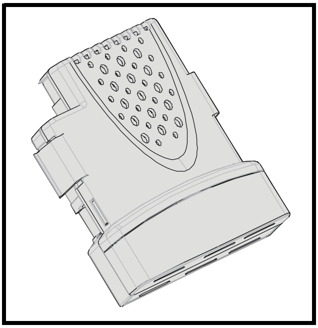
3 Introduction

3.1 Features

SM-Universal Encoder Plus option module

The SM-Universal Encoder Plus option module allows for various types of feedback device to be connected to the Unidrive SP, and to be configured for either reference or main feedback. The SM-Universal Encoder Plus option module also has a simulated encoder output which can be programmed to operate in either Ab, Fd or SSI mode.

Figure 3-1 SM-Universal Encoder Plus option module (green)

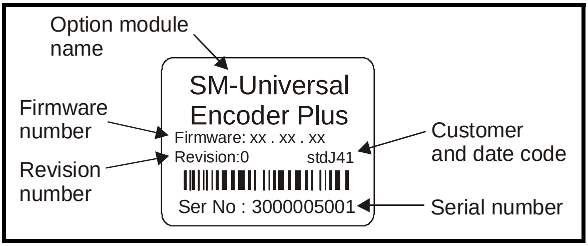


3.2 Solutions Module identification

The SM-Universal Encoder Plus option module can be identified by:

1. The label located on the underside of the Solutions Module.
2. The colour coding across the front of the Solutions Module. All Unidrive SP Solutions Modules are colour coded, with the SM-Universal Encoder Plus option module being green.

Figure 3-2 SM-Universal Encoder Plus label



3.3 Set-up parameters

All parameters associated to the SM-Universal Encoder Plus option module can be found in either menu 15, 16, or 17. Each of menus 15, 16, and 17 refer to one of the available slots into which the SM-Universal Encoder Plus option module can be fitted.

3.4 Compatible with encoder types

The SM-Universal Encoder Plus option module will allow for the following encoders to be used with Unidrive SP:

3.4.1 Incremental encoders Ab, Fd, Fr and SC

This type of encoder gives incremental position and can only be used for control in Closed Loop Vector mode.

Type	Encoder	Description	Pr x.15
Incremental	Ab	Quadrature incremental encoder. With or without marker pulse.	0
	Fd	Incremental encoder with frequency and direction outputs. With or without marker pulse.	1
	Fr	Incremental encoder with forward and reverse outputs. With or without marker pulse.	2
	SC	SinCos encoder with no serial communications No optional marker pulse.	6

Ab, Fd, Fr

Quadrature detection logic determines rotation from the phase relationship of the two channels. These encoders are available with a marker pulse, which identifies each individual rotation of the disc, and is also used to reset the drive position parameter. The incremental encoder can be used when operating in Closed Loop Vector mode, with the optional marker pulse not being required for correct operation.

SC

In this case the positional information and rotation is determined from the phase relationship of the analogue sine/cosine feedback signals. The incremental SinCos encoder can be used when operating in the Closed Loop Vector mode.

NOTE Refer to for section 3.4.3 *SinCos encoder feedback signals* on page 8 further information on the SinCos encoder feedback signals.

Limitations					
Type	**Encoder**	**Max Input Frequency**	**Max no. of Lines (LPR)**	**Max speed (rpm @ LPR)**	**Max Baud Rate (bits/s)**
Incremental	Ab	600kHz*	50,000	720**	
	Fd				
	Fr				
	SC	100kHz*		120**	

* Max input frequency = LPR x rpm / 60

** Max rpm = (60 x Max input frequency) / LPR

3.4.2 Incremental plus commutation, (absolute encoders) Ab.SErVO, Fd.SErVO, Fr.SErVO, SC.HiPEr and SC.EndAt

Type	Encoder	Description	Pr x.15
Incremental plus commutation (absolute encoders)	Ab.SErVO	Quadrature incremental encoder with commutation outputs. With or without marker pulse.	3
	Fd.SErVO	Incremental encoder with frequency, direction and commutation outputs. With or without marker pulse.	4
	Fr.SErVO	Incremental encoder with forward, reverse and commutation outputs With or without marker pulse.	5

Ab.SErVO, Fd.SErVO, Fr.SErVO

The incremental encoder with commutation works in the same way as the incremental encoder except that multiple channels are used to give a discrete code for every position increment.

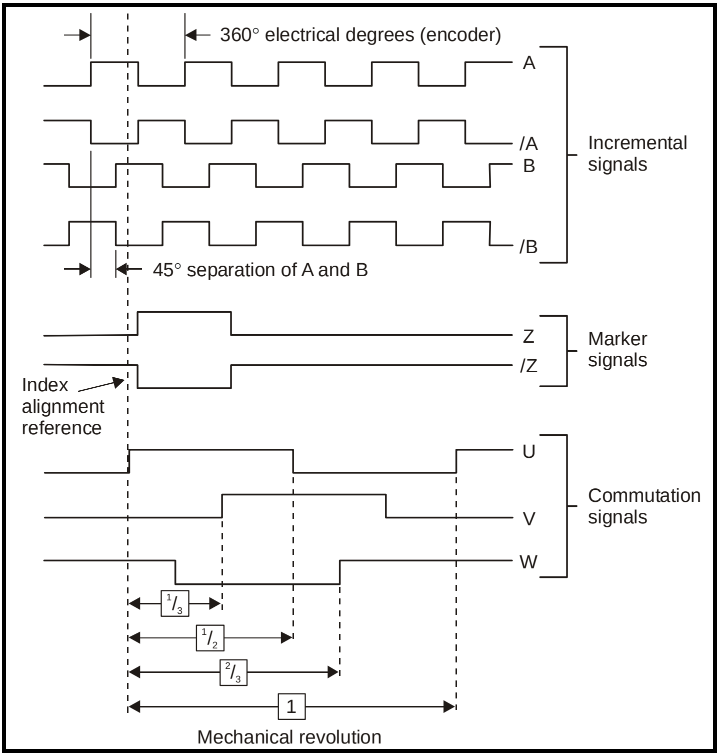
When operating in closed loop servo absolute position of the machine shaft is required as soon as the drive is enabled. Because the marker signal is not effective until the shaft passes a particular position, this cannot be used to determine the absolute position. Therefore an encoder with additional commutation is required. The U, V and W commutation signals should have a period that is one electrical revolution as shown in Figure 3-3. Therefore with a 6 pole machine the U, V and W commutation signals will repeat three times per mechanical revolution, or with an 8 pole machine four times per mechanical revolution etc.

The U, V and W commutation signals are used when the drive is enabled to locate the position of the machine shaft within 60° electrical so that the current vector can be applied within 30° electrical either side of the correct position for maximum torque production. At certain positions of the shaft, the torque capability of the drive is reduced to 0.866 of the nominal level.

Once the shaft has moved through a maximum of 60° electrical, one of the U, V or W signals will change state. The location of the waveform edge is used to locate the machine position exactly. This information is then stored by the drive and used until power-down to place the current vector in the correct position for maximum torque. To ensure that this process is carried out correctly the control algorithm waits for two changes of the state of the U,V and W waveforms, at this point there will be no additional torque ripple and maximum torque is available for all shaft positions.

Using this type of encoder does not result in any jump in position when the drive is first enabled after power-up, but only the small reduction in specification described above for the first 60 to 120° electrical of movement.

Figure 3-3 Encoder feedback signals



Type	Encoder	Description	Pr x.15
Incremental plus communications (absolute encoders)	SC.HiPEr	Absolute SinCos encoder using Stegmann 485 comms protocol (HiperFace). The drive checks the position from the sine and cosine waveforms against the internal encoder position using serial communications. If an error occurs the drive trips.	7
	SC.EndAt	Absolute SinCos encoder using EndAt comms protocol The drive checks the position from the sine and cosine waveforms against the internal encoder position using serial communications. If an error occurs the drive trips.	9

It should be noted that the SC.HiPEr and SC.EndAt encoders must be initialised before their position data can be used. The encoder is automatically initialised at power-up, after trips 1 - 8 are reset, or when the initialisation parameter (Pr **3.47**) is set to 1. If the encoder is not initialised or the initialisation is invalid, the drive initiates trip 7.

SC.HiPEr, SC.EndAt

The SC.HiPEr and SC.EndAt encoders can be considered as a mixture of an incremental encoder (analogue SinCos feedback signals) and an absolute encoder (serial link used for absolute position). The only difference between the two encoders being the serial link protocol.

The RS 485 serial link allows the drive at power up to interrogate the SinCos encoder in order to determine the initial absolute position of the encoder shaft. When the interrogation is complete and the initial absolute position is known the serial link is disabled and position incremented from the absolute value using the analogue sine/cosine interface. The incremental SinCos encoder can be used when operating in either Closed Loop Vector or Closed Loop Servo modes.

Limitations

Type	Encoder	Max Input Frequency	Max no. of Lines (LPR)	Max speed (rpm @ LPR)	Max Baud Rate (bits/s)
Incremental plus commutation	Ab.SErVO	600kHz*	50,000	720**	
	Fd.SErVO				
	Fr.SErVO				
	SC.HiPEr	100kHz*		120**	9600k
	SC.EndAt				4M

*   Max input frequency = LPR x rpm / 60

**   Max rpm = (60 x Max input frequency) / LPR

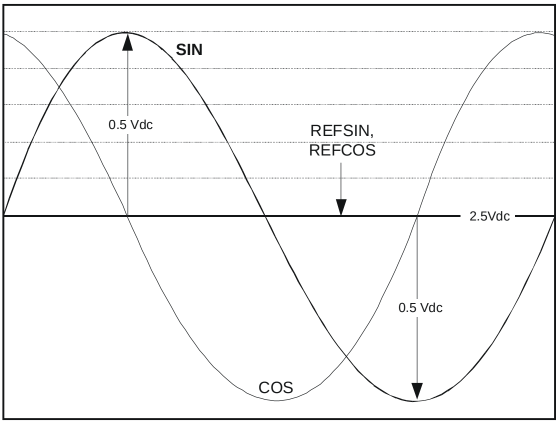
3.4.3 SinCos encoder feedback signals

For the SinCos encoder to be compatible with the SM-Universal Encoder Plus option module, the output signals from the encoder must be a 1V peak to peak differential voltage (across sinref to sin and cosref to cos).

The majority of encoders have a DC offset on all signals. Stegmann and Heidenhain encoders typically have a 2.5Vdc offset. The sinref and cosref are a flat DC level at 2.5Vdc and the cos and sin signals have a 1V peak to peak waveform biased at 2.5Vdc.

The result is a 1V peak to peak differential voltage as show in Figure 3-4.

Figure 3-4 SinCos encoder feedback signals



Encoders are available which have a 1V peak to peak voltage on sinref, sin, cos and cosref. This results in a 2V peak to peak voltage seen at the Solutions Module terminals. The drive will still function with this type of encoder, however reduced performance in the form of speed and torque ripple at four times the line rate will result. (line rate = no. of lines per revolution x revolutions per second)

It is recommended that encoders of this type are not used with Unidrive SP, and that the encoder feedback signals should meet the above parameters (1V peak to peak biased at 2.5Vdc).

3.4.4 Comms only, (absolute encoders) SSI and EndAt

Type	Encoder	Description	Pr x.15
Comms (absolute)	EndAt	Absolute EndAt only encoder Additional communications with the encoder is not possible.	8
	SSI	Absolute SSI only encoder. Additional communications with the encoder is not possible.	10

It should be noted that EndAt and SSI encoders must be initialised before their position data can be used. The encoder is automatically initialised at power-up, after trips 1 - 8 are reset, or when the initialisation parameter (Pr **3.47**) is set to 1. If the encoder is not initialised or the initialisation is invalid the drive initiates trip 7.

SSI, EndAt

Encoders with either an EndAt (Encoder Data) or SSI (Synchronous Serial) interface can transmit data synchronised with a CLOCK signal provided from the drive. This makes it possible to transmit position values quickly and reliably with only four signal lines.

The main difference between the SSI and the EndAt being that the SSI encoder is Unidirectional whereas the EndAt is Bi-directional. The data transfer for both the SSI and the EndAt takes the form of EIA Standard RS 485.

The SSI (Synchronous Serial interface) and EndAt (Encoder Data) encoders have a serial link between the encoder and drive which passes all positional information.

The encoder operates in the following manner:

1. A clock signal at a user defined frequency is sent out to the encoder
2. Once a downward latching signal is detected by the encoder
3. Followed by the data request
4. The encoder then returns data to the drive at the clock frequency

Limitations				
Type	**Encoder**	**Max Input Frequency**	**Max Baud Rate (bits/sec)**	**Max Speed Rpm**
Comms Only	EndAt	2MHz	4Mbits/sec	40,000rpm
	SSI	2MHz	4Mbits/sec	

NOTE In some applications using Closed Loop Vector control the maximum speed of the system is above the speed at which the encoder feedback frequency is to high to be used by the drive. For these types of applications Pr **3.24** Closed Loop Vector Mode should be set to 2 (Closed Loop Vector Mode with no maximum speed limit) for low speed operation and 3 (Closed Loop Vector Mode without position feedback and with no maximum speed limit) for high-speed operation. It should be noted that the drive no longer checks that the maximum encoder frequency cannot be exceeded, and so the user must ensure that Pr **3.24** is set to 3 before the encoder frequency limit is reached.

NOTE The SSI input at default is configured to operate in Gray code through Pr **x.18**, this can be configured to operate in binary format by setting Pr **x.18** = 1.

The simulated SSI encoder output will only operate with binary format, Gray code is not supported.

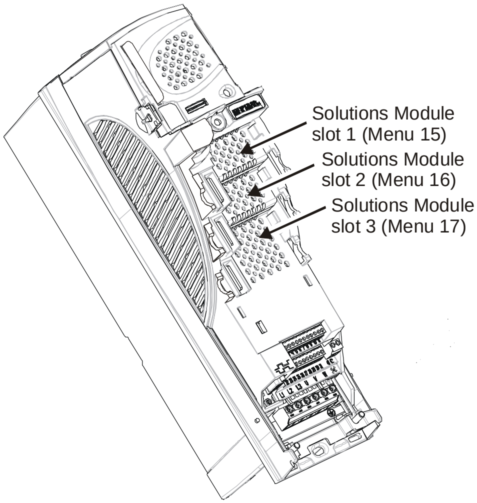
4 Installing the SM-Universal Encoder Plus

4.1 Solutions Module slots

> **WARNING**
>
> Before installing the SM-Universal Encoder Plus option module, refer to Chapter 2 *Safety Information* on page 2.

There are three slots available, which the Solutions Module can be plugged into as shown in Figure 4-1. The Solutions Module can be plugged into either one of these, but it is recommended that slot 3 be used for the first Solutions Module then slot 2 and slot 1. This ensures maximum mechanical support for the Solutions Module once fitted.

Figure 4-1 Location of slots 1, 2 and 3 on the Unidrive SP

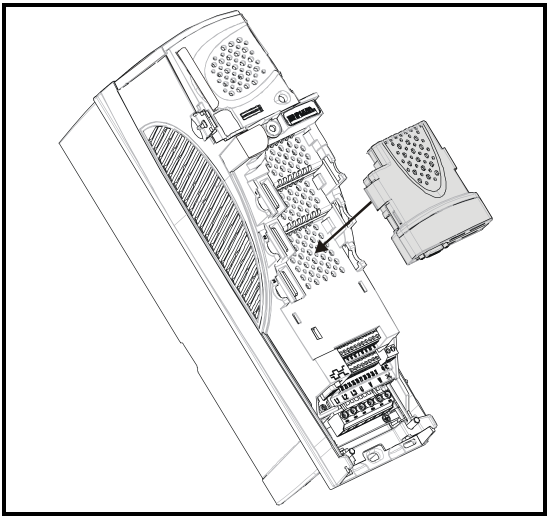


4.2 Installation

1. Before installing the SM-Universal Encoder Plus option module in the Unidrive SP, ensure the AC supply has been disconnected from the drive for at least 10 minutes.
2. Ensure that both the +24V, and +48V backup power supplies are disconnected from the drive for at least 10 minutes.
3. Check that the exterior of the SM-Universal Encoder Plus option module is not damaged, and that the multi-way connector is free from dirt and debris.
4. Do not install a damaged or dirty SM-Universal Encoder Plus option module in the drive.
5. Remove the terminal cover from the drive. (For removal / re-fitting instructions, see *Unidrive SP Option Module Installation Sheet* provided with the Solutions Module.)

6. Position the drive connector of the SM-Universal Encoder Plus option module over the connector of the appropriate slot in the drive and push downwards until it locks into place.

Figure 4-2 Fitting the SM-Universal Encoder Plus option module



7. Re-fit the terminal cover to the drive. (For removal / re-fitting instructions, see *Unidrive SP Option Module Installation Sheet* provided with the Solutions Module.)
8. Connect the AC supply to the drive.
9. Set Pr **0.49** to L2 to unlock read only security.
10. Check that Menu 15 (slot 1), 16 (slot 2), or 17 (slot 3) parameters are now available.
11. Check that Pr **15.01**, Pr **16.01** or Pr **17.01** show the correct code for the SM-Universal Encoder Plus option module (code = 102).
12. If the checks in steps 10 and 11 fail, either the SM-Universal Encoder Plus option module is not fully inserted, or the Solutions Module is faulty.
13. If a trip code is now present refer to Chapter 8 *Diagnostics* on page 55.

4.3 Terminal Descriptions

Figure 4-3 Connector SK1 terminal descriptions

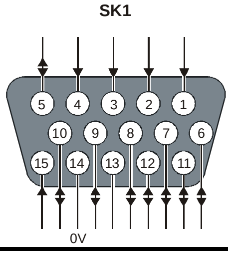


Table 4.1 Connector SK1 terminal descriptions

<table>
<tr><th rowspan="2">Term.</th><th colspan="11">Encoder</th></tr>
<tr><th>Ab</th><th>Fd</th><th>Fr</th><th>Ab. SErVO</th><th>Fd. SErVO</th><th>Fr. SErVO</th><th>SC</th><th>SC. HiPEr</th><th>SC. EndAt</th><th>EndAt</th><th>SSI</th></tr>
<tr><td>1</td><td>A</td><td>F</td><td>F</td><td>A</td><td>F</td><td>F</td><td>Sin</td><td>Sin</td><td>Sin</td><td colspan="2" rowspan="4"></td></tr>
<tr><td>2</td><td>A\</td><td>F\</td><td>F\</td><td>A\</td><td>F\</td><td>F\</td><td>Sin\</td><td>Sin\</td><td>Sin\</td></tr>
<tr><td>3</td><td>B</td><td>D</td><td>R</td><td>B</td><td>D</td><td>R</td><td>Cos</td><td>Cos</td><td>Cos</td></tr>
<tr><td>4</td><td>B\</td><td>D\</td><td>R\</td><td>B\</td><td>D\</td><td>R\</td><td>Cos\</td><td>Cos\</td><td>Cos\</td></tr>
<tr><td>5</td><td colspan="6">Z</td><td rowspan="2"></td><td colspan="4">Data</td></tr>
<tr><td>6</td><td colspan="6">Z\</td><td colspan="4">Data\</td></tr>
<tr><td>7</td><td colspan="3">Aout (Fout)</td><td colspan="3">U</td><td colspan="5">Aout (Fout)</td></tr>
<tr><td>8</td><td colspan="3">Aout\ (Fout\)</td><td colspan="3">U\</td><td colspan="5">Aout\ (Fout\)</td></tr>
<tr><td>9</td><td colspan="3">Bout (Dout)</td><td colspan="3">V</td><td colspan="5">Bout (Dout)</td></tr>
<tr><td>10</td><td colspan="3">Bout\ (Dout\)</td><td colspan="3">V\</td><td colspan="5">Bout\ (Dout\)</td></tr>
<tr><td>11</td><td colspan="3" rowspan="2"></td><td colspan="3">W</td><td colspan="2" rowspan="2"></td><td colspan="3">Clock</td></tr>
<tr><td>12</td><td colspan="3">W\</td><td colspan="3">Clock\</td></tr>
<tr><td>13</td><td colspan="11">+V</td></tr>
<tr><td>14</td><td colspan="11">0V</td></tr>
<tr><td>15</td><td colspan="11">th</td></tr>
</table>

Figure 4-4 Connector PL2

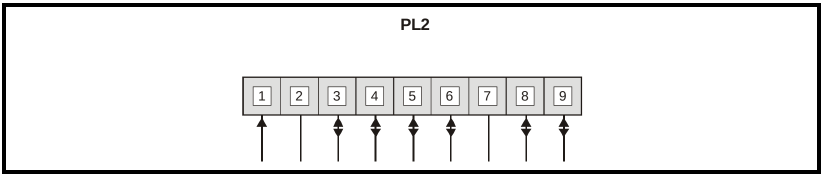


Table 4.2 Connector PL2 terminal descriptions

Terminal	Input / Encoder outputs					
	Freeze RS485 input	**Freeze +24V input**	**Ab output**	**Fd output**	**SSI output**	**Marker output**
1		Freeze				
2	0V					
3			A	F	Data	
4			A\	F\	Data\	
5			B	D	Clock\	
6			B\	D\	Clock	
7	0V					
8	Freeze					Z
9	Freeze\					Z\

4.4 Power supply

The total user load of the drive and Solutions Modules if exceeded will result in a 24V internal power supply overload, trip ‘PS.24V’.

The user load comprises of:

- the drive’s digital outputs plus the SM-I/O Plus option module digital outputs

or

- the drive’s main encoder supply plus the SM-Universal Encoder Plus option module encoder supply

Example

If exceeding the user load:

- the drive’s main encoder supply, SM-Universal Encoder Plus encoder supply, drive’s digital output and SM-I/O Plus digital outputs

an external 24V >50W power supply will be required. The external 24V supply should be connected to the drives control terminals 1 and 2.

NOTE If the encoder will exceed the SM-Universal Encoder Plus and encoder supply (5V, 8V >300mA, 15V >200mA), the encoder must be supplied externally without a power supply connection to the module.

NOTE There should be no parallel connection of the external 24V supply and the encoder supply from the drive.

4.5 Wiring, Screen Connections

Screening 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.

The sensitivity of various inputs to electromagnetic disturbance differs with the introduction of screening providing good data transfer. Circuits at particular risk are precision analogue inputs, where quite small induced voltages may cause significant errors, and fast data or encoder inputs where the signal levels are relatively high but the bandwidth is wide so that very brief excursions may cause errors.

Table 4.3 Feedback Device Properties

Input Type	Nature	Wiring Requirement
Resolver Inputs	Medium bandwidth e.g. 10kHz, sensitive	Screening recommended
Encoder Inputs	Wide bandwidth e.g. 500kHz. Good immunity but limited common mode range	Correct screening arrangement essential. Matched cable and correct termination recommended.
Data links/ comms port	Wide bandwidth for advanced communications systems, e.g. 500kHz to 10MHz. Good immunity but limited common mode range.	Correct screening arrangement essential/ Matched cable and correct termination recommended with no discontinuity.

Motor / Feedback Device, Mounting & Design

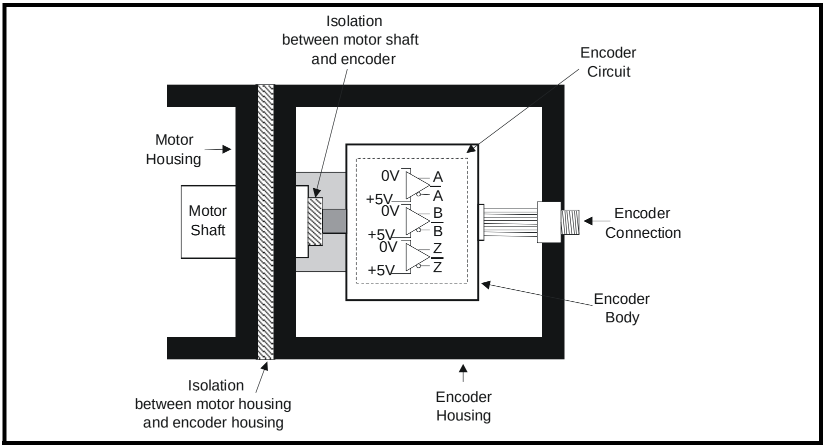
There are three methods for mounting a feedback device onto a motor:

1. Galvanic Isolation
2. Galvanic Isolation between Encoder Circuit and Body
3. No Isolation

4.5.1 Encoder with Galvanic Isolation from motor

When Galvanically Isolated the encoder device is mounted to the motor with isolation fitted between the motor housing / shaft and encoder as shown in Figure 4-5.

Figure 4-5 Galvanic Isolation from Motor

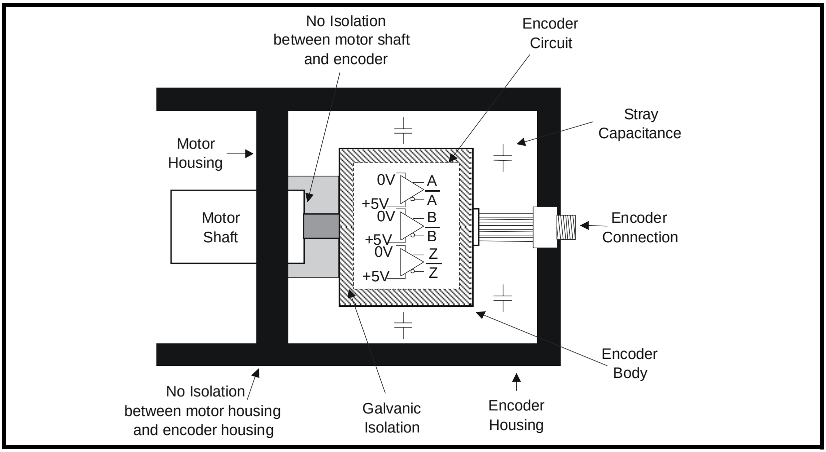


An example of this is the Unimotor where isolation to the motor is achieved by inserting a plastic mounting plate between the motor housing and encoder housing and a plastic insert fitted in the motor shaft for encoder mounting to the motor shaft. With this preferred method of mounting noise current is prevented from passing from the motor housing into the encoder housing, and hence into the encoder cable.

4.5.2 Encoder circuit with Galvanic Isolation from encoder body

In this case the encoder device is mounted directly to the motor housing with contact being made between the motor housing / shaft and encoder. Due to this mounting method and the presence of stray capacitance between the "encoder body and motor / encoder housing" and the "encoder and the encoder body" the electromagnetic disturbance present around the encoder is greatly increased. The encoder internal circuits need to be designed to withstand this situation. However this arrangement still prevents large noise currents from flowing from the motor body into the encoder cable.

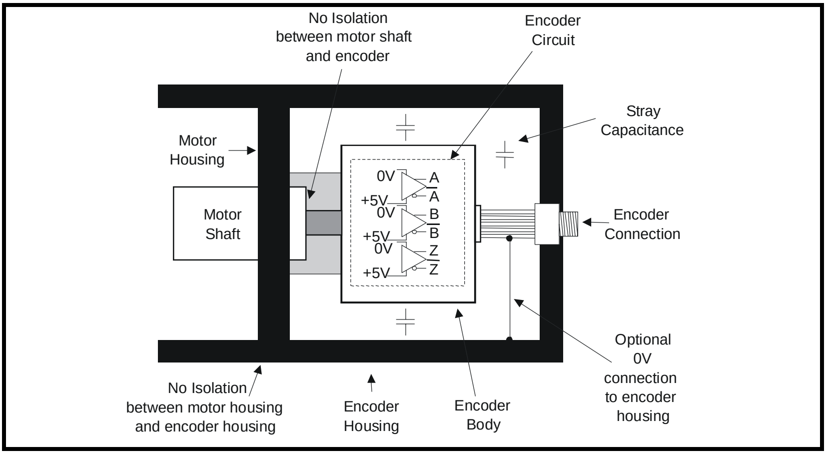
Figure 4-6 Encoder Galvanically Isolated from Encoder Body



4.5.3 No Isolation

As can be seen in Figure 4-7 an additional 0V connection may also be made to the encoder housing. This does have the advantage that the encoder body forms a screen for its internal circuits. However it does permit noise current from the motor body to flow into the encoder cable screen. A good quality screened cable correctly terminated does provide ample protection of the data against this noise current, but much more care is needed in ensuring correct cable management than for the isolated cases.

Figure 4-7 No Isolation



Screen Connections

The recommended connections for cable screens taking into account the feedback device mounting are as follows:

Galvanically Isolated, F/B device Circuit Isolated from Encoder Body, and No Isolation

- Screen connection at drives terminal to 0 volts.
- Screen connections at feedback device to 0 volts.
- It is strongly recommended that the screened cable should be run in a continuous length to the terminal, to avoid the injection of noise at intermediate pigtails and to maximise the screening benefit.
- The screen connections to the drive and f/b device should be kept as short as possible to avoid possible stray noise pick-up

NOTE Under no circumstances must the cable screen connection be omitted at either end of the cable in this case (No Isolation), since the noise voltage may well be sufficient to destroy the line driver and receiver chips in the encoder and the drive.

Ground connection

Grounding of the feedback cable screen prevents fast transients being passed along the feedback cable and should additionally be fitted, so as to:

- Prevent radiated emissions from the drives 0V line being passed to the feedback device.
- Prevent radiated emissions from the feedback device / motor being passed onto the signal cable.
- Provide an alternative low impedance path for noise currents to flow.

Table 4.4 Recommended ground connections

No.	F/B device	Ground Connection	
		Before Drive	Before F/B device
1	Isolated from Motor	Optional	Optional
2	Encoder circuit Isolated from Encoder Body	Optional	Yes
3	No Isolation from Motor	Yes	Yes

Galvanically Isolated

The galvanic isolation prevents noise currents passing from the motor onto the encoder body, and hence into the encoder cable. The ground connection of the screen is optional, this may be required to comply with safety measures or to reduce radiated emissions from either the drive or f/b device.

F/B Device Circuit Isolated from Encoder Body

F/B device circuit isolated from encoder body, with noise being radiated around the device. To prevent the noise currents being passed onto the 0 volts an ground connection should be fitted close to the f/b device at the motor providing an alternative low impedance path. An ground connection should also be made before the drive to comply with safety measures or to reduce emissions from the drive.

No Isolation

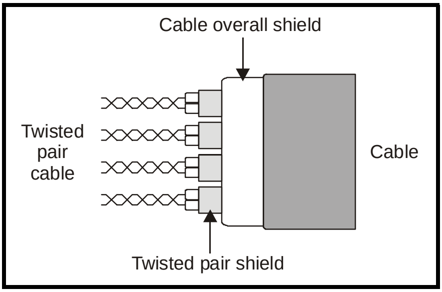
Ground connections should be provided to prevent noise currents from being passed onto the f/b device and the drives input. Additionally due to there being no isolation from the motor an additional connection is required from the outer screen to the encoder housing using a very short connection, or preferable a direct clamp, or a 360° bond providing a low impedance path for noise currents to flow.

NOTE The ground connection of a feedback cable screen at both ends carries the risk that an electrical fault may cause excessive power current to flow in the cable screen and overheat the cable.

Recommended Cable

The recommended cable for feedback signals is a twisted pair, screened with an overall screen type as shown below.

Figure 4-8 Feedback Cable, Twisted Pair

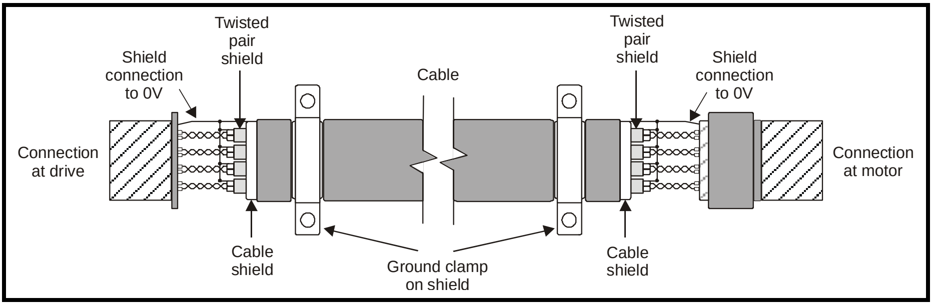


Using this type of cable allows for the connection of the outer shield to ground and the inner shields to 0 volts at both drive and encoder end when required. For example some local recommendations may insist that the cable screen has an ground at both ends, in this case the inner-screened cables would be connected to 0 volts of the drive and encoder.

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

When placing ground connections at either the drive or f/b device end suitable ground clamps should be used as shown below. The outer sheath of the cable should be stripped back enough to allow for the ground clamp to be fitted (the screen connection should not be broken). The ground clamps should be located as close as possible to the drive / f/b device with the ground connections being made to a common back plane.

Figure 4-9 Feedback cable connections



5 Getting Started

5.1 Installation

WARNING	The control circuits are isolated from the power circuits in the drive by basic insulation only, as specified in IEC664-1. 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 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.

Encoder feedback and communications data is transmitted from an encoder as low voltage analog or digital signals. Ensure that electrical noise from the drive or motor does not adversely affect the encoder feedback. Ensure that the drive and motor are connected as per the instructions given in Chapter 4 *Electrical Installation* in the *Unidrive SP User Guide*, and that the encoder feedback wiring and screening recommendations are followed in section 4.5 *Wiring, Screen Connections* on page 13.

NOTE To enable the SM-Universal Encoder Plus option module in either of the three slots as the main feedback for the drive Pr **3.26** *Speed feedback selector* must be set-up.

Encoder initialisation will only occur when trips 1 through to 74 in Pr **x.50**, option module error status are reset.

Pr x.18	Auto-configuration enable\SSI binary format select
When a SC.HiPEr or SC.EndAt encoder is being used, the option module will interrogate the encoder on power-up. If Pr **x.18** is set and the encoder type is recognised based on the information provided by the encoder, the option module will set the encoder turns Pr **x.09**, the equivalent lines per revolution Pr **x.10** and the encoder comms resolution Pr **x.11** for the encoder. If the encoder is recognised these parameters will all become read only. If the encoder is not recognised, the option module will initiate a 7 trip to prompt the user to enter the information. The option module should be able to auto-configure with any EndAt encoder where the number of turns and lines per revolution are a power of 2, and the following Hiperface encoders: SCS 60/70, SCM 60/70, SRS 50/60, SRM 50/60, SHS 170, LINCODER, SCS-KIT 101, SKS36, SKM36.	

NOTE When operating with an SSI encoder Pr **x.18** is used to set-up the date format, 0 = Gray code and 1 = binary.

5.1.1 Incremental encoders

The following parameter set-up should be followed when operating with an Incremental Encoder.

<table>
<tr><th colspan="2">Incremental encoders, Ab, Fd, Fr and SC</th></tr>
<tr><th>Action</th><th>Detail</th></tr>
<tr><td>Before power-up</td><td>Ensure:
• Drive enable signal is not given (terminal 31)
• Run signal is not given
• Option module is fitted in appropriate slot
• Feedback device is connected</td></tr>
<tr><td>Power up drive</td><td>Ensure:
• Drive displays ‘inh’
If the drive trips see Chapter 8 Diagnostics on page 55</td></tr>
<tr><td>Slot identification</td><td>Identify which option module slot and menu are being used
• Slot 1 – Menu 15
• Slot 2 – Menu 16
• Slot 3 – Menu 17</td></tr>
<tr><td>Set-up encoder power supply</td><td>Incremental encoder basic set-up
• Encoder supply voltage Pr x.13
0 (5V) 1 (8V) 2 (15V)
Also refer to section 4.4 Power supply on page 13</td></tr>
<tr><td>Set-up encoder parameters</td><td>Enter:
• Encoder type Pr x.15
0 (Ab) 1 (Fd) 2 (Fr) 6 (SC)</td></tr>
<tr><td>Set-up encoder lines per revolution</td><td>• Equivalent lines per revolution Pr x.10
Set according to encoder, see below for restrictions
• Line per revolution divider Pr x.46
The equivalent lines per revolution Pr x.10 is divided by the value in Pr x.46 this can be used This can be used when an encoder is used where the number of counts or sine waves per pole is not an integer. For example 128.123 lines per revolution would be set as 128123 in Pr x.10 and 1000 in Pr x.46 giving 128123 / 1000 = 128.123
<table><tr><th>Encoder</th><th>Pr x.10 Equivalent lines per revolution</th></tr><tr><td>Ab</td><td>Number of lines per revolution</td></tr><tr><td>Fd, Fr</td><td>Number of lines per revolution / 2</td></tr><tr><td>SC</td><td>Number of sine waves per revolution</td></tr></table></td></tr>
<tr><td>Set-up encoder turns</td><td>Encoder turns Pr x.09
Defines the maximum number of the revolution counter (when operating with an Incremental encoder) before it is reset to zero. For example, if Pr x.09 = 5, then Pr x.04 counts up to 31 before being reset.</td></tr>
<tr><td>Initialisation</td><td>Ensure:
Position feedback is initialised Pr x.45</td></tr>
</table>

5.1.2 Incremental plus commutation, absolute encoders

The following parameter set-up should be followed when operating with an incremental plus commutation absolute encoder.

<table>
<tr><th colspan="2">Incremental plus commutation, absolute encoders, Ab.SErVO, Fd.SErVO and Fr.SErVO</th></tr>
<tr><th>Action</th><th>Detail</th></tr>
<tr><td>Before power-up</td><td>Ensure:
• Drive enable signal is not given (terminal 31)
• Run signal is not given
• Option module is fitted in appropriate slot
• Feedback device is connected</td></tr>
<tr><td>Power up drive</td><td>Ensure:
• Drive displays ‘inh’
If the drive trips see Chapter 8 Diagnostics on page 55</td></tr>
<tr><td>Slot identification</td><td>Identify which option module slot and menu are being used
• Slot 1 – Menu 15
• Slot 2 – Menu 16
• Slot 3 – Menu 17</td></tr>
<tr><td>Set-up encoder power supply</td><td>Incremental plus commutation encoder basic set-up
• Encoder supply voltage Pr x.13
0 (5v) 1(8v) 2(15v)
Also refer to section 4.4 Power supply on page 13</td></tr>
<tr><td>Set-up encoder parameters</td><td>Enter:
• Encoder type Pr x.15
3 (Ab.SErVO) 4 (Fd.SErVO) 5 (Fr.SErVO)</td></tr>
<tr><td>Set-up encoder lines per revolution</td><td>• Equivalent lines per revolution Pr x.10
Set according to encoder, see below for restrictions
• Line per revolution divider Pr x.46
The equivalent lines per revolution Pr x.10 is divided by the value in Pr x.46 this can be used This can be used when an encoder is used where the number of counts or sine waves per pole is not an integer. For example 128.123 lines per revolution would be set as 128123 in Pr x.10 and 1000 in Pr x.46 giving 128123 / 1000 = 128.123
<table>
<tr><th>Encoder</th><th>Pr x.10 Equivalent lines per revolution</th></tr>
<tr><td>Ab.SErVO</td><td>Number of lines per revolution</td></tr>
<tr><td>Fd.SErVO, Fr.SErVO</td><td>Number of lines per revolution / 2</td></tr>
</table></td></tr>
<tr><td>Set-up encoder turns</td><td>Encoder turns Pr x.09
Defines the maximum number of the revolution counter (when operating with an Incremental encoder) before it is reset to zero. For example, if Pr x.09 = 5, then Pr x.04 counts up to 31 before being reset.</td></tr>
<tr><td>Initialisation</td><td>Ensure:
Position feedback is initialised Pr x.45</td></tr>
</table>

<table>
<tr><th colspan="2">Incremental absolute encoders, SC.HiPEr and SC.EndAt</th></tr>
<tr><th>Action</th><th>Detail</th></tr>
<tr><td>Before power-up</td><td>Ensure:
• Drive enable signal is not given (terminal 31)
• Run signal is not given
• Option module is fitted in appropriate slot
• Feedback device is connected</td></tr>
<tr><td>Power up drive</td><td>Ensure:
• Drive displays ‘inh’
If the drive trips see Chapter 8 Diagnostics on page 55</td></tr>
<tr><td>Identification</td><td>Identify which option module slot and menu are being used
• Slot 1 – Menu 15, Slot 2 – Menu 16, Slot 3 – Menu 17</td></tr>
<tr><td>Encoder power supply</td><td>Incremental absolute encoder basic set-up
• Encoder supply voltage Pr x.13
0 (5v) 1(8v) 2(15v)
Also refer to section 4.4 Power supply on page 13</td></tr>
<tr><td>Setup encoder parameters</td><td>Enter:
• Encoder type Pr x.15
7 (SC.HiPEr) 9 (SC.EndAt)</td></tr>
<tr><td>Encoder comms</td><td>• Encoder comms baud rate Pr x.14 (Only SC.EndAt)
• Encoder comms resolution Pr x.11
Where encoder comms is used for initial setting of the absolute position the comms resolution in bits must be set correctly, either by the user or the drive (Pr x.18), in parameter x.11. The comms resolution in Pr x.11 may be set to a higher resolution than the sine waves per revolution.
• Encoder turns Pr x.09
When an encoder with comms is used Pr x.09 must contain the number of bits in the comms message used to give the multi-turn information. For a single turn comms encoder Pr x.09 must be set to zero.It is possible for the drive to set up this parameter automatically from information obtained from the encoder. See Pr x.18.</td></tr>
<tr><td>Encoder lines per revolution</td><td>• Equivalent lines per revolution Pr x.10
Set according to encoder, see below for restrictions
• Line per revolution divider Pr x.46
The equivalent lines per revolution Pr x.10 is divided by the value in Pr x.46 this can be used This can be used when an encoder is used where the number of counts or sine waves per pole is not an integer. For example 128.123 lines per revolution would be set as 128123 in Pr x.10 and 1000 in Pr x.46 giving 128123 / 1000 = 128.123
<table><tr><th>Encoder</th><th>Pr x.10 Equivalent lines per revolution</th></tr><tr><td>SC.HiPEr, SC.EndAT</td><td>Number of sine waves per revolution</td></tr></table></td></tr>
<tr><td>Initialisation</td><td>Ensure:
• Position feedback is initialised Pr x.45</td></tr>
<tr><td>Encoder comms transmit, receive registers</td><td>• Disable encoder position check Pr x.44
If Pr x.44 is zero the drive can check the position derived with the sine and cosine waveforms from a SinCos encoder via serial communications. If Pr x.44 is set to one the checking is disabled and encoder comms is available via the transmit and receive registers.
• Transmit register Pr x.42
• Receive register Pr x.43</td></tr>
</table>

5.1.3 Comms only, absolute encoders

The following parameter set-up should be followed when operating with a Comms Only absolute encoder.

Comms only, absolute encoders, SSI and EndAt	
Action	**Detail**
Before power-up	Ensure: • Drive enable signal is not given (terminal 31) • Run signal is not given • Option module is fitted in appropriate slot • Feedback device is connected
Power up drive	Ensure: • Drive displays 'inh' If the drive trips see Chapter 8 *Diagnostics* on page 55
Slot Identification	Identify which option module slot and menu are being used • Slot 1 – Menu 15 • Slot 2 – Menu 16 • Slot 3 – Menu 17
Set-up encoder power supply	**Comms only absolute encoder basic set-up** Encoder supply voltage Pr **x.13** **0** (5v) **1**(8v) **2**(15v) Also refer to section 4.4 *Power supply* on page 13
Set-up encoder parameters	Enter: • Encoder type Pr **x.15** **8** (EndAt) **10** (SSI)
Set-up Data format	• SSI encoder Gray code data format Pr **x.18**
Auto Configuration	• EndAt Auto-configuration Pr **x.18**
Set-up encoder comms	• Encoder comms baud rate Pr **x.14** • Encoder comms resolution Pr **x.11** Where encoder comms is used for initial setting of the absolute position the comms resolution in bits must be set correctly, either by the user or the drive, Pr **x.18** (not SSI), in Pr **x.11**. The comms resolution in Pr **x.11** may be set to a higher resolution than the sine waves per revolution. • Encoder turns Pr **x.09** When an encoder with comms is used Pr **x.09** must contain the number of bits in the comms message used to give the multi-turn information. For a single turn comms encoder Pr **x.09** must be set to zero. It is possible for the drive to set up this parameter automatically from information obtained from the encoder see Pr **x.18** (not SSI)
Initialisation	Ensure: • Position feedback is initialised Pr **x.45**

5.2 Termination resistors

The encoder input termination resistors cannot be disabled when encoders with SinCos waveforms are selected. The Marker pulse input termination resistors cannot be disabled except when one of the following encoders is selected

Ab, Fd, Fr, Ab.SErVO, Fd.SErVO, Fr.SErVO.

By default the termination resistors on the encoder inputs are connected with the exception of the Marker pulse inputs which are disconnected. The termination resistors can be can be configured as shown below using encoder termination Pr **x.16**.

Terminal	Encoder Input	Pr x.16=0	Pr x.16=1	Pr x.16=2
1, 2	A, /A	Disabled	Enabled	Enabled
3, 4	B, /B	Disabled	Enabled	Enabled
5, 6	Z, /Z	Disabled	Disabled	Enabled
7, 8, 9, 10, 11, 12	U, /U V, /V W, /W	Enabled	Enabled	Enabled

The termination resistors on each of the above encoder inputs is 60Ω, when connected (A, /A) total resistance = 120Ω.

5.3 Simulated encoder outputs

NOTE The simulated encoder outputs available on terminal PL2 are identical to the simulated encoder outputs available on terminal SK1 (internally connected)

The simulated encoder outputs can be generated from either of the following sources.

- SM-Universal Encoder Plus option modules positional information.
- Any parameter, which has a 16-bit position value in the form of a roll-over counter (parameters with a range of -32768 to 32767 or 0 to 65535)

The simulated encoder output can be configured with Pr **x.28** to be either 0 or 1 (Ab or Fd) as shown below

Terminal	No	Mode	Output	Pr x.28
SK1	7, 8, 9, 10	Quadrature	Ab	0
PL2	3, 4, 5, 6			
SKI	7, 8, 9, 10	Frequency and direction	Fd	1
PL2	3, 4, 5, 6			

5.3.1 Simulated encoder output resolution

16-bit

The encoder output resolution at default will be 16-bit (source parameters range -32768 to 32767 or 0 to 65535) however this can be increased to 24-bit as detailed below.

24-bit

When using a high precision encoder as feedback i.e. SinCos, SSI or EndAt and the source parameter, Pr **x.24** has been selected as Pr **x.05** position, the encoder output resolution can only then be increased from 16-bit to a 24 bit position value by setting Pr **x.27** encoder simulation resolution.

5.3.2 Software simulation: high resolution encoder

This situation occurs when the source parameter is Pr **x.05** position of the same module, the source device is a high precision encoder i.e. Comms only, and the simulated encoder output is Ab or Fd and Pr **x.27** encoder simulation resolution is selected.

The position Pr **x.05** and fine position Pr **x.06** are read every 250µs with the output being generated during the next period. This gives a simulated encoder output of the main encoder with higher resolution (24 bit).

The output position is defined as follows.

Output position = Counted input position x (Pr **x.25** / Pr **x.26**)

Example:
in order to simulate one to one with a 13 bit (8192 count) comms only encoder resolution. (The current position is taken in 16777216th of a revolution (24 bit)). The ratio down to 8192 pulses requires 1/2048, or 0.0001/0.2048. So Pr **x.25** = 0.0001 and Pr **x.26** = 0.2048.

5.3.3 Software simulation: any other condition

If the source parameter is not as described above the parameter will be read every 250µs and the output generated during the next period under software control within the option module. The output position is defined as follows.

Output position = Parameter value x (Pr **x.25** / Pr **x.26**)

Example:
in order to simulate one to one with a 1024 line (4096 pulse) encoder.(*the current position is taken from the source parameter as a* 65536^{th} *of a revolution (16 bit)*). The ratio down to 4096 pulses requires 1/16, or 0.01/0.16. So Pr **x.25** = 0.01 and Pr **x.26** = 0.16.

5.3.4 Simulated encoder output SSI

The simulated SSI encoder outputs can be generated from either of the following sources, however there is no marker output generated with the SSI output.

- SM-Universal Encoder Plus option modules positional information.
- Any parameter, which has a 16-bit position value in the form of a roll-over counter (parameters with a range of -32768 to 32767 or 0 to 65535)

The simulated SSI encoder output can be configured with Pr **x.28** as shown below (SSI = Pr **x.28** = 2).

Terminal	No	Mode	Output	Pr x.28
SK1	7, 8, 9, 10	SSI synchronous serial interface	SSI	2
PL2	3, 4, 5, 6			

NOTE The simulated encoder outputs available on terminal PL2 are identical to the simulated encoder outputs available on terminal SKI (internally connected)

The position for the SSI encoder is in binary format not Gray code (cannot be configured to operate in Gray code) with the start bit high and the power supply alarm bit (last bit) low.

The SSI is an absolute encoder so the output position will be synchronised to the source's full position. Parameters Pr **x.47** SSI output turns and Pr **x.48** SSI output resolution are used to construct the SSI output position. If the source for the SSI output is a 32-bit parameter, the 32-bits will be used as the SSI output string.

Therefore the master (master = drive module supplying clock) controls the size of the transfer and decides how many bits are in the turns information and how many bits are in the position information. The same applies for a 16-bit source. The master can transfer up to the full 49 bits as the source parameter data will be the most significant part and the rest of the data will be packed with zeros.

It must be remembered that the option module acts as a slave (slave, sending out simulation) and is clocked by the master device. As the position is updated synchronised to the drive, this position will not be synchronised to the master.

The option module detects the end of a transfer when the master pauses the clock for more than 90µs. During this time the SSI interface resets and prepares for the next transfer. The baud rate is set in the master device, but the option module can output up to 500kHz**. The pause time of 90µs must never be reduced.**

A typical drive source example is given below:
The SSI output turns Pr **x.47** are set to the maximum, 16 and the SSI output resolution Pr **x.48** is set to its maximum, 32 to produce the full 48 bit multi-turn position (the start/ latching bit is added to this to give 49 bits that will be transferred). The master is set up for this also, and its clock rate is set at 400kHz. The master transfers a position value every 250µs.

At 400kHz, the transfer takes 122.5µs. As the next transfer will be 127.5µs later the pause condition is satisfied. If the clock were to be reduced to 300kHz, the pause time would be less than 90us so the communication channel could not be guaranteed.

A typical 32-bit source parameter example is given below:
The master controls the number of bits transferred and how many of the bits are the turn's information. For example a 32-bit parameter could contain 8 bits of turn information as the most significant part, and 10 bits of positional information as the next significant part. The bit string is shown below:

31 — 24	23 — 14	13 — 0
Turns information	Position	Do not care

The master is set to transfer 18 bits (plus one for the start/latch). The least significant bit sent will be forced low to indicate that the power supply is fine. The master is also set to take the most significant 8 bits as the turns information. The user is responsible for preparing the source parameter.

5.4 Marker inputs

A marker channel input is only optional when operating with either of the following incremental encoders:

Ab Ab.SErVO
Fd Fd.SErVO
Fr Fr.SErVO

When the marker channel input becomes active this can be used to

1. Reset the encoder position Pr **x.05** and Pr **x.06** and set the marker flag Pr **x.08** (Pr **x.07** should = 0)
2. Set the marker flag Pr **x.08** (Pr **x.07** should = 1)

When the position is reset by the marker channel input, Pr **x.05** and Pr **x.06** are reset to zero. The marker flag is set each time the marker input becomes active, but it is not reset by the drive, and so this must be done by the user.

Marker data
Each time the marker becomes active the non-marker position values in Pr **x.29** revolution counter Pr **x.30** position and Pr **x.31** fine position are sampled and stored in Pr **x.32** marker revolution counter, Pr **x.33** marker position and Pr **x.34** marker fine

position.

Non marker data

Pr **x.29**, Pr **x.30**, and Pr **x.31** positional information is taken from the position feedback device with these not being affected by the marker inputs.

5.5 Simulated marker outputs

A simulated marker output is available when selecting either Fd or Ab as the encoder output and Pr **x.24** encoder simulation source has been setup with a source. The marker output is only present when the output port is not being used for the RS485 freeze input.

5.5.1 Configuration

Parameter setup

1. Define source in Pr **x.24** simulated encoder source
2. Using Pr **x.38** configure terminals 8 and 9 on connector PL2 for marker output

Synchronisation

The simulated marker output is generated when either both A and B Quadrature signals or F frequency are high, (when the source defined by Pr **x.24** reaches zero).

By default the marker output will be active on the rising edge of the simulated encoder output, however this can be configured to be active on falling edge.

In order to have the marker pulse synchronised to the falling edge of the encoder output the encoder input signals on terminals 1, 2, 3, and 4 have to be reversed (e.g. A with /A and B with /B).

5.6 Freeze inputs

The freeze input can take the form of either a 485 signal on terminals 8 and 9 of PL2 or a 24V signal on the freeze 24V input on terminal 1 of PL2.

5.6.1 Configuration

If a freeze input of 24V or RS485 is to be used to freeze more than one SM-Universal Encoder Plus option module, the freeze must be connected to all of the SM-Universal Encoder Plus option modules that are required to freeze.

When Pr **x.41** = 0 freeze occurs on the rising edge of the freeze input and when Pr **x.41** = 1 freeze occurs on the falling edge of the freeze input.

The selection of which freeze input is used is dependent upon the value of Pr **x.38**. The selection of the freeze inputs are as shown following. The default is 1 that corresponds to only the 24V input.

Pr x.38	24V input	485 input
0	No	No
1	Yes	No
2	No	Yes
3	Yes	Yes

Freeze data

Each time the freeze input to the option module becomes active the non-marker position Pr **x.29** revolution counter Pr **x.30** position and Pr **x.31** fine position are stored in Pr **x.35** freeze revolution counter Pr **x.36** freeze position and Pr **x.37** freeze fine position and the freeze flag Pr **x.39** is set.

The freeze flag Pr **x.39** is not reset by the module and must be reset by the user, if not reset no other freeze conditions will be stored.

When a freeze occurs on the option module the main drive position can also be stored if Pr **x.40** freeze main drive position is set to one.

5.6.2 Freeze input with SM-Applications option module

Whenever a SM-Applications option module and a SM-Universal Encoder Plus option module are used, the freeze input should be connected to the SM-Universal Encoder Plus option module and Pr **x.40**, freeze main drive position should be set to allow the SM-Applications option module to see the freeze via the drive.

6 Advanced Operation

6.1 Serial communications

6.1.1 SinCos

Encoder Comms Resolution

Where encoder comms is used for initial setting of absolute position (SC.HiPEr or SC.EndAt), the comms resolution in bits must be set correctly, either by the user in Pr **x.11** or the drive see Pr **x.18**. The comms resolution may be higher than the resolution of the sine waves per revolution. It is possible for the drive to set up this parameter automatically from information obtained from the encoder via Hiperface or EndAt interfaces see Pr **x.18**.

Encoder Comms Baud Rate

The SinCos encoder comms baud rate is fixed at 9600 baud when using a Stegmann Hiperface encoder with Pr **x.14** encoder comms baud rate having no effect.

Any baud rate can be used when encoder comms is used with a SinCos encoder to obtain the absolute position during initialisation.

Encoder Turns

When an encoder with comms is used, Pr **x.09** must contain the number of bits in the comms message used to give the multi-turn information. For a single turn comms encoder Pr **x.09** must be set to zero. It is possible for the drive to set up this parameter automatically from information obtained from the encoder via Hiperface or EndAt interfaces during auto configuration.

Encoder Position Check

If Pr **x.44** encoder position check is zero the drive can check the position derived with the sine and cosine waveforms from a SinCos encoder via serial communications.

Encoder Transmit - Receive

If Pr **x.44** is set to one the checking is disabled and encoder comms is available via the transmit and receive registers. The transmission system can be used to communicate with encoders provided the mode is SC.HiPEr or SC.EndAt as follows:

For both comms protocols more than one byte of data must be written to the transmit register or read from the receive register during the transfer of one message. Bits 13-15 are used to indicate the following:

Register	Bit	Function
Transmit	15	Must be set for the option module to transfer the LS byte to the comms buffer.
Transmit	14	The LS byte is the last byte of the message and this byte should be put in the comms buffer and be transferred to the encoder.
Transmit	13	The LS byte is the first byte of the message. (If this is used the buffer pointer is reset to the start of the buffer.)
Receive	15	Indicates data from the last transfer can be read from the receive buffer.
Receive	14	The byte in the LS byte is the last byte of the receive message
Receive	13	There is no data in the receive buffer and the LS byte is the comms system status. If there was an error in the received message this will always be set and one of the status error bits will be set until the comms is used again by this system.

Data should be written to the transmit buffer when the buffer has been reset to zero by the module. The data will be transferred to the comms buffer and the transmit register will be cleared. Data can be read from the receive buffer at any time. If there is receive data in the buffer bit 15 will be set. Once the data has been read the buffer should be cleared and the module will then transfer more data. The buffer is 16 bytes long and any messages that exceed this length (including the checksum added for Hiperface) will cause an error. The status flags are defined as follows:

Bit	Meaning
0	The number of bytes put into the transmit buffer is not consistent with the expected message length.
1	The number of bytes written to the transmit buffer, or the expected length of the store data transmit message, or the expected length of a read data message have exceed the length of the buffer.
2	The command code is not supported.
3	The encoder has signalled an error.
4	There was an error in the checksum/CRC of the received message.
5	A timeout occurred.
6	The last message was to auto-configure the drive encoder and the encoder was identified successfully.
7	The last message was initiated through the option module interface or from the drive electronic nameplate system and the last message was successful.

SC.HiPEr

The Stegmann Hiperface comms protocol is an asynchronous byte based system. Up to 15 bytes of data can be written to the buffer. The first byte should be the encoder address. The checksum will be calculated by the module and added to the end of the message before the message is transmitted to the encoder. The module checks the checksum of the received message. If successfully received, the receive message can be read via the receive register including the address and the checksum received from the encoder. It should be noted that the encoder must be set up for 9600 baud, 1 start bit, 1 stop bit and even parity (default set-up) for the encoder comms to operate with the module. Also the data block security should not be enabled if the option module encoder nameplate system is to operate correctly.

The following commands are supported:

Code	Command
0x42	Read position
0x43	Set position
0x44	Read analogue value
0x46	Read counter
0x47	Increment counter
0x49	Clear counter
0x4a	Read data (maximum of 10 bytes)
0x4b	Store data (maximum of 9 bytes)
0x4c	Data field status
0x4d	Create a data field
0x4e	Available memory
0x50	Read encoder status
0x52	Read type

Example of a SC.HiPEr positional data transfer via serial comms
Requesting the position from a SC.HiPEr encoder (12/14 = Turns/Position).

Pr **x.44** has to be set to a one (encoder comms set-up for transmit / receive registers Pr **x.42** and Pr **x.43**) to open the parameter channels. For position, only two bytes need to be sent from the SM-Universal Encoder Plus option module, the address and command being 0x42 (hex). For simplicity the address is chosen as the broadcast address 0xFF, which can be seen by encoders of any address.

The 16-bit word to be placed through drive serial comms, or a SM-Applications option module, is made up of a transfer command byte (the highest byte) and the data to be transferred (the least significant byte). To alert the SM-Universal Encoder Plus option module to the fact that there is new data in Pr **x.42**, the most significant bit of the transfer command byte (bit 15 of the full word) must be set. To alert the SM-Universal Encoder Plus option module that this is the first byte to be transferred, bit 13 of the full word should be high. The first byte to be sent is the address, so the full word to be placed in Pr **x.42** is below in binary:

Most significant end

1010	0000	: 1111	1111
Transfer Command		: Data to transfer	
0xa0		: 0xff	

Gives the decimal number 41215.

Once placed into Pr **x.42**, the parameter will be read by the option and its value returned to zero to signify that the next word can be entered. This is the last byte required to send (as the option will add the checksum) so bit 15 and bit 14 of the full word must be set. The data byte to be sent is the read position command 0x42. The last byte to be sent is the Hiperface command, so the full word to be placed in x.42 is below in binary:

Most significant end

1100	0000	: 0100	0010
Transfer Command		: Data to transfer	
0xc0		: 0x42	

Gives the decimal number 49218.

Once placed into the Pr **x.42**, the parameter will be read by the SM-Universal Encoder Plus option module and its value returned to zero to signify that the data has been sent. Next the receive register, Pr **x.43** should be read. If the most significant bit is high (if the value is equal to or higher than 32768) new data has been placed there by the SM-Universal Encoder Plus option module. This data should be read by the user and then Pr x.**43** should be set to zero by the user to alert the option that the next word should be placed into this parameter.

In this particular example the position with SinCos interpolation according to Pr **x.04** and Pr **x.05** was turn 3429 and position 36446. The position requires dividing by 8 to produce a 14-bit position as will be given from the read position data transfer, this gives a position of 9112. The returned data from the encoder and read through Pr **x.43** is given in the following table:

Word number	Returned value	Returned value in hex.	Data in decimal	Data in hex.	Data in binary
1	32832	0x8040	64	0x40	0100 0000
2	32834	0x8042	66	0x42	0100 0010
3	32771	0x8003	03	0x03	0000 0011
4	32857	0x8059	89	0x59	0101 1001
5	32867	0x8063	99	0x63	0110 0011
6	32919	0x8097	151	0x97	1001 0111
7	49324	0xc0ac	172	0xac	1010 1100

All the returned values have been offset by 32768 which is the most significant bit. The last byte has an addition offset of 16384 to denote that it is the last byte.

First check the CRC (which is also checked by the option module), this is the XOR of all the data bytes before bit position by bit position, for example the least significant bit of the CRC is zero as the XOR (001111) is zero.

Words 3 to 6 are the position with the least significant bit as the least significant bit of word 6 so any unused bits being placed in the more significant part of word 3. Below are the numbers laid out in the correct order:

Word 3	Word 4	Word 5	Word 6
3	89	99	151
0000 0011	0101 1001	0110 0011	1001 0111

Shifted to turns and position (which is 12-bits then 14-bits):

1101 0110 0101 (end of turns and start of the position)	10 0011 1001 0111
3429	9111

So the absolute position is 3429/9111 which should be compared to the displayed interpolated position of 3429/9112.

SC.EndAt

The Heidenhain EndAt protocol is a synchronous protocol using the following message format.

Command	1st byte
Address	
Data (LSB)	
Data (MSB)	4th byte

The following commands are supported:

Code	Command	Address	Data
0x00	Encoder to send position	Don't care	Don't care
0x01	Selection of memory area	MRS code	Don't care
0x03	Encoder to receive parameter	Address	Data
0x04	Encoder to send parameter	Address	Don't care
0x05	Encoder to receive reset	Don't care	Don't care

The following is an example of the response when the Encoder to send position command is used.

LS byte	1st byte	Bit 7-0 = 0
		Bit 7-0 = 0
		Bit 7-0 = 0
		Bit 7-0 = 0
		Bits 5-0 = 0 Bit 6 = Alarm bit Bit 7 = Bit 0 of position
		Bits 7-0 = Bits 8-1 of position
		Bits 3-0 = Bits 12-9 of position Bits 7-4 = Bits 3-0 of turns
MS byte	8th byte	Bits 7-0 = Bits 11-4 of turns

The example shown above is for an encoder with 12 bits representing the turns and 13 bits representing the position within a turn. The position command only requires one byte to be sent to the encoder. Bits 14 and 13 can both be set in the transmit register to indicate that this is both the first and last byte of the message.

If any other command is used then the response is as follows:

Address	1st byte
Data (LSB)	
Data (MSB)	3rd byte

Example of a SC.EndAt positional data transfer via serial comms
Requesting the position from a SC.EndAt encoder (12/13 = Turns/Position).

To request the position the following data output must be sent:

Command = 0x00	1st byte
Address = not needed = 0x00	
Data (LSB) = not needed = 0x00	
Data (MSB) = not needed = 0x00	4th byte

The 16-bit word to be placed through drive serial comms, or a SM-Applications option module, is made up of a transfer command byte (the highest byte) and the data to be transferred (the least significant byte). To alert the SM-Universal Encoder Plus option module to the fact that there is new data in Pr **x.42**, the most significant bit of the transfer command byte (bit 15 of the full word) must be set. To alert the SM-Universal Encoder Plus option module that this is the first byte to be transferred, bit 13 of the full word should be high. The first byte to be sent is the command, so the full word to be placed in Pr **x.42** is below in binary:

Most significant end

1010	0000	: 000	0000
Transfer Command		: Data to transfer	
0xa0		: 0x00	

Gives the decimal number 40960.

Once placed into Pr **x.42**, the parameter will be read by the SM-Universal Encoder Plus option module and its value returned to zero to signify that the next word can be entered.

The next two words only require the most significant bit to be high:

32768

32768

Once placed into the Pr **x.42**, the parameter will be read by the SM-Universal Encoder Plus option module and its value returned to zero to signify that the next word can be entered. This is the last byte required to send so bit 15 and bit 14 of the full word must be set. The data byte to be sent is the read position command 0x42. The last byte to be sent is the most significant byte of data, so the full word to be placed in x.42 is below in binary:

Most significant end			
1100	0000	: 0000	0000
Transfer Command		: Data to transfer	
0xc0		: 0x00	

Gives the decimal number 49152.

Once placed into the Pr **x.42**, the parameter will be read by the option and its value returned to zero to signify that the data has been sent. Next the receive register Pr **x.43** should be read. If the most significant bit is high (if the value is equal to or higher than 32768) new data has been placed there by the SM-Universal Encoder Plus option module. This data should be read by the user and then the Pr **x.43** should be set to zero by the user to alert the SM-Universal Encoder Plus option module that the next word should be placed into this parameter.

In this particular example the position with SinCos interpolation according to Pr **x.04** and Pr **x.05** was turn 1860 and position 59887. The position requires dividing by 16 to produce a 13-bit position as will be given from the read position data transfer, this gives a position of 7485. The returned data from the encoder and read through Pr **x.43** is given below:

Word number	Returned value	Data in decimal	Data in binary
1	32832	00	0000 0000
2	32832	00	0000 0000
3	32832	00	0000 0000
4	32832	00	0000 0000
5	32832	00	0000 0000
6	32927	159	1001 1111
7	32846	78	0100 1110
8	49268	116	0111 0100

All the returned values have been offset by 32768, which is the most significant bit. The last byte has an addition offset of 16384 to denote that it is the last byte.

Words 5 to 8 are the position with the least significant bit in word 5. Below are the numbers laid out in the correct order:

Word 8	Word 7	Word 6	Word 5
116	78	159	00
0111 0100	0100 1110	1001 1111	0000 0000

Shifted to turns and position (which is 12 bits then 13 bits):

0111 0100 0100 (end of turns and start of the position)	1 1101 0011 1110
1860	7486

So the absolute position is 1860/7486 which should be compared to the displayed interpolated position of 1860/7485.

6.1.2 SSI - EndAt

Encoder Comms Resolution

Where encoder comms alone is used the encoder single turn comms resolution Pr **x.11** and the encoder turns bits Pr **x.09** must be set correctly. Although Pr **x.11** can be set to any value from 0 to 32, if the value is less than 1, the resolution is 1 bit.

Some SSI encoders include a power supply monitor alarm using the least significant bit of the position. It is possible for the drive to monitor this bit and produce an EnC6 trip if the power supply is too low see Pr **x.17**. If the encoder gives this information the comms resolution should be set up to include this bit whether or not it is being monitored by the drive.

It is possible for the drive to set up this parameter automatically from information obtained from the encoder via the EndAt interface see Pr **x.18**.

Encoder Turns

When an encoder with comms is used, Pr **x.09** must contain the number of bits in the comms message used to give the multi-turn information. For a single turn comms encoder Pr **x.09** must be set to zero. It is possible for the drive to set up this parameter automatically from information obtained from the encoder via Hiperface or EndAt interfaces during auto configuration.

Encoder Comms Baud Rate

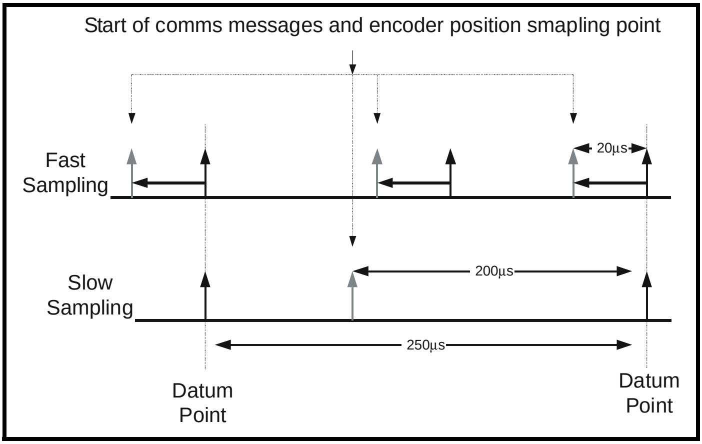
Pr **x.14** defines the baud rate for the encoder comms when using SSI or EndAt encoders.

Parameter value	Parameter string	Baud rate
0	100	100k
1	200	200k
2	300	300k
3	400	400k
4	500	500k
5	1000	1M
6	1500	1.5M
7	2000	2M
8	4000	4M

When encoder comms is used alone the time taken to obtain the comms position must be 160µs or less.

There is a delay associated with obtaining the position from an encoder using comms alone to transmit the position. The length of this delay affects the sample rate and timing of the position used by the drive for control. If the position within one turn can be obtained in 30µs and the whole comms message including CRC (if appropriate) can be obtained in 60µs then fast sampling is used, otherwise slow sampling is used as shown in Figure 6-1. In each case the encoder position is sampled by the encoder at the start of the comms message.

Figure 6-1 Encoder data transferral via comms



In the example the current / torque sampling rate is 4kHz, but this will change if a different switching frequency is selected. If fast sampling is used the control position used to define the drive reference frame is obtained every current/torque control sample. If slow sampling is used the control position is obtained 200µs before the datum. When fast sampling is used the delay introduced into the control system by the encoder is less, and so a higher control system bandwidth will be possible. So that the position values from the encoder can be used in a position control system compensation is provided for the delay in obtaining the position so that it appears to have been sampled at the datum. This compensation is based on the delay (i.e. 20µs or 200µs) and the change of position over the previous sample (between the last two datum points).

EndAt Comms

The following equations are used by the option module to determine the time taken to obtain the position information from an EndAt encoder. These are based on $t_{cal} \leq 5\mu s$, where t_{cal} is the time from the first clock edge of the position command message from the drive to the first clock edge when the encoder responds as defined in the EndAt specification. This limit of 5µs includes may exclude a small number of EndAt encoders from being used by the drive as a comms only feedback device. It is also assumed that $t_D \leq 1.25\mu s$ where t_D is the data delay from the encoder as defined by the EndAt specification for 105m of cable. It should be noted that all values are rounded up to the nearest microsecond.

Command message time = $t_{command}$ = 10T or t_{cal} whichever is the longest

Where:

T = 1/Baud Rate, $t_{cal} = 5\mu s$

Time for single turn position = $t_{command} + t_D$ + (2 + Single turn resolution) x T

= $t_{command} + t_D$ + (2 + Pr **x.11**) x T

Where:

$t_D = 1.25\mu s$

Time for whole message including CRC = Time for single turn position + (Number of turns bits + 5) x T

= Time for single turn position + (Pr **x.09** + 5) x T

For example an encoder with 12 turns bits, 13 bit single turn resolution and a baud rate of 2M would give the following times:

Time for single turn position = 14µs (13.75µs rounded up)

Time for the whole message including CRC = 23µs (22.25µs rounded up)

SSI Comms

The whole position must be obtained from an SSI encoder before it can be used by the option module, therefore the time for the single turn position and the time for the whole message are the same.

Time to obtain the position = (Number of turns bits + Single turn resolution + 1) x T

= (Pr **x.09** + Pr **x.11** + 1) x T

For example and encoder with 12 turns bits, 13 bit single turn resolution and a baud rate of 1M would give the following time: Time to obtain the position data = 28µs (27.25µs rounded up).

6.1.3 Electronic nameplate transfers

The electronic nameplate system is a means of storing some specific drive parameters within the EEPROM of a Stegmann or Heidenhain encoder attached to the drive. The parameters are transferred to the encoder using the Stegmann 485, or EndAt comms protocols and stored are in two categories:

- Motor object parameters
- Performance object parameters.

Loading/storing object parameters

Parameters may be transferred to or from the drive to a suitable encoder attached to the drive or one of its option modules by entering a code into Pr **x.00,** 110z0 and then resetting the drive. The z in the request defines the location of the encoder for the transfer, 0 = drive, 1 = option slot 1, 2 = option slot 2, and 3 = option slot 3.

Transfer	Data	Pr x.00 Code
Drive to encoder	Motor object parameters	110z0
Encoder to drive	Motor object parameters	110z1
Drive to encoder	Performance object block 1 parameters	110z2
Encoder to drive	Performance object block 1 parameters	110z3
Drive to encoder	Performance object block 2 parameters	110z4
Encoder to drive	Performance object block 2 parameters	110z5

Motor object parameters

The encoder can contain one motor object that holds parameters related to the motor on which the encoder is fitted and the motor load.

Parameter	Description
18.11	Motor object version number**
18.12	Motor type (LSW)**
18.13	Motor type (MSW)**
18.14	Motor manufacturer**
18.15	Motor serial number (LSW)**
18.16	Motor serial number**
18.17	Motor serial number (MSW)**
1.06	Maximum speed
03.18	Motor and load inertia
03.25	Encoder phase angle
04.15	Motor thermal time constant
04.25	Low speed thermal protection mode
05.06	Rated frequency
05.07	Rated current
05.08	Rated load rpm
05.09	Rated voltage
05.10	Rated power factor
05.11	Motor poles
05.17	Stator resistance (Rs)
05.24	Transient inductance (Ls')
05.25	Stator inductance (Ls)
05.29	Motor saturation breakpoint 1
05.30	Motor saturation breakpoint 2
05.32	Motor torque per amp (Kt)
05.33	Motor volts per 1000rpm (Ke)

** The motor object includes some data that does not normally have associated parameters, but would be entered into the object by the motor manufacturer. To allow this data to be transferred to an encoder from a drive without additional equipment, Pr **18.11** to Pr **18.17** can be used to transfer this data if Pr **3.49** is set to one.

Performance object parameters

The encoder can contain up to 2 performance objects each of which contains a set of parameters that can be used to give different levels of motor performance.

Parameter	Performance object 1	Performance Object 2
	Description	Description
03.10	Speed controller Kp gain	Speed controller Kp gain
03.11	Speed controller Ki gain	Speed controller Ki gain
03.12	Speed controller Kd gain	Speed controller Kd gain
03.17	Speed controller set-up method	Speed controller set-up method
03.19	Compliance angle	Compliance angle
03.20	Bandwidth	Bandwidth
03.21	Damping factor	Damping factor
04.05	Motoring current limit	Motoring current limit
04.06	Regen current limit	Regen current limit
04.12	Torque demand filter	Torque demand filter
04.13	Current controller Kp gain	Current controller Kp gain
04.14	Current controller Ki gain	Current controller Ki gain

It should be noted that the data within the objects in the encoder is undefined until it has been written and that the manufacturer's data is undefined until it has been written by a complete motor object write with Pr **3.49** set to one. If a value stored in the nameplate data exceeds the maximum of a parameter when the data is transferred the parameter in the drive is not updated.

The checksum for each object is Zero – sum of bytes in the object excluding the checksum itself. The number of bytes defines the number of bytes used to generate the checksum. This includes all the parameters and the number of bytes parameter, and so this value will always be 62 for the motor object and 30 for a performance object.

When either a motor or performance object is transferred to the drive all drive parameters are saved. When a performance object is loaded the speed control gain select parameter is automatically set to zero. Therefore either the speed controller gains defined in the performance object or those derived from the compliance angle, bandwidth and damping factor parameters are used.

7 Parameters

7.1 Introduction

The parameters listed in this chapter are used for programming and monitoring the SM-Universal Encoder Plus.

NOTE The same parameter structure is available in menu 15, 16 and 17 referring to slots 1, 2 and 3.

WARNING Before attempting to adjust any parameters, refer to Chapter 2 *Safety Information* on page 2.

Table 7.1 Key to parameter 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
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: indicates that this parameter can be a destination parameter.
RA	Rating dependant: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. This parameters is not transferred by smart cards when the rating of the destination drive is different from the source drive.
NC	Not cloned: not transferred to or from smart cards during cloning.
PT	Protected: cannot be used as a destination.
US	User save: saved in drive EEPROM when the user initiates a parameter save.
PS	Power-down save: automatically saved in drive EEPROM at power-down.

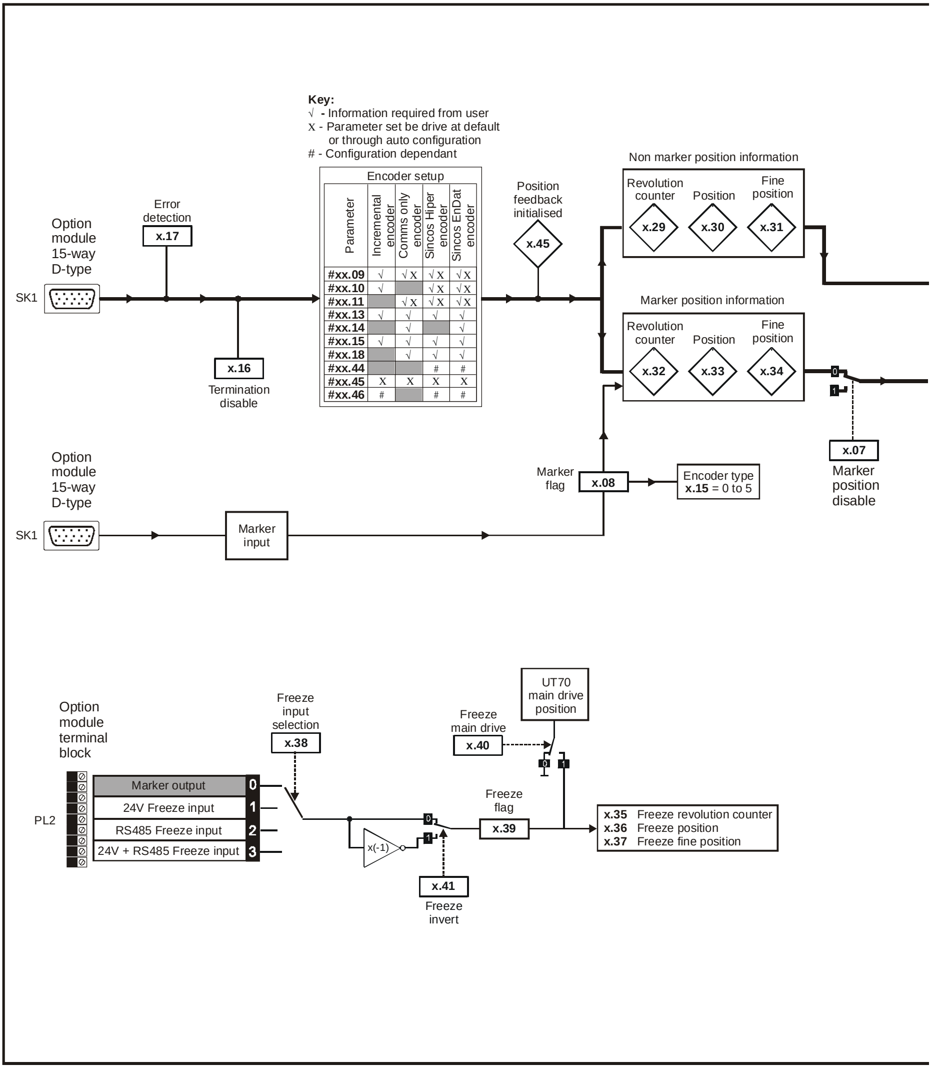
7.2 Single line descriptions

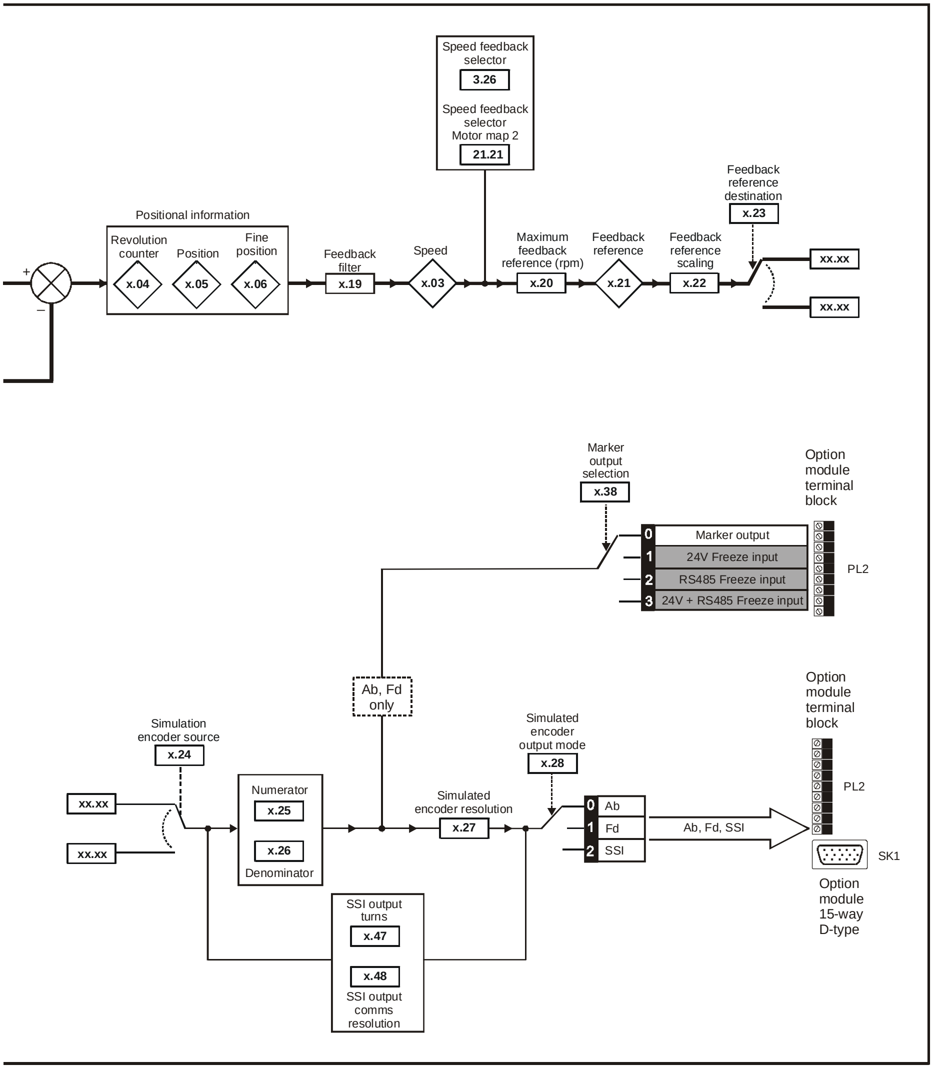
Parameter		Range(⇕)		Default(⇨)			Type					
		OL	CL	OL	VT	SV						
x.01	Solutions Module ID	0 to 499					RO	Uni			PT	US
x.02	Solutions Module software version	0.0 to 99.99					RO	Uni		NC	PT	
x.03	Speed	±40,000.0 rpm					RO	Bi	FI	NC	PT	
x.04	Revolution counter	0 to 65,535 revolutions					RO	Uni	FI	NC	PT	
x.05	Position	0 to 65,535 (1/2^{16}ths of a revolution)					RO	Uni	FI	NC	PT	
x.06	Fine position	0 to 65,535 (1/2^{32}nds of a revolution)					RO	Uni	FI	NC	PT	
x.07	Marker position reset disable	OFF (0) or On (1)		OFF (0)			RW	Bit				US
x.08	Marker flag	OFF (0) or On (1)		OFF (0)			RW	Bit		NC		
x.09	Encoder turns	0 to 16		16			RW	Uni				US
x.10	Equivalent lines per revolution	0 to 50,000		4096			RW	Uni				US
x.11	Encoder comms resolution	0 to 32 bits		0			RW	Uni				US
x.12	Motor thermistor check *enable*	OFF (0) or On (1)		OFF (0)			RW	Bit				US
x.13	Encoder supply voltage	5V (0) 8V (1) 15V (2)		5V (0)			RW	Uni				US
x.14	Encoder comms baud rate	100 (0), 200 (1), 300 (2), 400 (3), 500 (4), 1,000 (5), 1,500 (6), 2,000 (7), 4,000 (8)		300 (2)			RW	Txt				US
x.15	Encoder type	Ab (0), Fed (1), Fr (2), Ab.SErVO (3), Fd.SErVO (4), Fr.SErVO (5), SC (6), SC.HiPEr (7), EndAt (8), SC.EndAt (9), SSI (10)		Ab (0)			RW	Uni				US
x.16	Encoder termination	0 to 2		1			RW	Uni				US
x.17	Error detection level	0 to 7		0			RW	Uni				US
x.18	Auto configuration	OFF (0) or On (1)		OFF (0)			RW	Bit				US
x.19	Feedback filter		0 to 5 (0 to 16 ms)	0			RW	Uni				US
x.20	Maximum feedback reference	0.0 to 40,000.0 rpm		1500.0			RW	Uni				US
x.21	Feedback reference	±100.0 %					RO	Bi		NC	PT	
x.22	Feedback reference scaling	0.000 to 4.000		1.000			RW	Uni				US
x.23	Feedback reference destination	Pr **0.00** to Pr **21.51**		Pr **0.00**			RW	Uni	DE		PT	US
x.24	Encoder simulation source	Pr **0.00** to Pr **21.51**		Pr **0.00**			RW	Uni			PT	US
x.25	Encoder simulation ratio numerator	0.0000 to 3.0000		1.0000			RW	Uni				US
x.26	Encoder simulation ratio denominator	0.0001 to 3.0000		1.0000			RW	Uni				US
x.27	Encoder simulation resolution select	OFF (0) or On (1)		OFF (0)			RW	Bit		NC		
x.28	Encoder simulation mode	Ab (0), Fd (1), SSI (2)		Ab (0)			RW	Txt				US
x.29	Non-marker reset revolution counter	0 to 65,535 revolutions					RO	Uni		NC	PT	
x.30	Non-marker reset position	0 to 65,535 (1/2^{16}ths of a revolution)					RO	Uni		NC	PT	

Parameter		Range(⇕)		Default(⇨)			Type					
		OL	CL	OL	VT	SV						
x.31	Non-marker reset fine position	0 to 65,535 ($1/2^{32}$nds of a revolution)					RO	Uni		NC	PT	
x.32	Marker revolution counter	0 to 65,535 revolutions					RO	Uni		NC	PT	
x.33	Marker position	0 to 65,535 ($1/2^{16}$ths of a revolution)					RO	Uni		NC	PT	
x.34	Marker fine position	0 to 65,535 ($1/2^{32}$nds of a revolution)					RO	Uni		NC	PT	
x.35	Freeze revolution counter	0 to 65,535 revolutions					RO	Uni		NC	PT	
x.36	Freeze position	0 to 65,535 ($1/2^{16}$ths of a revolution)					RO	Uni		NC	PT	
x.37	Freeze fine position	0 to 65,535 ($1/2^{32}$nds of a revolution)					RO	Uni		NC	PT	
x.38	Freeze input mode selection	0 to 3		1			RW	Uni				US
x.39	Freeze flag	OFF (0) or On (1)		OFF (0)			RW	Bit		NC		
x.40	Freeze main drive position	OFF (0) or On (1)		OFF (0)			RW	Bit		NC		US
x.41	Freeze invert	OFF (0) or On (1)		OFF (0)			RW	Bit				US
x.42	Encoder comms transmit register	0 to 65,535					RW	Uni		NC		
x.43	Encoder comms receive register	0 to 65,535		0			RW	Uni		NC		
x.44	Disable encoder position check	OFF (0) or On (1)		OFF (0)			RW	Bit		NC		
x.45	Position feedback initialised	OFF (0) or On (1)					RO	Bit		NC	PT	
x.46	Lines per revolution divider	1 to 1024		1			RW	Uni				US
x.47	SSI output turns	0 to 16		16			RW	Uni				US
x.48	SSI output comms resolution	0 to 32 bits		0			RW	Uni				US
x.50												

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar
Bit	Bit parameter	Txt	Text string	FI	Filtered	DE	Destination
NC	Not cloned	RA	Rating dependent	PT	Protected	US	User save
PS	Power down save						

Figure 7-1 SM-Universal Encoder Plus logic diagram




Speed feedback selector
3.26
Speed feedback selector Motor map 2
21.21
Feedback reference destination
x.23
Positional information
Revolution counter
Position
Fine position
x.04
x.05
x.06
Feedback filter
x.19
Speed
x.03
Maximum feedback reference (rpm)
x.20
Feedback reference
x.21
Feedback reference scaling
x.22
xx.xx
xx.xx
Marker output selection
x.38
Option module terminal block
Marker output
24V Freeze input
RS485 Freeze input
24V + RS485 Freeze input
PL2
Ab, Fd only
Simulation encoder source
x.24
xx.xx
xx.xx
Numerator
x.25
x.26
Denominator
Simulated encoder resolution
x.27
Simulated encoder output mode
x.28
Ab
Fd
SSI
Ab, Fd, SSI
Option module terminal block
PL2
SK1
Option module 15-way D-type
SSI output turns
x.47
x.48
SSI output comms resolution

7.3 Parameter descriptions

x.01	Option ID code							
RO	Uni					PT	US	
⇕	0 to 499			⇨				

When no Solutions Module is fitted in the relevant slot this parameter is zero. When a module is fitted this parameter displays the identification code of the module as shown below.

Code	Module	Category
0	No module fitted	
101	SM-Resolver	Position feedback
102	SM-Universal Encoder Plus	
201	SM-I/O Plus	I/O expansion module
301	SM-Applications	Applications module
302	SM-Applications Lite	
403	SM-PROFIBUS-DP	Fieldbus
404	SM-INTERBUS	
407	SM-DeviceNet	

When parameters are saved by the user in the drive EEPROM the option code of the currently fitted module is saved in EEPROM. If the drive is subsequently power-up with a different module fitted, or no module fitted where a module was previously fitted, the drive gives a Slot.dF trip. The menu for the relevant slot appears for the new module category with the default parameter values for the new category. The new parameters values are not stored in EEPROM until the user performs a parameter save.

x.02	Option software version							
RO	Uni				NC	PT		
⇕	00.00 to 99.99			⇨				

x.03	Speed							
RO	Bi	FI			NC	PT		
⇕	-40,000.0rpm to +40,000.0rpm			⇨				

Provided the set-up parameters for the position feedback are correct this parameter shows the speed in rpm.

x.04	Revolution counter							
RO	Uni	FI			NC	PT		
⇕	0 to 65535 revolution			⇨				

x.05	Position								
RO	Uni	FI				NC	PT		
⇳	0 to 65535 revolution				⇨				

x.06	Fine position								
RO	Uni	FI				NC	PT		
⇳	0 to 65535 revolution				⇨				

These parameters give the position with a resolution of $1/2^{32}$ths of a revolution as a 48 bit number as shown below.

47 32	31 16	15 0
Revolutions	Position	Fine position

Provided the set-up parameters are correct, the position is always converted to units of $1/2^{32}$ths 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 digital encoder produces 4096 counts per revolution, and so the position is represented by the bits in the shaded area only.

47 32	31 20	19 16	15 0
Revolutions	Position		Fine position

When the feedback device rotates by more than one revolution, the revolutions in Pr **x.04** increment or decrement in the form of a sixteen bit roll-over counter. If an absolute position feedback is used the position is initialised at power-up with the absolute position.

x.07	Marker position reset disable								
RW	Bit							US	
⇳	OFF (0) or On (1)				⇨	OFF (0)			

x.08	Marker flag								
RW	Bit					NC			
⇳	OFF (0) or On (1)				⇨	OFF (0)			

An incremental digital encoder may have a marker channel and when this channel becomes active (rising edge in the forward direction and falling edge in reverse) it may be used to reset the encoder position and set the marker flag (Pr **x.07** = 0), or just to set the marker flag (Pr **x.07** = 1). When the position is reset by the marker, Pr **x.05** and Pr **x.06** are reset to zero.

The marker flag is set each time the marker input becomes active, but it is not reset by the drive, and so this must be done by the user. The marker function only operates when Ab, Fd, Fr, Ab.SErVO, Fd.SErVO, Fr.SErVO type encoders are selected with Pr **x.15**.

x.09		Encoder turns							
RW	Uni					NC		US	
⇳	0 to 16				⇨	16			

When an encoder without comms is used it is sometimes desirable to mask off the most significant bits of the revolution counter. Normally this would be required with an absolute multi-turn encoder where the number of turns measured is less than 65536. If Pr **x.09** is zero the revolution counter (Pr **x.04**) is held at zero. If Pr **x.09** has any other value it defines the maximum number of the revolution counter before it is reset to zero. For example, if Pr **x.09** = 5, then Pr **x.04** counts up to 31 before being reset.

When an encoder with comms is used, Pr **x.09** must contain the number of bits in the comms message used to give the multi-turn information. SSI encoders always require the user to enter this parameter. For a single turn comms encoder, Pr **x.09** must be set to zero.

x.10		Equivalent lines per revolution							
RW	Uni							US	
⇳	0 to 50000				⇨	4096			

When Ab, Fd, Fr or SinCos signals are used the equivalent number of encoder lines per revolution must be set-up correctly in Pr **x.10** to give the correct speed and position feedback. The equivalent number of encoder lines per revolution (ELPR) is defined as follows:

Position feedback device	ELPR
Ab	number of lines per revolution
Fd, Fr	number of lines per revolution / 2
SC.HiPEr, SC.EndAt, SC	number of sine waves per revolution

x.11		Encoder comms resolution							
RW	Uni							US	
⇳	0 to 32 bits				⇨	0			

Where encoder comms is used for initial setting of absolute position (SC.HiPEr or SC.EndAt), the comms resolution in bits must be set correctly, either by the user or the drive (see Pr **x.18**), in Pr **x.11**. The comms resolution may be higher than the resolution of the sine waves per revolution.

Where encoder comms alone is used as position feedback, the lines per revolution must be a power of two. The equivalent lines per revolution (Pr **x.10**) is not used but the encoder comms resolution (Pr **x.11**) and the encoder turns (Pr **x.09**) must be set correctly, either by the user or the drive (see Pr **x.18**). Although Pr **x.11** can be set to any value from 0 to 32, if the value is less than 1, the resolution is 1 bit.

x.12		Motor thermistor check enable							
RW	Bit							US	
⇳	OFF (0) or On (1)				⇨	OFF (0)			

This bit should be set if the Solutions Module is connected to a motor thermistor and the user wants the temperature to be checked. The Solutions Module will trip for over temperature and thermistor short circuit.

x.13	Encoder supply voltage								
RW	Uni							US	
⇳	0 to 2			⇨	0				

The encoder supply voltage present on the SM-Universal Encoder option module is defined by this parameter as 0(5V), 1(8V), or 2(15V).

x.14	Encoder comms baud rate								
RW	Txt							US	
⇳	0 to 7			⇨	2				

This parameter defines the baud rate for the encoder comms when using SSI or EndAt encoders. However, a fixed baud rate of 9600 baud is used with Hiperface encoders and this parameter has no effect.

When the encoder comms is used and the position within one turn can be obtained in 30us and the rest of the message including CRC within a further 30us, the encoder position for control is taken during each level 1 interrupt.

If either of these conditions is not met the position is taken every 250us. The position feedback used for speed feedback is taken every 250us irrespective of the encoder message time. The comms message must not be longer than 160us or else position feedback errors will occur. Compensation based on the speed over the previous 250us is applied to correct the position so that it appears to have been taken at the encoder datum used by all other encoder types.

Parameter value	Parameter string	Baud rate
0	100	100k
1	200	200k
2	300	300k
3	400	400k
4	500	500k
5	1000	1M
6	1500	1.5M
7	2000	2M
8	4000	4M

x.15	Encoder type								
RW	Uni							US	
⇳	0 to 10			⇨	0				

The following encoders can be connected to the SM-Universal Encoder option module.

0, Ab: Quadrature incremental encoder, with or without marker pulse

1, Fd: Incremental encoder with frequency and direction outputs, with or without marker pulse

2, Fr: Incremental encoder with forward and reverse outputs, with or without marker *pulse*

3, Ab.SErVO: Quadrature incremental encoder with commutation outputs, with or without marker pulse

4, Fd.SErVO: Incremental encoder with frequency, direction and commutation outputs, with or without marker pulse

5, Fr.SErVO: Incremental encoder with forward, reverse and commutation outputs, with or without marker pulse

6, SC: SinCos encoder with no serial communications

This type of encoder gives incremental position and can only be used for control in Closed-loop vector mode.

7, SC.HiPEr: Absolute SinCos encoder using Stegmann 485 comms protocol (HiperFace).

This type of encoder gives absolute position and can be used for motor control in closed-loop vector or servo modes. The drive continuously checks the position from the sine and cosine waveforms against the internal encoder position using serial communications. If an error occurs the drive trips.

8, EndAt: Absolute EndAt only encoder

This type of encoder gives absolute position and can be used for motor control in closed-loop vector or servo modes. Additional communications with the encoder is not possible.

9, SC.EndAt:Absolute SinCos encoder using EndAt comms protocol

This type of encoder gives absolute position and can be used for motor control in closed-loop vector or servo modes. The drive continuously checks the position from the sine and cosine waveforms against the internal encoder position using serial communications. If an error occurs the drive trips.

10, SSI: Absolute SSI only encoder

This type of encoder gives absolute position and can be used for motor control in closed-loop vector or servo modes. Additional communications with the encoder is not possible.

It should be noted that SC.HiPEr, SC.EndAt and EndAt must be initialised before their position data can be used. The encoder is automatically initialised at power-up, after trips 1 to 8 are reset, or when the initialisation parameter (Pr **3.48**) is set to 1. If the encoder is not initialised or the initialisation is invalid the drive initiates trip 8.

x.16	**Encoder termination**								
RW	Txt							US	
⇕	0 to 2			⇨	1				

The terminations may be enabled/disabled by this parameter as follows:

Encoder input	x.16=0	x.16=1	x.16=2
A-A\	Disabled	Enabled	Enabled
B-B\	Disabled	Enabled	Enabled
Z-Z\	Disabled	Disabled	Enabled
U-U\, V-V\, W-W\	Enabled	Enabled	Enabled

A-A\ and B-B\ terminations cannot be disabled when encoders with SinCos waveforms are selected.

Z-Z\ terminations cannot be disabled except when Ab, Fd, Fr, Ab.SErVO, Fd.SErVO, Fr.SErVO encoders are selected.

x.17	**Error detection level**							
RW	Uni						US	
⇕	0 to 7			⇨	0			

Trips can be enabled/disabled using Pr **x.17** as follows:

Bit	Function
0	Wire break detect
1	Phase error detect
2	SSI power supply monitor

x.18	**Auto configuration enable / SSI binary format select**							
RW	Bit						US	
⇕	OFF (0) or On (1)			⇨	OFF (0)			

When a SC.HiPEr, SC.EndAt or EndAt encoder is being used, the Solutions Module will interrogate the encoder on power-up. If Pr **x.18** is set and the encoder type is recognised, based on the information provided by the encoder the, Solutions Module will set the encoder turns (Pr **x.09**), the equivalent lines per revolution (Pr **x.10**) and the encoder comms resolution (Pr **x.11**) for the encoder. If the encoder is recognised these parameters will all become read only. If the encoder is not recognised, the Solutions Module will initiate a trip 7 to prompt the user to enter the information. The Solutions Module should be able to auto-configure with any EndAt encoder where the number of turns and line per revolution are a power of 2, and the following Hiperface encoders: SCS 64/70, SCM 60/70, SRS 50/60, SRM 50/60, SHS 170, LINCODER, SCS-KIT 101, SKS36, SKM36

SSI

SSI encoders normally use Gray code data format. However, some encoders use binary format which may be selected by setting this parameter to 1.

x.19	**Feedback filter**							
RW	Uni						US	
⇕	0 to 16ms			⇨	0			

A sliding window filter may be applied to the feedback. This is particularly useful in applications where the feedback 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.

x.20	**Maximum feedback reference**							
RW	Uni						US	
⇕	0.0 to 40,000.0rpm			⇨				

x.21	Feedback reference							
RO	Bi				NC	PT		
⇕	-100.0 to 100.00%			⇨				

x.22	Feedback reference scaling							
RW	Uni						US	
⇕	0.000 to 4.000			⇨	1.000			

x.23	Feedback reference destination							
RW	Uni			DE			US	
⇕	00.00 to 21.51			⇨	00.00			

The position feedback can be used as a reference for any unprotected parameter. The percentage of the maximum position feedback reference (Pr **x.20**) is calculated and displayed via the feedback reference (Pr **x.21**). The value written to the destination parameter is a percentage of the full-scale value of the destination defined by Pr **x.23**.

To enable a faster update rate, if the destination for the feedback is the hard speed reference (Pr **3.22**), a shortcut facility is provided in the drive. In order to invoke this facility, the maximum feedback reference (Pr **x.20**) must be set to the maximum currently used for the hard speed reference.

x.24	Encoder simulation source							
RW	Uni					PT	US	
⇕	00.00 to 21.51			⇨	00.00			

x.25	Encoder simulation ratio numerator							
RW	Uni						US	
⇕	0.0000 to 3.0000			⇨	1.0000			

x.26	Encoder simulation ratio denominator							
RW	Uni						US	
⇕	0.0000 to 3.0000			⇨	1.0000			

x.27	Encoder simulation resolution select							
RW	Bit				NC		US	
⇕	OFF (0) or On (1)			⇨	OFF (0)			

An encoder simulation output can be generated from any parameter as a source as defined by Pr **x.24** (00.00 disables encoder simulation). Although any parameter can be used, the source parameter is assumed to be a 16 bit position value in the form of a roll-over counter. Therefore only parameters with a range of -32768 to 32767 or 0 to 65535 are normally used. The marker is simulated when the source rolls over or under.

When the Solutions Module is connected to a high precision encoder (i.e. SinCos) and the source has been selected as the internal position (Pr **x.05**), the resolution can be increase to a 24 bit position value by setting Pr **x.27** to a one.

x.28	**Encoder simulation mode**								
RW	Txt							US	
⇳	0 to 2			⇨	0				

This parameter defines the output mode for encoder simulation as follows.

Pr x.28	String	Mode
0	Ab	Quadrature
1	Fd	Frequency and direction
2	SSI	SSI

The marker pulse is simulated if the marker output port is not being used for RS485 freeze input.

x.29	**Non-marker reset revolution counter**								
RO	Uni					NC	PT		
⇳	0 to 65535 revolutions			⇨					

x.30	**Non-marker reset position**								
RO	Uni					NC	PT		
⇳	0 to 65535 (1/2^{16}ths of a revolution)			⇨					

x.31	**Non-marker reset fine position**								
RO	Uni					NC	PT		
⇳	0 to 65535 (1/2^{32}nds of a revolution)			⇨					

This position is taken from the position feedback device and is not affected by the marker or the freeze inputs.

x.32	**Marker revolution counter**								
RO	Uni					NC	PT		
⇳	0 to 65535 revolutions			⇨					

x.33	**Marker position**								
RO	Uni					NC	PT		
⇳	0 to 65535 (1/2^{16}ths of a revolution)			⇨					

x.34	Marker fine position								
RO	Uni					NC	PT		
⇕	0 to 65535 (1/2^{32}nds of a revolution)	⇨							

Each time the marker becomes active the non-marker position values (Pr **x.29** to Pr **x.31**) are sampled and stored in Pr **x.32** to Pr **x.34**.

x.35	Freeze revolution counter								
RO	Uni					NC	PT		
⇕	0 to 65535 revolutions	⇨							

x.36	Freeze position								
RO	Uni					NC	PT		
⇕	0 to 65535 (1/2^{16}ths of a revolution)	⇨							

x.37	Freeze fine position								
RO	Uni					NC	PT		
⇕	0 to 65535 (1/2^{32}nds of a revolution)	⇨							

x.38	Freeze input mode select								
RW	Uni							US	
⇕	0 to 3	⇨	1						

The freeze input can take the form of either a 485 signal through the encoder marker simulation output pins or a 24V signal on the freeze 24V input. The selection of which mode is used is dependent on the value of Pr **x.38**.

Value in x.38	24V input	485 input
0	No	No
1	Yes	No
2	No	Yes
3	Yes	Yes

x.39	Freeze flag								
RW	Bit					NC			
⇕	OFF (0) or On (1)	⇨	OFF (0)						

Each time the freeze input on the Solutions Module becomes active the non-marker position (Pr **x.29** to Pr **x.31**) is stored in Pr **x.35** to Pr **x.37** and the freeze flag (Pr **x.39**) is set. The freeze flag is not reset by the module and must be reset by the user. No other freeze conditions will be trapped if the flag is set.

x.40	Freeze main drive position								
RW	Bit					NC		US	
⇳	OFF (0) or On (1)			⇨	OFF (0)				

When a freeze occurs on the Solutions Module the main drive position can also be stored if this parameter is set to one. Whenever a SM-Applications and a SM-Universal Encoder Plus are used, the freeze should be connected to the SM-Universal Encoder Plus, Pr **x.40** should be set to allow the drive and the SM-Applications to see the freeze.

x.41	Freeze invert								
RW	Bit							US	
⇳	OFF (0) or On (1)			⇨	OFF (0)				

When Pr **x.41** = 0 freeze occurs on the rising edge of the freeze input. When Pr **x.41** = 1 freeze occurs on the falling edge of the freeze input.

x.42	Encoder comms transmit register								
RW	Uni					NC			
⇳	0 to 65535			⇨					

x.43	Encoder comms receive register								
RW	Uni					NC			
⇳	0 to 65535			⇨	0				

x.44	Disable encoder position check								
RW	Bit					NC	PT		
⇳	OFF (0) or On (1)			⇨	OFF (0)				

If Pr **x.44** is zero the drive can check the position derived with the sine and cosine waveforms from a SinCos encoder via serial communications. If Pr **x.44** is set to one the checking is disabled and encoder comms is available via the transmit and receive registers.

x.45	Position feedback initialised								
RO	Bit					NC	PT		
⇳				⇨					

At power-up Pr **x.45** is initially zero, but is set to one when the encoder connected to position module has been initialised. The drive cannot be enabled until this parameter is one.

If the encoder power-supply is lost, or the encoder type parameter is changed for an encoder connected to a the Solutions Module, and the encoder type is SC, SC.HiPEr, SC.EndAt or EndAt the encoder will no longer be initialised. When an encoder is no longer initialised Pr **x.45** is reset to zero and the drive cannot be enabled. The encoder may be re-initialised, provided the drive is not active, by setting Pr **3.48** to one. This parameter is automatically reset to zero when the initialisation is complete.

x.46		**Line per revolution divider**							
RW	Uni							US	
⇳	0 to 1024				⇨	1			

The equivalent line per revolution parameter (Pr **x.10**) is divided by the value in Pr **x.46**. This can be used when an encoder is used with a linear motor where the number of counts or sine waves per pole is not an integer.

For example, 128.123 lines per revolution would be set as 128123 in Pr **x.10** and 1000 in Pr **x.46** giving:

128123 / 1000 = 128.123.

x.47		**SSI output turns**							
RW	Uni							US	
⇳	0 to 16				⇨	16			

Used by the simulation module.

x.48		**SSI output comms resolution**							
RW	Uni							US	
⇳	0 to 32 bits				⇨	0			

Used by the simulation module.

x.50		**Solutions Module error status**							
RO	Uni					NC	PT		
⇳	0 to 255				⇨				

The error status is provided so that the only one option error trip is required for each option module slot. If an error occurs, the reason for the error is written to this parameter and the drive may produce a 'SLX.Er' trip, where x is the slot number. A value of zero indicates that the Solutions Module has not detected an error, a non-zero value indicates that an error has been detected. (See Chapter 8 *Diagnostics* for the meaning of the values in this parameter.) When the drive is reset, this parameter is cleared for the relevant Solutions Module.

All Solutions Modules include a temperature monitoring circuit. If the PCB temperature exceeds 90°C, the drive fan is forced to operate at full speed (for a minimum of 10s). If the temperature falls below 90°C, the fan can operate normally again. If the PCB temperature exceeds 100°C, the drive is tripped and the error status is set to 74.

8 Diagnostics

If the drive trips, the output is disabled so that the drive stops controlling the motor. The lower display indicates that a trip has occurred and the upper display shows the trip.

Trips are listed alphabetically in Table 8.1 based on the trip indication shown on the drive display. Refer to Figure 8-1.

If a display is not used, the drive LED Status indicator will flash if the drive has tripped. Refer to Figure 8-2.

The trip indication can be read in Pr **10.20** providing a trip number.

8.1 Displaying the trip history

The drive retains a log of the last 10 trips that have occurred in Pr **10.20** to Pr **10.29** and the corresponding time for each trip in Pr **10.43** to Pr **10.51**. The time of the trip is recorded from the powered-up clock (if Pr **6.28** = 0) or from the run time clock (if Pr **6.28** = 1).

Pr **10.20** is the most recent trip, or the current trip if the drive is in a trip condition (with the time of the trip stored in Pr **10.43**). Pr **10.29** is the oldest trip (with the time of the trip stored in Pr **10.51**). Each time a new trip occurs, all the parameters move down one, such that the current trip (and time) is stored in Pr **10.20** (and Pr **10.43**) and the oldest trip (and time) is lost out of the bottom of the log.

If any parameter between Pr **10.20** and Pr **10.29** inclusive is read by serial communications, then the trip number in Table 8-1 is the value transmitted.

Figure 8-1 Keypad status modes

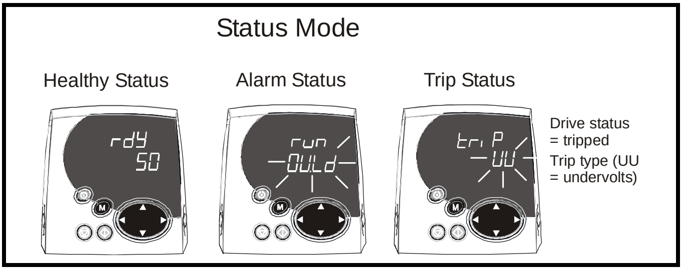
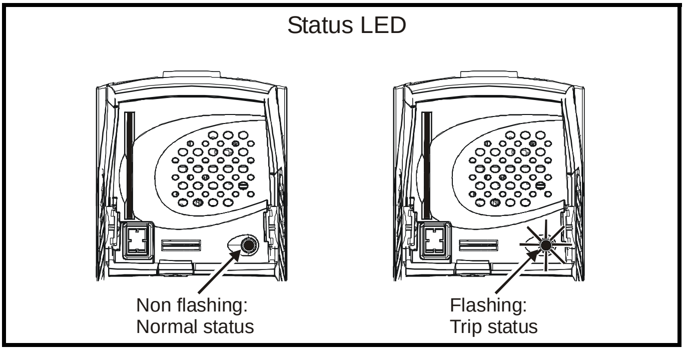


Figure 8-2 Location of the status LED



Any trip can be initiated by writing the relevant trip number to Pr **10.38**. If any trips shown as user trips are initiated the trip string is "txxx", where xxx is the trip number.

Trips can be reset after 1.0s if the cause of the trip has been rectified.

A full list of drive trips can be found in the *Unidrive SP User Guide.*

Table 8.1 Trip codes

Trip	Diagnosis
C.Optn	**SMARTCARD trip: Solutions Modules fitted are different between source drive and destination drive**
180	Ensure correct Solutions Modules are fitted Ensure Solutions Modules are in the same Solutions Module slot Press the red reset button
Enc1	**Drive encoder trip: Encoder power supply overload**
189	Check encoder power supply wiring and encoder current requirement Maximum current = 200mA @ 15V or 300mA @ 8V and 5V
ENP.Er	**Data error from electronic nameplate stored in selected position feedback device**
178	Replace feedback device
PS.24V	**24V internal power supply overload**
9	The total user load of the drive and Solutions Modules has exceeded the internal 24V power supply limit. The user load consists of the drive's digital outputs plus the SM-I/O Plus digital outputs, or the drive's main encoder supply plus the SM-Universal Encoder Plus encoder supply. • Reduce load and reset • Provide an external 24V >50W power supply • Remove any Solutions Modules and reset
SLX.dF	**Solutions Module slot X trip: Solutions Module type fitted in slot X changed**
204,209, 214	Save parameters and reset

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>SLX.Er</td><td>Solutions Module slot X trip: Error detected with Solutions Module, where X is the slot number</td></tr>
<tr><td>202
207
212</td><td>
<table>
<tr><th>Error code</th><th>Encoders</th><th>Reason for error</th></tr>
<tr><td>0</td><td>All</td><td>No fault detected</td></tr>
<tr><td>1</td><td>All</td><td>Power supply short circuit</td></tr>
<tr><td>2</td><td>Ab, Fd, Fr, Ab.SErVO, Fd.SErVO, Fr.SErVO, SC, SC.HiPEr, SC.EndAt, SSI</td><td>Hardware detectors on the A(F), B(D,R) and Z signal detect a wire break.
The differential levels of the sine and cosine waveforms are available to the drive. The drive detects wire break if $Sine^2$+$Cosine^2$ is less than the value produced by two valid waveforms with a differential peak to peak magnitude of 0.25V (1/4 of the nominal level). This detects wire break in the sine and cosine connections.</td></tr>
<tr><td>3</td><td>Ab.SErVO, Fd.SErVO, Fr.SErVO, SC.HiPEr, SC.EndAt</td><td>+UVW phase angle incorrect whilst running, i.e. incremental pulses not counted correctly.
+*Sine/cosine phase error.</td></tr>
<tr><td>4</td><td>SC.HiPEr</td><td rowspan="2">Wire break in the comms link is detected by a CRC or timeout error.
Data line (Z) checked.</td></tr>
<tr><td>5</td><td>SC.HiPEr, SC.EndAt, EndAt</td></tr>
<tr><td>6</td><td>SC.HiPEr, SC.EndAt, SSI, EndAt</td><td>The encoder has indicated an error</td></tr>
<tr><td>7</td><td>SC.HiPEr, SC.EndAt, EndAt</td><td>The encoder has failed to initialise.</td></tr>
<tr><td>8</td><td>SC.HiPEr, SC.EndAt, EndAt</td><td>Auto parameter configuration on power-up has been requested Pr x.17 > 1 but the encoder type has not been recognised. The user must supply Pr x.09 and Pr x.11, and possibly Pr x.10.</td></tr>
<tr><td>9</td><td>All</td><td>Thermistor trip</td></tr>
<tr><td>10</td><td>All</td><td>Thermistor short circuit</td></tr>
<tr><td>74</td><td>All</td><td>The Solutions Module has overheated.</td></tr>
</table>
* - Phase errors are detected when the error is greater than 10^o electrical over ten consecutive one second samples.
+ - These trips can be enabled/disabled by Pr x.17.
# - If the terminations are not enabled on the A, B or Z inputs the wire break system will not operate. (Note that as default the Z input terminations are disabled to disable wire break detection on this input.)
Encoder initialisation will occur when trips 1 to 8 are reset. This causes an encoder with comms to be re-initialised and auto-configuration to be performed if selected.
It is important that a break in the connections between the drive and the position feedback device can be detected. This feature is provided either directly or indirectly as listed.
When the drive is reset this parameter is cleared for the relevant Solutions Module
</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 fitted correctly
Return Solutions Module to supplier</td></tr>
</table>

Trip	Diagnosis
SLX.nF	**Solutions Module slot X trip: Solutions Module has been removed**
203,208, 213	Ensure Solutions Module is fitted correctly Replace Solutions Module Save parameters and reset drive
SLX.tO	**Solutions Module slot X trip: Solutions Module watchdog time-out**
203,208, 211	Press reset. If the trip persists, contact the supplier of the drive.
SL.rtd	**Solutions Module trip: Drive mode has changed and Solutions Module parameter routing is now incorrect**
215	Press reset. If the trip persists, contact the supplier of the drive.

9 Terminal Data

9.1 Encoder inputs SK1

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**
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 frequency	600kHz
Line loading	<2 unit loads (for terminals 1 to 4) 32 unit loads (for terminals 5 and 6) 1 unit load (for terminals 7 to 12)
Line termination components	120Ω
Working common mode range	+12V to –7V
Absolute maximum applied voltage relative to 0V	±14V
Absolute maximum applied differential voltage	±14V

SC, SC.HiPEr and SC.EndAt encoders

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

Type	Differential voltage
Maximum signal level	1.25V peak to peak
Maximum frequency	100kHz
Maximum applied differential voltage	±1.5V

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

5	**Data**
6	**Data**
9	**Clock*** **
10	**Clock*** **

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

*** Not used with SC.HiPEr encoders.

9.2 Simulated encoder outputs SK1

Simulated Ab, Fd encoder outputs

7	**Frequency output F, Quadrature output A**
8	**Frequency output F\, Quadrature output A**
9	**Frequency output D, Quadrature output B**
10	**Frequency output D\, Quadrature output B**

Type	EIA 485 differential receivers
Maximum frequency	500kHz
Line loading	<2 unit loads (for terminals 1 to 4) 32 unit loads (for terminals 5 and 6) 1 unit load (for terminals 7 to 12)
Line termination components	120Ω
Working common mode range	+12V to –7V
Absolute maximum applied voltage relative to 0V	±14V
Absolute maximum applied differential voltage	±14V

NOTE The simulated encoder outputs available on terminal PL2 are identical to the simulated encoder outputs available on terminal SK1 (internally connected)

Simulated SSI encoder output (binary format)

5	**Data**	
6	**Data**	
7	**Data**	
8	**Data**	
9	**Clock**	
10	**Clock**	

Type	EIA 485 differential transceivers
Maximum frequency	500kHz
Line loading	32 unit loads (for terminals 5 and 6) 1 unit load (for terminals 11 and 12)
Working common mode range	+12V to –7V
Absolute maximum applied voltage relative to 0V	±14V
Absolute maximum applied differential voltage	±14V

9.3 Drive encoder power supply

Common to all Encoder types

13	**Encoder supply voltage**
Supply voltage	5V, 8V or 15V
Maximum output current	300mA for 5V and 8V 200mA for 15V

The encoder supply voltage is controlled by Pr **x.13**. The default for this parameter is 5V (0) but this can be set to 8V (1) or 15V (2). Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device.

The termination resistors should be disabled if the outputs from the encoder are higher than 5V.

14	**0V common**

15	**Motor thermistor input**

9.4 Encoder inputs PL2

Ab, Fd, Fr, Ab.SErVO, Fd.SErVO, Fr.SErVO, SC, SC.HiPEr and SC.EndAt encoders

1	**Freeze Input +24V**
8	**Freeze Input RS485**
9	**Freeze Input RS485**

Type	EIA 485 differential receivers
Maximum frequency	600kHz
Line loading	<2 unit loads (for terminals 1 to 4) 32 unit loads (for terminals 5 and 6) 1 unit load (for terminals 7 to 12)
Line termination components	120Ω
Working common mode range	+12V to –7V
Absolute maximum applied voltage relative to 0V	±14V
Absolute maximum applied differential voltage	±14V

NOTE The freeze input function is not available with EndAt and SSI encoders

9.5 Encoder outputs PL2

Simulated Ab, Fd encoder output

3	**Channel A frequency output F**
4	**Channel A\ frequency output F**
5	**Channel B direction output D**
6	**Channel B\ direction output D**
8	**Marker pulse Z output**
9	**Marker pulse Z output**

Type	EIA 485 differential receivers
Maximum frequency	500kHz
Line loading	<2 unit loads (for terminals 1 to 4) 32 unit loads (for terminals 5 and 6) 1 unit load (for terminals 7 to 12)
Line termination components	120Ω
Working common mode range	+12V to –7V
Absolute maximum applied voltage relative to 0V	±14V
Absolute maximum applied differential voltage	±14V

Simulated SSI encoder output (binary format)

5	**Data output**
6	**Data output**
9	**Clock output**
10	**Clock output**

Type	EIA 485 differential transceivers
Maximum frequency	500kHz
Line loading	32 unit loads (for terminals 5 and 6) 1 unit load (for terminals 11 and 12)
Working common mode range	+12V to –7V
Absolute maximum applied voltage relative to 0V	±14V
Absolute maximum applied differential voltage	±14V

NOTE The simulated encoder outputs available on terminal PL2 are identical to the simulated encoder outputs available on terminal SK1 (internally connected)

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