

User Guide

UD53

**Resolver interface
small option module
for Unidrive**

Part Number: 0460 - 0088

Issue Number: 4

General Information

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the operating parameters of the equipment or from mismatching the 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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Use within the European Union, etc

The following information applies where the end use of the Drive is within the European Union, the European Economic Area, or other regions which have implemented Directives of the European Council or equivalent measures.

The Drive complies with the Low Voltage Directive 73/23/EEC.

The installer is responsible for ensuring that the equipment into which the Drive is incorporated complies with all relevant Directives.

The complete equipment must comply with the EMC Directive 89/336/EEC.

If the Drive is incorporated into a machine, the manufacturer is responsible for ensuring that the machine complies with the Machinery Directive 89/392/EEC. In particular, the electrical equipment should generally comply with European Harmonised standard EN60204-1.

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1 Introduction

1.1 Main features of the UD53

Applications The UD53 Resolver *small option module* is an interface module for installation in a Unidrive. The UD53 operates with resolvers having the following specifications:

Input impedance: $>85\Omega$ at 6kHz

Turns ratio (primary:secondary): 3:1 or 2:1

Excitation voltage: 6V_{RMS} or 4V_{RMS}

The Drive must be operating in the Closed-loop Vector or Closed-loop Servo mode; the resolver connected to the UD53 is used for speed and position feedback.

Simulated encoder outputs The simulated-encoder outputs produce *quadrature AB* signals corresponding to the *line counts* from the source encoder. Alternatively, these outputs can be configured for frequency and direction (F/D) signals. In both cases, the outputs retain position information when direction is changed.

By default, the resolver is used as the source for the simulated-encoder outputs; alternatively, the main encoder (Encoder 1) connected to the 15-way D-type on the Drive can be used as the source.

The number of pulses per revolution can be scaled by factors of 2.

Installation The UD53 must be fitted in the *small option module* bay of the Unidrive.

All connections to the Drive are made by a multi-way connector. Connections from external equipment are made by a plug-in 16-way screw-terminal block on the UD53.

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.

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 electric 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.

The installation must comply with all relevant safety legislation in the country of use.

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

2.3 **System design**

The Drive is intended as a component for professional incorporation into complete equipment or systems. 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 mechanical 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.

To ensure mechanical safety, additional safety devices such as electro-mechanical interlocks may be required. The Drive must not be used in a safety-critical application without additional high-integrity protection against hazards arising from a malfunction.

2.4 Environmental limits

Instructions in the *Unidrive Installation Guide* regarding transport, storage, installation and use of Drives 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 Installation Guide* contains instructions 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:

89/392/EEC: Safety of Machinery

89/336/EEC: Electromagnetic Compatibility

2.6 Safety of personnel

The STOP function of the Drive does not remove dangerous voltages from the output of the Drive or from any external option unit.

The Stop and Start controls or electrical inputs of the Drive must not be relied upon to ensure safety of personnel. If a safety hazard could exist from unexpected starting of the Drive, an interlock that electrically isolates the Drive from the AC supply must be installed to prevent the motor being inadvertently started.

Careful consideration must be given to the functions of the Drive which might result in a hazard, either through their intended functions (eg. Auto-start) or through incorrect operation due to a fault or trip (eg. stop/start, forward/reverse, maximum speed).

Under certain conditions, the Drive can suddenly discontinue control of the motor. If the load on the motor could cause the motor speed to be increased (eg. hoists and cranes), a separate method of braking and stopping the motor must be used (eg. a mechanical brake).

Before connecting the AC supply to the Drive, it is important that you understand the operating controls and their operation. If in doubt, do not adjust the Drive. Damage may occur, or lives put at risk. Carefully follow the instructions in this User Guide.

Before making adjustments to the Drive, ensure all personnel in the area are warned. Make notes of all adjustments that are made.

2.7 Risk analysis

In any application where a malfunction of the Drive could lead to damage, loss of life or injury, a risk analysis must be carried out, and where necessary, further measures taken to reduce the risk. This would normally be an appropriate form of independent safety back-up system using simple electro-mechanical components.

2.8 Signal connections

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) (eg. to a personal computer), an additional isolating barrier must be included in order to maintain the SELV classification.

2.9 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 Installing the UD53



Warning

Before using the following procedure, refer to the Warnings at the beginning of Chapter 2 *Installing the Drive in the Unidrive Installation Guide*.

- 1 Before installing the UD53 in the Unidrive, ensure the AC supply has been disconnected from the Drive for at least 10 minutes.
- 2 Check that the exterior of the UD53 is not damaged, and that the multi-way connector is free from dirt and debris. Do not install a damaged or dirty UD53 in the Drive.
- 3 Remove the terminal cover from the Drive (for removal instructions, see *Installing the Drive and RFI filter* in Chapter 2 of the *Unidrive Installation Guide*).
- 4 Position the multi-way connector on the rear of the UD53 over the connector in the Drive (see Figure 1), and press on the thumb pad to push the UD53 into place.
- 5 Re-fit the terminal cover to the Drive.
- 6 Connect the AC supply to the Drive.
- 7 Set parameter **.00** at **149** to unlock security.
- 8 Check that parameter **16.01** is set at **3** to indicate that the module is fitted.
- 9 If the check in step 8 fails, perform the following:
 - Remove the AC supply from the Drive.
 - Wait at least 10 minutes.
 - Remove the terminal cover.
 - Check that the UD53 is fully inserted.
 - Replace the terminal cover.
 - Re-apply the AC supply.
 - Check again that parameter **16.01** is set at **3**.

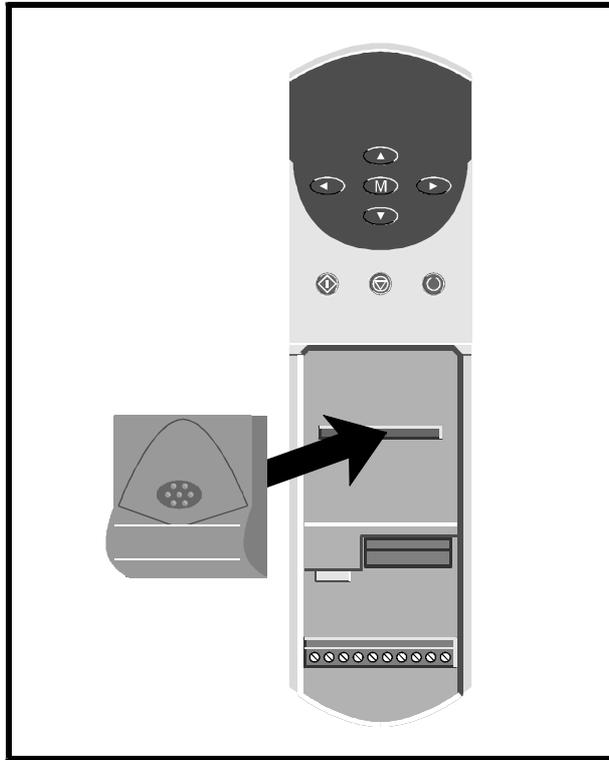


Figure 1 *Installing the UD53 in the Unidrive*

4 Making Connections



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) (eg. to a personal computer), an additional isolating barrier must be included in order to maintain the SELV classification.

4.1 Locations of the terminals

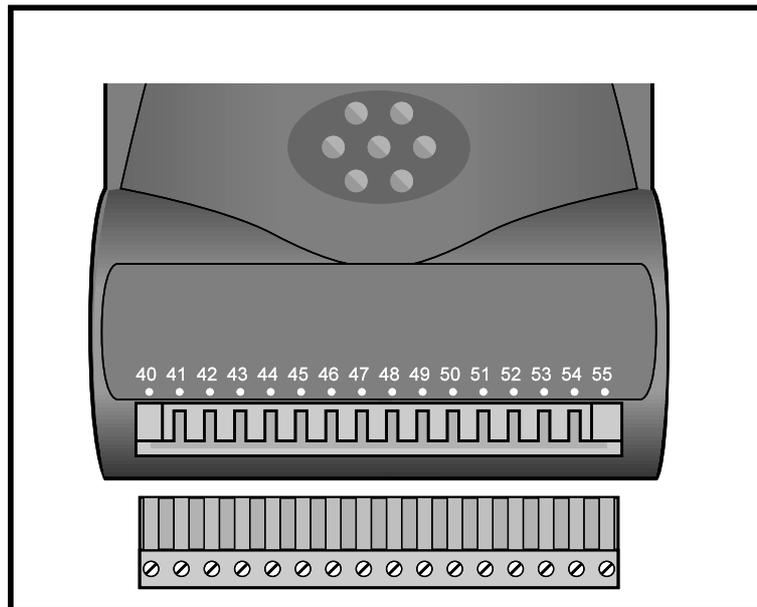


Figure 2 Location of the connector on the UD53

4.2 Functions of the terminals

Terminal	Function
40	Simulated-encoder phase quadrature output A or frequency output F (EIA485 serial link)
41	Simulated-encoder phase quadrature output A \ or frequency output F \ (EIA485 serial link)
42	0V
43	Simulated-encoder phase quadrature output B or frequency output D (EIA485 serial link)
44	Simulated-encoder phase quadrature output B \ or frequency output D \ (EIA485 serial link)
45	0V
46	Marker pulse Z output
47	Marker pulse Z \ output
48	SIN coil input (low)
49	SIN coil input (high)
50	COS coil input (low)
51	COS coil input (high)
52	Excitation output (high)
53	Excitation output (low)
54	0V
55	0V

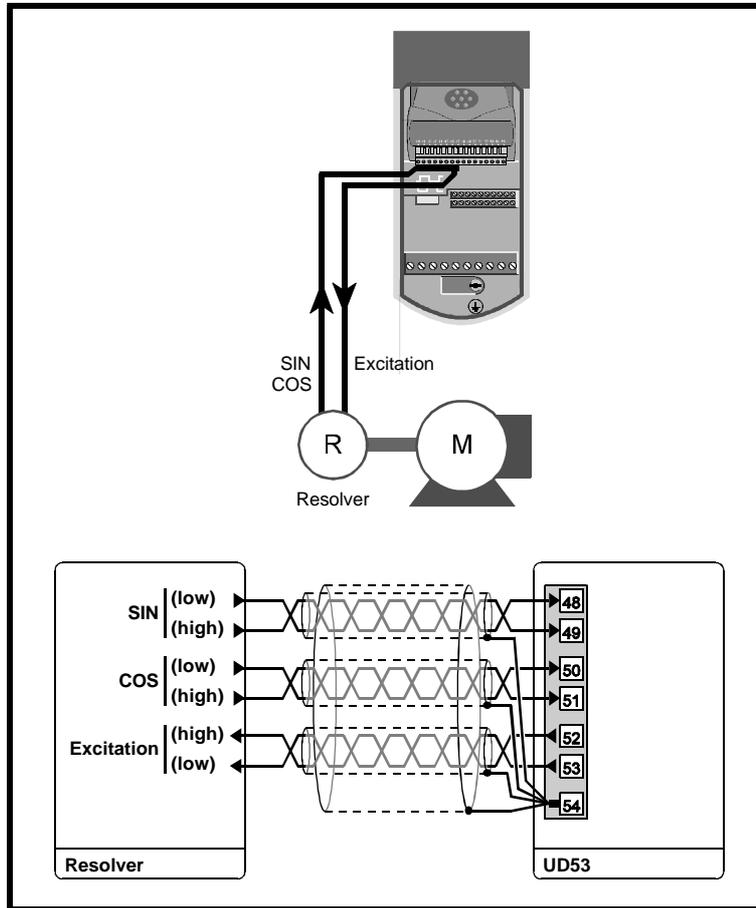


Figure 3 Resolver connections to the UD53

5 Setting Up the UD53

The instructions in this chapter apply when the Drive is being set up for the first time with a UD53 fitted.

5.1 Initial setting up

By default, the UD53 is configured for operation with a resolver having a 3:1 turns ratio. If the resolver to be used has a turns ratio of 2:1, set parameter **16.10 Resolver turns ratio select** at 1.

5.2 Phase offset

When the Drive is operating in the Servo mode, either the resolver shaft must be aligned with the motor shaft so that no phase offset exists, or the phase-offset must be entered in parameter **16.09 Resolver phase offset**.

The phase offset can be entered in either of the following ways:

- Performing a resolver phasing test. The UD53 measures the phase offset automatically and enters the value in **16.09**.
- If the phase offset is known, you can enter the value manually in parameter **16.09**.

See also Appendix B *Aligning the resolver mechanically*.

Resolver phasing test (Closed-loop Servo mode)



Warning

During the phasing test, the motor shaft rotates slowly. Before starting, make sure it will be safe for the motor to be run.

During the phasing test, the motor shaft rotates in two stages, as follows:

- Initial jump in position by up to $\frac{1}{N}$ revolution
- Subsequent rotation by $\frac{4}{N}$ revolution

Where N is the number of motor poles.

Examples

No. of poles	Initial jump	Subsequent rotation
2	Up to $\frac{1}{2}$ revolution	2 revolutions
6	Up to $\frac{1}{6}$ revolution	$\frac{2}{3}$ revolution

Procedure

- 1 Ensure the motor is unloaded (any load will create errors in the phase-offset measurement).
- 2 Set parameter **16.05** *Resolver phasing test* at 1.
- 3 Enable the Drive.

The motor shaft rotates (as described before this procedure) and the measured value of phase offset is automatically entered in parameter **16.09** *Resolver phase offset*. The motor shaft should rotate clockwise; if it rotates anti-clockwise, reverse two of the phase connections from the Drive to the motor.

If a phasing test is attempted with a motor that has high inertia, no damping or a small load on the shaft, an incorrect value for the phase offset will be measured. Refer to parameter **5.27** in the *Unidrive Advanced User Guide*.

Note

If the Drive trips and the display indicates trip code ENC.PH7, this indicates either of the following:
The SIN and COS connections from the resolver are incorrectly made
The phase sequence of the motor is reversed
Correct the connections and repeat the procedure.

Magnetizing current test (Closed-loop Vector)

Refer to *Autotune* in Chapter 3 *Setting Up the Drive* in the *Unidrive User Guide*, or to parameter **5.12** in the *Unidrive Advanced User Guide*. If the Drive trips while Autotune is being performed, see the Note above.

5.3 Change in feedback resolution with change of maximum speed

The resolver feedback signals are sampled by the UD53 at a resolution that depends on the maximum speed of the Drive. (This is determined by the value of **1.06 Maximum speed**, and when **1.08 Negative minimum speed select** is set at 1, it can also be determined by **1.07 Maximum reverse speed**.)

The resolution of the SIN and COS inputs is affected as follows:

Maximum speed [1.06] RPM	Resolution of the SIN and COS inputs
0 - 3000	14-bit
3001 - 12000	12-bit
>12000	10-bit

Note that the simulated-encoder outputs are affected by the value of **1.06** (and/or **1.07**). See *Simulated-encoder outputs*.

5.4 Simulated-encoder outputs (terminals 40, 41, 43, 44)

The simulated-encoder outputs can be connected to external equipment for monitoring the output of either a resolver connected to the UD53 or the main encoder (Encoder 1) that is connected to the 15-way D-type on the Drive. By default, the resolver is used as the source. To select Encoder 1, set parameter **16.06 Simulated encoder output select** at 1.

Quadrature AB, or frequency and direction

By default, the simulated-encoder outputs are phase-quadrature **A** and **B** signals. For frequency (**F**) and direction (**D**) signals, set parameter **16.08 Simulated-encoder F/D output enable** at 1.

Pulses per revolution

The maximum number of pulses per revolution (PPR) of the simulated-encoder outputs depends on the resolution of the SIN and COS inputs; the resolution is affected by the maximum speed which is set in **1.06** and/or **1.07**, as follows:

Maximum speed [1.06] RPM	Resolution of the SIN and COS inputs	Maximum pulses per revolution of the simulated-encoder outputs	
		Quadrature	Frequency and direction
0 - 3000	14-bit	4096	8192
3001 - 12000	12-bit	1024	4096
12000	10-bit	256	1024

The actual PPR is dependent on the resolution of the SIN and COS inputs as well as on the value of **16.07** *Simulated-encoder output scaling*.

If a different PPR is required, enter the required scaling value in parameter **16.07** *Simulated-encoder output scaling*. The scaling factor is given by the following:

$$\frac{1}{2^{[16.07]}}$$

5.5 Z marker-pulse outputs (terminals 46, 47)

The Z marker pulse is created each time the resolver passes through its zero position. If the marker pulse is required to occur at a different position, it is necessary to re-position the resolver on the motor shaft. It will then be necessary to change the value of parameter **16.09** *Resolver phase offset* by an appropriate means (see *Phase offset* earlier in this chapter).

The Z marker pulse outputs are by default synchronized to the quadrant where the quadrature A and B signals are both low. When synchronization is disabled, the Z marker pulse can be present in any of the four quadrants, as follows:

- A and B both low
- A and B both high
- A low and B high
- A high and B low

Drive software version V03.xx.07 onward UD53 version 2 onward (both present)

Synchronization of the Z marker-pulse output can be disabled by setting parameter **16.12** *Simulated-encoder output marker-pulse synchronization disable* at 1. Synchronization is automatically disabled when parameter **16.07** *Simulated-encoder output scaling* is set at either of the following:

- At a value that would cause the resolution of the encoder-simulation outputs **not** to be an **integral number** of lines per revolution (LPR)
- At such a high value that the number of lines per revolution (LPR) of the simulated-encoder outputs is **less than 1**

Parameter **16.13** *Simulated-encoder Z marker-pulse outputs synchronization inactive indicator* indicates the state of synchronization.

See the following logic table.

16.07	16.12	Synchronization	16.13
Set for integral number of lpr	0	Enabled	0
	1	Disabled	1
Set for no integral number of LPR Set for less than 1 LPR	0	Disabled	1
	1	Disabled	1

**Drive software V03.xx.05 or earlier
UD51 version 3 or earlier
(either or both present)**

The Z marker-pulse outputs are synchronized to the simulated-encoder quadrature AB outputs only when the resolution of the AB outputs is equal to or greater than 1 LPR.

Drive software V03.xx.04 or earlier

No simulated-encoder outputs are available.

6 Related Parameters

6.1 Introduction

The parameters listed in this chapter are used for programming and monitoring the UD53. Refer to the *Unidrive User Guide* for programming instructions.



Warning

Before attempting to adjust any parameters, refer to the Warnings and Notes at the beginning of Chapter 3 Setting up the Drive in the Unidrive User Guide.

6.2 Programmable software

Key

Type of parameter



RO Read-only



RW Read–write

...select

Select from two settings

...enable

Make or allow a function to operate

...disable

Stop or disallow a function from operating

...indicator

The value can only be read

Limitations of use

S The new parameter-value is saved when the AC supply is disconnected from the Drive.

P Protected parameter; the parameter cannot be used as the destination parameter for a programmable input.

Range

Bi Variable parameter having bipolar value range.

Uni Variable parameter having unipolar value range.

Bit Bit parameter

Symbols

⇔ Default value

⌈⌋ Range of values

~ Indicates a range of values
(in the case of bit parameters, ~ indicates *or*).

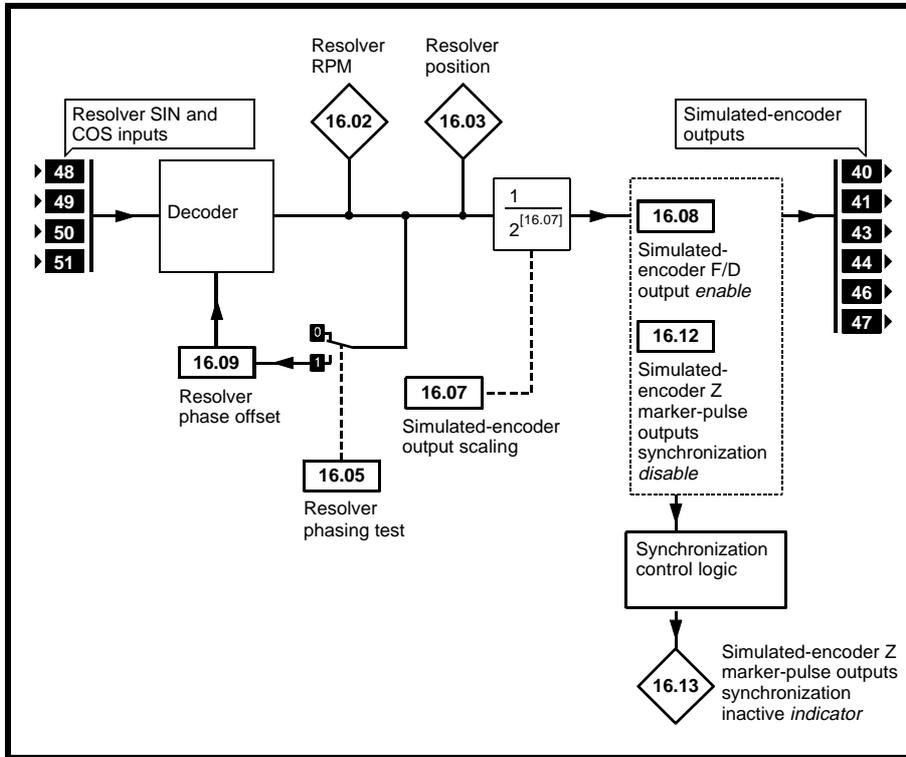


Figure 6 Logic diagram for the UD53

6.3 Parameter descriptions

16.01 Option module fitted code

⇅	0 - 100	⇒			RO	Uni			P
---	---------	---	--	--	----	-----	--	--	---

16.01 indicates the type of small option module that is fitted in the Drive, as follows:

- 0 No small option module
- 1 UD50 Additional I/O
- 2 UD51 Second encoder interface
- 3 UD53 Resolver interface
- 4 UD52 SIN-COS encoder

16.02 Resolver RPM

⇅	±30 000	⇒		RPM	RO	Bi			P
---	---------	---	--	-----	----	----	--	--	---

16.02 indicates the speed of rotation of the resolver.

16.03 Resolver position

⇅	0 - 16383	⇒		rev/16384	RO	Uni			P
---	-----------	---	--	-----------	----	-----	--	--	---

16.03 indicates the absolute position of the motor shaft (the indication takes into account any phase offset entered in **16.09** *Resolver phase offset*).

16.05 Resolver phasing test

⇅	0 - 1	⇒	0		RW	Bit			
---	-------	---	---	--	----	-----	--	--	--

Set **16.05** at 1 to initiate the resolver phasing test (on completion, **16.05** automatically returns to 0). See *Phase offset* in Chapter 5 *Setting up the UD53*.

16.06 Simulated encoder output select

↕	0 ~ 1	⇄	0		RW	Bit			
---	-------	---	---	--	----	-----	--	--	--

Note

This parameter is available only with the following:
UD53 version 2 onward
Drive software version V03.xx.07 onward

Set **16.06** as follows to select the required source for the simulated-encoder outputs:

16.06	Source
0	Resolver
1	Encoder 1

The simulated-encoder outputs appear on the following terminals:

Terminal	Function	
	Quadrature AB	Frequency and direction
40	A	F
41	A\	F\
43	B	D
44	B\	D\
46	Z	Z
47	Z\	Z\

16.07 Simulated-encoder output scaling

↕	0 ~ 15	⇄	0	2 ⁿ	RW	Uni			
---	--------	---	---	----------------	----	-----	--	--	--

Enter the required value in **16.07** for scaling the simulated-encoder output. The scaling factor is as follows:

$$\frac{1}{2^{[16.07]}}$$

For example, for a division of $\frac{1}{16}$, set **16.07** at 4 ($16 = 2^4$)

16.08 Simulated-encoder F/D output enable

↕	0 ~ 1	⇄	0		RW	Bit			
---	-------	---	---	--	----	-----	--	--	--

Use **16.08** to select the output mode of terminals 40, 41, 43, 44, as follows:

16.08	Output mode
0	AB quadrature signals
1	Frequency and direction signals

16.09 Resolver phase offset

↕	0 ~ 6143	⇄		1/6143 rev.	RW	Uni	S		P
---	----------	---	--	-------------	----	-----	---	--	---

16.09 indicates the value of phase offset. See *Phase offset* in Chapter 5 *Setting up the UD53* for ways in which the value is entered.

The value is saved at power-down and is changed only when one of the procedures indicated in *Phase offset* is performed.

When the operating mode of the Drive is changed, **16.09** is reset to zero. Restoring default values does not affect the value of **16.09**.

16.10 Resolver turns ratio select

↕	0 ~ 1	⇄	0		RW	Uni			
---	-------	---	---	--	----	-----	--	--	--

Note

This parameter is available only with the following:
UD53 version 2 onward
Drive software version V03.xx.07 onward

Set **16.10** as follows to select the required resolver turns ratio:

16.10	Turns ratio
0	3:1
1	2:1

16.12	Simulated-encoder Z marker-pulse outputs synchronization <i>disable</i>
--------------	--

↕	0 ~ 1	⇒	0		RW	Bit			
---	-------	---	---	--	----	-----	--	--	--

Note

This parameter is available only with the following:
UD53 version 2 onward
Drive software version V03.xx.07 onward

Use **16.12** to control the setting of **16.13** *Simulated-encoder Z marker-pulse outputs synchronization inactive indicator*.

16.13	Simulated-encoder Z marker-pulse output synchronization inactive <i>indicator</i>
--------------	--

↕	0 ~ 1	⇒			RO	Bit			
---	-------	---	--	--	----	-----	--	--	--

Note

This parameter is available only with the following:
UD53 version 2 onward
Drive software version V03.xx.07 onward

16.13 indicates as follows:

16.13 set at 0

Z marker-pulses are synchronized to the quadrant where the quadrature A and B outputs are both low.

16.13 set at 1

Z marker-pulses can be present in any of the four quadrants, as follows:

- A and B both low
- A and B both high
- A low and B high
- A high and B low

See *Z marker-pulse outputs (terminals 46, 47)* in Chapter 5 *Setting Up the UD53*.

A Specifications

A.1 Terminals

Resolver Inputs (terminals 48, 49, 50, 51)

Maximum voltage (relative to 0V) applied to SIN (low) and COS (low)	±4V
Maximum voltage (relative to 0V) applied to SIN (high) and COS (high)	±12V
Protection	Series resistors and diode clamp

Excitation outputs (terminals 52, 53)

Output frequency	6kHz
Output voltage	6V RMS or 4V RMS (programmable)
Absolute maximum voltages that can be applied to terminal 52 <i>Excitation output (high)</i>	-4V ~ + 24V (Short-circuit protection may occur)
Maximum current applied to terminal 53	200mA
Protection	Over-current protection and ferrite beads

Simulated encoder outputs
(terminals 40, 41, 43, 44, 46, 47)

Output type	EIA485
Maximum output frequency	Quadrature: 205kHz Frequency and direction: 410kHz
Output voltage	Conforms to EIA485
Minimum width of the Z marker pulse	300ns
Absolute maximum voltage that can be applied to each terminal	-10V ~ + 15V
Protection	Current limit with thermal protection

Output state	Typical output voltage	
	5mA load	25mA load
Low	1.0V	1.5V
High	4.5V	4.0V

0V common
(terminals 42, 45, 54, 55)

Absolute maximum current that can be applied through each terminal	200mA
--	-------

A.2 Temperature and humidity

Ambient temperature range: 0°C to 50°C (32°F to 122°F).
 Minimum temperature at power-up: -10°C (14°F)
 Maximum humidity: 95% non-condensing at 40°C (104°F)
 Storage temperature range: -40°C to 50°C (-40°F to 122°F)

A.3 Resolver

The UD53 operates with resolvers having the following specification:

- Input impedance: >85Ω at 6kHz
- Turns ratio (pri:sec): 3:1 or 2:1
- Excitation voltage: 6V RMS or 4V RMS

Suitable resolvers can be obtained from Control Techniques Dynamics, as follows:

- Frames sizes: 55RSS and 80RS
- Winding code: 1

B Aligning the Resolver Mechanically

Note

Use this procedure only when the procedure described in *Phase offset in Chapter 5 Setting Up the UD53* cannot be performed.

Use the following procedure to precisely align the resolver with the motor (for zero phase-offset). Precise alignment can be achieved only when the resolver is connected to the Drive.

The Drive detects the exact points of polarity reversal of the (sine wave) outputs. It would not be possible to identify these accurately on an oscilloscope as in the case of standard encoders.



Warning

During this procedure, the motor shaft will be rotated suddenly to a new position. Before starting, make sure it will be safe for the motor shaft to be rotated.

- 1 Disconnect the motor from the Drive.
- 2 Ensure the shaft is unloaded and free to rotate.
- 3 Apply a *direct current* of 50% of the motor rated current through the motor windings, as shown in Figure B–1

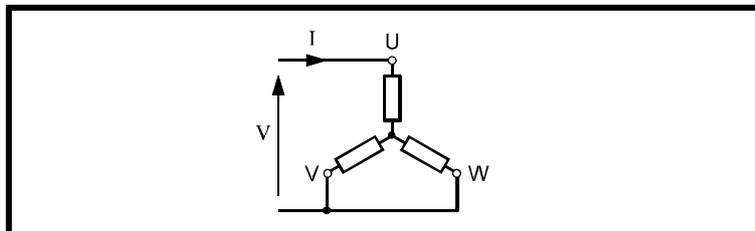


Figure B–1 Connecting a motor to a DC source for mechanically aligning the resolver shaft

The motor shaft will rotate to one of several positions depending on the number of pole-pairs. For example, the shaft of a 6-pole motor will stop at one of three places.

The resolver position is indicated by parameter **16.03** *Resolver position*. The value will be given by:

$$\frac{n}{[\text{No. pole pairs}]} \times 16384$$

If the resolver is correctly aligned, the value of **n** will always be an integer (varying from 0 to [number of pole pairs – 1]). For a 6-pole motor, this value would be 0, 1 or 2 depending on the shaft position. The value of **16.04** will then be one of the following:

$$0 \quad \left[\frac{0}{3} \times 16384 \right]$$

$$5461 \quad \left[\frac{1}{3} \times 16384 \right]$$

$$10923 \quad \left[\frac{2}{3} \times 16384 \right]$$

If the resolver is not aligned with the motor windings, **16.03** will indicate other values (**n** will not be an integer). To align the resolver, continue to pass direct current through the motor windings and rotate the resolver relative to the motor until parameter **16.03** indicates one of the correct values.

Ensure the value of parameter **16.09** *Resolver phase offset* is zero.

C Diagnostics

C.1 Trip codes

The following trip codes are associated with the UD53:

Drive display	No.	Conditions
SEP	9	Internal fault in the UD53, or connections to the UD53 have not been made.
ENC.PH7	17	The SIN and COS connections from the resolver are incorrectly made or the phase sequence of the motor connections is reversed.
ENC.PH8	18	Resolver phasing test or magnetizing current test prematurely ended.
ENC.PH9	181	Closed-loop Vector: Loss of resolver output signals. Servo mode: Resolver and/or motor phase connections incorrect, causing reverse torque to be produced.
SEP.diS	180	The type of small option module that the Drive has been programmed to operate with has been removed or is not fitted correctly. Perform either of the following: Ensure the appropriate type of small option module is correctly fitted To operate the Drive in the present configuration, set parameter 00 at 1000 and press the STOP/RESET key.

D 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 D-1 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 D-2). The diagram 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.

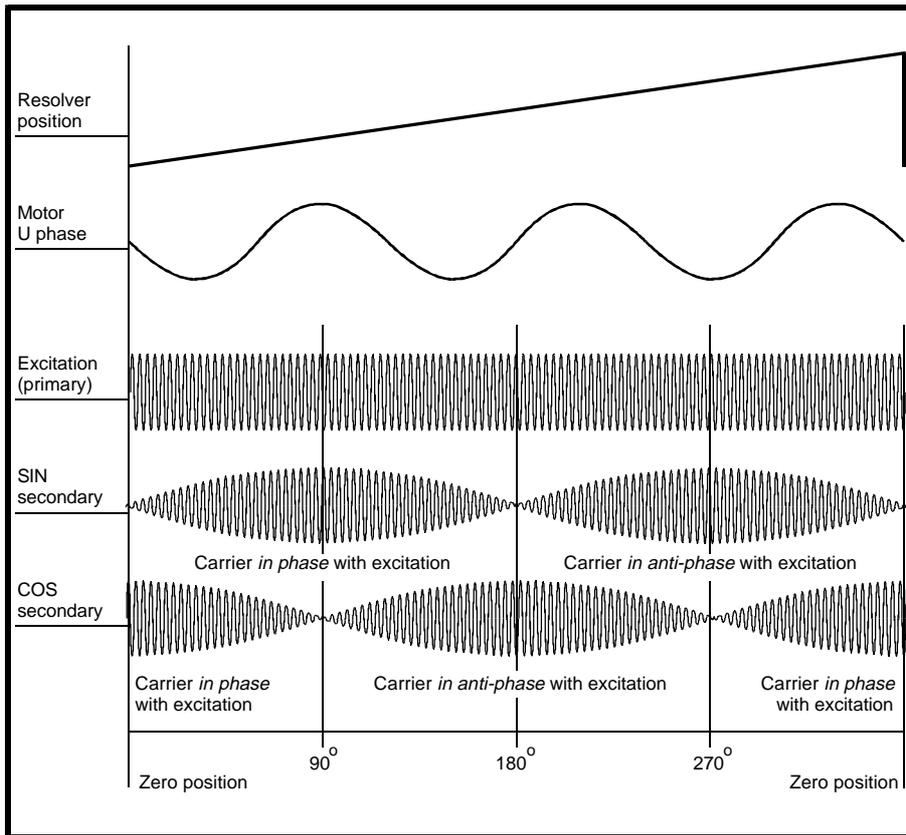


Figure D-1 Sine and cosine modulation on the secondary windings

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 D–2)

Zero-position point

The resolver passes through its zero position when the following occur (see Figure 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

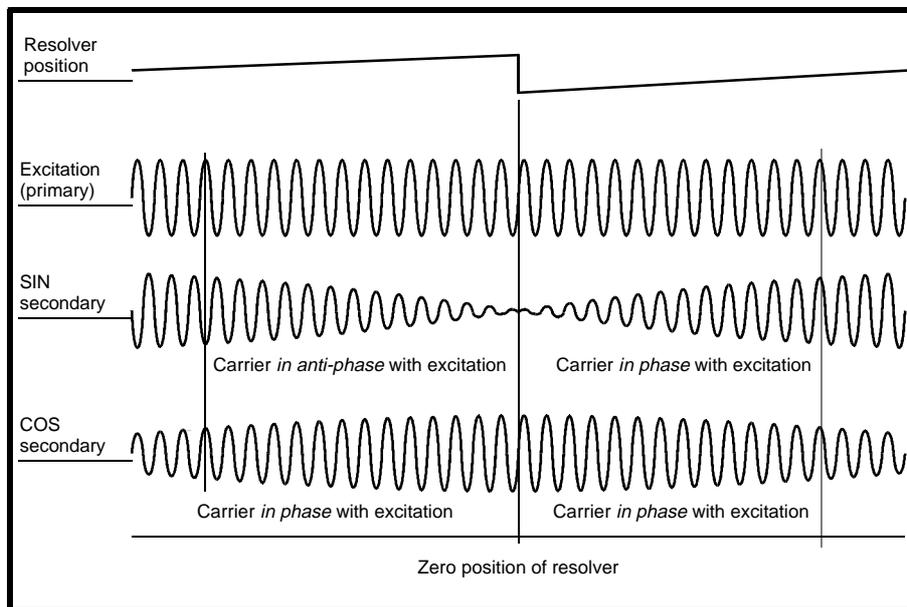


Figure D–2 Modulation and carrier-phase conditions around the zero position of the resolver