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User Guide

SM-Resolver

Solutions Module for
Unidrive SP

Part Number: 0471-0015-04
Issue Number: 4

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.

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Drive software version

The SM-Resolver can only be used with drive software version 01.01.00 onwards.

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Issue Code: 4

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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.

2 Safety information

2.1 Warnings, Cautions and Notes

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

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

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

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 by BIA has been given for sizes 1 to 3.

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:

98/37/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

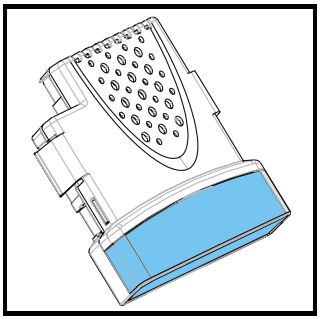
3.1 Features

The SM-Resolver provides an interface for a resolver to be connected to the Unidrive SP, to be used as position and speed feedback for the drive. The SM-Resolver also provides a simulated quadrature encoder output.

NOTE The SM-Resolver will only provide speed and position feedback when it is selected as the source of the drive speed/position feedback. Hence the SM-Resolver does not function when the drive is operating in open-loop mode. Similarly, it is not possible to use a resolver as a speed/position reference.

All three Solutions Module slots can simultaneously accommodate a SM-Resolver, however, only one of the three can be used to provide speed/position feedback at any given time (see NOTE above).

Figure 3-1 SM-Resolver

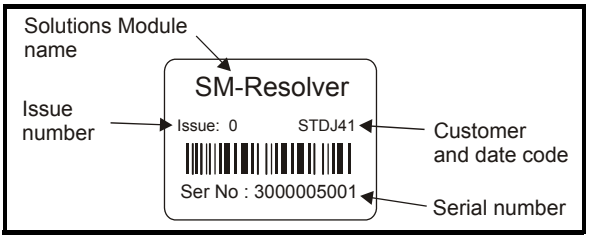


3.2 Solutions Module identification

The SM-Resolver 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-Resolver being light blue.

Figure 3-2 SM-Resolver label



3.2.1 Date code format

The date code is split into two sections: a letter followed by a number.

The letter indicates the year, and the number indicates the week number (within the year) in which the Solutions Module was built.

The letters go in alphabetical order, starting with A in 1990 (B in 1991, C in 1992 etc.).

Example:
A date code of L35 would correspond to week 35 of year 2002.

3.3 Set-up parameters

All parameters associated to the SM-Resolver 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-Resolver can be fitted. See Figure 4-1 on page 11.

3.4 Compatible resolver types

The SM-Resolver will allow for resolvers with the following specification to be used with the Unidrive SP:

Input impedance:	>85Ω at 6kHz
Turns ratio:	3:1 or 2:1 (input : output)
Number of poles:	2, 4, 6 or 8

Suitable resolvers from CT Dynamics are frames sizes 55RSS and 80RS.

NOTE If the number of poles of the resolver is not 2, then the resolver can only work with a motor that has the same number of poles (e.g. a 6 pole resolver with a 6 pole motor).

NOTE A 4-pole resolver will give two electrical cycles within one mechanical revolution. Therefore, a 4-pole resolver cannot provide absolute position (mechanical). Similarly, a 6-pole or 8-pole resolver cannot provide absolute position (mechanical).

3.4.1 SM-Resolver excitation output

Output wave form:	either	6kHz 6V rms sine wave (turns ratio = 3:1)
	or	6kHz 4V rms sine wave (turns ratio = 2:1)

3.4.2 SM-Resolver inputs

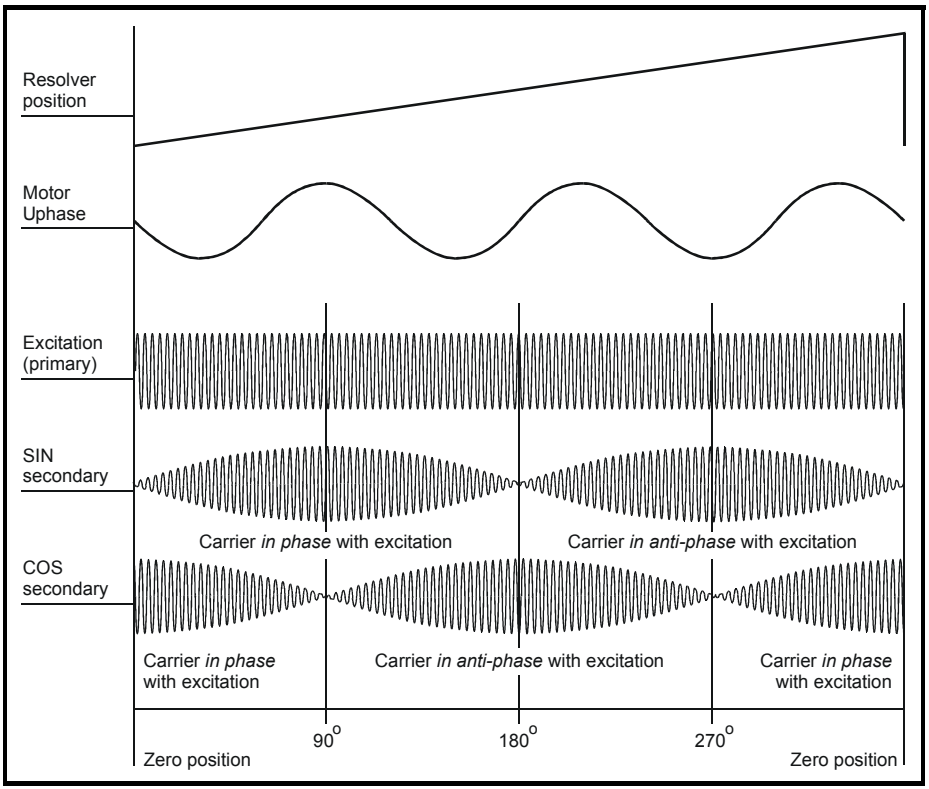
Input voltage:	2V rms

3.5 Operation of a resolver

A resolver is a rotating transformer that produces output voltages on a pair of SIN and COS secondary windings. When an excitation voltage is applied to the primary winding and the resolver shaft is rotated, amplitude-modulated voltage waveforms appear on the secondary windings, where the excitation voltage acts as a carrier for the modulation. In addition, on each secondary, the phase of the carrier voltage is reversed twice every revolution.

Figure 3-3 shows the relationships between the resolver position and the SIN and COS outputs, as well as the phase reversals in the carrier waveforms for forward rotation (for a clearer indication of the phase reversals, see Figure 3-4). Figure 3-3 also shows the waveform of the U motor phase for a six-pole motor when the motor and resolver are aligned for zero phase offset.

Figure 3-3 Sine and Cosine modulation on the secondary windings



3.5.1 Direction of rotation

Forward rotation is defined as follows:

Motor
Phase sequence: U V W

Resolver
COS modulation leads the SIN modulation (by 90°) (see Figure 3-4)

3.5.2 Zero-position point

The resolver passes through its zero position when the following occur (see Figure 3-4):

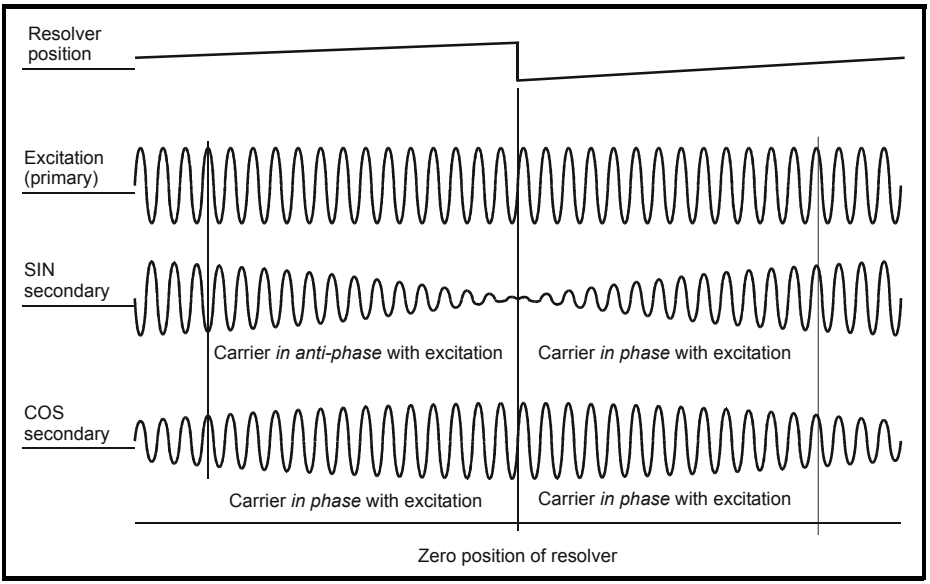
SIN output

- The modulation is at minimum
- The carrier waveform changes from being in anti-phase with the excitation voltage on the primary to being in phase with the excitation voltage on the primary

COS output

- The modulation is at maximum
- The carrier waveform is in phase with the excitation voltage on the primary

Figure 3-4 Modulation and carrier-phase conditions around the zero position of the resolver



4 Installing the SM-Resolver

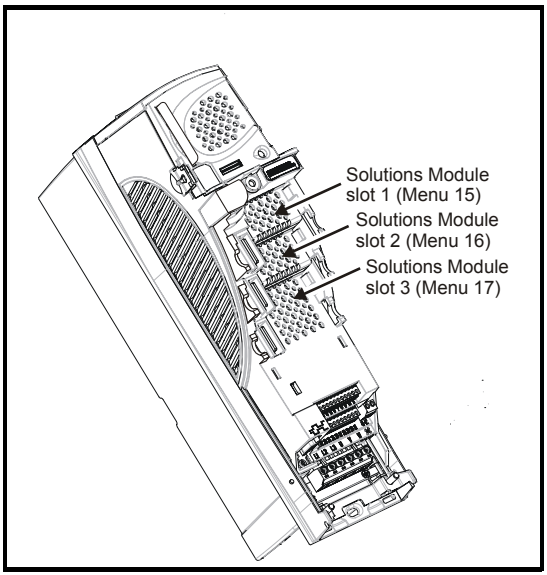
4.1 Solutions Module slots

WARNING

Before installing the SM-Resolver, refer to Chapter 2 *Safety information* on page 5.

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.

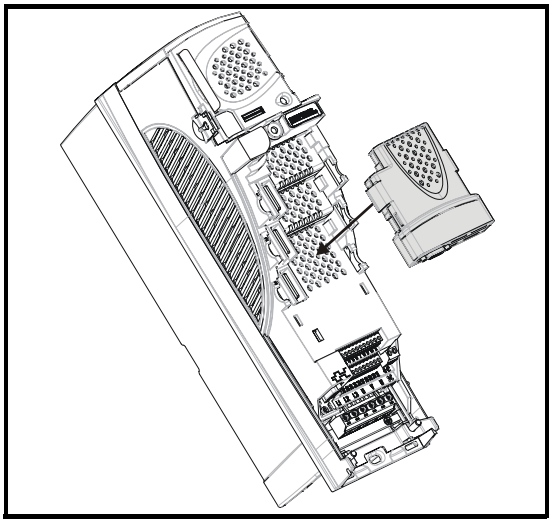
Figure 4-1 Location of slots 1, 2 and 3 on the Unidrive SP



4.2 Installation

1. Before installing the SM-Resolver 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 if used.
3. Check that the exterior of the SM-Resolver is not damaged, and that the multi-way connector is free from dirt and debris.
4. Do not install a damaged or dirty SM-Resolver in the drive.
5. Remove the terminal cover from the drive. (For removal / re-fitting instructions, see *Unidrive SP Solutions Module Installation Sheet* provided with the Solutions Module.)
6. Position the drive connector of the SM-Resolver over the connector of the appropriate slot in the drive and push downwards until it locks into place.

Figure 4-2 Fitting the SM-Resolver



7. Re-fit the terminal cover to the drive. (For removal / re-fitting instructions, see *Unidrive SP Solutions 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** shows the correct code for the SM-Resolver (code = 101).
12. If the checks in steps 10 and 11 fail, either the SM-Resolver is not fully inserted, or the Solutions Module is faulty.
13. If a trip code is now present refer to Chapter 7 *Diagnostics* on page 31.

4.3 Terminal descriptions

Figure 4-3 SM-Resolver terminals

Table 4.1 SM-Resolver terminal descriptions

Term	Simulated encoder output connections
1	A
2	A\
3	0V
4	B
5	B\
6	0V
7	Z
8	Z\

Term	Resolver connections
9	SIN LOW
10	SIN HIGH
11	COS LOW
12	COS HIGH
13	REF HIGH (excitation)
14	REF LOW (excitation)
15	0V
16	0V
17	0V

4.4 Wiring, Shield connections

Shielding considerations are important for PWM drive installations due to the high voltages and currents present in the output circuit with a very wide frequency spectrum, typically from 0 to 20 MHz.

The sensitivity of various inputs to electromagnetic disturbance differs with the introduction of shielding providing good data transfer. Circuits at particular risk are precision analog 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 4.2 Feedback Device Properties

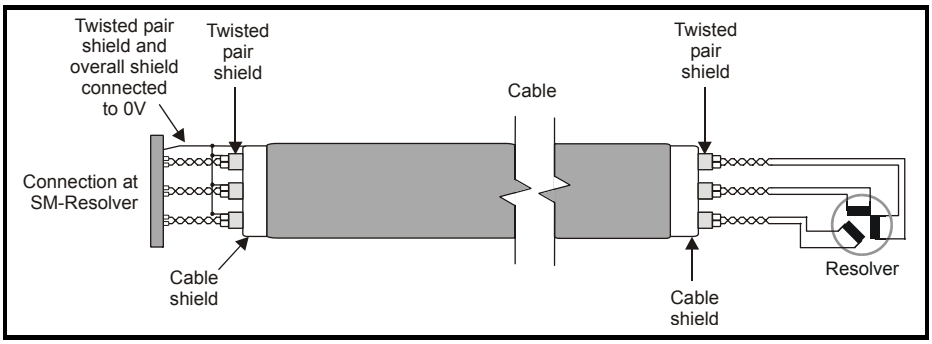
Input Type	Nature	Wiring Requirement
Resolver Inputs	Medium bandwidth e.g. 10kHz, sensitive	Shielding recommended
Encoder Inputs	Wide bandwidth e.g. 500kHz. Good immunity but limited common mode range	Correct shielding arrangement essential. Matched cable and correct termination recommended.
Data links/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

It is also necessary to provide the correct shielding arrangement in order to meet the radiated emission requirements of EMC standards.

4.4.1 Functional shielding requirements

These requirements are necessary to ensure the correct transfer of data from the resolver to the drive.

Figure 4-4 Functional shielding requirements

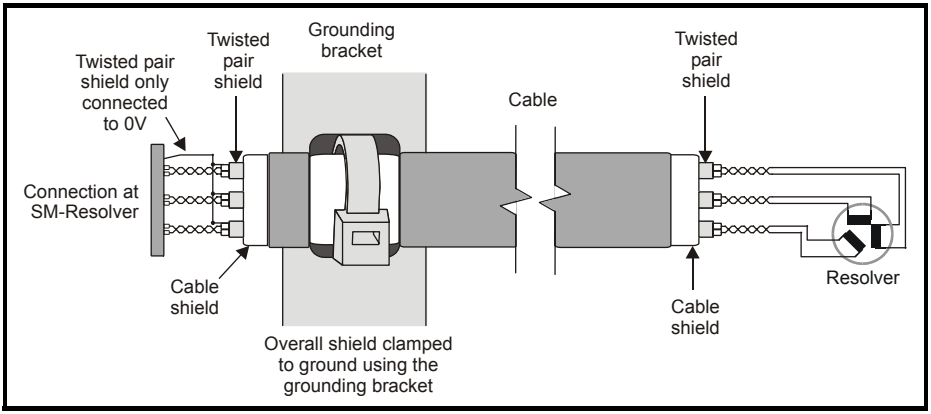


Note that the resolver provides inherent galvanic isolation of the signal connections from ground. This means that no special provisions are required in order to provide surge immunity for cables exceeding 30m.

4.4.2 Compliance with generic emission standards

In this case the outer cable shield must be clamped to ground at the drive end using the grounding bracket, as shown in the EMC section of the Unidrive SP User guide. It is recommended that the overall shield is not connected to 0V.

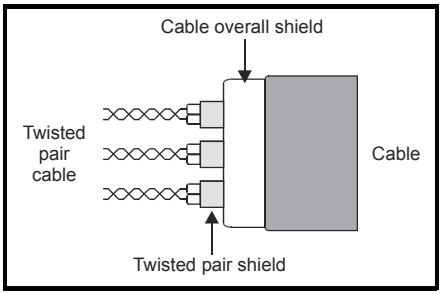
Figure 4-5 Shielding for compliance with generic emission standards



4.4.3 Recommended cable

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

Figure 4-6 Feedback Cable, Twisted Pair



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

5 Getting started

5.1 Installation

The control circuits are isolated from the power circuits in the drive by basic insulation only, as specified in IEC60664-1. The installer must ensure that the external control circuits are insulated from human contact by at least one layer of insulation rated for use at the AC supply voltage.
If the 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.

Resolver feedback is transmitted from a resolver as low voltage analog signals. Ensure that electrical noise from the drive or motor does not adversely affect the resolver 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 resolver feedback wiring and shielding recommendations are followed in section 4.4 *Wiring, Shield connections* on page 13.

5.2 Solutions Module set-up

<table>
<tr><th>Action</th><th>Detail</th></tr>
<tr><td>Before power-up</td><td>Ensure:
• Drive enable signal is not given (terminal 31)
• Solutions Module is fitted in appropriate slot
• Resolver is connected to the SM-Resolver</td></tr>
<tr><td>Power-up the drive</td><td>Ensure:
• Encoder Phase Error Detect is disabled (Pr 3.40 = 0) to prevent Enc2 trip
• Module error detectionis set-up as required (Pr x.17)
• Drive displays ‘inh’
If the drive trips, see Chapter 7 Diagnostics on page 31.</td></tr>
<tr><td>Slot identification</td><td>Identify which Solutions Module slot and associated menu are being used:
• Slot 1 – Menu 15
• Slot 2 – Menu 16
• Slot 3 – Menu 17</td></tr>
<tr><td>Set-up the operating resolution and variable maximum speed limit</td><td>Enter the equivalent number of lines per revolution in Pr x.10:
<table>
<tr><th>Max speed of motor (2-pole resolver)</th><th>Operating resolution</th><th>Equivalent resolution in encoder lines per revolution (Pr x.10)</th></tr>
<tr><td>0 to 3,300 rpm</td><td>14 bit</td><td>4,096</td></tr>
<tr><td>3,300.1 to 13,200 rpm</td><td>12 bit</td><td>1,024</td></tr>
<tr><td>13,200.1 to 40,000 rpm</td><td>10 bit</td><td>256</td></tr>
</table></td></tr>
<tr><td>Set-up resolver excitation voltage</td><td>Set-up the correct excitation voltage for resolver:
• Turns ratio 3:1 (6V rms excitation), set Pr x.13 = 0
• Turns ratio 2:1 (4V rms excitation), set Pr x.13 = 2</td></tr>
<tr><td>Set-up the resolver number of poles</td><td>Set-up the resolver number of poles:
• 2-pole set Pr x.15 = 0 (default setting)
• 4-pole set Pr x.15 = 1
• 6-pole set Pr x.15 = 2
• 8-pole set Pr x.15 = 3</td></tr>
<tr><td>Enable SM-Resolver</td><td>Enable the SM-Resolver as the drive position / speed feedback by setting Pr 3.26 to Slot1 (1), Slot2 (2) or Slot3 (3) depending on the location of the Solutions Module.</td></tr>
</table>

5.3 Encoder simulation output

The SM-Resolver provides a simulated encoder output with this being configured for a 1024 line quadrature output at default. The source of the output can be selected by parameter configuration (Pr **x.24**), as either the resolver itself or the drive main encoder (EIA485 encoder only).

Table 5.1

<table>
<tr><th>Simulation based upon the resolver</th><th>Simulation based upon the drive encoder</th></tr>
<tr><td colspan="2">Outputs are to EIA485 specification.</td></tr>
<tr><td colspan="2">Maximum output frequency of 500kHz</td></tr>
<tr><td>Simulated outputs are generated in hardware. Output format: Quadrature with marker-pulse (A, B, Z).</td><td>Simulated outputs are a buffered version of the EIA485 inputs of the drive encoder</td></tr>
<tr><td>Scaling of the output is available in order to reduce the number of lines per revolution (to a minimum of 128) in defined steps as shown below:
<table>
<tr><th>Pr x.25</th><th>Ratio</th></tr>
<tr><td>0.0000 to 0.0312</td><td>1/32</td></tr>
<tr><td>0.0313 to 0.0625</td><td>1/16</td></tr>
<tr><td>0.0626 to 0.1250</td><td>1/8</td></tr>
<tr><td>0.1251 to 0.2500</td><td>1/4</td></tr>
<tr><td>0.2501 to 0.5000</td><td>1/2</td></tr>
<tr><td>0.5001 to 3.0000</td><td>1</td></tr>
</table></td><td>Scaling is not possible.</td></tr>
<tr><td>A marker pulse will be generated when the resolver is at the zero position. Both A and B are low in the zero position.</td><td rowspan="3">The marker pulse is a buffered version of the Z input of the drive encoder.</td></tr>
<tr><td>The width of the marker pulse is determined by the operating resolution of the resolver, not the resolution of the encoder simulation output.</td></tr>
<tr><td>The minimum marker pulse width is 300ns</td></tr>
</table>

5.4 Freeze function

The SM-Resolver has a freeze function, but does not have freeze inputs. The freeze function can be activated by the SM-Applications or SM-Universal Encoder Plus. When a freeze signal is provided, the freeze flag (Pr **x.39**) is set to "ON". When activated, the non-marker position (Pr **x.30**) is transferred into the freeze position (Pr **x.36**).

The freeze flag does not re-set itself. Before carrying out consecutive freeze functions, the freeze flag must be cleared by the user (Pr **x.39** = "OFF") on both the SM-Resolver, the source of the freeze, and any additional associated Solutions Module..

NOTE A 4-pole resolver will give two electrical cycles within one mechanical revolution. Therefore, a 4-pole resolver cannot provide absolute position (mechanical). Similarly, a 6-pole or 8-pole resolver cannot provide absolute position (mechanical).

It is for this reason that the freeze function does not operate with a resolver that has 4, 6 or 8 poles.

6 Parameters

6.1 Introduction

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

The SM-Resolver is classed as a dumb module as it does not have its own processor and as a result all parameters are updated by the drive processor.

The SM-Resolver parameters are read/written by the drive background task or at the combined update time for time critical parameters. The combined update time depends on the number and type of dumb modules fitted to the drive. For each dumb module the update rate of these parameters is specified as either 4 or 8ms. The combined update time is the total of the update times for all dumb modules fitted. (E.g. if two modules with 4ms and 8ms update times are fitted to the drive, then the combined update time for the time critical parameters of each module will be 12ms.)

Dumb module	Update time
SM-I/O Plus	8ms
SM-Encoder Plus	4ms
SM-Resolver	4ms

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

NOTE Parameter changes for the SM-Resolver will only take effect when the drive is not enabled.

Before attempting to adjust any parameters, refer to Chapter 2 *Safety information* on page 5.

Table 6.1 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.

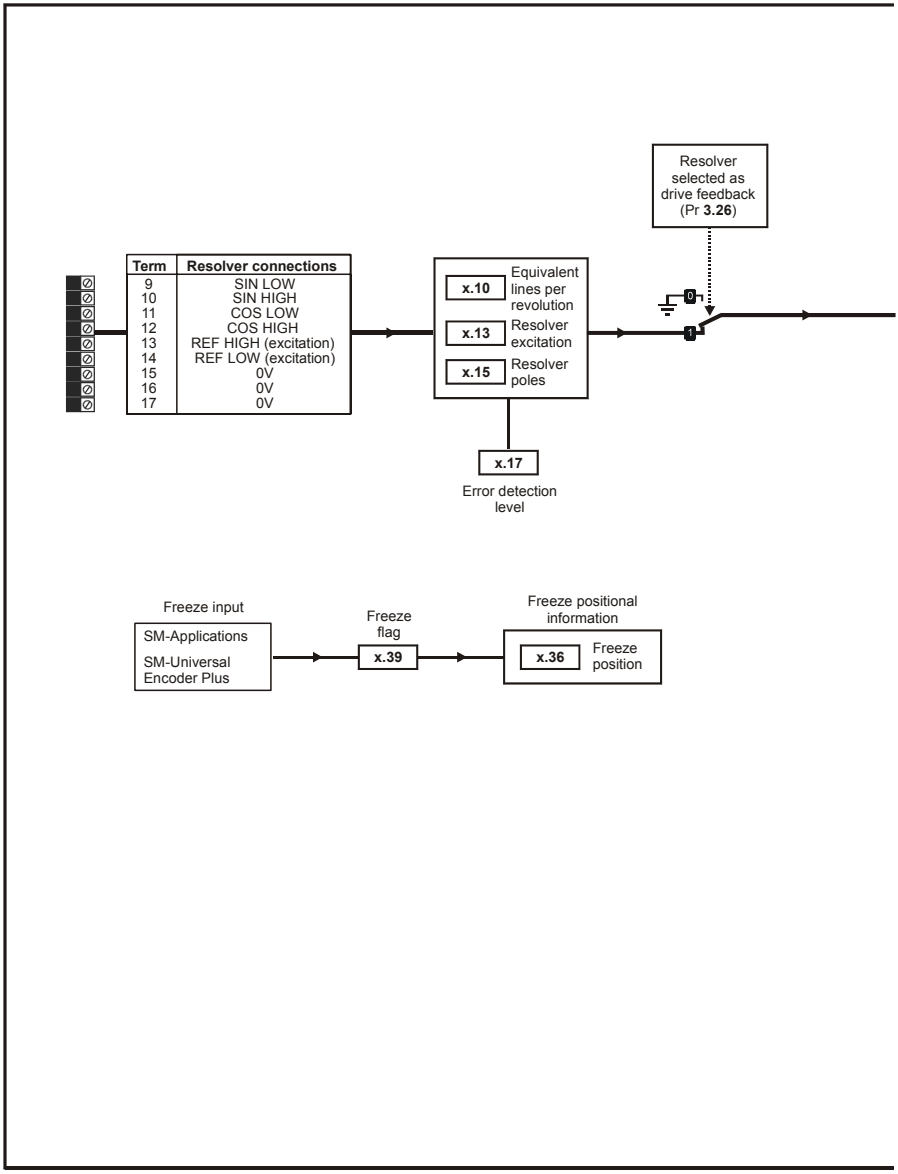
6.2 Single line descriptions

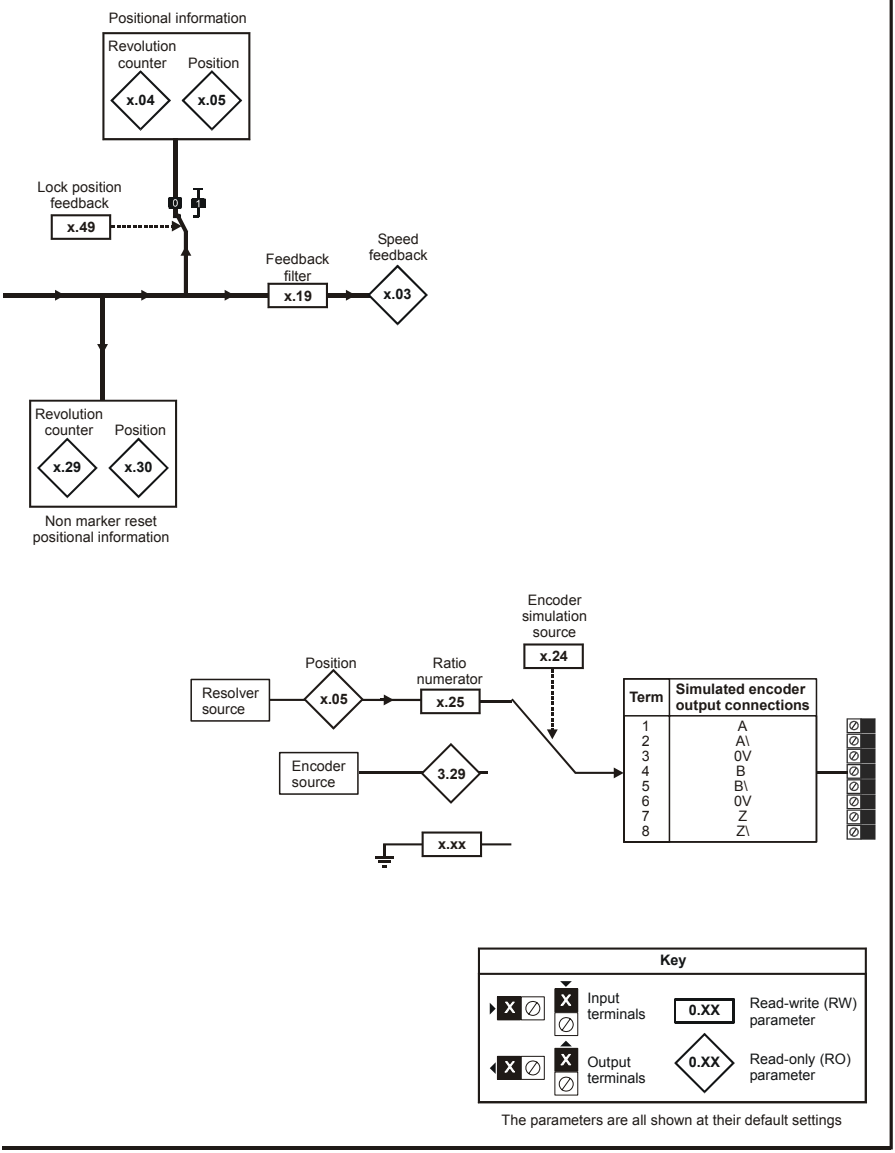
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	CL	OL	VT	SV						
x.01	Solutions Module ID	0 to 599		101			RO	Uni			PT	US
x.02	No function											
x.03	Speed feedback	±40,000.0 rpm					RO	Bi	FI	NC	PT	
x.04	Revolution counter	0 to 65,535 revolutions					RO	Uni	FI	NC	PT	
x.05	Position	0 to 65,535 ($1/2^{16}$ths of a revolution)					RO	Uni	FI	NC	PT	
x.06	No function											
x.07	No function											
x.08	No function											
x.09	No function											
x.10	Equivalent lines per revolution	0 to 50,000		4,096			RW	Uni				US
x.11	No function											
x.12	No function											
x.13	Resolver excitation	3:1 (0), 2:1 (1 or 2)		3:1 (0)			RW	Uni				US
x.14	No function											
x.15	Resolver poles	2POLE (0), 4POLE (1), 6POLE (2), 8POLE (3 to 11)		2POLE (0)			RW	Uni				US
x.16	No function											
x.17	Error detection level	0 to 7		1			RW	Uni				US
x.18	No function											
x.19	Feedback filter	0 to 5 (0 to 16 ms)		0			RW	Uni				US
x.20	No function											
x.21	No function											
x.22	No function											
x.23	No function											
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	No function											
x.27	No function											
x.28	No function											
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	
x.31	No function											
x.32	No function											
x.33	No function											
x.34	No function											
x.35	No function											
x.36	Freeze position	0 to 65,535 ($1/2^{16}$ths of a revolution)					RO	Uni		NC	PT	
x.37	No function											
x.38	No function											
x.39	Freeze flag	OFF (0) or On (1)		OFF (0)			RW	Bit		NC		
x.40	No function											
x.41	No function											
x.42	No function											
x.43	No function											
x.44	No function											

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	CL	OL	VT	SV						
x.45	Position feedback initialised	OFF (0) or On (1)					RO	Bit		NC	PT	
x.46	No function											
x.47	No function											
x.48	No function											
x.49	Lock position feedback	OFF (0) or On (1)					RW	Bit				
x.50	Solutions Module error status	0 to 255					RO	Uni		NC	PT	
x.51	No function											

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 6-1 SM-Resolver logic diagram




Positional information
Revolution counter
Position
x.04
x.05
Lock position feedback
x.49
0
1
Feedback filter
x.19
Speed feedback
x.03
Revolution counter
Position
x.29
x.30
Non marker reset positional information
Encoder simulation source
x.24
Position
Ratio numerator
Resolver source
x.05
x.25
Encoder source
3.29
x.xx
Term
Simulated encoder output connections
1 A
2 A\
3 0V
4 B
5 B\
6 0V
7 Z
8 Z\
Key
Input terminals
Output terminals
0.XX
Read-write (RW) parameter
Read-only (RO) parameter
The parameters are all shown at their default settings

6.3 Parameter descriptions

x.01	Solutions Module ID code								
RO	Uni						PT	US	
⇳	0 to 599				⇨	101			
Update rate: Write on power-up									

The menu for the relevant slot appears for the new Solutions Module category with the default parameter values for the new category. When no Solutions Module is fitted in the relevant slot this parameter is zero. When a Solutions Module is fitted this parameter displays the identification code as shown below.

Code	Solutions Module	Category	Dumb module
0	No Solutions Module fitted		
101	SM-Resolver	Feedback	✓
102	SM-Universal Encoder Plus	Feedback	
104	SM-Encoder Plus	Feedback	✓
201	SM-I/O Plus	Automation	✓
301	SM-Applications	Automation	
302	SM-Application Lite	Automation	
401	reserved	Fieldbus	
402	reserved	Fieldbus	
403	SM-Profibus DP	Fieldbus	
404	SM-Interbus	Fieldbus	
405	reserved	Fieldbus	
406	SM-CAN	Fieldbus	
407	SM-DeviceNet	Fieldbus	
408	SM-CANopen	Fieldbus	
501	SM-SLM	SLM	

The new parameters values are not stored in EEPROM until the user performs a parameter save. When parameters are saved by the user in the drive EEPROM the option code of the currently fitted Solutions Module is saved in EEPROM. If the drive is subsequently powered-up with a different Solutions Module fitted, or no Solutions Module fitted where one was previously fitted, the drive gives a Slot.dF or SLot.nf trip.

x.03	Speed feedback								
RO	Bi	FI				NC	PT		
⇳	±40,000.0 rpm				⇨				
Update rate: 4ms x number of dumb modules									

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 65,535 revolutions				⇨					
Update rate: 4ms x number of dumb modules										

x.05	Position									
RO	Uni	FI					NC	PT		
⇳	0 to 65,535 (1/2^{16}ths revolutions)				⇨					
Update rate: 4ms x number of dumb modules										

Pr **x.04** and Pr **x.05** give the position with a resolution of 1/2^{16}ths of a revolution as a 32 bit number as shown below.

31	16	15	0
Revolutions		Position	

Provided the set-up parameters are correct, the position is always converted to units of 1/2^{16}ths of a revolution, but some parts of the value may not be relevant depending on the resolution of the feedback device. For example if 10 bit resolution is selected the resolver produces 4,096 counts per revolution, and so the position is represented by the bits in the shaded area only.

31	16	15	4	3	0
Revolutions		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.

NOTE The internal update time for the position Pr **x.03** and Pr **x.05** when used as feedback runs at level 1, this being switching frequency dependant as follows.

Update time	Switching frequency	Level
167µs	3kHz	1
125µs	4kHz, 8kHz, 16kHz	1
83µs	6kHz, 12kHz	1

NOTE The internal update time for the speed Pr **x.03** when used as feedback runs at level 2 as follows.

Update time	Switching frequency	Level
250µs	3kHz, 4kHz, 6kHz, 8kHz, 12kHz, 16kHz	2

x.10	Equivalent lines per revolution								
RW	Uni							US	
⇳	0 to 50,000			⇨	4,096				
Update rate: Background read									

This parameter relates to the equivalent lines per revolution of a quadrature encoder that would provide same resolution of feedback. This parameter should only be set to 256 (10 bit resolution), 1,024 (12 bit resolution) or 4,096 (14 bit resolution). If the parameter is set to any other value the drive assumes the following: 32 to 256 = 256; 257 to 1,024 = 1,024; 1,025 to 50,000 = 4,096. If the drive is operating in Closed-loop vector or Servo modes and the resolver is selected to provide speed feedback for the drive (see Pr **3.23**) then variable maximum SPEED_LIMIT_MAX is defined in the following table.

Resolver poles (Pr x.15)	Equivalent lines per revolution (Pr x.10)	Operating resolution (bit)	SPEED_LIMIT_MAX
2	4,096	14	3,300.0
2	1,024	12	13,200.0
2	256	10	40,000.0
4	4,096	14	1,650.0
4	1,024	12	6,600.0
4	256	10	26,400.0
6	4,096	14	1,100.0
6	1,024	12	4,400.0
6	256	10	17,600.0
8	4,096	14	825.0
8	1,024	12	3,300.0
8	256	10	13,200.0

x.13	Resolver excitation								
RW	Uni							US	
⇳	3:1 (0), 2:1 (1 or 2)			⇨	3:1 (0)				
Update rate: Background read									

The excitation level can be controlled for use with 3:1 ratio resolvers (Pr **x.13** = 0), or 2:1 ratio resolvers (Pr **x.13** = 1 or 2).

x.15	Resolver poles									
RW	Uni								US	
⇳	2POLE (0), 4POLE (1), 6POLE (2), 8POLE (3 to 11)				⇨	2POLE (0)				
Update rate: Background read										

Resolvers with the following numbers of poles can be used with the Solutions Module.

0: 2POLE

1: 4POLE

2: 6POLE

3 to 11: 8POLE

A 2 pole resolver can be selected as drive speed feedback with a motor with any number of poles. A resolver with a number of poles greater than 2 can only be used with a motor with the same number of poles. If the number of resolver poles is set up incorrectly and the resolver is selected as the drive speed feedback for motor control Solutions Module error 11 is produced.

x.17	Error detection level									
RW	Uni								US	
⇳	0 to 7				⇨	1				
Update rate: Background read										

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

Bit	Function
0	Wire break detect
1	Not used
2	Not used

The binary sum defines the level of error detection as below:

Bit 2	Bit 1	Bit 0	Error detection level	Value in Pr x.17
0	0	0	Error detection disabled	0
0	0	1	Wire break detect	1
0	1	0	Error detection disabled	2
0	1	1	Wire break detect	3
1	0	0	Error detection disabled	4
1	0	1	Wire break detect	5
1	1	0	Error detection disabled	6
1	1	1	Wire break detect	7

NOTE The wire break trip is not activated provided one signal is >1.5Vrms or both are >0.2Vrms approximately.

x.19	Feedback filter									
RW	Uni								US	
⇳	0 to 5 (0 to 16 ms)				⇨	0				
Update rate: Background read										

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. The filter is not active if the parameter value is 0 or 1ms, but operates over the defined window for parameter values of 2, 4, 8 and 16ms.

Value in Pr x.19	Filter window
0	Not active
1	Not active
2	2ms
3	4ms
4	8ms
5	16ms

x.24	Encoder simulation source									
RW	Uni							PT	US	
⇳	Pr **0.00** to Pr **21.51**				⇨	Pr **0.00**				
Update rate: Background read										

x.25	Encoder simulation ratio numerator									
RW	Uni								US	
⇳	0.0000 to 3.0000				⇨	1.0000				
Update rate: Background read										

Pr x.24 = Pr x.05

Encoder simulation output is derived from the resolver input via hardware. The resolution multiplier can be set up using Pr **x.25** as shown in the table below. The marker output is active when the resolver position is zero, therefore the marker pulse width is equivalent to one encoder count if the ratio is 1, but is reduced if the ratio is less than 1.

NOTE Some ratios are not possible when the resolver resolution is reduced below 14 bits as shown in the table below.

Pr x.25	Resolver resolution		
	14 bit	12 bit	10 bit
0.0000 to 0.0312	1/32	1/8	1/2
0.0313 to 0.0625	1/16	1/8	1/2
0.0626 to 0.1250	1/8	1/8	1/2
0.1251 to 0.2500	1/4	1/4	1/2
0.2501 to 0.5000	1/2	1/2	1/2
0.5001 to 3.0000	1	1	1

Pr x.24 = Pr 3.29

Encoder simulation output is derived from the drive encoder port via hardware from the A, B and Z inputs. The drive encoder signals must be digital and not SINCOS. No ratio is possible, therefore Pr **x.25** has no effect.

If Pr **x.24** has any value than those above the encoder simulation outputs are not active.

x.29	**Non-marker reset revolution counter**									
RO	Uni					NC	PT			
⇳	0 to 65,535 revolutions				⇨					
Update rate: 4ms x number of dumb modules										

x.30	**Non-marker reset position**									
RO	Uni					NC	PT			
⇳	0 to 65,535 ($1/2^{16}$ths of a revolution)				⇨					
Update rate: 4ms x number of dumb modules										

Pr **x.29** and Pr **x.30** are duplicates of Pr **x.04** and Pr **x.05** respectively.

x.36	**Freeze position**									
RO	Uni					NC	PT			
⇳	0 to 65535 ($1/2^{16}$ths of a revolution)				⇨					
Update rate: 4ms x number of dumb modules										

x.39	**Freeze flag**									
RW	Bit					NC				
⇳	OFF (0) or On (1)				⇨	OFF (0)				
Update rate: 4ms x number of dumb modules										

This Solutions Module does not have its own freeze input, therefore the freeze input must come from a SM-Applications or SM-Universal Encoder Plus. The freeze data is processed every 4ms x number of dumb modules fitted. If a freeze has occurred and the freeze flag (Pr **x.39**) is zero, the position is stored in Pr **x.36** and the freeze flag is set. The freeze flag must be reset by the user before the next freeze event is stored. This function is only active with 2 pole resolvers.

x.45	**Position feedback initialised**									
RO	Bit					NC	PT			
⇳	OFF (0) or On (1)				⇨					
Update rate: Background write										

At power-up Pr **x.45** is initially OFF (0), but is set to On (1) when the SM-Resolver can provide position feedback. Pr **x.45** then remains at On (1) whilst the drive is powered-up.

x.49	Lock position feedback								
RW	Bit								
⇳	OFF (0) or On (1)				⇨				
Update rate: Background write									

If Pr **x.49** is set to one, Pr **x.04** and Pr **x.05** are not updated. If this parameter is zero, Pr **x.04** and Pr **x.05** are updated normally.

x.50	Solutions Module error status								
RO	Uni					NC	PT		
⇳	0 to 255				⇨				
Update rate: Background write									

The error status is provided so that the only one option error trip is required for each Solutions 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 7 *Diagnostics* for the meaning of the values in this parameter.) When the drive is reset, this parameter is cleared.

This Solutions Module includes 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.

7 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 7.1 based on the trip indication shown on the drive display. Refer to Figure 7-1.

If a display is not used, the drive LED Status indicator will flash if the drive has tripped. Refer to Figure 7-2.

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

7.1 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 7-1 is the value transmitted.

Figure 7-1 Keypad status modes

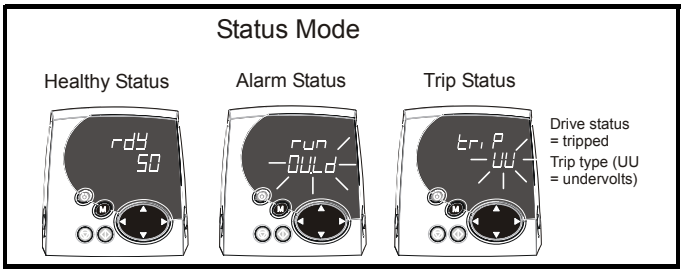
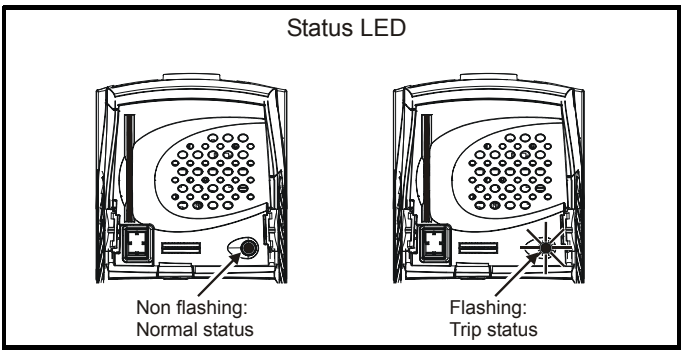


Figure 7-2 Location of the status LED



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 7.1 Trip codes

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>C.Optn</td><td>SMARTCARD trip: Solutions Modules fitted are different between source drive and destination drive</td></tr>
<tr><td>180</td><td>1. Ensure correct Solutions Modules are fitted
2. Ensure Solutions Modules are in the same Solutions Module slot
3. Reset the drive</td></tr>
<tr><td>SL.rtd</td><td>Solutions Module trip: Solutions Module has failed to recognise that the drive operating mode has changed</td></tr>
<tr><td>215</td><td>1. Ensure Solutions Module is fitted correctly
2. Contact the supplier of the Solutions Module</td></tr>
<tr><td>SLX.dF</td><td>Solutions Module slot X trip: Solutions Module type fitted in slot X changed</td></tr>
<tr><td>204,209, 214</td><td>Save parameters and reset the drive</td></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>If the drive trips SLX.Er, Pr x.50 will display the error code. An explanation of all error codes is given below:
<table>
<tr><th>Pr x.50</th><th>Fault description</th></tr>
<tr><td>0</td><td>No errors</td></tr>
<tr><td>1</td><td>Supply short circuit</td></tr>
<tr><td>2*</td><td>The wire break detection looks at the SIN and COS signals and expects one signal to be above the high threshold when the other is below the low threshold, or for both signals to be in-between the threshold values. If the above conditions are not satisfied, an error code 2 is produced.</td></tr>
<tr><td>11</td><td>The number of poles of the resolver is greater than 2, but is different to the number of poles of the motor.</td></tr>
<tr><td>74</td><td>Solutions Module overtemperature.</td></tr>
</table>
*This trip can be enabled/disabled by Pr x.17.
When the drive is reset Pr x.50 is cleared.</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>1. Ensure Solutions Module is fitted correctly
2. Contact the supplier of the Solutions Module</td></tr>
<tr><td>SLX.nF</td><td>Solutions Module slot X trip: Solutions Module has been removed</td></tr>
<tr><td>203,208, 213</td><td>1. If the Solutions Module has been purposely removed from the drive, save parameters and reset the drive.
2. Ensure Solutions Module is fitted correctly
3. Replace Solutions Module
4. Save parameters and reset drive</td></tr>
</table>

NOTE The SM-Resolver will only provide speed and position feedback when it is selected as the source of the drive speed/position feedback. Hence the SM-Resolver does not function when the drive is operating in open-loop mode.

8 Terminal data

1	Simulated encoder output channel A
2	Simulated encoder output channel A\
Type	EIA485 differential voltage
Maximum frequency	500kHz
Absolute maximum applied voltage relative to 0V	±14V
Protection	Current limit with thermal protection

3	0V
Total current for all 0V terminals of Solutions Module	200mA

4	Simulated encoder output channel B
5	Simulated encoder output channel B\
Type	EIA485 differential voltage
Maximum frequency	500kHz
Absolute maximum applied voltage relative to 0V	±14V
Protection	Current limit with thermal protection

6	0V
Total current for all 0V terminals of Solutions Module	200mA

7	Simulated encoder output channel Z
8	Simulated encoder output channel Z\
Type	EIA485 differential voltage
Maximum frequency	500kHz
Absolute maximum applied voltage relative to 0V	±14V
Minimum marker pulse width	300ns
Protection	Current limit with thermal protection

9	**Resolver input SIN LOW**
10	**Resolver input SIN HIGH**
11	**Resolver input COS LOW**
12	**Resolver input COS HIGH**

Type	2V rms (max) sinusoidal signal
Operating frequency	6kHz
Absolute maximum applied DC voltage (SIN LOW or COS LOW) to 0V	±2.5V
Absolute maximum applied DC voltage (SIN HIGH or COS HIGH) to 0V	±12V
Protection	Series resistors and clamp diodes

13	**Resolver excitation REF HIGH**
14	**Resolver excitation REF LOW**

Type	6kHz sine wave synchronised to drive control loops
Maximum load (minimum impedance)	85Ω
Nominal voltage	6V rms (turns ratio = 3:1) 4V rms (turns ratio = 2:1)
Absolute maximum applied DC voltage (REF HIGH) with reference to 0V	±36V
Absolute maximum applied current (REF LOW)	200mA
Protection	Over-current protection

15	**0V**
16	**0V**
17	**0V**

Total current for all 0V terminals of Solutions Module	200mA

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