CONTROL TECHNIQUES
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Advanced User Guide

Unidrive

Model sizes 1 to 5

Universal Variable Speed AC Drive
for induction and servo motors

Part Number: 0460-0099-03
Issue Number: 3

General Information

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the optional operating parameters of the equipment or from mismatching the variable speed drive with the motor.

The contents of this guide are believed to be correct at the time of printing. In the interests of a commitment to a policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance, or the contents of the guide, without notice.

Drive software version

This product is supplied with the latest version of user-interface and machine control software. If this product is to be used in a new or existing system with other drives, there may be some differences between their software and the software in this product. These differences may cause this product to function differently. This may also apply to drives returned from a Control Techniques Service Centre.

If there is any doubt, contact a Control Techniques Drive Centre.

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The electronic variable-speed drives manufactured by Control Techniques have the potential to save energy and (through increased machine/process efficiency) reduce raw material consumption and scrap throughout their long working lifetime. In typical applications, these positive environmental effects far outweigh the negative impacts of product manufacture and end-of-life disposal.

Nevertheless, when the products eventually reach the end of their useful life, they can very easily be dismantled into their major component parts for efficient recycling. Many parts snap together and can be separated without the use of tools, whilst other parts are secured with conventional screws. Virtually all parts of the product are suitable for recycling.

Product packaging is of good quality and can be re-used. Large products are packed in wooden crates, whilst smaller products come in strong cardboard cartons which themselves have a high recycled fibre content. If not re-used, these containers can be recycled. Polyethylene, used on the protective film and bags for wrapping product, can be recycled in the same way. Control Techniques' packaging strategy favours easily-recyclable materials of low environmental impact, and regular reviews identify opportunities for improvement.

When preparing to recycle or dispose of any product or packaging, please observe local legislation and best practice.

Issue Number: 3

Software: V03.xx.xx onwards

Contents

1 Unidrive menus and parameters

1.1 Menu and parameter structure

Unidrive parameters are organised in a tabular fashion as a two dimensional array. The major index value is the menu, this is the table column. The minor index value is the parameter number, the table row. Every Unidrive parameter is specified by it's menu and parameter number, the row and column in the table of values. The parameter 'number' is specified as a decimal number, where the digit(s) to the left of the decimal point are the menu, and the digits to the right of the decimal point are the parameter number (including leading zeros) within that menu. For example, motor active current is in menu 4, parameter number 2, so this is Pr **4.02**. Conversely, Pr **5.18** is parameter 18 in menu 5, the PWM switching frequency. The reduced table below illustrates the parameter number arrangement.

Parameter	Menu				
	0	1	2	3	4
0	00.00	01.00	02.00	03.00	04.00
1	00.01	01.01	02.01	03.01	04.01
2	00.02	01.02	02.02	03.02	04.02
3	00.03	01.03	02.03	03.03	04.03
4	00.04	01.04	02.04	03.04	04.04
5	00.05	01.05	02.05	03.05	04.05

1.2 Menus

Unidrive has 21 menus, each with up to 50 parameters, which organise the 700 plus parameters into functional groups. Menu zero is available in all drive types and irrespective of security status. All the other menus can only be accessed with standard security unlocked, see 1.5 *Parameter security* . Menus 16 and 20 are only present with option modules fitted. Menu 15 is only present in Regen mode, and when in this mode menus 1 to 5, and some parameters in menu 6, which are concerned with motor control are not present. The following table summaries each menu function and which are available in each mode of operation.

Menu	Function	Open Loop	Closed loop Vector	Servo	Regen
0	General purpose user programmable	✓	✓	✓	✓
1	Speed reference selection, limits and filters	✓	✓	✓	
2	Ramps	✓	✓	✓	
3	Frequency slaving, Speed loop control	✓	✓	✓	
4	Current control	✓	✓	✓	
5	Machine control	✓	✓	✓	
6	Drive sequencer and Timers	✓	✓	✓	✓
7	Analog inputs and outputs	✓	✓	✓	✓
8	Digital inputs and outputs	✓	✓	✓	✓
9	Programmable logic and motorised pot	✓	✓	✓	✓
10	Drive status and trip information	✓	✓	✓	✓
11	Drive setup	✓	✓	✓	✓
12	Programmable thresholds	✓	✓	✓	✓
13	Position control and Frequency input setup	✓	✓	✓	
14	PID loop	✓	✓	✓	✓
15	Regen input bridge setup				✓
16	Small option module setup	1	1	1	1
17	Large option module setup	✓	✓	✓	✓
18	Application menu 1	✓	✓	✓	✓
19	Application menu 2	✓	✓	✓	✓
20	LAM menu	2	2	2	2

Key:
✓ Menu available (with security unlocked)

1 Menu only present with Small Option Module fitted.

2 Menu only present with second processor Large Application Module fitted.

1.3 Parameter descriptions

Type of parameter

The following types of parameters are present:

..selector select from a number of settings
..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

Coding

There are two fundamental types of parameters in the drive, read only (RO) and read/write (R/W). The read only parameters cannot be changed by the user and are there to give the user useful information about the state of the drive. Read/write parameters are for the user to set up the way in which the drive operates.

Parameters can be further broken down into Bit parameters and Non-bit parameters. Bit parameters are two state only (0 or 1) and if R/W are used as switches or two state input variables to the drive logic, or if R/W indicate various drive conditions which are either true (1) or false (0). Non-bit parameters have more than two values, the range of each being given in the following descriptions.

Some parameters are represented as strings, rather than numeric values which give a more informative indication of the parameter setting. However in the descriptions below, numeric values are given as well as the string value because setting up via the serial interface requires numeric data.

Most parameters when being adjusted take immediate effect, but there are some which do not. These are generally parameters which could cause a malfunction in the operation of the drive if an intermediary value were taken during the adjustment, such as parameters defining the destination of programmable inputs. For the new value of one of these parameters to take effect a 'Drive Reset' must be carried out (see below). Parameters which require a 'Drive Reset' before any new value becomes effective are coded with an R in the following descriptions.

Except for a very few parameters, any adjustment made to RW parameters will be lost when power is removed unless the new values are stored in EEPROM. The few parameters which do not require to be stored manually are coded with an S in the following descriptions to indicate that they are stored at power down.

It will be seen later that Bit parameters can be controlled by programmable logic inputs or internal logic functions, and Non-bit parameters can be controlled by programmable analog inputs or internal drive functions. However, some parameters are of such a sensitive nature that they are protected from being controlled by programmable inputs and functions and these are coded with a P in the following descriptions.

Abbreviations used in the parameter descriptions are as follows:

RW Read/Write.
RO Read Only.
Bit Two state only parameter, 0 or 1.
Bi Bipolar - can have positive and negative values.
Uni Unipolar - can have positive values only.
Txt Parameter value is represented on the display with strings of Text.
R Requires a 'Drive Reset' before any new value will be implemented.
S Parameter is Saved at power down.
P Parameter is Protected from being controlled by programmable inputs and functions.

Symbols used in the parameter descriptions are as follows:

⇒ default value
⇑ range of values
[...] indicates the value of parameters
~ indicates a range of values (in the case of bit parameters, ~ indicates *or*)

Range

This defines the numerical range for each parameter. For unipolar parameters the range is 0 to maximum value, and for bipolar parameters the range is from -(maximum value) to +(maximum value). Bit parameters can only have the value 0 or 1. Note that for string parameters each numerical parameter value has a corresponding string description.

Units

This defines the units in which the parameter is measured (where appropriate).

Default setting

This defines the value that a parameter will be set to if 'Factory defaults' are loaded. Note that for some parameters the value depends on the drive type selected.

1.4 Storing drive parameters

Parameters are stored by setting Parameter 0 to a value of 1000 and performing a 'Drive reset'. Because a 'Drive Reset' causes the values of certain parameters to be implemented, storing parameters has the effect of implementing all new values as the store takes place.

1.5 Parameter security

There are two independent levels of security that can be enabled / disabled in the Unidrive. This gives four possible combinations of security settings as shown in the table below:

Standard security	User security	Menu 0 status	Advanced menus status (i.e menus 1 to 20)
Open	Open	RW	RW
Open	Closed	RO	RO
Closed	Open	RW	Not visible
Closed	Closed	RO	Not visible

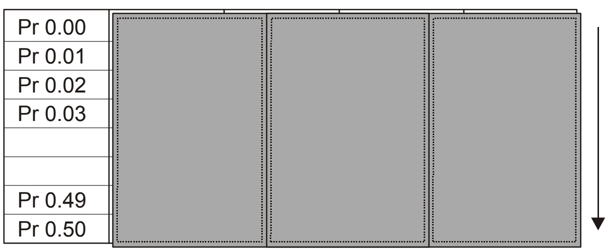
RW = Read / write access
RO = Read only access

The default settings of the drive are standard security closed and user security open, i.e. read / write access to Menu 0 with the advanced menus (i.e. menus 1 to 20) not visible.

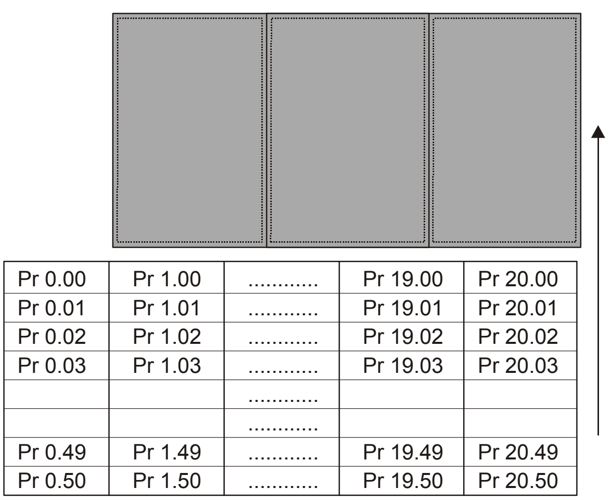
1.5.1 Standard security

Standard security prevents read and write access to the advanced menu parameters.

Standard security closed - Menu 0 only visible



Standard security open - All parameters visible



Opening standard security

Set Pr **xx.00** to 149 and press the M button.

Closing security

Set Pr **xx.00** to 2000 and press the M button or cycle the power to the drive.

NOTE

This action also closes user security if it has been enabled.

Disabling standard security

Set Pr **0.34** to 0 and press the M button.

NOTE

This action also disables user security if it has been enabled.

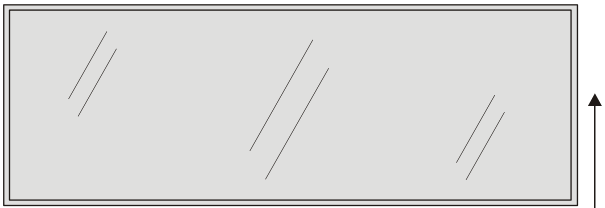
Enabling standard security

Set Pr **0.34** to 149 and press the M button.

1.5.2 User security

User security prevents write access to all parameters except Pr **xx.00**.

User security open - All parameters: Read / Write access



Pr 0.00	Pr 1.00	....	Pr 19.00	Pr 20.00
Pr 0.01	Pr 1.01	....	Pr 19.01	Pr 20.01
Pr 0.02	Pr 1.02	....	Pr 19.02	Pr 20.02
Pr 0.03	Pr 1.03	....	Pr 19.03	Pr 20.03
		....		
		....		
Pr 0.49	Pr 1.49	....	Pr 19.49	Pr 20.49
Pr 0.50	Pr 1.50	....	Pr 19.50	Pr 20.50

User security closed - All parameters: Read Only access, except Pr **xx.00**

Pr 0.00	Pr 1.00	....	Pr 19.00	Pr 20.00
Pr 0.01	Pr 1.01	....	Pr 19.01	Pr 20.01
Pr 0.02	Pr 1.02	....	Pr 19.02	Pr 20.02
Pr 0.03	Pr 1.03	....	Pr 19.03	Pr 20.03
		....		
		....		
Pr 0.49	Pr 1.49	....	Pr 19.49	Pr 20.49
Pr 0.50	Pr 1.50	....	Pr 19.50	Pr 20.50

Setting user security

Enter a value between 1 and 256 (except 149) in Pr **0.34**. Once the M button has been pressed the value reverts to 149 to hide the security code which has been set.

Save parameters by setting Pr **xx.00** to 1000 and press the button.

Opening user security

Enter the security code into Pr **xx.00**.

Closing user security

Set parameter **xx.00** to 2000 and press the mode button or cycle the power to the drive.

NOTE

This action also closes standard security if it has been enabled.

Disabling user security

Set Pr **0.34** to 0 and press the M button to disable both user and standard security

Set Pr **0.34** to 149 and press the M button to disable user, but set standard, security.

1.6 Drive types

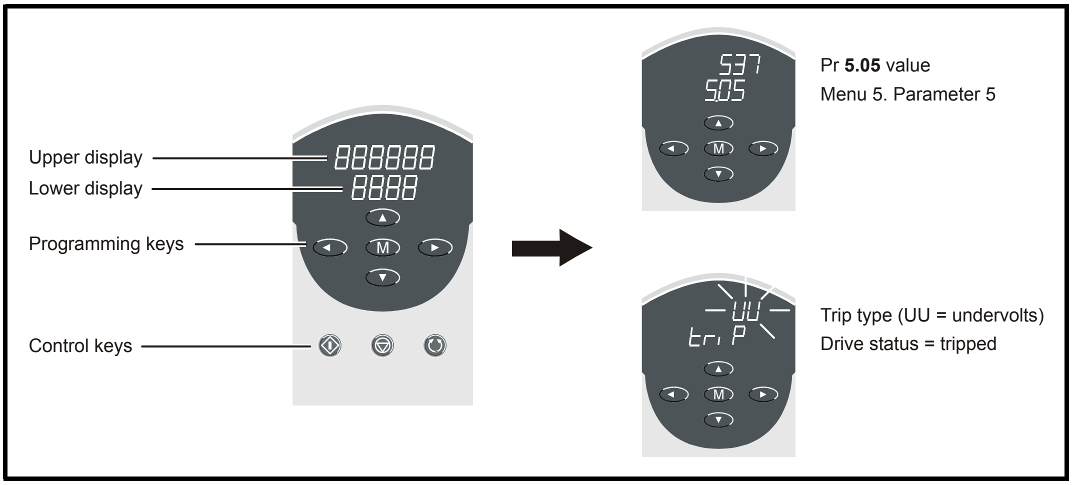
Although the drive can be set up as either an Open loop inverter, Closed loop vector, Closed loop servo, or Regen; as far as the parameter set is concerned most parameters are common across all three motor drive types and where the menu is present in Regen as well.

2 Unidrive keypad and display

2.1 Keypad and display

Unidrive has a two line LED display and eight control keys, of these five are used for changing the display mode, moving around the parameter menus, and changing parameter values, and three are for controlling and resetting the drive. The following diagram shows the position of each key and the display.

Figure 2-1 Keypad and display



The display shows the following types of parameter on each line:

Upper DisplayParameter value in numerical or text format
Lower DisplayStatus string, alarm string or parameter number

Basic key functions are as follows:

Up key Move up a parameter or increase a parameter value
Down keyMove down a parameter or decrease a parameter value
Left keyMove down a menu or to a more significant parameter digit
Right keyMove up a menu or to a less significant parameter digit
Mode keyChange display mode
Start keyStart the drive in keypad mode
Stop/Reset keyStop the drive in keypad mode or reset the drive
Reverse keyReverse the direction of rotation in keypad mode

Note that in some circumstances the keys do not have the functions as described above, for instance when rolling over from the top of a menu to the bottom the up key actually causes the parameter number to decrease. The more detailed descriptions of key actions that follow should be referred to for a full explanation of what each key does.

2.2 Display modes

The display has several modes of operation in which the display has the format shown below:

2.2.1 Status mode

The upper display shows the parameter value, and the lower display shows the status string.

Parameter.Value
Status.String

2.2.2 Parameter mode

The upper display shows the parameter value, and the lower display the menu and parameter number.

Parameter.Value
Menu.Param

2.2.3 Edit mode

The upper display flashes showing the parameter value, and the lower display the menu and parameter number.

Parameter.Value
Menu.Param

2.2.4 Alarm mode

The upper display shows the parameter value, and the lower display flashes between the alarm string and the parameter number.

Parameter.Value
Alarm.String

2.2.5 Trip mode

The upper display flashes showing the trip string, and the lower display shows 'trip'.

Trip.String
Trip

A list of the status and alarm strings can be found later in this section. For a list of all the trip strings see the description of Pr **10.20** on page 137.

2.3 Alarm strings

During an alarm condition the lower display will flash between the alarm string and the current parameter number. Apart from the LO.PS alarm all the other alarms are caused by some form of drive overload, and indicate that a parameter is getting close to the trip threshold. Unless action is taken to remove the overload the drive will trip. Alarm strings shown on the display have the following meanings:

br.rS	Brake resistor alarm
OVLd	Motor overload alarm
hot	Heatsink temperature alarm
Air	Control module ambient temperature alarm
LO.PS	Drive is running from UD78 option module power supply IGBTs will not operate Power down parameters have been saved A full parameter save is not possible

2.4 Status strings

In the default display mode (status) the drive status is shown on the lower display. This indicates what the drive is doing at the present time. Drive status strings have the following meanings:

inh	Drive inhibited (output bridge disabled), or in Regen mode can also indicate soft start contactor not closed
rdY	Drive ready (output bridge disabled)
StoP	Drive holding zero speed, or in Regen mode means drive is waiting for DC bus to stabilise or the AC supply is too low
SCAN	Drive catching a spinning motor, or in Regen mode means drive is synchronising to the supply
run	Motor running
AC.UU	AC supply under voltage, mains loss mode entered
dEC	Decelerating to stop
dc	DC injection braking
POS	Moving to stop position in orientation mode
triP	Drive tripped
act	Regen mode input converter active

2.5 Keypad operation - parameter and mode setting

There are five keys used for changing the display mode and setting the parameter number and value; the up, down, left, right and mode keys. These keys can be used to change the display mode between the status, parameter and edit modes as described previously. The action of the keys in each of these modes is described here:

2.5.1 Status mode

When in status mode, pressing any one of the Left, Right or Mode keys will change the display mode to Parameter mode. If the Keypad reference (Pr **1.17**) is not selected then the Up and Down keys will also change the display mode to parameter mode, but when the keypad reference is selected the Up and Down keys change the Keypad reference and hence the motor speed. Depending on the settings of parameters 1.08 (Negative min speed select) and Pr **1.10** (Bipolar), the range of the keypad reference will be as follows, where Pr **1.06** and Pr **1.07** are the maximum and minimum speed respectively:

Pr **1.08**	Pr **1.10**	Speed range
0	0	Pr **1.07** to Pr **1.06** (Positive only)
0	1	-Pr **1.06** to Pr **1.06**
1	0	0 to Pr **1.06**
1	1	Pr **1.07** to Pr **1.06** (Both signs)

The rate at which the speed reference changes increases as the Up or Down keys are held longer. Pressing the Up and Down keys simultaneously will set the keypad reference to 0.

Status mode is automatically entered in the event of a drive trip.

2.5.2 Parameter mode

In this mode the Up and Down keys are used to select the parameter within the selected menu. Holding the Up key will cause the parameter number to increment until the top of the menu is reached. A single Up key action when the last parameter in a menu is being displayed will cause the parameter number to roll over to 0. Similarly holding the Down key will cause the parameter number to decrement until parameter 0 is reached and a single Down key action will cause the parameter number to roll under to the top of the menu. Pressing the Up and Down keys simultaneously will select parameter 0 in the presently selected menu.

The Left and Right keys are used to select the required menu (provided the security has been unlocked to allow access to menus other than 0). Holding the Right key will cause the menu number to increment until the last menu is reached. A single Right key action when the last menu is being displayed will cause the menu number to roll over to 0. Similarly holding the Left key will cause the menu number to decrement to 0 and a single key action will cause the menu number to roll under to the last menu. Pressing the Left and Right keys simultaneously will select menu 0.

The drive remembers the parameter last accessed in each menu such that when a new menu is entered the last parameter viewed in that menu will re-appear. This allows the user to change between parameters in menus very quickly.

If the selected parameter is RW and is not protected by security, pressing the Mode key will change the display mode to Edit mode for parameter adjustment. Conversely if the parameter is RO or protected by security, pressing the Mode key will take the drive back into Status mode.

If none of the five adjustment keys are pressed for a period of 8 seconds the Status mode is entered automatically.

2.5.3 Edit mode

Up and Down keys are used to increase and decrease parameter values respectively. If a parameters maximum value is greater than 9 and it is not represented by strings, then the Left and Right keys can be used to select a digit to adjust. The number of digits which can be independently selected for adjustment depends on the maximum value of the parameter and can be up to a maximum of the full six digits. Pressing the Right key when the least significant digit is selected will cause the most significant digit to be selected, and vice-versa if the Left key is pressed when the most significant digit is selected. When a digit value is not being changed by the Up or Down keys the selected digit flashes to indicate which one is currently selected. For string type parameters the whole string flashes when adjustment is not occurring because there is no digit selection.

During adjustment of a parameter value with the Up or Down keys the display does not flash, providing the parameter value is in range, such that the user can see the value being edited without interruption. Adjustment of a numerical value can be done in one of two ways; firstly by using the Up and Down keys only, the selected digit remaining the least significant digit; and secondly by selecting each digit in turn and adjusting them to the required value. Holding the Up or Down key in the first method will cause the parameters value to change more rapidly the longer the key is held, until such time that the parameters maximum or minimum is reached. However with the second method an increasing rate of change does not take place when adjusting any other digit than the least significant digit since a digit can only have one of 10 different values. Holding the Up or Down will cause an auto repeat and roll over to more significant digits but the rate of change is unaltered. If the maximum or minimum is hit when adjusting any other digit than the least significant one, the maximum value will flash on the display to warn the user that the maximum or minimum has been reached. If the user releases the Up or Down key before the flashing stops the last in range value will re-appear on the display. If the Up or Down key is held the display will stop flashing after 3 seconds and the maximum value will be written to the parameter. This feature is to prevent users accidentally altering digits that have already been set by taking a more significant digit outside the parameters range.

Parameters can be set to 0 very quickly by simultaneously pressing the Up and Down keys, and pressing the Left and Right keys simultaneously will select the least significant digit.

Parameter mode is re-entered from edit mode by pressing the Mode key.

2.5.4 Alarm display mode

When the drive is flashing the display in alarm mode the keypad mode of operation is unaffected.

2.5.5 Trip display mode

When the drive trips the keypad automatically enters status mode, and the display enters trip mode. This is a special status mode in which the status is 'trip' and the parameter value, in this case the trip string, is shown flashing. If whilst in this mode any of the five editing keys are pressed the display will return to parameter mode and show the parameter that was being shown before the drive tripped. Following a trip condition all RO parameters within the drive are stored at their last value before the trip occurred.

2.6 Keypad operation - drive control

Keypad mode enables the drive speed (or frequency) and direction to be controlled from the front panel keypad without the need for any analog or digital I/O, other than the Enable digital input.

Keypad mode is entered by setting the speed (or frequency) reference select Pr **1.14** to 4 (or in menu 0 Pr **0.05**). In this mode the only digital I/O connection required is the Enable input. Once in keypad mode run forward and run reverse sequencer bits Pr **6.30** and Pr **6.32**, normally controlled from digital inputs F4 and F5 (Din1 and 2), have no effect. Analog input 1 and 2 will have no effect on the speed (frequency) reference (unless deliberately programmed to do so). The value of the speed (frequency) reference in keypad mode is stored in Pr **1.17**. Although this parameter does not appear in menu 0 by default, Pr **0.11** can be used to check the final speed (frequency) reference. The key pad has the following functions:

In status mode:

In this mode the up and down keys alter the keypad reference, parameter 1.17, and hence motor speed when running. Note that this parameter can not be changed in edit mode, and the current parameter does not need to be the keypad reference in order to adjust it's value. Key actions are as follows:

Up   Increase keypad reference
Down   Decrease keypad reference
Up and DownSet keypad reference to zero

In other display modes:

Key actions as in menu and parameter mode

In all modes:

Start	Start the drive
Stop	Stop the drive
Reverse	Change the direction of rotation
Stop and Start when running	Perform a drive reset and keep on running
Stop and Start when not running	Drive does not start

2.7 Drive reset

2.7.1 Drive reset functions

A drive reset is required for a number of reasons:

To reset the drive from a tripped state
To change the drive type
To implement a change in the value of certain parameters
To initiate the saving of parameters in EEPROM

The later two of these can be done while the drive is running.

2.7.2 Performing a drive reset:

The drive can be reset from the keypad, digital I/O or via serial comms thus:

1. The Stop/Reset key. If the drive has been set up such that the stop key is not operative then the key has a drive reset function only. When the stop key is being used to stop the drive, a drive reset can be done while the drive is running by holding the Run key while the Stop/Reset key is activated. When the drive is not running the Stop/Reset key will always reset the drive.
2. The drive will be reset when a 0 to 1 transition of the drive reset parameter (Pr **10.33**). This parameter is provided for a programmable digital input to be programmed to such that a terminal can be used to reset the drive.
3. By the serial interface or an intelligent large option module such as the UD70. This drive reset is triggered by a value of 100 being written to the User trip parameter (Pr **10.38**).

2.7.3 Drive reset when auto-restart is programmed

If the drive is set in a latching sequencing mode, the run forward and run reverse inputs are not active, the drive is programmed for auto restart, and has tripped, then pressing the front panel reset key whilst in the trip state will reset the trip and also clear the run latch. This will prevent the drive doing an auto restart when the trip is cleared. Note that this function only applies to a keypad reset, not a reset from the digital I/O or from serial comms.

3 Menu 0

Menu 0 is a general purpose menu containing a sub-set of the Unidrive parameters that can be found in the other menus. Contained in menu 0 are the basic drive setup parameters such as drive type, motor parameters, minimum and maximum speeds, and ramp rates. With standard security locked the user only has access to the parameters in menu 0.

3.1 Parameter Descriptions

0.00	Multi-function Parameter		
RW	Uni		
⇳ 0 to 9,999		⇨ 0	

Parameter zero actually appears in every menu, not just menu zero and is the same in all menus so for example, Pr **6.00** is exactly the same as Pr **0.00** and Pr **1.00**. This parameter is used for locking and unlocking drive security, loading and storing parameters. Only certain values have a function associated with them, as shown below, all other values have no function.

Special values

149	Unlock standard security - this will allow access to other menus.
1000	Save parameters - copies all non-volatile parameters to EEPROM.
1070	Reset Large Application Module - has no effect on drive reset.
1233	Load factory defaults - resets all RW parameters to default values.
1244	Load USA defaults - resets all RW parameters to default values suitable for use on 60Hz systems.
1253	Allows the drive type parameter to be changed.
1254	Allows the drive type to be changed, once changed USA defaults are loaded.
1255	Load user defaults - Loads factory default values and then parameter settings stored in the user defaults table.
1256	Load user USA defaults - Loads USA default values and then parameter settings stored in the user defaults table.
2000	Re-lock security.
2001-2008	Load drive macro 1 to 8.
3001-3008	Save drive parameters to the cloning small option module in set given by last digit.
3099	Erase all parameter sets from the cloning small option module.
4001-4008	Restore drive parameters from the cloning small option module from the set given by the last digit.
8001-8008	Initiate a comparison between parameters in the drive RAM and the set stored in the cloning small option module given by the last digit.

0.49	Security status		
RO	Uni		
⇳ 0 to 100		⇨ 0	

This parameter indicates the current status of the drive parameter security system. Each digit indicates a particular aspect of security as follows:

Units digit:	0 = Standard security has been unlocked 1 = Standard security is still set
Tens digit:	0 = User security has been unlocked or is not active 1 = User security is active preventing RW access
Hundreds digit:	1 = Pr **11.30** not equal to 149*
Thousands digit:	1 = Pr **11.30** equal to zero*

* The value of Pr **11.30** is the last value written by the user. Pr **11.30** always appears as 149 when first accessed by the key pad to hide the real value last written by the user. If Pr **11.30** = 149 then user security is cleared. If Pr **11.30** = 0 then user security and security preventing access outside menu 0 is cleared.

NOTE

In contrast to all the other parameters in menu 0, this parameter does not exist in any other menu.

Other Menu 0 Parameters

All other parameters in menu zero are copies of parameters from other menus. Pr **0.01** to Pr **0.10** are fixed parameters, Pr **0.11** to Pr **0.30** are user programmable parameters and are defined by Pr **11.01** to Pr **11.20**, and Pr **0.31** to Pr **0.50** are fixed. The general layout of parameters in menu 0 is that basic speed setting parameters are at the bottom, and motor parameters are at the top. The following table lists the default contents of menu 0 for each type of drive.

3.2 Single line descriptions

3.2.1 Unidrive (All variants excluding Unidrive VTC)

Parameter			Range(⇕)		Default(⇨)			Type			
			OL	**CL**	**OL**	**VT**	**SV**				
0.00	Operating mode, Macro selection, Configuration, Saving		0 to 9,999		0			RW	Uni	R	
0.01	OL> Minimum frequency	{**1.07**}	0 to [Pr **0.02**]Hz		0			RW	Uni		
	CL> Minimum speed	{**1.07**}		0 to [Pr **0.02**]rpm		0		RW	Uni		
0.02	OL> Maximum frequency	{**1.06**}	0 to 1,000.0Hz		EUR> 50 USA> 60			RW	Uni		
	CL> Maximum speed	{**1.06**}		0 to 30,000rpm		EUR> 1,500 USA> 1,800	3000	RW	Uni		
0.03	Acceleration rate	{**2.11**}	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 s/1000rpm SV> 0 to 32.000 s/1000rpm	5	2	0.2	RW	Uni		
0.04	Deceleration rate	{**2.21**}	0 to 3,200.0 s/100Hz	VT> 0 to 32.000 s/ 1000rpm SV> 0 to 32,000 s/ 1000rpm	10	2	0.2	RW	Uni		
0.05	Reference *selector*	{**1.14**}	0 to 5		EUR> 0 USA> 4	0		RW	Uni		
0.06	Current limit	{**4.07**}	0 to I_{max} %		150		175	RW	Uni		
0.07	OL> Voltage mode *selector*	{**5.14**}	Ur_S (0), Ur_I (1), Ur (2), Fd (3)		Ur_I (1)			RW	Uni		P
	CL> Speed control P gain	{**3.10**}		0 to 32,000 %		200		RW	Uni		
0.08	OL> Voltage boost	{**5.15**}	0.0 to 25.0 %		3.0			RW	Uni		
	CL> Speed control I gain	{**3.11**}		0 to 32,000		100		RW	Uni		
0.09	OL> Dynamic V/f select	{**5.13**}	0 or 1		0			RW	Bit		
	CL> Speed control D gain	{**3.12**}		0 to 32,000		0		RW	Uni		
0.10	OL> Estimated motor speed	{**5.04**}	±6,000 rpm					RO	Bi		
	CL>Motor speed	{**3.02**}		±30,000 rpm				RO	Bi		
0.11	Pre-ramp reference	{**1.03**}	±1,000.0 Hz	±30,000 rpm				RO	Bi		
0.12	Post-ramp reference	{**2.01**}	±1,000.0 Hz	±30,000 rpm				RO	Bi		
0.13	Motor active-current	{**4.02**}	±I_{max} A					RO	Bi		
0.14	Jog reference	{**1.05**}	0 to 400.0 Hz	0 to 4,000.0 rpm	1.5	50		RW	Uni		
0.15	Ramp mode *selector*	{**2.04**}	Stnd.Hd (0), FASt (1), Stnd.Ct (2)		Stnd.Ct (2)			RW	Txt		
0.16	Stop mode *selector*	{**6.01**}	COASt (0), rP (1), rP-dcI (2), dcI (3), td.dcI (4)	COASt (0), rP (1), no.rP (2), rP-POS (3)	rP (1)		no.rP (2)	RW	Txt		
0.17	Torque mode *select*	{**4.11**}	0 to 1	0 to 4	0			RW	Uni		
0.18	S-Ramp *enable*	{**2.06**}	0 or 1		0			RW	Bit		
0.19	S-Ramp da / dt limit	{**2.07**}	0 to 3,000.0 s^2/100 Hz	0 to 30,000 s^2/1000 rpm	3.1	1.5	0.03	RW	Uni		
0.20	Skip frequency/speed 1	{**1.29**}	0.0 to 1,000.0 Hz	0 to 30,000 rpm	0			RW	Uni		
0.21	Skip band 1	{**1.30**}	0.0 to 5.0 Hz	0 to 50 rpm	0.5	5		RW	Uni		
0.22	Skip frequency/speed 2	{**1.31**}	0.0 to 1,000.0 Hz	0 to 30,000 rpm	0			RW	Uni		
0.23	Skip band 2	{**1.32**}	0.0 to 5.0 Hz	0 to 50 rpm	0.5	5		RW	Uni		
0.24	Analog input 1 mode *selector*	{**7.06**}	VOLt (0), 0 - 20 (1), 20 - 0 (2), 4 - 20.tr (3), 20 - 4.tr (4), 4 - 20.Lo (5), 20 - 4.Lo (6), 4 - 20.Pr (7), 20 - 4.Pr (8)		VOLt (0)			RW	Txt	R	
0.25	Analog input 2 mode *selector*	{**7.11**}	(as Pr **0.24**)		VOLt (0)			RW	Txt	R	
0.26	Analog input 2 *destination*	{**7.14**}	Pr **0.00** to Pr **20.50**		Pr **1.37**			RW	Uni	R	P
0.27	EUR> Positive logic *select*	{**8.27**}	0 or 1		0			RW	Bit	R	P
	USA> Sequencing mode *selector*	{**6.04**}	0 to 4		4			RO	Uni		P
0.28	EUR> Current control P gain	{**4.13**}	0 to 30,000		20	150	30	RW	Uni		
	USA> Frequency/speed demand	{**1.01**}	±1,000Hz	±30,000 rpm				RO	Bi		
0.29	EUR> Current control I gain	{**4.14**}	0 to 30,000		40	2,000	1,200	RW	Uni		
	USA> Terminal-29 destination parameter	{**8.23**}	Pr **0.00** to Pr **20.50**		Pr **1.41**			RW	Uni	R	P
0.30	Forward / reverse key *enable*	{**6.13**}	0 or 1		0			RW	Bit		
0.31	Macro number	{**11.37**}	0 to 8					RO	Uni		
0.32	Serial comms mode	{**11.24**}	ANSI 2 (0), ANSI 4 (1), OUtPUt (2), INPUt (3)		ANSI 4 (1)			RW	Txt	R	P
0.33	Drive rated current (FLC)	{**11.32**}	2.10 to 1920 A					RO	Uni		P
0.34	User security code	{**11.30**}	0 to 255		149			RW	Uni	S	P
0.35	Keypad reference	{**1.17**}	± [Pr **0.02**] Hz	± [Pr **0.02**] rpm				RO	Bi	S	P
0.36	Serial comms. baud rate	{**11.25**}	4,800 (0), 9,600 (1), 19,200 (2) baud		4,800 (0)			RW	Txt		P
0.37	Serial comms. address	{**11.23**}	0.0 to 9.9 Group.Unit		1.1			RW	Uni		P
0.38	Initial parameter displayed	{**11.22**}	Pr **0.00** to Pr **0.50**		Pr **0.10**			RW	Uni		P
0.39	Synchronise to a spinning motor	{**6.09**}	0 or 1		0	1		RW	Bit		

Parameter			Range(⇳) OL	Range(⇳) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
0.40	Autotune	{**5.12**} (**3.25**)	0 or 1		0			RW	Bit		P
0.41	PWM switching frequency	{**5.18**}	3 kHz (0), 4.5 kHz (1), 6 kHz (2), 9 kHz (3), 12 kHz (4)		3 (0)*			RW	Txt		
0.42	Motor - no. of poles	{**5.11**}	2 POLE (0) to 32 POLE (15)		4 POLE (1)		6 POLE (3)	RW	Txt		P
0.43	Motor - rated power factor	{**5.10**}	0.000 to 1.000	VT> 0.000 to 1.000 SV> 1	0.92		1	RW	Uni	S	P
0.44	Motor - rated voltage	{**5.09**}	200V drive: 0 to 240 V 400V drive: 0 to 480 V		200V drive: 220 400V drive: EUR> 400 USA> 460		0	RW	Uni		
0.45	Motor - rated speed	{**5.08**}	0 to 6,000 rpm	0 to 30,000 rpm	0	EUR> 1450 USA> 1770		RW	Uni		
0.46	Motor - rated current	{**5.07**}	0 to FLC A		FLC			RW	Uni		
0.47	Motor - rated frequency	{**5.06**}	0 to 1,000.0 Hz	VT> 0 to 1,000.0 Hz SV> 0	EUR> 50 USA> 60		0	RW	Uni		
0.48	Drive operating mode *selector*	{**11.31**}	OPENLP (0), CL.VECT (1), SErVO (2), rEGEN (3)		OPENLP (0)	CL.VECT (1)	SErVO (2)	RW	Txt	R	P
0.49	Security status		0 to 1,000		1			RO	Uni		P
0.50	Software version number	{**11.29**}	1.00 to 99.99					RO	Uni		P

* Pr **0.41** PWM switching frequency has a default setting of 9kHz in Unidrive LFT

Key:

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous)

Types of current range

FLC Full load current of the drive (maximum continuous output current up to 40^{o}C ambient temperature). Displayed in Pr **11.32** {**0.33**}.

I_{MAX} A Maximum overload output current of the drive up to 40^{o}C ambient temperature, derived as follows:

Size 1 to 4: OL> 150% x FLC
CL> 175% x FLC
Size 5: 150% x FLC

I_{MAX} % See section *Current limits* on page 75 for the definition of I_{MAX}%.

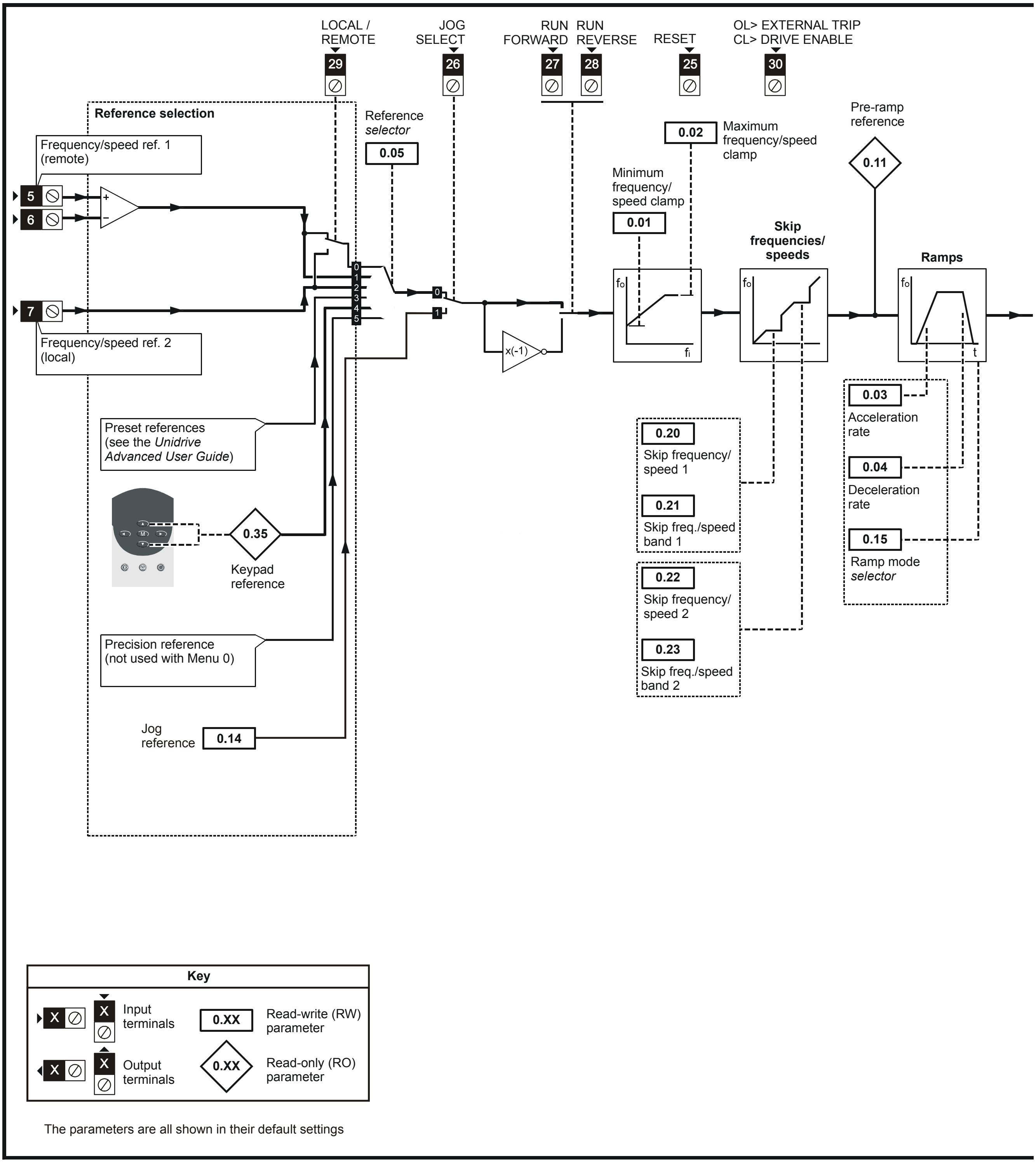
NOTE

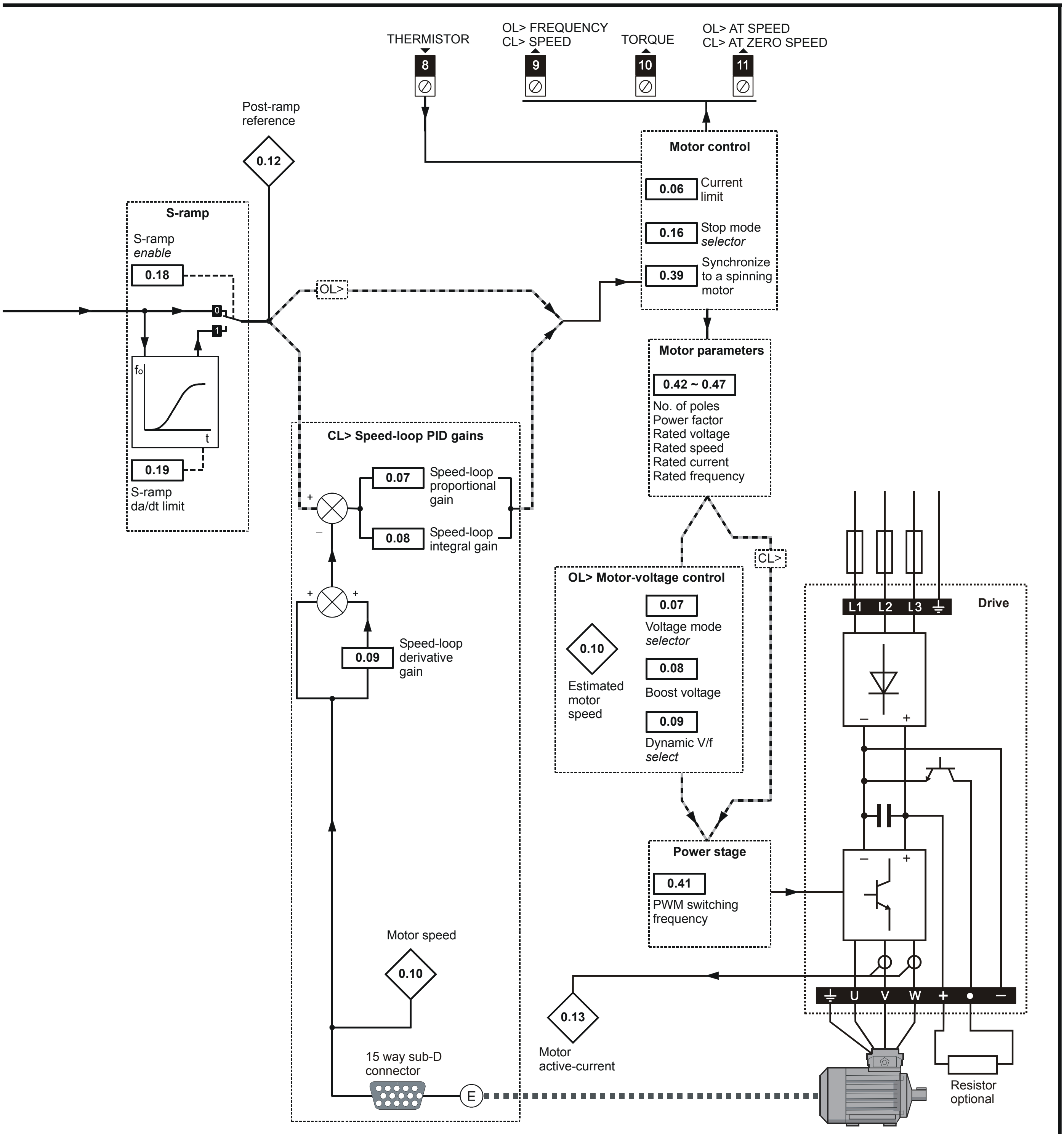
Where a parameter is represented by a text value, the value in brackets in the range column is the setting used for serial communications.

Operation mode abbreviations:

OL> Open loop
CL> Closed loop (which incorporates closed loop vector and servo mode)
VT> Closed loop vector mode
SV> Servo

Figure 3-1 Unidrive menu 0 logic diagram (excluding VTC)




THERMISTOR
OL> FREQUENCY
CL> SPEED
TORQUE
OL> AT SPEED
CL> AT ZERO SPEED
8
9
10
11
Post-ramp reference
0.12
Motor control
0.06 Current limit
0.16 Stop mode selector
0.39 Synchronize to a spinning motor
S-ramp
S-ramp enable
0.18
OL>
0
1
f0
t
0.19
S-ramp da/dt limit
Motor parameters
0.42 ~ 0.47
No. of poles
Power factor
Rated voltage
Rated speed
Rated current
Rated frequency
CL> Speed-loop PID gains
0.07 Speed-loop proportional gain
0.08 Speed-loop integral gain
0.09 Speed-loop derivative gain
CL>
OL> Motor-voltage control
0.07 Voltage mode selector
0.10 Estimated motor speed
0.08 Boost voltage
0.09 Dynamic V/f select
Drive
L1 L2 L3
Power stage
0.41 PWM switching frequency
Motor speed
0.10
0.13
Motor active-current
U V W + • −
15 way sub-D connector
E
Resistor optional

3.2.2 Unidrive VTC

Parameter			Range(⇕)	Default(⇨)	Type			
0.00	Operating mode, Macro selection, Configuration, Saving		0 to 9,999	0	RW	Uni	R	
0.01	Minimum frequency	{**1.07**}	0 to [Pr **0.02**]Hz	0	RW	Uni		
0.02	Maximum frequency	{**1.06**}	0 to 250.0Hz	EUR> 50, USA> 60	RW	Uni		
0.03	Acceleration rate	{**2.11**}	0 to 3,200.0 s/100Hz	60	RW	Uni		
0.04	Deceleration rate	{**2.21**}	0 to 3,200.0 s/100Hz	60	RW	Uni		
0.05	Reference *selector*	{**1.14**}	0 to 5	0	RW	Uni		
0.06	Current limit	{**4.07**}	0 to I_{max} %	120	RW	Uni		
0.07	Voltage mode *selector*	{**5.14**}	Ur_S (0), Ur_I (1), Ur (2), Fd (3)	Fd (3)	RW	Txt		P
0.08	Voltage boost	{**5.15**}	0.0 to 15.0 %	3.0	RW	Uni		
0.09	Dynamic V/f select	{**5.13**}	0 or 1	0	RW	Bit		
0.10	Estimated motor speed	{**5.04**}	±6,000 rpm		RO	Bi		P
0.11	Pre-ramp reference	{**1.03**}	±1,000.0 Hz		RO	Bi		P
0.12	Post-ramp reference	{**2.01**}	±1,000.0 Hz		RO	Bi		P
0.13	Motor active-current	{**4.02**}	$\pm I_{max}$ A		RO	Bi		P
0.14	Total motor current	{**4.01**}	0 to 400.0 Hz		RO	Uni		P
0.15	Ramp mode *selector*	{**2.04**}	Stnd.Hd (0), FASt (1), Stnd.Ct (2)	Stnd.Ct (2)	RW	Txt		
0.16	Stop mode *selector*	{**6.01**}	COASt (0), rP (1), rP-dcI (2), dcI (3), td.dcI (4)	rP (1)	RW	Txt		
0.17	Total motor power	{**5.03**}	$\pm P_{\mathbf{MAX}}$		RO	Bi		P
0.18	S-Ramp *enable*	{**2.06**}	0 or 1	0	RW	Bit		
0.19	S-Ramp da / dt limit	{**2.07**}	0 to 3,000.0 s^2/100 Hz	450.0	RW	Uni		
0.20	Skip frequency 1	{**1.29**}	0.0 to 1,000.0 Hz	0	RW	Uni		
0.21	Skip band 1	{**1.30**}	0.0 to 5.0 Hz	0.5	RW	Uni		
0.22	Drive rated current (FLC)	{**11.32**}	2.10 to 202 A		RO	Uni		P
0.23	Analog input 1 mode *selector*	{**7.06**}	VOLt (0), 0 - 20 (1), 20 - 0 (2), 4 - 20.tr (3), 20 - 4.tr (4), 4 - 20.Lo (5), 20 - 4.Lo (6), 4 - 20.Pr (7), 20 - 4.Pr (8)	VOLt (0)	RW	Txt	R	
0.24	Preset frequency 1	{**1.21**}	±1,000.0 Hz	0	RW	Bi		
0.25	Preset frequency 2	{**1.22**}	±1,000.0 Hz	0	RW	Bi		
0.26	Standard ramp voltage	{**2.08**}	200V drive: 0 to 400 V 400V drive: 0 to 800 V	200V drive: 375 400V drive: EUR> 750, USA> 775	RW	Uni		
0.27	Current control P gain	{**4.13**}	0 to 30,000	20	RW	Uni		
0.28	Current control I gain	{**4.14**}	0 to 30,000	20	RW	Uni		
0.29	DC bus voltage	{**5.05**}	200V drive: 0 to 415 V 400V drive: 0 to 830 V		RO	Uni		P
0.30	Last trip	{**10.20**}	0 to 200		RO	Txt	S	P
0.31	Macro number	{**11.37**}	0, 1, 2, 3, 5	0	RO	Uni		
0.32	Number of auto-reset attempts	{**10.34**}	0 to 5	0	RW	Uni		
0.33	Auto-reset time delay	{**10.35**}	0.0 to 25.0 s	1.0	RW	Uni		
0.34	User security code	{**11.30**}	0 to 255	149	RW	Uni	S	P
0.35	Serial comms. mode	{**11.24**}	ANSI 2 (0), ANSI 4 (1), OUtPUt (2), INPUt (3)	ANSI 4 (1)	RW	Txt	R	P
0.36	Serial comms. baud rate	{**11.25**}	4,800 (0), 9,600 (1), 19,200 (2) baud	EUR> 4,800, USA> 9,600	RW	Txt		P
0.37	Serial comms. address	{**11.23**}	0.0 to 9.9 Group.Unit	1.1	RW	Uni		P
0.38	Initial parameter displayed	{**11.22**}	Pr **0.00** to Pr **0.50**	EUR> Pr **0.10**, USA> Pr **0.12**	RW	Uni		P
0.39	Synchronise to a spinning motor	{**6.09**}	0 or 1	0	RW	Bit		
0.40	Autotune	{**5.12**}	0 or 1	0	RW	Bit		P
0.41	PWM switching frequency	{**5.18**}	3 (0), 4.5 (1), 6 (2), 9 (3), 12 (4) kHz	3 (0)	RW	Txt		
0.42	Motor - no. of poles	{**5.11**}	2 POLE (0) to 32 POLE (15)	4 POLE (1)	RW	Txt		P
0.43	Motor - rated power factor	{**5.10**}	0.000 to 1.000	0.92	RW	Uni	S	P
0.44	Motor - rated voltage	{**5.09**}	200V drive: 0 to 240 V 400V drive: 0 to 480 V	200V drive: 220 400V drive: EUR> 400, USA> 460 0	RW	Uni		
0.45	Motor - rated speed	{**5.08**}	0 to 6,000 rpm	0	RW	Uni		
0.46	Motor - rated current	{**5.07**}	0 to FLC A	FLC	RW	Uni		
0.47	Motor - rated frequency	{**5.06**}	0 to 1,000.0 Hz	EUR> 50, USA> 60	RW	Uni		
0.48	Overload accumulator	{**4.19**}	0 to 100 %		RO	Uni		P
0.49	Security status		0 or 1	1	RO	Bit		
0.50	Software version number	{**11.29**}	1.00 to 99.99		RO	Uni		P

Key:

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous)

Types of current range

FLC Full load current of the drive (maximum continuous output current up to 40°C ambient temperature). Displayed in Pr **11.32** {**0.22**}.

$\mathbf{I_{MAX}}$ **A** Maximum overload output current of the drive up to 40°C ambient temperature, derived as follows:

120% x FLC

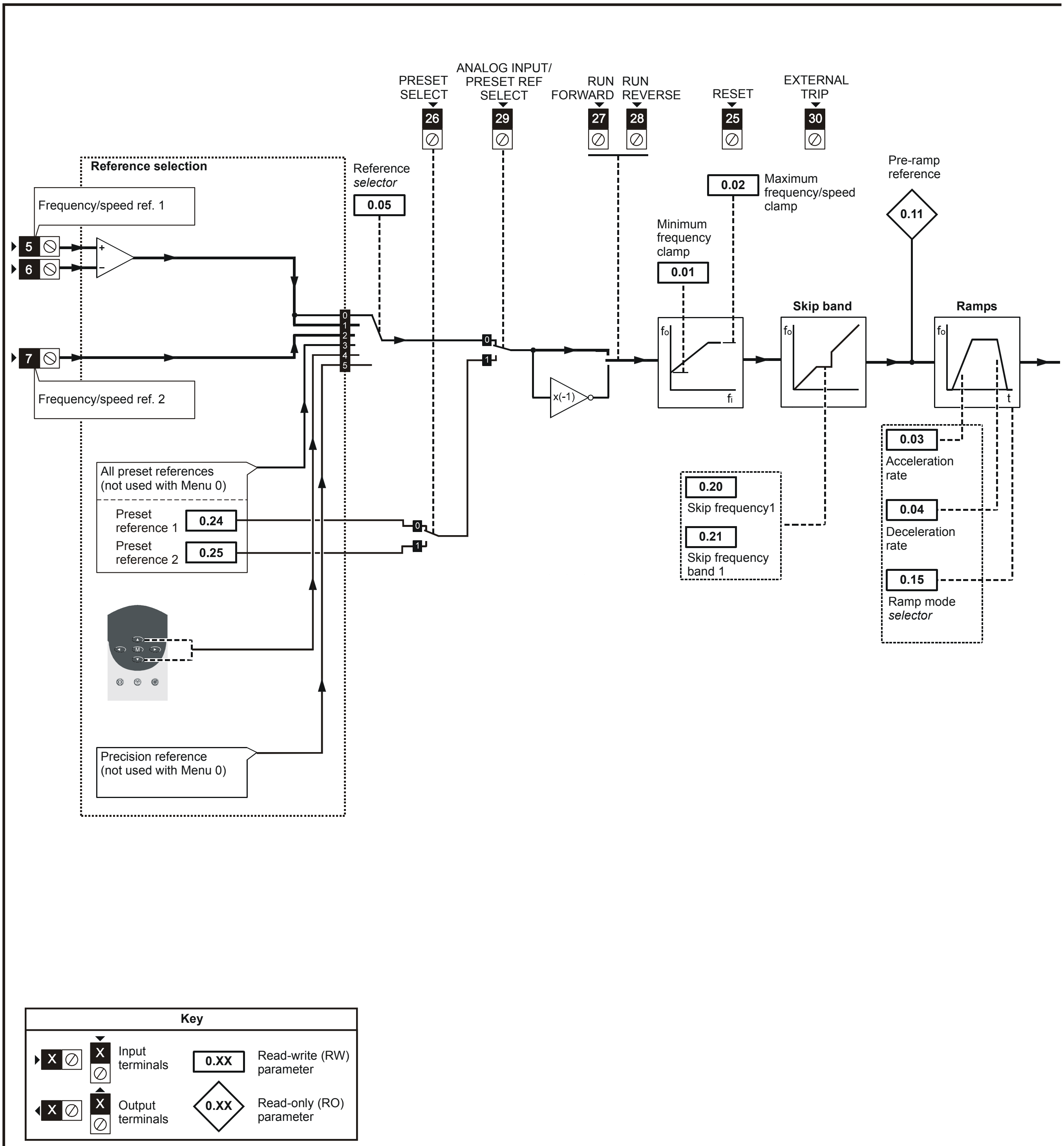
$\mathbf{I_{MAX}}$ **%** See section *Current limits* on page 75 for the definition of I_{MAX}%.

$$P_{MAX} = \sqrt{3} \times I_{MAX} \times \frac{Pr5.09}{1000}$$

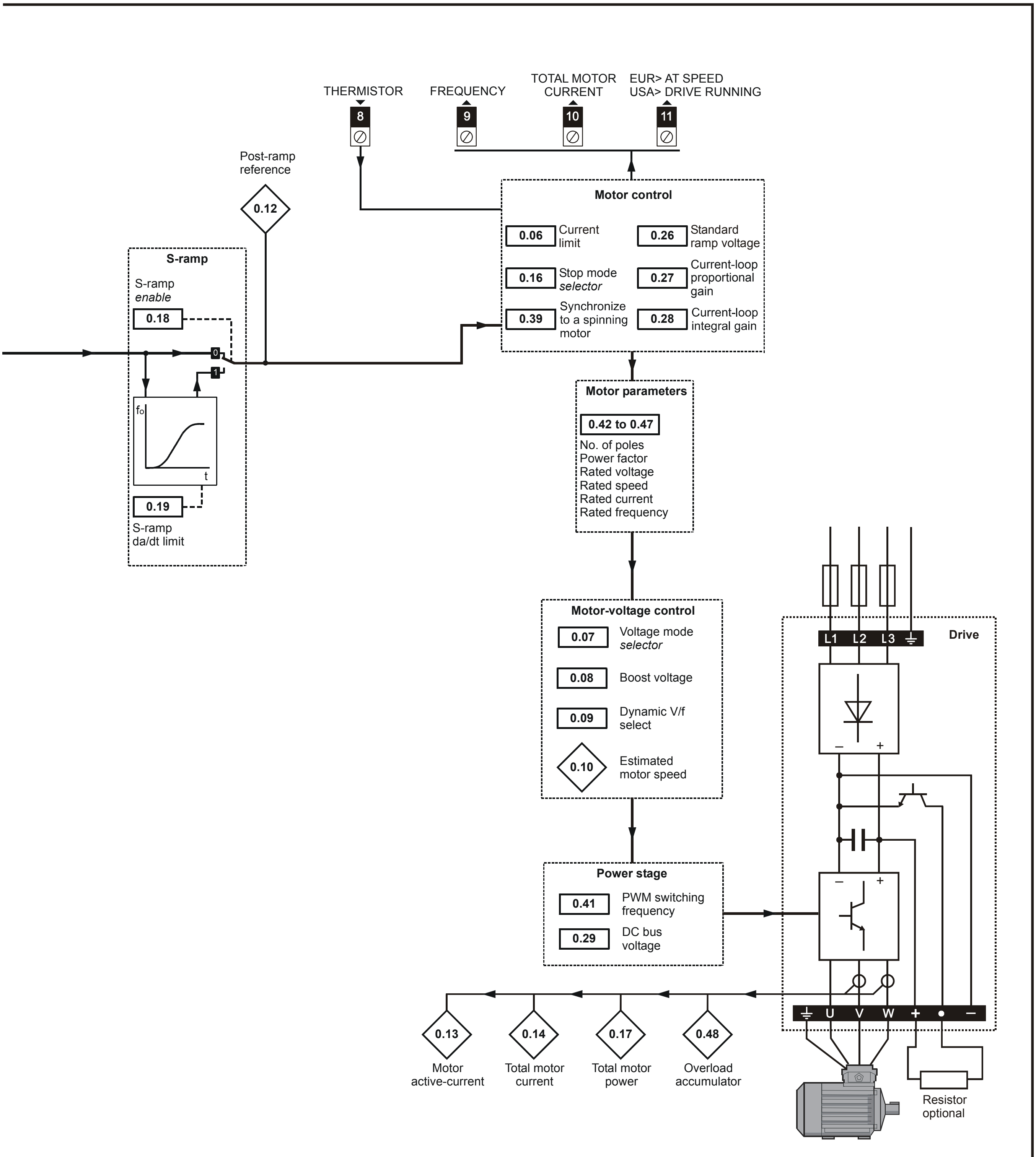
NOTE

Where a parameter is represented by a text value, the value in brackets in the range column is the setting used for serial communications.

Figure 3-2 Unidrive VTC menu 0 logic diagram



The parameters are all shown in their default settings


THERMISTOR
FREQUENCY
TOTAL MOTOR CURRENT
EUR> AT SPEED
USA> DRIVE RUNNING
8
9
10
11
Post-ramp reference
0.12
Motor control
0.06 Current limit
0.26 Standard ramp voltage
0.16 Stop mode selector
0.27 Current-loop proportional gain
0.39 Synchronize to a spinning motor
0.28 Current-loop integral gain
S-ramp
S-ramp enable
0.18
0
1
fo
t
0.19
S-ramp da/dt limit
Motor parameters
0.42 to 0.47
No. of poles
Power factor
Rated voltage
Rated speed
Rated current
Rated frequency
Motor-voltage control
0.07 Voltage mode selector
0.08 Boost voltage
0.09 Dynamic V/f select
0.10 Estimated motor speed
Drive
L1 L2 L3
Power stage
0.41 PWM switching frequency
0.29 DC bus voltage
U V W + • –
0.13 Motor active-current
0.14 Total motor current
0.17 Total motor power
0.48 Overload accumulator
Resistor optional

3.3 Menu 0 full descriptions

0.00	**Operating mode, Macro selection, Configuration, Saving**				
RW	Uni		R		
⇕	0 to 9,999	⇨	0		

Value	Function
1000	Save new parameter-values
1233	Restore parameters to their default values for 50Hz AC supply frequency (Europe)
1244	Restore parameters to their default values for 60Hz AC supply frequency (USA)
1253	Enable the operating mode of the drive to be changed and restore parameters to their default values for 50Hz AC supply frequency (Europe)
1254	Enable the operating mode of the drive to be changed and restore parameters to their default values for 60Hz AC supply frequency (USA)
2001	Macro 1 Easy mode
2002	Macro 2 Motorized potentiometer
2003	Macro 3 Preset speeds
2004	Macro 4 Torque control
2005	Macro 5 PID control
2006	Macro 6 Axis-limit control
2007	Macro 7 Brake control
2008	Macro 8 Digital lock / shaft orientation

Press after setting Pr **0.00** at the required value.

0.01 {1.07}		**OL> Minimum frequency** **CL> Minimum speed**		
RW		Uni		
OL	⇕	0 to [Pr **0.02**]Hz	⇨	0
CL	⇕	0 to [Pr **0.02**]rpm	⇨	0

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

Open-loop

Set **0.01** at the required minimum output frequency of the drive for both directions of rotation. The drive runs at the minimum frequency when the frequency reference is zero.

[Pr **0.01**] is a nominal value; slip compensation may cause the actual frequency to be higher.

Closed-loop

Set Pr **0.01** at the required minimum motor speed for both directions of rotation. The motor runs at the minimum speed when the speed reference is zero.

0.02 {1.06}		**OL> Maximum frequency** **CL> Maximum speed**		
RW		Uni		
OL	⇕	0 to 1,000Hz*	⇨	EUR> 50 USA> 60
CL	⇕	VT> 0 to 30,000rpm SV> 0 to 30,000rpm	⇨	EUR> 1,500 USA> 1,800 3,000

* This parameter has a maximum range of 250Hz in Unidrive VTC.

(The drive has additional over-speed protection.)

Open-loop

Set Pr **0.02** at the required maximum output frequency for both directions of rotation. The frequency reference cannot cause the drive to run at a frequency higher than [Pr **0.02**].

[Pr **0.02**] is a nominal value; slip compensation may cause the actual frequency to be higher.

Closed-loop

Set Pr **0.02** at the required maximum motor speed for both directions of rotation. The speed reference cannot cause the drive to run the motor at a speed higher than [Pr **0.02**].

CAUTION

For closed loop vector operation at motor frequencies greater than 400Hz (24,000rpm for 2-pole motors) may result in instability. For further advice, contact the supplier of the drive.

0.03 {2.11}		**Acceleration rate**		
RW		Uni		
OL	⇳	0.0 to 3,200.0s/100Hz	⇨	5*
CL	⇳	VT> 0 to 3,200.0 s/1,000rpm SV> 0 to 32.000 s/1,000rpm	⇨	2 0.2

*This parameter has a default setting of 60s in Unidrive VTC.

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

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

0.04 {2.21}		**Deceleration rate**		
RW		Uni		
OL	⇳	0.0 to 3,200.0s/100Hz	⇨	10*
CL	⇳	VT> 0 to 3,200.0 s/1,000rpm SV> 0 to 32.000 s/1,000rpm	⇨	2 0.2

*This parameter has a default setting of 60s in Unidrive VTC.

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

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

0.05 {1.14}		**Reference *selector***		
RW		Uni		
OL	⇳	0 to 5	⇨	EUR> 0* USA> 4*
CL	⇳	0 to 5	⇨	EUR> 0 USA> 0

*This parameter has a European and USA default setting of 0 in Unidrive VTC.

The default setting of Pr **0.05** depends on the default configuration of the drive and the operating mode, as follows:

EUR	All operating modes	0	Terminal mode
USA	Closed-loop modes	0	Terminal mode
USA	Open-loop mode	4	Keypad mode

The default settings apply also when a macro is enabled.

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

Setting	Control mode	Function
0	Terminal	Analog frequency / speed reference selected by ANALOG INPUT 1 / INPUT 2 contact
1	Terminal	Analog frequency / speed reference 1 selected
2	Terminal	Analog frequency / speed reference 2 selected
3	Terminal	Preset frequency / speed references selected (not used with Menu 0)
4	Keypad	Frequency / speed controlled by the keypad
5	Terminal	Precision reference selected (not used with Menu 0)

0.06 {4.07}		Current Limit		
RW		Uni		
OL	⇳	0 to I_{MAX} %	⇨	150*
VT	⇳		⇨	150
SV	⇳		⇨	175

*This parameter has a default setting of 120% in Unidrive VTC.

For the definition of I_{MAX}%, see section *Current limits* on page 75.

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

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

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

Where:

T_R Required maximum torque

T_{RATED} Motor rated torque

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

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

Where:

I_R Required maximum active current

I_{RATED} Motor rated active current

0.07 {5.14} 0.07 {3.10}		OL> Voltage mode *selector* CL> Speed controller proportional gain		
RW		Uni		OL> P
OL	⇳	Ur_S (0), Ur_I (1), Ur (2),, Fd (3)	⇨	Ur_I (1)*
CL	⇳	0 to 32,000 %	⇨	200

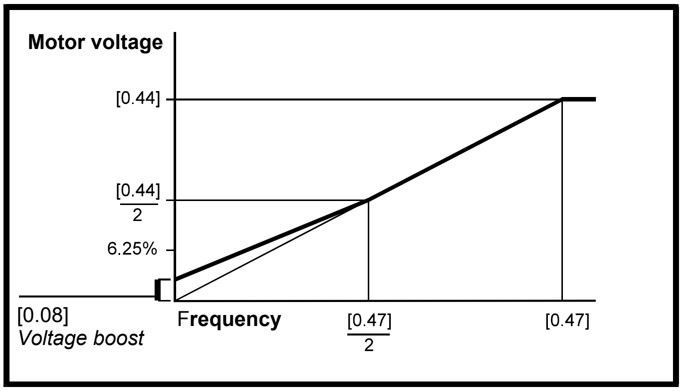
*This parameter has a default setting of Fd (3) in Unidrive VTC.

Open-loop

Setting		Function
		Vector modes
Ur_S	0	Motor stator resistance is measured each time the drive is started.
Ur_I	1	Motor stator resistance is measured at power-up if the **EXTERNAL TRIP** contact is closed and no other trip condition exists.
Ur	2	Motor stator resistance is not measured (use this mode only after having used **Ur_S** or **Ur_I** to measure the stator resistance).
		Fixed boost mode
Fd	3	Fixed voltage boost that can be manually adjusted by parameter **0.08** *Boost voltage*.

Use Pr **0.07** (Pr **5.14**) to select fixed voltage boost, or Vector control of voltage boost. Fixed boost requires a value to be set in Pr **0.08** *Boost voltage* by the user. See Figure 3-3. Fixed boost should be used when Pr **0.39** *Synchronize to a spinning motor* is set at 1.

Figure 3-3 Effect of fixed voltage boost on the voltage-to-frequency characteristic



Vector control causes the voltage boost to be automatically regulated according to the load on the motor.

Vector control requires the value of stator winding resistance to be stored in a parameter in the drive. The three Vector modes allow the resistance to be measured under different circumstances.

Closed-loop

Pr **0.07** (Pr **3.10**) is the proportional term applied to the speed error in the feed-forward path of the speed-control loop in the drive. For more information, see Pr **3.10**, Pr **3.11** and Pr **3.12** on page 68.

0.08 {5.15} **0.08 {3.11}**	**OL> Voltage boost** **CL> Speed controller integral gain**			
RW	Uni			
OL	⇳	0 to 25.0 % of motor rated voltage*	⇨	3.0
CL	⇳	0 to 32,000	⇨	100

*This parameter has a maximum range of 15% in Unidrive VTC.

Open-loop

When Pr **0.07** *Voltage mode selector* is set at **Fd**, set Pr **0.08** (Pr **5.15**) at the required value for the motor to run reliably at low speeds.

See Figure 3-3.

Excessive values of Pr **0.08** can cause the motor to be overheated.

Closed-loop

Pr **0.08** (Pr **3.11**) is the integral term applied to the speed error in the feed-forward path of the speed-control loop in the drive. For more information, see Pr **3.10**, Pr **3.11** and Pr **3.12** on page 68.

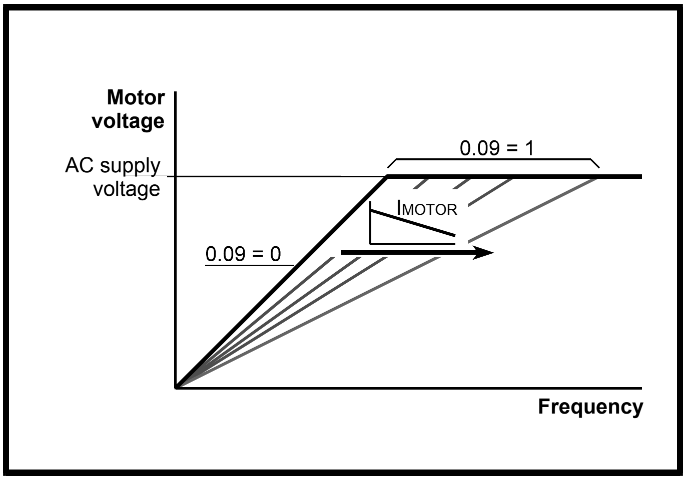
0.09 {5.13}	**Dynamic V/f select**			
RW	Bit			
OL	⇳	0 or 1	⇨	0

Open-loop

Set Pr **0.09** (Pr **5.13**) at 0 when the V/f characteristic applied to the motor is to be fixed. It is then based on the rated voltage and frequency of the motor.

Set Pr **0.09** at 1 when reduced power dissipation is required in the motor when it is lightly loaded. The V/f characteristic is then variable resulting in the motor voltage being proportionally reduced for lower motor currents. Figure 3-4 shows the change in V/f slope when the motor current is reduced.

Figure 3-4 Fixed and variable V/f characteristics



0.09 {3.12}	Speed control D gain				
RW	Uni				
CL	⇕	0 to 32,000	⇨	0	

Closed-loop

Pr **0.09** (Pr **3.12**) is the derivative term applied to the speed error in the feed-forward path of the speed-control loop in the drive. For more information, see Pr **3.10**, Pr **3.11** and Pr **3.12** on page 68.

0.10 {5.04} 0.10 {3.02}	OL> Estimated motor speed CL> Motor speed			
RO	Bi			
OL	⇕	±60,00rpm	⇨	
CL	⇕	±30,000rpm	⇨	

Open-loop

Pr **0.10** (Pr **5.04**) indicates the value of motor speed that is estimated from the following:

Pr **0.12** *Post-ramp frequency reference*
Pr **0.42** *Motor - no. of poles*

The value of Pr **0.10** is applied to the analog output on terminal 9 to indicate estimated speed.

Closed-loop

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

The value of Pr **0.10** is applied to the analog output on terminal 9 to indicate speed.

0.11 {1.03}	Pre-ramp reference			
RO	Bi			
OL	⇕	±1,000Hz	⇨	
CL	⇕	±30,000rpm	⇨	

0.12 {2.01}	Post-ramp reference			
RO	Bi			
OL	⇕	±1,000Hz	⇨	
CL	⇕	±30,000rpm	⇨	

When the frequency/speed is constant, [Pr **0.12**] = [Pr **0.11**]. During acceleration and deceleration, the two values may differ.

OL> [Pr **0.12**] differs from [Pr **0.11**] also under either of the following conditions:

- When the drive is in current limit
- During braking in a standard ramp mode (Pr **0.15** Ramp mode selector set at **Stnd.Hd** or **Std.Ct**).

0.13 {4.02}	Motor active-current			
RO	Bi			
⇳	$\pm I_{max}$ A	⇨		

When the motor is being driven below its rated speed, the torque is proportional to [Pr **0.13**].

	0.14 {1.05}	Jog reference		
	RW	Uni		
OL	⇳	0 to 400.0Hz	⇨	1.5
CL	⇳	0 to 4,000.0rpm	⇨	50

Enter the required value of jog frequency/speed.

The frequency/speed limits affect the drive when jogging as follows:

Frequency-limit parameter	Limit applies
0.01 *Minimum frequency/speed*	No
0.02 *Maximum frequency/speed*	Yes

0.15 {2.04}	Ramp mode *selector*			
RW	Txt			
⇳	(See below)	⇨	Stnd.Ct (2)	

Select the required ramp mode as follows:

Stnd.Hd	**(0)**	Standard ramp with ramp hold
FASt	**(1)**	Fast ramp
Stnd.Ct	**(2)**	Standard ramp with proportional control (refer to the *Unidrive Advanced User Guide*)

For more information, see Pr **2.04** on page 56.

	0.16 {6.01}	Stop mode *selector*			
	RW	Txt			
OL	⇳	0 to 4 (see below)	⇨		rP (1)
CL	⇳	0 to 3 (see below)	⇨	**VT**	rP (1)
				SV	no.rP (1)

Select the required stop mode as follows:

Open loop		
COASt	(0)	The motor is allowed to coast
rP	(1)	Ramp to a stop
rP-dcI	(2)	Ramp followed by 1 second DC injection
dcI	(3)	AC injection braking followed by 1 second DC injection braking
td-dcI	(4)	DC injection braking for an adjustable time (see the *Unidrive Advanced User Guide*).
Closed loop		
COASt	(0)	The motor is allowed to coast
rP	(1)	Ramp to a stop
no.rP	(2)	Stop under current limiting (no ramp)
rP-POS	(3)	Ramp, orientate and stop

For more information, see Pr **6.01** on page 104.

0.17 {4.11}	**Torque mode *select***				
RW	Uni				
OL	⇳	0 to 1	⇨	0	
CL	⇳	0 to 4	⇨	0	

Set Pr **0.17** as follows:

Setting	Open-loop	Closed-loop
0	Frequency control	Speed control
1	Torque control	Torque control
2		Torque control with speed over-ride
3		Coiler/uncoiler mode
4		Speed control with torque feed-forward

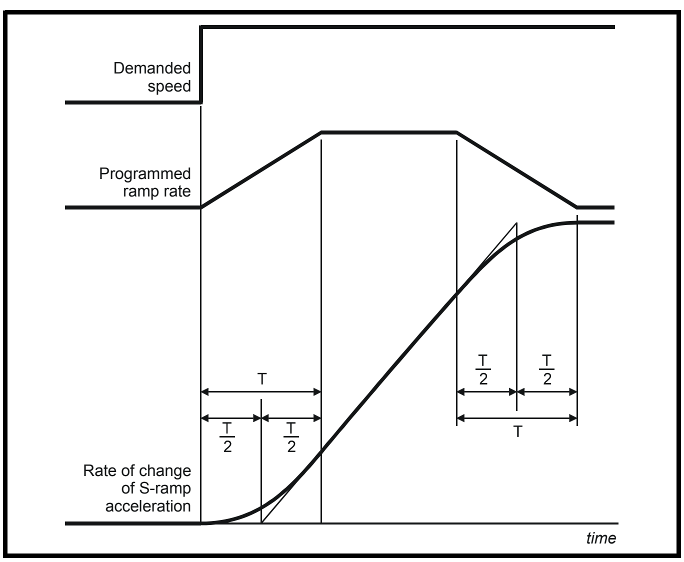
For more information, see Pr **4.11** on page 82.

0.18 {2.06}	**S-Ramp *enable***			
RW	Bit			
⇳	0 or 1	⇨	0	

Setting this parameter enables the S ramp function. S ramp is disabled during deceleration using Standard ramp with P control (Pr **2.04** = 2). When the motor is accelerated again after decelerating in standard ramp with P control the acceleration ramp used by the S ramp function is reset to zero.

0.19 {2.07}	**S-ramp da/dt limit**				
RW	**Uni**				
OL	⇳	0.0 to 3,000.0s^2/100Hz	⇨		3.1
CL	⇳	0.000 to 30,000 s^2/1,000rpm	⇨	**VT**	1.5
				SV	0.03

This parameter defines the maximum rate of change of acceleration/deceleration that the drive will operate with. The default values have been chosen such that for the default ramps and maximum speed, the curved parts of the S will be 25% of the original ramp if S ramp is enabled.



Since the ramp rate is defined in s/100Hz or s/1000rpm and the S ramp parameter is defined in s2 /100Hz or s2 /1,000rpm, the time T for the 'curved' part of the S can be determined from:

$$T = \frac{\text{S ramp rate of change}}{\text{Ramp rate}}$$

Enabling S ramp increases the total ramp time by the period T since an additional T/2 is added to each end of the ramp in producing the S.

0.20 {1.29} 0.22 {1.31}		Skip frequency/speed 1 Skip frequency/speed 2		
RW		Uni		
OL	⇳	0.0 to 1,000.0Hz	⇨	0.0
CL	⇳	0 to 30,000rpm	⇨	0

See Pr **0.21** and Pr **0.23** *Skip bands*.

0.21 {1.30} 0.23 {1.32}		Skip band 1 Skip band 2		
RW		Uni		
OL	⇳	0 to 5.0Hz	⇨	0.5
CL	⇳	0 to 50rpm	⇨	5

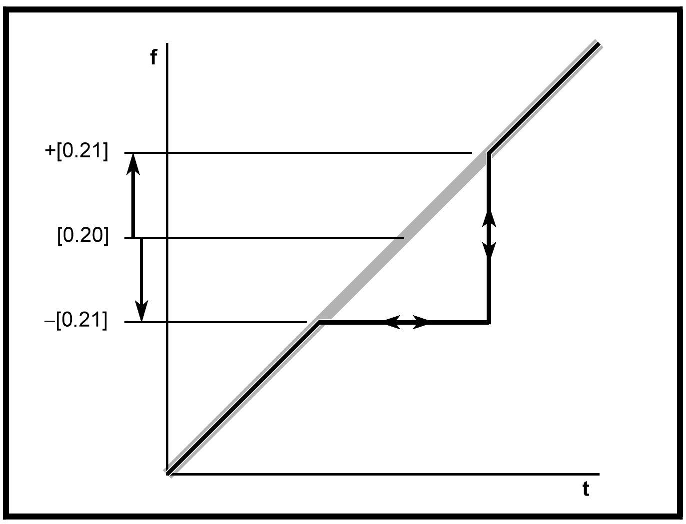
Use skip frequencies/speeds and skip bands to prevent the motor from running at speeds that cause mechanical resonances in the machine. During acceleration and deceleration, the drive passes through the skip bands, but it does not stabilize in a skip band.

Up to two skip frequencies/speeds can be programmed.

Enter the centre frequency/speed of the band in Pr **0.20** (or Pr **0.22**) *Skip frequency/speed*, then enter the width of each sideband in Pr **0.21** (or Pr **0.23**) *Skip band*.

When the value of a skip frequency is zero, the related skip band is disabled.

Figure 3-5 Action of skip frequency/speed 1 and skip band 1



When the frequency/speed (input) reference ascends into a skip band, the resulting (output) reference remains at the lower edge of the band until the input reference has reached the upper edge of the band. The output reference then jumps to the value of the input reference.

When the frequency/speed (input) reference descends into a skip band, the resulting (output) reference jumps immediately to the lower edge of the band.

Example

Skip speed 1 = 250rpm
Enter 250 in Pr **0.20**
Required skip band = 60rpm
Enter 30 in Pr **0.21**

(Skip band = 2 x Value of skip-band parameter.)

0.24 {7.06} **0.25 {7.11}**	**Analog input 1 mode *selector*** **Analog input 2 mode *selector***			
RW	Txt		R	
⇳	0 to 8	⇨	VOLt (0)	

Set the required mode as follows:

Setting		Input signal	When current signal ≤3mA...
VOLt	(0)	±10V	
0-20	(1)	0 to 20mA	Signal treated as zero
20-0	(2)	20mA to 0	Signal treated as zero
4-20.tr	(3)	4mA to 20mA	Drive trips
20-4.tr	(4)	20mA to 4mA	Drive trips
4-20.Lo	(5)	4mA to 20mA	Drive runs at minimum or low speed
20-4.Lo	(6)	20mA to 4mA	Drive runs at minimum or low speed
4-20.Pr	(7)	4mA to 20mA	Drive runs at previous speed
20-4.Pr	(8)	20mA to 4mA	Drive runs at previous speed

0.26 {7.14}	**Analog input 2 destination parameter**			
RW	Txt		R	P
⇳	Pr **0.00** to Pr **21.50** (Menu param.)	⇨	Pr **1.37**	

A signal applied to an input terminal is converted into a value which is applied to a parameter. The function of this parameter determines the function of the terminal.

By default, terminal 7 (Analog input 2) is assigned to Pr **1.37** *Analog reference 2*. Use Pr **0.26** to change the function of terminal 7.

0.27 {8.27}	**EUR> Positive logic *select***			
RW	Bit		R	P
⇳	0 or 1	⇨	0	

European configuration

Use Pr **0.27** (Pr **8.27**) to select the logic polarity of the digital inputs, as follows:

0	Negative logic
1	Positive logic

0.27 {6.04}	**USA> Sequencing mode *selector***			
RW	Uni			P
⇳	0 to 4	⇨	4	

Refer to Pr **6.04** on page 105.

0.28 {4.13}		**EUR> Current-loop proportional gain**			
RW		Uni			
OL	⇳	0 to 30000	⇨	20	
CL	⇳	VT> 0 to 30,000 SV> 0 to 30,000	⇨	150 130	

0.29 {4.14}	EUR> Current-loop integral gain			
RW	Uni			
OL ⇳	0 to 30,000	⇨	40	
CL ⇳	VT> 0 to 30,000 SV> 0 to 30,000	⇨	2000 1200	

European configuration

The values of Pr **0.28** and Pr **0.29** affect the dynamic performance of the drive in the following conditions:

- Current-limit in frequency/speed control
- Torque control
- Braking when Pr **0.15** *Ramp mode selector* is set at **Stnd.Ct** (default)
- Synchronizing the drive to a spinning motor (Pr **0.39** set at 1)
- Loss of AC supply when Pr **6.03** *AC supply loss mode selector* is set at **ridE.th**.

For information on adjusting these parameters, refer to Pr **4.13** and Pr **4.14** on page 84.

0.28 {1.01}	USA> Frequency/speed demand			
RO	Bi			
OL ⇳	±1,000Hz	⇨		
CL ⇳	±30,000rpm	⇨		

USA configuration

Pr **0.28** differs from Pr **0.11** *Pre-ramp reference* in that it indicates the demanded reference before frequency/speed limiting and skip bands.

0.29 {8.23}	USA> Terminal-29 destination parameter			
RW	Uni		R	P
⇳	Pr **0.00** to Pr **20.50** (Menu param.)	⇨	Pr **1.41**	

USA configuration

Use Pr **0.29** to change the function of the digital input on terminal 29.

The default setting (Pr **1.41**) gives **LOCAL/REMOTE** switching.

0.30 {6.13}	Forward / reverse key *enable*			
RW	Bit			
⇳	0 or 1	⇨	0	

The drive is supplied with the ⊙ button disabled. To enable this button, set Pr **0.30** *FWD/REV enable* at 1.

0.31 {11.37}	Macro number			
RO	Uni			
⇳	0 to 9	⇨		

Pr **0.31** indicates the number of the macro that is currently in operation.

0.32 {11.24}	Serial comms. mode			
RW	Uni		R	P
⇳	ANSI 2 (0), ANSI 4 (1), OUtPUt (2), INPUt (3)	⇨	ANSI 4 (1)	

Use Pr **0.32** to select the required serial communications mode as follows:

ANSI 2 (0)	ANSI protocol, two-wire
ANSI 4 (1)	ANSI protocol, four-wire
Use the following modes to transfer the value of a parameter in one drive to a parameter in another drive:	
OUtPUt (2)	Transmit the value of the parameter specified by the setting of Pr **11.27** *Serial comms. source / destination parameter* (CT protocol)
INPUt (3)	Apply the received value to the parameter specified by the setting of Pr **11.27** *Serial comms. source / destination parameter* (CT protocol)

0.33 {11.32}	**Drive rated current (FLC)**			
RO	Uni			P
⇳	2.10 to 1,920 A	⇨		

0.34 {11.30}	**User security code**			
RW	Uni	S		P
⇳	0 to 255	⇨	149	

Use Pr **0.34** to set up a User Security code. Irrespective of the code number entered in Pr **0.34**, it always indicates the default value **149**. When Pr **0.34** is actually set at **149**, no User Security is applied.

See *section 1.5 Parameter security* on page 7.

0.35 {1.17}	**Keypad control mode reference**				
RO	Bi	S		P	
OL	⇳	±[Pr **0.02**]Hz	⇨		
CL	⇳	±[Pr **0.02**]rpm	⇨		

0.35 indicates the value of the frequency/speed reference when the drive is operating in Keypad mode. The reference is then controlled by the following control buttons (when the display is in Status mode):

The value is automatically saved when the drive is powered-down. At the next power-up, the drive ramps up to the frequency/speed that applied before the power-down.

0.36 {11.25}	**Serial comms. baud rate**			
RW	Txt			P
⇳	4,800 (0), 9,600 (1), 19,200 (2), 2,400 (3)	⇨	4800 (0)*	

*This parameter has a default setting of 9,600 (1) in the VTC variant when USA defaults are loaded.

Use Pr **0.36** to select the required baud rate for serial communications when a UD71 *Basic serial communications* large option module is fitted in the drive.

0.37 {11.23}	**Serial comms. address**			
RW	Uni			P
⇳	0.0 to 9.9 (Group.Unit)	⇨	1.1	

Use Pr **0.37** to select the required address for serial communications when a UD71 *Serial communications* large option module is fitted in the drive.

Do not enter an address that contains a zero, since this is used when addressing a group of drives.

0.38 {11.22}	**Initial parameter displayed**			
RW	Uni			P
⇳	Pr **0.00** to Pr **0.50**	⇨	Pr **0.10***	

*This parameter has a default setting of Pr **0.11** in the VTC variant when USA defaults are loaded.

At the time the AC supply is connected to the drive, Pr **0.10** *Motor frequency/speed* is automatically pre-selected as the initial parameter to be displayed. This results in the following:

1. After the AC supply is connected to the drive, and before any other parameter is selected, the value of Pr **0.10** is shown on the upper display. This allows the motor frequency/speed to be monitored without the need to select the parameter.
2. If the keypad is subsequently used to select another parameter, the value of the newly selected parameter is displayed in place of the initial parameter.

To select a different Menu 0 parameter to be displayed initially, enter the required parameter number in Pr **0.38** (e.g. to display Pr **0.12** *Post-ramp frequency/speed reference*, enter **0.12**).

0.39 {6.09}		Synchronise to a spinning motor			
RW		Bit			
OL	⇕	0 or 1	⇨	0	
CL	⇕	0 or 1	⇨	1	

Open-loop

Set Pr **0.39** at 1 for the drive to always automatically synchronise itself to the motor if the motor is already rotating when the drive is started.

If the drive is started when the motor is already spinning and Pr **0.39** is set at 0, the drive cannot detect the speed of the motor; the normal operation of the drive will cause the motor to be braked to a stand-still in the same way as DC injection braking. The drive will then accelerate the motor to the value of the frequency reference.

NOTE

The drive can be synchronised to a single motor only. If more than one motor is connected to the drive, this function should not be used.

NOTE

For the drive to operate correctly during and after synchronisation, Pr **0.07** Voltage mode selector must be set at Fd.

The drive starts a sequence of operations at one quarter of the rated motor voltage in order to detect the frequency associated with the speed of the motor. The sequence is stopped when the motor frequency is detected. The stages in the sequence are as follows:

1. The frequency of the drive is set at maximum (the value of Pr **0.02**) in the direction that the motor was last driven. (If the AC supply to the drive was interrupted before an attempt is made to synchronise to a spinning motor, the drive always starts in the forward direction.)
2. The frequency is reduced to zero. If the motor frequency is detected during the reduction in drive frequency, the test is stopped. The drive frequency is set at the detected motor frequency and the drive takes control of the motor.
3. If the motor frequency is not detected, the drive is set at maximum frequency in the opposite direction, and the test is repeated.
4. If the motor frequency is still not detected, the drive frequency is set at 0Hz, and the drive takes control of the motor.

Closed-loop

Pr **0.39** is set at 1 by default. The value of Pr **0.12** *Post-ramp reference* is automatically set at the value of speed feedback. The drive then takes control of the motor.

When Pr **0.39** is set at 0, the motor will be decelerated under current limit until the motor speed meets the value of Pr **0.12** *Post-ramp reference.*

0.40 {5.12}	Autotune			
RW	Bit			P
⇕	0 or 1	⇨	0	

Set Pr **0.40** at 1 to start the Autotune sequence.

Pr **0.40** is related to the advanced parameters as follows:

OL + VT> Pr **5.12** on page 94 (*Magnetising current test enable*)
SV> Pr **3.25** on page 72 (*Encoder phasing test enable*)

0.41 {5.18}	PWM switching frequency			
RW	Txt			
⇕	3 (0), 4.5 (1), 6 (2), 9 (3), 12 (4) kHz	⇨	3 (0)	

If the switching frequency is increased from the default value, the power loss inside the drive is increased. The drive ensures the losses remain within acceptable levels by the use of an intelligent thermal model.

Intelligent thermal modelling in the drive effectively monitors the junction temperature of the IGBTs in the power stage. When the junction temperature is calculated to reach the maximum permissible value, two levels of protection occur, as follows:

1. When a PWM switching frequency of 6kHz, 9kHz or 12kHz is selected, the PWM switching frequency is automatically halved. This reduces switching losses in the IGBTs. (The value of parameter Pr **0.41** *PWM switching frequency* remains at the value set by the user.) Then at one-second intervals, the drive will attempt to return the PWM switching frequency to the original value. This will be successful when the thermal modelling has calculated that the temperature has reduced sufficiently.
2. If the junction temperature continues to rise (due to the output current) after the PWM switching frequency has been halved, and the temperature reaches the maximum permissible value, the drive will trip. The display will indicate trip code **Oh1**.

If the drive is required to run at a high load continuously with an elevated switching frequency, derating must be applied. Please see Chapter 11 *Technical Data* in the *Unidrive User Guide*.

NOTE

The Unidrive LFT default switching frequency is 9kHz, however, a limited duty cycle applies. See Figure 2-3 *Standard S4/S5 duty cycle (Unidrive LFT)* in the *Unidrive User Guide*.

0.42 {5.11}	Motor - number of poles			
RW	Txt			P
OL ⇳	2 to 32 poles	⇨	4 (1)	
CL ⇳	VT> 2 to 32 poles SV> 2 to 32 poles	⇨	4 (1) 6 (2)	

Enter the number of motor poles (not pole pairs).

0.43 {5.10}	Motor - power factor			
RW	Uni	S		P
OL ⇳	0 to 1.000	⇨	0.92	
CL ⇳	VT> 0 to 1.000 SV> 1	⇨	0.92 1.0	

Open-loop

Closed-loop Vector

When Autotune is used, the power factor of the motor is measured by the drive and stored in Pr **0.43**. The value can be seen when Pr **0.43** is accessed. The value may be slightly higher than the value stated on the motor rating plate.

If Autotune is not used, enter the value in Pr **0.43**.

0.44 {5.09}	Motor - rated voltage			
RW	Uni			
OL ⇳	0 to 480	⇨	400	
CL ⇳	VT> 0 to 480 SV> 0	⇨	460 0	

Open-loop and Closed-loop Vector

Enter the value from the rating plate of the motor.

0.45 {5.08}	Motor - rated speed			
RW	Uni			
OL ⇳	0 to 6,000rpm	⇨	0	
CL ⇳	VT> 0 to 30,000rpm SV> 0 to 30,000rpm	⇨	EUR> 1,450, USA> 1,770 0	

Open-loop

This parameter should be set to the synchronous speed minus the slip speed if slip compensation is required.

Closed-loop Vector

This parameter should be set to the synchronous speed minus the slip speed.

Closed-loop Servo

Leave Pr **0.45** set at 0. This parameter is not used in this operating mode.

0.46 {5.07}	Motor - rated current			
RW	Uni			
⇳	0 to FLC A	⇨	FLC	

FLC is the maximum permissible continuous output current of the drive up to 40°C ambient temperature and 3kHz PWM switching frequency.

Enter the value from the rating plate of the motor.

0.47 {5.06}	Motor - rated frequency			
RW	Bit			
OL ⇳	0 to 1,000.0Hz*	⇨	EUR> 50, USA> 60	
CL ⇳	VT> 0 to 1,000.0Hz SV> 0Hz	⇨	EUR> 50, USA> 60 0	

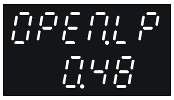
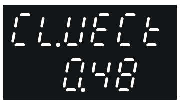
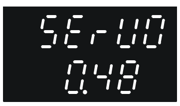
*This parameter has a maximum range of 250Hz in Unidrive VTC.

Open-loop and Closed-loop Vector

Enter the value from the rating plate of the motor.

0.48 {11.31}	**Drive operating mode *selector***			
RW	Txt		R	P
⇕ (See below)		⇨ OPEN.LP (0)		

The settings for Pr **0.48** are as follows:

Pr 0.48 setting		**Operating mode**
	0	Open-loop
	1	Closed-loop Vector
	2	Closed-loop Servo
	3	For operation in this mode, refer to the *Unidrive Regen Installation Guide*

The operating mode cannot be changed while the drive is running.

0.49	**Security status**			
RO	Uni			P
⇕ 0 to 1,000		⇨ 1		

This parameter indicates the current status of the drive parameter security system. Each digit indicates a particular aspect of security as follows:

Units digit: 0 = Standard security has been unlocked
1 = Standard security is still set

Tens digit: 0 = User security has been unlocked or is not active
1 = User security is active preventing RW access

Hundreds digit: 1 = Pr **11.30** not equal to 149*

Thousands digit: 1 = Pr **11.30** equal to zero*

* The value of Pr **11.30** is the last value written by the user. Pr **11.30** always appears as 149 when first accessed by the key pad to hide the real value last written by the user. If Pr **11.30** = 149 then user security is cleared. If Pr **11.30** = 0 then user security and security preventing access outside menu 0 is cleared.

NOTE

In contrast to all the other parameters in menu 0, this parameter does not exist in any other menu.

0.50 {11.29}	**Software version number**			
RO	Uni			P
⇕ 1.00 to 99.99		⇨		

Displays the first two sections of the software version of the drive.

3.3.1 Unidrive VTC Menu 0 differences

Menu 0 in Unidrive VTC contains some different parameters to menu 0 in Unidrive. The following menu 0 parameters are found in Unidrive VTC. Any parameter not listed below is the same as open loop Unidrive.

0.14 {4.01}	Total motor current			
RO	Uni			P
⇕	0 to I_{MAX} A	⇨		

Pr **0.14** indicates the total motor current (the vector sum of Pr **0.13** *Motor active-current* and Pr **4.17** *Motor magnetising current*).

0.17 {5.03}	Total motor power			
RO	Bi			P
⇕	$\pm P_{MAX}$	⇨		

Total output power of the drive (positive for power flow out of the drive output terminals).

0.22	Drive rated current			
RO	Uni			P
⇕	2.10 to 202 A	⇨		

0.23	Analog input 1 mode selector			
RW	Txt		R	
⇕	VOLt (0), 0 - 20 (1), 20 - 0 (2), 4 - 20.tr (3), 20 - 4.tr (4), 4 - 20.Lo (5), 20 - 4.Lo (6), 4 - 20.Pr (7), 20 - 4.Pr (8)	⇨	VOLt (0)	

Setting		Input signal	When current signal ≤30mA
VOLt	(0)	±10V	
0-20	(1)	0 to 20mA	Signal treated as zero
20-0	(2)	20mA to 0	Signal treated as zero
4-20.tr	(3)	4mA to 20mA	Drive trips
20-4.tr	(4)	20mA to 4mA	Drive trips
4-20.Lo	(5)	4mA to 20mA	Drive runs at minimum or low speed
20-4.Lo	(6)	20mA to 4mA	Drive runs at minimum or low speed
4-20.Pr	(7)	4mA to 20mA	Drive runs at previous speed
20-4.Pr	(8)	20mA to 4mA	Drive runs at previous speed

0.24 {1.21}	Preset frequency 1			
0.25 {1.22}	Preset frequency 2			
RW	Bi			
⇕	±1000.0 Hz	⇨	0.0	

Enter the value of frequency as required. When Pr **1.10** *Bipolar reference select* is set at 0, negative values are treated as zero. When Pr **1.10** is set at 1, negative values will cause the drive to run in the reverse direction.

0.26 {2.08}	Standard ramp voltage				
RW	Uni				
⇳	200V drive: 0 to 400 V 400V drive: 0 to 800 V	⇨	200V drive: 375 400V drive: EUR> 750, USA> 775		

This voltage is used as the level for both standard ramp modes. If hold mode is used and this is set too low the drive will never stop, and if it is too high and no braking resistor is used the drive may trip on OV (DC bus over voltage). If Standard ramp with P control (Pr **2.04** = Stnd.Ct (2)) is used and Pr **2.08** is set too low the machine will coast to rest, and if it is set too high and no braking resistor is used it may trip on OV. The minimum level should be greater than the voltage produced on the DC bus by the highest supply voltage.

Normally the DC bus voltage will be approximately the rms supply voltage x √2.

WARNING

Care should be taken in the setting of Pr **2.08**. It is recommended that the setting should be at least 50V higher than the maximum expected level of the DC bus voltage. If this is not done, the motor may fail to decelerate on a STOP command.

0.27 {4.13}	Current-loop proportional gain				
RW	Uni				
⇳	0 to 30,000	⇨	20		

0.28 {4.14}	Current-loop integral gain				
RW	Uni				
⇳	0 to 30,000	⇨	40		

The values of Pr **0.27** and Pr **0.28** affect the dynamic performance of the drive in the following conditions:

- Operation in current limit
- Braking when Pr **0.15** *Ramp mode selector* is set at Stnd.Ct (default)
- Loss of AC supply when Pr **6.03** *AC supply loss mode selector* is set at ridE.th.

0.29 {5.05}	DC bus voltage				
RW	Uni				P
⇳	200V drive: 0 to 415 V 400V drive: 0 to 830 V	⇨			

0.30 {10.20}	Last trip				
RW	Txt	S			P
⇳	0 to 200 V	⇨			

See Pr **10.20** on page 137 for details of the trip codes.

If the drive trips, the trip code representing the cause of the trip is logged in Pr **0.30**. Pr **0.30** continues to display this trip until the drive trips with a different trip code.

0.32 {10.34}	Number of auto-reset attempts				
RW	Uni				
⇳	0 to 5	⇨	0		

If this parameter is set to zero then no auto-reset attempts are made. Any other value will cause the drive to automatically reset following a trip for the number of times programmed. Pr **10.35** defines the time between the trip and the auto reset. The reset count is only incremented when the trip is the same as the previous trip, otherwise it is reset to 0. When the reset count reaches the programmed value, any further trip of the same value will not cause an auto-reset.

If there has been no trip for 5 minutes then the reset count is cleared. Auto reset will not occur on an External trip (Et).

0.33 {10.35}	Auto-reset time delay				
RW	Uni				
⇳	0.0 to 25.0 s	⇨	1.0		

This parameter defines the time between a trip and an auto reset subject to the 10s minimum trip time for IGBT over-current trips (OI.AC and OI.br trips).

0.35 {11.24}	**Serial comms. mode**			
RW	Txt		R	P
⇳	ANSI 2 (0), ANSI 4 (1), OUtPUt (2), INPUt (3)	⇨	ANSI 4 (1)	

Use Pr **0.32** to select the required serial communications mode as follows:

ANSI 2 (0)	ANSI protocol, two-wire
ANSI 4 (1)	ANSI protocol, four-wire
Use the following modes to transfer the value of a parameter in one drive to a parameter in another drive:	
OUtPUt (2)	Transmit the value of the parameter specified by the setting of Pr **11.27** *Serial comms. source / destination parameter* (CT protocol)
INPUt (3)	Apply the received value to the parameter specified by the setting of Pr **11.27** *Serial comms. source / destination parameter* (CT protocol)

0.48 {4.19}	**Overload accumulator**			
RO	Uni			P
⇳	0 to 100 %	⇨		

When the total current level is above 105% motor rated current (Pr **5.07** x 1.05) the overload accumulator increases, until it reaches 100% when the drive will give an Ixt trip or apply a restriction on the current limit. The level of the accumulator is given by:

Accumulator = $(I^2 / (\text{Pr } \mathbf{5.07} \times 1.05)^2) \times (1 - e^{-t/\tau}) \times 100\%$

NOTE

If the motor rated current parameter (Pr **5.07**) is modified the overload accumulator is reset to zero. This allows the drive to be used with more than one motor of different ratings without producing overload trips when the drive has been running with a large motor and then a smaller motor is connected.

4 Advanced Parameters

Menu number	Description
0	Commonly used basic set up parameters for quick / easy programming
1	Speed references and limits
2	Ramps (accel / decel)
3	Speed feedback / frequency slaving
4	Current control
5	Machine control
6	Sequencing logic
7	Analog I/O
8	Digital I/O
9	Programmable logic
10	Status flags / trip log
11	Menu 0 customisation / drive specific ratings
12	Programmable thresholds
13	Digital lock / orientation
14	Programmable PID function
15	Regen
16	Small option module set up
17	Large option module set up
18	Application menu 1
19	Application menu 2
20	Large option module set up

Operation mode abbreviations:

OL> Open loop
CL> Closed loop (which incorporates closed loop vector and servo mode)
VT> Closed loop vector mode
SV> Servo

4.1 Menu 1: Speed references and limits

Menu 1 controls the main reference selection. When the Unidrive operates in open-loop mode a frequency reference is produced, and when Unidrive operates in closed-loop vector or servo modes a speed reference is produced.

Reference Update Rate

Sample rates vary with switching frequency. In the following the sample rate is given for 3, 6 and 12kHz switching followed by an alternative value in square brackets for 4.5 and 9kHz switching. Speed and frequency references are generally updated from analog inputs and parameter values every 5.5ms [7.4ms], however, a better update rate can be obtained as follows.

Analog input references (not including small option module inputs)

For a faster update rate these must be connected via Pr **1.36** or Pr **1.37**. The frequency reference is sampled every 1.4ms [1.9ms]. To obtain 12 bit resolution from analog input 1, which is based on a V to F converter, a sliding window technique is used over three samples. Therefore a full change of reference takes 4.2ms [5.6ms]. Analog inputs 2 and 3 are based on A to D converters, and so the reference is updated every 1.4ms [1.9ms]. The speed reference is sampled every 345µs [460µs]. A sliding window may be applied to analog input 1 if required (time defined by Pr **7.26**).

Analog Input References - small option module

The analog inputs on the small option module are only sampled every 5.5ms [7.4ms], even when thay are used as a speed or frequency reference.

UD70 large option module

For faster update rate large option module Pr **91.02** must be used (this parameter is only visible from the UD70). Any value written to Pr **91.02** is automatically mapped into preset speed Pr **1.21**. The frequency reference is sampled every 1.4ms [1.9ms]. The speed reference is sampled every 345µs [460µs].

Encoder reference

Fast updating of the speed reference from an A,B (quadrature encoder) or F,D (frequency and direction signal) digital reference is possible. This type of reference would come from a UD51 encoder module. The speed reference is sampled every 345µs [460µs]. This type of fast updating can be used to provide a simple form of digital speed locking, see section 4.13 *Menu 13: Digital lock / orientation* for set-up procedure.. The speed loop counts all pulses from the reference and feedback encoders without losing any. Therefore the speed loop integrator maintains a count of the position difference between the reference and feedback. (Counts are lost if the speed reference hits a limit or zero in unipolar mode. Therefore bipolar mode should be used. The destination from menu 13 must be one of the preset speeds.)

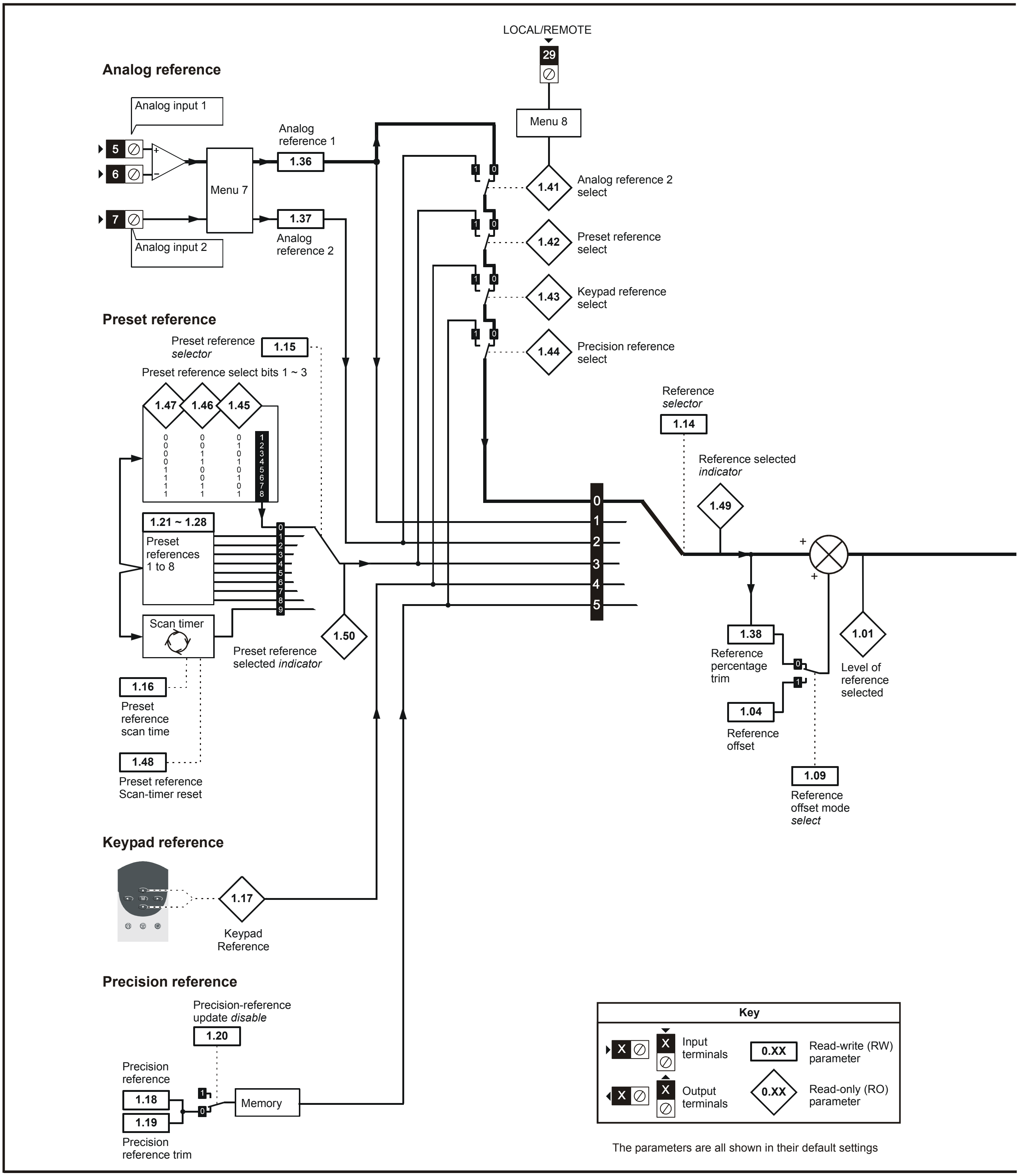
Table 4-1 Menu 1 single line descriptions

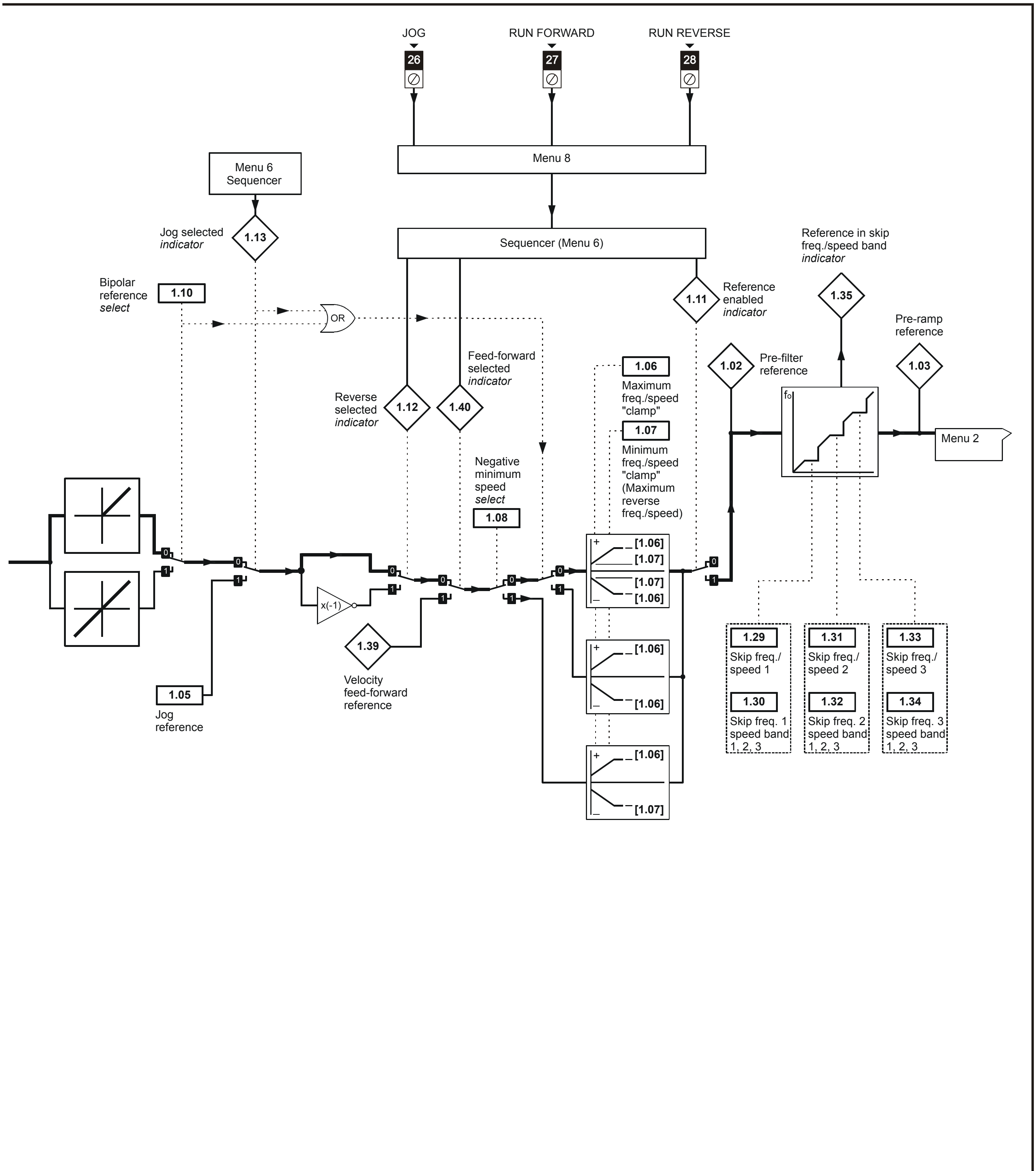
Parameter			Range(⇕) OL	Range(⇕) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
1.01	Final reference		±1,000.0 Hz *	±30,000 rpm *				RO	Bi		P
1.02	Pre-filter reference		±1,000.0 Hz *	±30,000 rpm *				RO	Bi		P
1.03	Pre-ramp reference	{**0.11**}	±1,000.0 Hz *	±30,000 rpm *				RO	Bi		P
1.04	Reference offset		±1,000.0 Hz	±30,000 rpm	0			RW	Bi		
1.05	Jog reference	{**0.14**}	0 to 400.0 Hz	0 to 4,000 rpm	1.5	50		RW	Uni		
1.06	Maximum frequency/speed	{**0.02**}	0 to 1,000.0 Hz	0 to 30,000 rpm	EUR> 50 USA> 60	EUR> 1,500 USA> 1,800	3,000	RW	Uni		
1.07	Minimum frequency/speed	{**0.01**}	0 to [Pr **1.06**], if Pr **1.08** = 0 -1,000 to 0 Hz, if Pr **1.08** = 1		0			RW	Bi		
1.08	Negative minimum speed *select*		0 or 1		0			RW	Bit		
1.09	Reference offset *select*		0 or 1		0			RW	Bit		
1.10	Bipolar reference *select*		0 or 1		0			RW	Bit		
1.11	Reference enabled *indicator*		0 or 1					RO	Bit		P
1.12	Reverse selected *indicator*		0 or 1					RO	Bit		P
1.13	Jog selected *indicator*		0 or 1					RO	Bit		P
1.14	Reference *selector*	{**0.05**}	0 to 5		EUR> 0 USA> 4	0		RW	Uni		
1.15	Preset reference *selector*		0 to 9		0			RW	Uni		
1.16	Preset reference scan time		0 to 400.0 s		10			RW	Uni		
1.17	Keypad reference	{**0.35**}	±1,000.0 Hz	±30,000 rpm	0			RO	Bi	S	P
1.18	Precision reference		±1,000.0 Hz	±30,000 rpm	0			RW	Bi		
1.19	Precision reference trim		0 to 0.099 Hz	0 to 0.99 rpm	0			RW	Uni		
1.20	Precision-reference update *disable*		0 or 1		0			RW	Bit		
1.21	Preset reference 1		±1,000.0 Hz	±30,000 rpm	0			RW	Bi		
1.22	Preset reference 2		±1,000.0 Hz	±30,000 rpm	0			RW	Bi		
1.23	Preset reference 3		±1,000.0 Hz	±30,000 rpm	0			RW	Bi		
1.24	Preset reference 4		±1,000.0 Hz	±30,000 rpm	0			RW	Bi		
1.25	Preset reference 5		±1,000.0 Hz	±30,000 rpm	0			RW	Bi		
1.26	Preset reference 6		±1,000.0 Hz	±30,000 rpm	0			RW	Bi		
1.27	Preset reference 7		±1,000.0 Hz	±30,000 rpm	0			RW	Bi		
1.28	Preset reference 8		±1,000.0 Hz	±30,000 rpm	0			RW	Bi		
1.29	Skip freq./speed 1	{**0.20**}	0 to 1,000.0 Hz	0 to 30,000 rpm	0			RW	Uni		
1.30	Skip band 1	{**0.21**}	0 to 5.0 Hz	0 to 50 rpm	0.5	5		RW	Uni		
1.31	Skip freq./speed 2	{**0.22**}	0 to 1,000.0 Hz	0 to 30,000 rpm	0			RW	Uni		
1.32	Skip band 2	{**0.23**}	0 to 5.0 Hz	0 to 50 rpm	0.5	5		RW	Uni		
1.33	Skip freq./speed 3		0 to 1,000.0 Hz	0 to 30,000 rpm	0			RW	Uni		
1.34	Skip band 3		0 to 5.0 Hz	0 to 50 rpm	0.5	5		RW	Uni		
1.35	Reference in skip-band *indicator*		0 or 1					RO	Bit		P
1.36	Analog reference 1		±1,000 Hz *	±30,000 rpm *				RO	Bi		
1.37	Analog reference 2		±1,000 Hz *	±30,000 rpm *				RO	Bi		
1.38	Reference percentage-trim		±100.0 %					RO	Bi		
1.39	Velocity feed-forward reference		±1,000.0 Hz	±30,000 rpm				RO	Bi		P
1.40	Feed-forward selected *indicator*		0 or 1					RO	Bit		P
1.41	Analog reference 2 selected *indicator*		0 or 1					RO	Bit		
1.42	Preset reference selected *indicator*		0 or 1					RO	Bit		
1.43	Keypad reference selected *indicator*		0 or 1					RO	Bit		
1.44	Precision reference selected *indicator*		0 or 1					RO	Bit		
1.45	Preset reference select bit 0 (LSB)		0 or 1					RO	Bit		
1.46	Preset reference select bit 1		0 or 1					RO	Bit		
1.47	Preset reference select bit 2 (MSB)		0 or 1					RO	Bit		
1.48	Scan-timer reset		0 or 1		0			RW	Bit		
1.49	Reference selected *indicator*		1 to 5					RO	Uni		P
1.50	Preset reference selected *indicator*		1 to 8					RO	Uni		P

* The maximum value that can be used is limited to the larger value of Pr **1.06** and Pr **1.07**.

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

Figure 4-1 Menu 1 logic diagram




JOG
26
RUN FORWARD
27
RUN REVERSE
28
Menu 8
Menu 6
Sequencer
Jog selected
indicator
1.13
Sequencer (Menu 6)
Reference in skip
freq./speed band
indicator
Bipolar
reference
select
1.10
OR
Reference
enabled
indicator
1.11
1.35
Pre-ramp
reference
Feed-forward
selected
indicator
1.06
Maximum
freq./speed
"clamp"
1.02
Pre-filter
reference
1.03
Reverse
selected
indicator
1.12
1.40
1.07
Minimum
freq./speed
"clamp"
(Maximum
reverse
freq./speed)
Menu 2
Negative
minimum
speed
select
1.08
[1.06]
[1.07]
[1.07]
[1.06]
x(-1)
1.39
Velocity
feed-forward
reference
1.05
Jog
reference
1.29
Skip freq./
speed 1
1.30
Skip freq. 1
speed band
1, 2, 3
1.31
Skip freq./
speed 2
1.32
Skip freq. 2
speed band
1, 2, 3
1.33
Skip freq./
speed 3
1.34
Skip freq. 3
speed band
1, 2, 3

Menu 1 parameter descriptions

The range section of some menu 1 parameters indicate the maximum possible range followed by '*'. This is used to indicate that the range is further restricted so that it cannot be larger than the magnitude of Pr **1.06** (maximum speed clamp) and Pr **1.07** (minimum speed clamp), which ever is the greater.

1.01		**Final reference**		
RO		Bi		P
OL	⇳	±1,000.0 Hz *	⇨	
CL	⇳	±30,000 rpm *	⇨	

Indication of the reference being used by the drive is given for system setup and fault finding.

1.02		**Pre-filter reference**		
1.03		**Pre-ramp reference**		
RO		Bi		P
OL	⇳	±1,000.0 Hz *	⇨	
CL	⇳	±30,000 rpm *	⇨	

Indication of the reference being used by the drive is given for system setup and fault finding.

1.04		**Reference offset**		
RW		Bi		
OL	⇳	±1,000.0 Hz	⇨	0
CL	⇳	±30,000 rpm	⇨	0

This reference is added to the selected reference if Pr **1.09** is set to 1. It can be used as a trim to finely adjust the main reference being selected or to provided a reference that is the sum of two input values.

1.05		**Jog reference**		
RW		Uni		
OL	⇳	0 to 400.0 Hz	⇨	1.5
CL	⇳	0 to 4,000 rpm	⇨	50

Speed reference used for jogging. See notes in section 4.6 *Menu 6: Sequencing logic* on when the jog mode can be activated. The jog reference can be used for relative jogging in digital lock mode, (see section 4.13 *Menu 13: Digital lock / orientation*).

1.06		**Maximum frequency/speed**		
RW		Uni		
OL	⇳	0 to 1000.0 Hz	⇨	EUR> 50 USA> 60
VT	⇳	0 to 30,000 rpm	⇨	EUR> 1,500 USA> 1,800
SV	⇳		⇨	3,000

If Pr **1.08** is 0, this parameter is a symmetrical limit on both directions of rotation. When Pr **1.08** is 1 this is a clamp on the forward direction only.

Open loop
Defines drive absolute maximum frequency reference. Slip compensation and operation under regenerating current limit can increase the motor frequency further. Overspeed detection is provided to prevent excessive frequencies - see Pr **3.29** on page 74. (This parameter is limited to 250Hz on a Unidrive VTC.)

Closed loop
Clamp on the speed reference. (See Pr **3.21** on page 71 for further restrictions.)

1.07		**Minimum frequency/speed**		
RW		Bi		
OL	⇳	0 to [Pr **1.06**] Hz	⇨	0
CL	⇳	0 to [Pr **1.06**] rpm	⇨	

If Pr **1.08** is 0, Pr **1.07** is used in unipolar mode to define drive minimum speed. Inactive during jogging. When Pr **1.08** is 1, Pr **1.07** is the negative clamp on the speed reference limiting the speed set point in the reverse direction. (This parameter is limited to -250Hz on a Unidrive VTC.)

1.08	**Negative minimum speed select**			
RW	Bit			
⇳	0 or 1		⇨	0

When this parameter is 0, Pr **1.07** can be set to a positive value between 0 and the value of Pr **1.06** only. Providing minimum speed clamp (Pr **1.07**) has not been disabled (by bipolar mode being selected or jog being selected) then the drive will run at a speed no lower than +Pr **1.07** in the forward direction and no lower than -Pr **1.07** in the reverse direction. Pr **1.06** provides a symmetrical clamp on maximum speed in both directions and is used as the maximum value of Pr **1.36** and Pr **1.37** for correct scaling of analog inputs.

Setting this parameter to 1 changes the range of Pr **1.07**; 0 to -1,000.0Hz for the open loop drive or 0 to -30,000rpm for the closed loop drives. The maximum speed for the forward direction is Pr **1.06** and maximum speed for the reverse direction is Pr **1.07**. Either Pr **1.06** or the modulus of Pr **1.07**, which ever is the greater, defines the maximum value of Pr **1.36** and Pr **1.37** for scaling of analog inputs.

1.09	**Reference offset select**			
RW	Bit			
⇳	0 or 1		⇨	0

When this parameter is at 0 the offset added is a percentage trim derived from the selected reference and the percentage trim parameter (Pr **1.38**). When set to 1 the offset added is the reference offset (Pr **1.04**).

The trim values have a resolution of 1rpm.

1.10	**Bipolar reference select**			
RW	Bit			
⇳	0 or 1		⇨	0

If the user requires to change the direction of rotation with a bipolar reference this parameter should be set. If it is not, all negative references are treated as zero.

1.11	**Reference enabled indicator**			
1.12	**Reverse selected indicator**			
1.13	**Jog selected indicator**			
RO	Bit			P
⇳	0 or 1		⇨	

These flags are controlled by the drive sequencer defined in Menu 6. They select the appropriate reference as commanded by the drive logic.

1.14	**Reference selector**				
RW		Uni			
OL	⇳	0 to 5		⇨	EUR> 0 USA> 4
CL	⇳			⇨	EUR> 0 USA> 0

Pr **1.14** selects a speed reference as follows:

0 Reference selection by terminal input
1 Analog reference 1 selected
2 Analog reference 2 selected
3 Preset reference selected
4 Keypad reference selected
5 Precision reference selected

0: Reference selection by terminal input
The reference selected depends on the state of bit Pr **1.41** to Pr **1.44**. These bits are for control by digital inputs such that references can be selected by external control. If any of the bits are set, the appropriate reference is selected (indicated by Pr **1.49**). If more than one bit is set the highest numbered will have priority.

1 or 2: Analog reference 1 or 2 selected
The reference selected is either one of the analog inputs, see Pr **1.36** and Pr **1.37** on page 48 for a complete description.

3: Preset Reference Selected
The reference is one of the eight preset speeds, see Pr **1.15** on page 46 and Pr **1.21** to Pr **1.28** on page 47 for further details.

4: Keypad reference selected
The drive sequencing (Pr **6.04**) is ignored, sequencing bits (Pr **6.30** to Pr **6.33**) have no effect, and the keypad controls stop, run and reverse. Jog is disabled.

5: Precision Reference Selected
Precision speed reference is selected, see Pr **1.18** on page 47 to Pr **1.19** on page 47 for further details.

1.15	Preset reference selector			
RW	Uni			
⇳	0 to 9	⇨	0	

Pr **1.15** selects a preset speed reference as follows:

0	Preset selection by terminal input
1	Preset 1 selected
2	Preset 2 selected
3	Preset 3 selected
4	Preset 4 selected
5	Preset 5 selected
6	Preset 6 selected
7	Preset 7 selected
8	Preset 8 selected
9	Preset selection by timer

0: Preset selection by terminal input
The preset selected depends on the state of bit Pr **1.45** to Pr **1.47**. These bits are for control by digital inputs such that presets can be selected by external control. The preset selected depends on the binary code generated by these bits as follows:

Pr 1.47	Pr 1.46	Pr 1.45	Preset selected
0	0	0	1
0	0	1	2
0	1	0	3
0	1	1	4
1	0	0	5
1	0	1	6
1	1	0	7
1	1	1	8

9: Preset selection by timer
The presets to be selected in turn automatically. Pr **1.16** defines the time between each change.

Pr **1.50** indicates the preset selected at all times.

1.16	Preset reference scan time			
RW	Uni			
⇳	0 to 400.0 s	⇨	10	

This parameter defines the time between preset reference change when Pr **1.15** is set to 9. If Pr **1.48** is set to 1 then the preset counter and timer are reset and preset 1 will be selected.

1.17		Keypad reference			
RO		Bi		S	P
OL	⇳	Hz	⇨	0	
CL	⇳	rpm	⇨		

When this parameter is selected as the reference (Pr **1.14** = 4), it is adjusted by the Up and Down keys when the display is in status mode. It is saved on power down such that the speed reference does not have to be set up again on power up.

The range depends on the setting of Pr **1.08** and Pr **1.10**:

Pr 1.08	Pr 1.10	Range
0	0	Pr **1.07** to Pr **1.06** (Pr **1.07** positive only)
0	1	±Pr **1.06**
1	0	0 to Pr **1.06**
1	1	Pr **1.07** to Pr **1.06** (Pr **1.07** positive only)

1.18		Precision reference		
RW		Bi		
OL	⇳	±1,000.0 Hz	⇨	0
CL	⇳	±30,000 rpm	⇨	

1.19		Precision reference trim		
RW		Uni		
OL	⇳	0 to 0.099 Hz	⇨	0
CL	⇳	0 to 0.99 rpm	⇨	

Open loop

For normal resolution control the drive has a maximum frequency range from 0 to 1kHz represented internally as a value from 0 to (2^{15} - 1) (0.03Hz resolution). Although frequency demand inputs may restrict the resolution further, it is not possible to obtain better resolution than 0.03Hz unless high resolution control is used.

Selecting these two parameters as a reference automatically selects high resolution control (unless a frequency limit is reached). The frequency in this case will have a resolution of 0.001Hz. Pr **1.18** defines the reference (either positive or negative) with a resolution of 0.1Hz. Pr **1.19** defines the fine part of the reference (always positive). The final reference is given by Pr **1.18** + Pr **1.19**. Therefore Pr **1.19** increases positive references away from zero, and decreases negative references towards zero.

Closed loop

As with open loop a higher resolution speed reference can be programmed by selecting these parameters. In this case the speed will have a resolution of 0.01 rpm. Pr **1.18** defines the reference (either positive or negative) with a resolution of 1rpm. Pr **1.19** defines the fine part of the reference (always positive). The final reference is given by Pr **1.18** + Pr **1.19**. Therefore Pr **1.19** increases positive references away from zero, and decreases negative references towards zero.

1.20	Precision reference update disable		
RW	Bit		
⇳	0 or 1	⇨	0

When this bit is at 0 the precision reference parameters are read and stored in internal memory. Because the precision reference has to be set in two parameters, this bit is provided to prevent the drive reading the parameters while the reference is being updated. Instead, the drive uses the value stored in memory thus preventing the possibility of data skew.

1.21		Preset reference 1		
1.22		Preset reference 2		
1.23		Preset reference 3		
1.24		Preset reference 4		
1.25		Preset reference 5		
1.26		Preset reference 6		
1.27		Preset reference 7		
1.28		Preset reference 8		
RW		Bi		
OL	⇳	±1,000.0 Hz	⇨	0
CL	⇳	±30,000 rpm	⇨	

Preset speed references 1 to 8.

1.29		Skip freq./speed 1		
RW		Uni		
OL	⇳	0 to 1,000.0 Hz	⇨	0
CL	⇳	0 to 30,000 rpm	⇨	

Three skip speeds are available to prevent continuous operation at a speed that would cause mechanical resonance. When a skip speed parameter is set to 0 that filter is disabled.

1.30	Skip band 1				
RW		Uni			
OL	⇳	0 to 5.0 Hz	⇨	0.5	
CL	⇳	0 to 50 rpm	⇨	5	

The skip speed band parameters define the frequency or rpm range either side of the programmed skip speed, over which references are rejected. The actual reject band is therefore twice that programmed in these parameters, the skip speed parameters defining the centre of the band. When the selected reference is within a band the lower limit of the band is passed through to the ramps such that speed is always less than demanded.

1.31	Skip freq./speed 2				
RW		Uni			
OL	⇳	0 to 1,000.0 Hz	⇨	0	
CL	⇳	0 to 30,000 rpm	⇨		

Three skip speeds are available to prevent continuous operation at a speed that would cause mechanical resonance. When a skip speed parameter is set to 0 that filter is disabled.

1.32	Skip band 2				
RW		Uni			
OL	⇳	0 to 5.0 Hz	⇨	0.5	
CL	⇳	0 to 50 rpm	⇨	5	

The skip speed band parameters define the frequency or rpm range either side of the programmed skip speed, over which references are rejected. The actual reject band is therefore twice that programmed in these parameters, the skip speed parameters defining the centre of the band. When the selected reference is within a band the lower limit of the band is passed through to the ramps such that speed is always less than demanded.

1.33	Skip freq./speed 3				
RW		Uni			
OL	⇳	0 to 1,000.0 Hz	⇨	0	
CL	⇳	0 to 30,000 rpm	⇨		

Three skip speeds are available to prevent continuous operation at a speed that would cause mechanical resonance. When a skip speed parameter is set to 0 that filter is disabled.

1.34	Skip band 3				
RW		Uni			
OL	⇳	0 to 5.0 Hz	⇨	0.5	
CL	⇳	0 to 50 rpm	⇨	5	

The skip speed band parameters define the frequency or rpm range either side of the programmed skip speed, over which references are rejected. The actual reject band is therefore twice that programmed in these parameters, the skip speed parameters defining the centre of the band. When the selected reference is within a band the lower limit of the band is passed through to the ramps such that speed is always less than demanded.

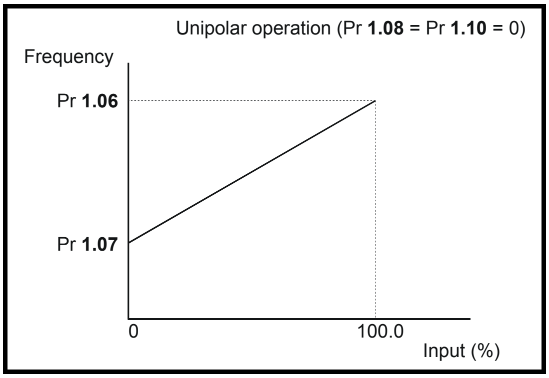
1.35	Reference in skip-band indicator			
RO	Bit		P	
⇳	0 or 1	⇨		

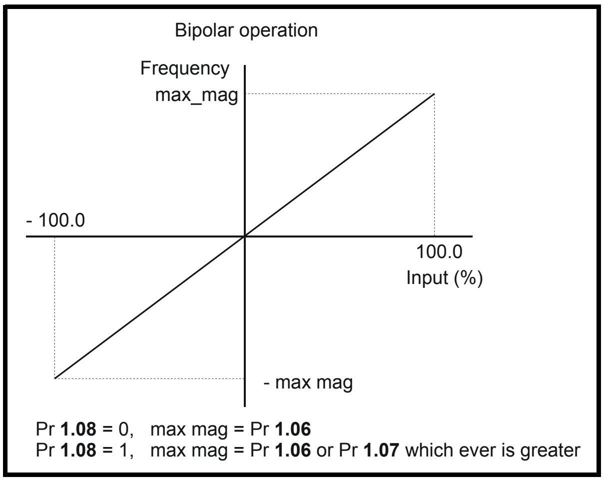
This parameter indicates that the selected reference is within one of the skip speed regions such that the motor speed is not as demanded.

1.36	Analog reference 1				
1.37	Analog reference 2				
RO		Bi			
OL	⇳	±1,000.0 Hz *	⇨		
CL	⇳	±30,000 rpm *	⇨		

Although most parameters can be controlled from analog inputs, these two parameters are special case in that if an analog input programmed in voltage mode is directed to one of these parameters, the scan rate of that analog input is increased. See section on reference frequency update at the beginning of menu 1 description.

The programmed input is automatically scaled such that 100.0% input corresponds to the set maximum speed (Pr **1.06** if Pr **1.08** = 0, or maximum of Pr **1.06** and Pr **1.07** if Pr **1.08** = 1). Also the 0% input level corresponds to the minimum speed level (Pr **1.07**) if bipolar (Pr **1.10**) is not selected and Pr **1.08** is set to 0.





1.38	Reference percentage-trim		
RO	Bi		
⇳ ±100.0 %		⇨	

If an analog input is routed to this parameter, the selected reference can be trimmed by the analog input. The resolution of the trim is 1rpm.

$$\text{Pr } \mathbf{1.01} = \text{Selected Ref} + \frac{\text{Selected Ref x Pr } \mathbf{1.38}}{100}$$

1.39		Velocity feed-forward reference		
RO		Bi		P
OL	⇳	±1,000.0 Hz	⇨	
CL	⇳	±30,000 rpm	⇨	

This variable indicates the velocity feed forward reference when position control is being used (Menu 13).

1.40	Feed-forward selected indicator		
RO	Bit		P
⇳ 0 or 1		⇨	

This bit indicates that the position control has selected the velocity feed forward as a speed reference for the drive. This bit is only active for digital lock modes with digital feed forward.

1.41	**Analog reference 2 selected indicator**		
1.42	**Preset reference selected indicator**		
1.43	**Keypad reference selected indicator**		
1.44	**Precision reference selected indicator**		
1.45	**Preset reference select bit 0 (LSB)**		
1.46	**Preset reference select bit 1**		
1.47	**Preset reference select bit 2 (MSB)**		
RO	Bit		
⇕	0 or 1	⇨	

These bits are provided for control by logic input terminals for external reference selection (see Pr **1.14** on page 45 and Pr **1.15** on page 46).

1.48	**Scan-timer reset**		
RW	Bit		
⇕	0 or 1	⇨	0

When this flag is set the timer and counter in the auto preset selection mode (Pr **1.15** = 9) are reset to 0 such that preset 1 is selected. This can be used to start a new sequence of speed selection by a programmable input terminal or function. When this bit is zero the preset selection will follow the timer, see Pr **1.15** and Pr **1.16** on page 46, even when the drive is disabled.

1.49	**Reference selected indicator**		
RO	Uni		P
⇕	1 to 5	⇨	

Indicates the reference currently being selected.

1.50	**Preset reference selected indicator**		
RO	Uni		P
⇕	1 to 8	⇨	

Indicates the preset currently being selected.

4.2 Menu 2: Ramps (accel. / decel.)

The pre-ramp frequency or speed reference passes through the ramp block controlled by menu 2 before being used by the drive to produce the basic output frequency (open loop), or as an input to the speed regulator (closed loop). The ramp block includes:

- Linear ramps
- S ramp function for ramped acceleration and deceleration
- Deceleration ramp control to prevent rises in the DC bus voltage within the drive that would cause an over-voltage trip if no braking resistor is fitted

Table 4-2 Menu 2 single line descriptions

Parameter		Range(⇕) OL	Range(⇕) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
2.01	Post-ramp reference **{0.12}**	±1,000 Hz *	±30,000 rpm *				RO	Bi		P
2.02	Ramp enable		0 or 1		1	0	RW	Bit		
2.03	Ramp hold enable	0 or 1		0			RW	Bit		
2.04	Ramp mode selector **{0.15}**	Stnd.Hd (0), FASt (1), Stnd.Ct (2)		Stnd.Ct (2)			RW	Txt		
2.05	Ramp-rate range select		0 or 1		0	1	RW	Bit		
2.06	S-ramp enable **{0.18}**	0 or 1		0			RW	Bit		
2.07	S-ramp da/dt **{0.19}**	0 to 3,000.0 s^2/100 Hz	0 to 30.000 s^2/1,000 rpm	3.1	1.5	0.03	RW	Uni		
2.08	Standard ramp voltage	200V drive: 0 to 400 V 400V drive: 0 to 800 V		200V drive: 375 400V drive: EUR> 750, USA> 775			RW	Uni		
2.09	Reverse acceleration and deceleration select	0 or 1		0			RW	Bit		
2.10	Forward acceleration ramp selector	0 to 9		0			RW	Uni		
2.11	Acceleration rate 1 / Forward acceleration rate 1 **{0.03}**	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	5**	2	0.2	RW	Uni		
2.12	Acceleration rate 2 / Forward acceleration rate 2	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	5**	2	0.2	RW	Uni		
2.13	Acceleration rate 3 / Forward acceleration rate 3	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	5**	2	0.2	RW	Uni		
2.14	Acceleration rate 4 / Forward acceleration rate 4	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	5**	2	0.2	RW	Uni		
2.15	Acceleration rate 5 / Reverse acceleration rate 1	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	5**	2	0.2	RW	Uni		
2.16	Acceleration rate 6 / Reverse acceleration rate 2	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	5**	2	0.2	RW	Uni		
2.17	Acceleration rate 7 / Reverse acceleration rate 3	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	5**	2	0.2	RW	Uni		
2.18	Acceleration rate 8 / Reverse acceleration rate 4	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	5**	2	0.2	RW	Uni		
2.19	Jog acceleration rate	0 to 3,200.0 s/100Hz	VT>0 to 32.0 s/1,000rpm SV>0 to 32.000 s/1,000rpm	0.2	0		RW	Uni		
2.20	Forward deceleration ramp *selector*	0 to 9		0			RW	Uni		
2.21	Deceleration rate 1 / Forward deceleration rate 1 **{0.04}**	0 to 3,200.0 s/100Hz	VT> 0 to 32.000 s/1000rpm SV> 0 to 32,000 s/1000rpm	10**	2	0.2	RW	Uni		
2.22	Deceleration rate 2 / Forward deceleration rate 2	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	10**	2	0.2	RW	Uni		
2.23	Deceleration rate 3 / Forward deceleration rate 3	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	10**	2	0.2	RW	Uni		
2.24	Deceleration rate 4 / Forward deceleration rate 4	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	10**	2	0.2	RW	Uni		
2.25	Deceleration rate 5 / Reverse deceleration rate 1	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	10**	2	0.2	RW	Uni		
2.26	Deceleration rate 6 / Reverse deceleration rate 2	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	10**	2	0.2	RW	Uni		
2.27	Deceleration rate 7 / Reverse deceleration rate 3	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	10**	2	0.2	RW	Uni		
2.28	Deceleration rate 8 / Reverse deceleration rate 4	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	10**	2	0.2	RW	Uni		
2.29	Jog deceleration rate	0 to 3,200.0 s/100Hz	VT> 0 to 3,200 SV> 0 to 32.000 s/1,000rpm	0.2	0		RW	Uni		
2.30	Rev acceleration *selector*	0 to 4		0			RW	Uni		P
2.31	Rev deceleration *selector*	0 to 4		0			RW	Uni		P
2.32	Forward acceleration *select bit 0 (LSB)*	0 or 1		0			RO	Bit		
2.33	Forward acceleration *select bit 1*	0 or 1		0			RO	Bit		
2.34	Forward acceleration *select bit 2 (MSB)*	0 or 1		0			RO	Bit		
2.35	Forward deceleration *select bit 0 (LSB)*	0 or 1		0			RO	Bit		
2.36	Forward deceleration *select bit 1*	0 or 1		0			RO	Bit		
2.37	Forward deceleration *select bit 2 (MSB)*	0 or 1		0			RO	Bit		
2.38	Reverse acceleration *select bit 0 (LSB)*	0 or 1		0			RO	Bit		
2.39	Reverse acceleration *select bit 1 (MSB)*	0 or 1		0			RO	Bit		
2.40	Reverse deceleration *select bit 0 (LSB)*	0 or 1		0			RO	Bit		
2.41	Reverse deceleration *select bit 1 (MSB)*	0 or 1		0			RO	Bit		

* The maximum value that can be used is limited to the larger value of Pr **1.06** and Pr **1.07**.

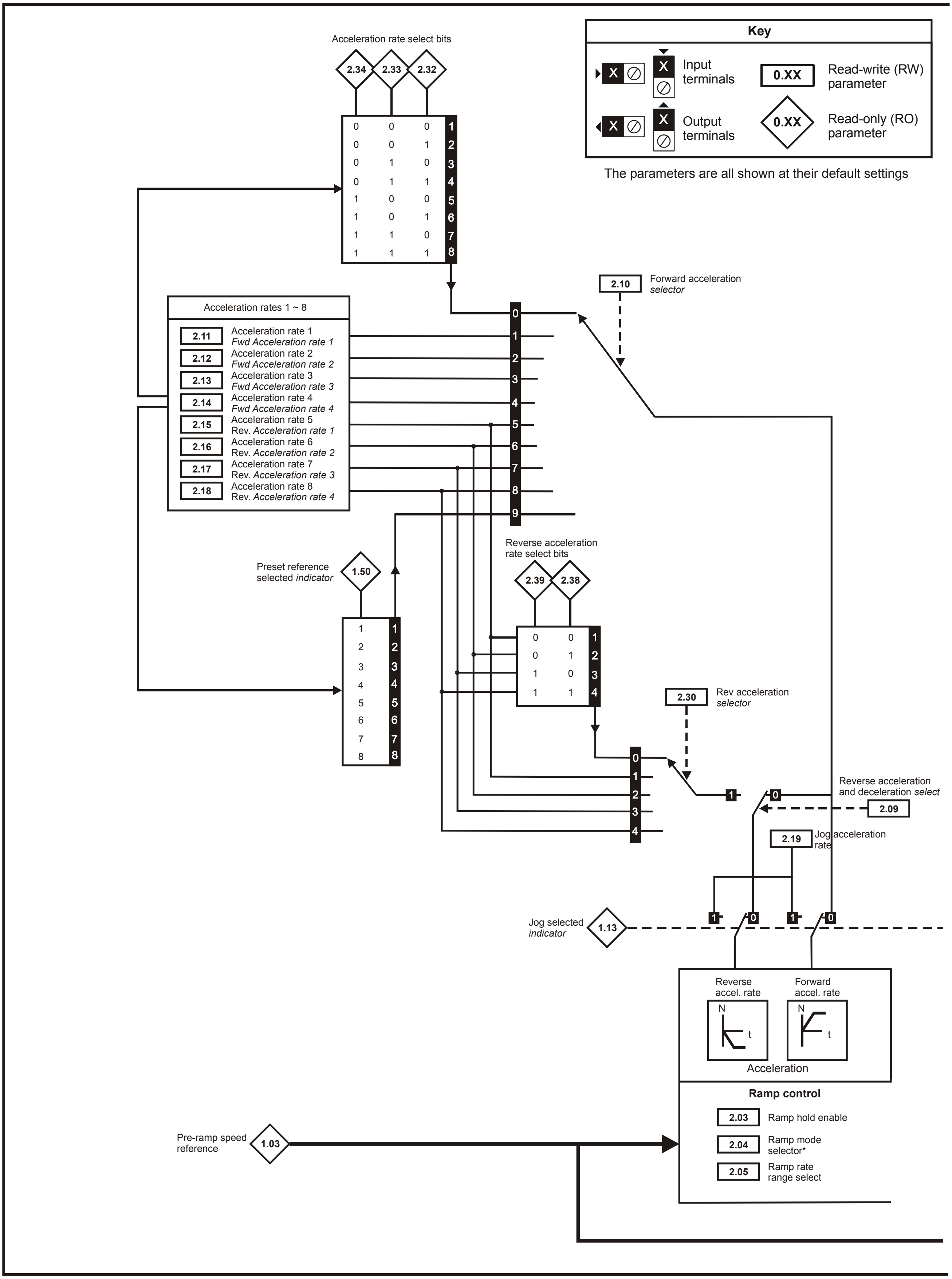
RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

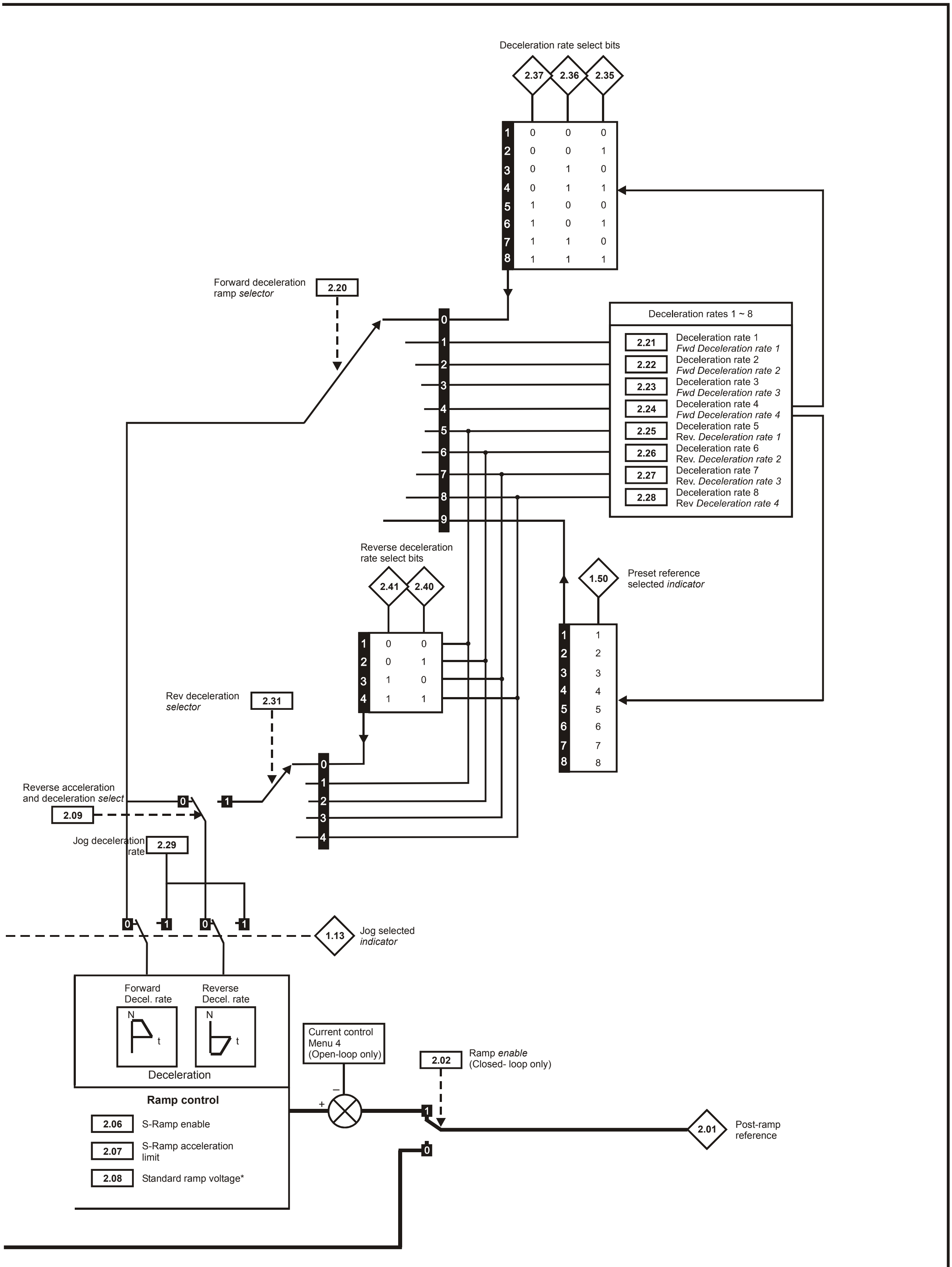
** These parameters have a default setting of 60s in the VTC variant.

NOTE

Where a parameter is represented by a text value, the value in brackets in the range column is the setting used for serial communications.

Figure 4-2 Menu 2 logic diagram





* For more information, see Pr **2.08** on page 58.

Menu 2 parameter descriptions

The range section of some menu 2 parameters indicate the maximum possible range followed by '*'. This range is further restricted so that it cannot be larger than the magnitude of parameters 01.06 (maximum speed clamp) or 01.07 (minimum speed clamp) which ever is the greater.

2.01		Post-ramp reference		
RO		Bi		P
OL	⇳	±1,000.0 Hz *	⇨	
CL	⇳	±30,000 rpm *	⇨	

This is the speed reference after the ramps.

2.02		Ramp enable		
RW		Bit		P
VT	⇳	±30,000 rpm *	⇨	1
SV	⇳		⇨	0

Set to enable ramps.

2.03	Ramp hold enable		
RW	Bit		
⇳	0 or 1	⇨	0

If this bit is set the ramp will be held. If S ramp is enabled, see Pr **2.06** on page 57, the acceleration will ramp towards zero causing the ramp output to curve towards a constant speed.

2.04	Ramp mode selector		
RW	Txt		
⇳	Stnd.Hd (0), FASt (1), Stnd.Ct (2)	⇨	Stnd.Ct (2)

This parameter has 3 settings as follows:

0 Stnd.HdStandard ramp with ramp hold
1 FASt Fast ramp
2 Stnd.CtStandard ramp with P control

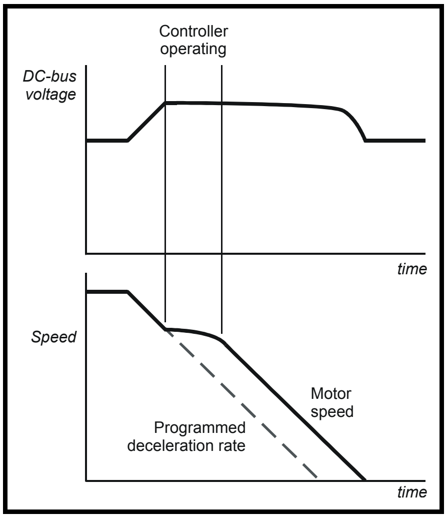
The acceleration ramp is not affected by the ramp mode, and the ramp output will rise at the programmed acceleration rate (subject to the current limits programmed in an open loop drive).

1: Fast ramp
The output of the ramp will fall at the programmed deceleration rate (subject to the current limits programmed in an open loop drive).

0: Standard ramp with ramp hold
The deceleration ramp will be frozen if the DC bus voltage rises above the standard ramp voltage (Pr **2.08**). Normally the DC bus voltage will then begin to fall as the machine should stop regenerating. Once the voltage drops below the standard ramp voltage, the ramp will again begin to fall. This type of control does not usually give smooth deceleration especially if the machine is lightly loaded, however it is easy to set up.

2: Standard ramp with P control
The voltage rising to the standard ramp level (Pr **2.08**) causes a proportional controller to operate, the output of which changes the demanded current in the motor. As the controller regulates the bus voltage, the motor deceleration increases as the speed approaches zero speed. When the motor deceleration rate reaches the programmed deceleration rate the controller ceases to operate and the drive continues to decelerate at the programmed rate. This gives smoother control than standard hold mode. If the standard ramp voltage (Pr **2.08**) is set lower than the nominal DC bus level the drive will not decelerate but will coast to rest. The standard controlled mode is most likely to be useful in applications where smooth deceleration is required, particularly with lightly loaded machines, or where the supply voltage is high where the drive would trip on OV (DC bus over voltage) due to the transients produced in standard hold mode.

The output of the ramp controller (when active) is a current demand that is fed to the frequency changing current controller (open loop) or the torque producing current controller (closed loop). The gain of these controllers can be modified with Pr **4.13** and Pr **4.14**.



2.05		Ramp-rate range selector		
RW		Bit		
VT	⇕	0 or 1	⇨	0
SV	⇕		⇨	1

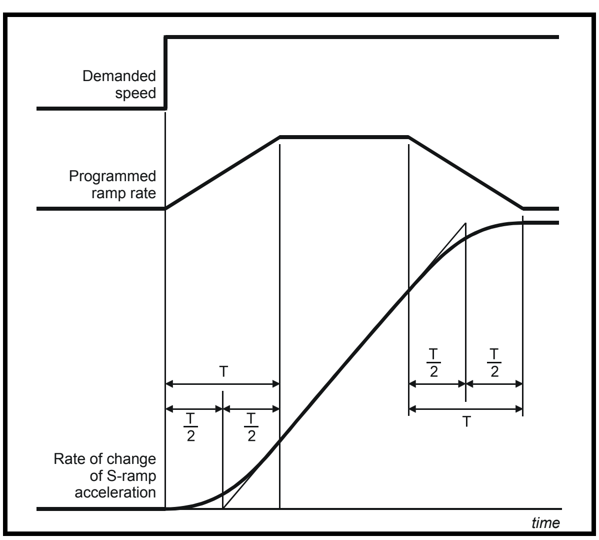
The ramp rate range when this bit is 0 is 0.0 to 3,200.0 seconds and when this bit is set it is 0.000 to 32.000 seconds.

2.06	S-ramp enable		
RW	Bit		
⇕	0 or 1	⇨	0

Setting this parameter enables the S ramp function. S ramp is disabled during deceleration using Standard ramp with P control (Pr **2.04** = 2). When the motor is accelerated again after decelerating in standard ramp with P control the acceleration ramp used by the S ramp function is reset to zero.

2.07		S-ramp da/dt		
RW		Uni		
OL	⇕	0 to 3,000.0 s^2/100 Hz	⇨	3.1
VT	⇕	0 to 30.000 s^2/1,000 rpm	⇨	1.5
SV	⇕		⇨	0.03

This parameter defines the maximum rate of change of acceleration/deceleration that the drive will operate with. The default values have been chosen such that for the default ramps and maximum speed, the curved parts of the S will be 25% of the original ramp if S ramp is enabled.



Since the ramp rate is defined in s/100Hz or s/1000rpm and the S ramp parameter is defined in s^2/100Hz or s^2/1000rpm, the time T for the 'curved' part of the S can be determined from:

T = S ramp rate of change / Ramp rate

Enabling S ramp increases the total ramp time by the period T since an additional T/2 is added to each end of the ramp in producing the S.

2.08	Standard ramp voltage		
RW	Uni		
⇳	0 to 800 V	⇨	EUR> 750 USA> 775

This voltage is used as the level for both standard ramp modes. If hold mode is used and this is set too low the drive will never stop, and if it is too high and no braking resistor is used the drive may trip on 0V (DC bus over voltage). If P controlled mode is used and this parameter is set too low the machine will coast to rest, and if it is set too high and no braking resistor is used it may trip on OV. The minimum level should be greater than the voltage produced on the DC bus by the highest supply voltage. Normally the DC bus voltage will be approximately the rms supply voltage x

√2.

2.09	Reverse acceleration and deceleration select		
RW	Bit		
⇳	0 or 1	⇨	0

When this bit is set to 0 there are 8 acceleration and 8 deceleration rates which are operational in both the forward and reverse directions. Setting this bit to 1 splits the eight acceleration and deceleration rates into 4 forward and 4 reverse.

2.10	Forward acceleration ramp selector		
RW	Uni		
⇳	0 to 9	⇨	0

This parameter is used to select acceleration ramp rates as follows:

0 Ramp rate selection by terminal input
1 Ramp rate 1 selected
2 Ramp rate 2 selected
3 Ramp rate 3 selected
4 Ramp rate 4 selected
5 Ramp rate 5 selected
6 Ramp rate 6 selected
7 Ramp rate 7 selected
8 Ramp rate 8 selected
9 Ramp rate selection by preset reference selection

When Pr **2.10** is set to 0 the acceleration ramp rate selected depends on the state of bit Pr **2.32** to Pr **2.34**. These bits are for control by digital inputs such that ramp rates can be selected by external control. The ramp rate selected depends on the binary code generated by these bits as follows:

Pr 2.34	Pr 2.33	Pr 2.32	Ramp rate selected
0	0	0	1
0	0	1	2
0	1	0	3
0	1	1	4
1	0	0	5
1	0	1	6
1	1	0	7
1	1	1	8

When Pr **2.10** is set to 9 the appropriate acceleration rate is automatically selected depending on the preset reference selected. Thus an acceleration rate can be programmed to operate with each preset reference. Since the new ramp rate is selected with the new reference, the deceleration applies towards the selected preset.

If Pr **2.09** is set such that separate reverse acceleration's are required, this parameter becomes a forward acceleration selector and is only able to select the four forward acceleration rates. If acceleration rate 5 is selected, deceleration rate 1 will be used, and so on up to or deceleration 8.

2.11		**Acceleration rate 1 / Forward acceleration rate 1**			
2.12		**Acceleration rate 2 / Forward acceleration rate 2**			
2.13		**Acceleration rate 3 / Forward acceleration rate 3**			
2.14		**Acceleration rate 4 / Forward acceleration rate 4**			
2.15		**Acceleration rate 5 / Reverse acceleration rate 1**			
2.16		**Acceleration rate 6 / Reverse acceleration rate 2**			
2.17		**Acceleration rate 7 / Reverse acceleration rate 3**			
2.18		**Acceleration rate 8 / Reverse acceleration rate 4**			
RW		Uni			
OL	⇳	0 to 3,200.0 s/100 Hz	⇨	5*	
VT	⇳	0 to 3,200 s/1,000 rpm	⇨	2	
SV	⇳	0 to 32.000 s/1,000 rpm	⇨	0.2	

*Default setting of 60s on Unidrive VTC

The drive can be set up to either have eight acceleration and deceleration rates which are used in both the forward and reverse direction, or have four acceleration and deceleration rates in each of the four areas; forward acceleration, forward deceleration, reverse acceleration, and reverse deceleration; selectable by bit Pr **2.09**.

Open loop
The ramp rates are expressed as time for a change of 100Hz on the ramp output. Therefore with a programmed ramp time of 5 seconds the ramp output will reach 50Hz from 0 in 2.5 seconds.

Closed loop
Ramp rates are expressed as the time in seconds for a change of 1000rpm on the ramp output. There are two ranges for the ramp rate parameters selectable by Pr **2.27**, 0 to 3200.0s (s/1,000rpm) and 0 to 32.000s (s/1,000rpm, ms ramp range).

2.19		**Jog acceleration rate**		
RW		Uni		
OL	⇳	0 to 3,200.0 s/100 Hz	⇨	0.2
VT	⇳	0 to 32.0 s/1,000 rpm	⇨	0
SV	⇳	0 to 32.000 s/1,000 rpm	⇨	0

Set up for the required acceleration rate when jogging.

2.20	**Forward deceleration ramp selector**		
RW	Uni		
⇳	0 to 9	⇨	0

This parameter is used to select deceleration ramp rates as follows:

0 Ramp rate selection by terminal input
1 Ramp rate 1 selected
2 Ramp rate 2 selected
3 Ramp rate 3 selected
4 Ramp rate 4 selected
5 Ramp rate 5 selected
6 Ramp rate 6 selected
7 Ramp rate 7 selected
8 Ramp rate 8 selected
9 Ramp rate selection by preset reference selection

When Pr **2.20** is set to 0 the deceleration ramp rate selected depends on the state of bit Pr **2.35** to Pr **2.37**. These bits are for control by digital inputs such that ramp rates can be selected by external control. The ramp rate selected depends on the binary code generated by these bits as follows:

Pr 2.37	Pr 2.36	Pr 2.35	Ramp rate selected
0	0	0	1
0	0	1	2
0	1	0	3
0	1	1	4
1	0	0	5
1	0	1	6
1	1	0	7
1	1	1	8

When Pr **2.20** is set to 9 the appropriate deceleration rate is automatically selected depending on the preset reference selected. Thus a deceleration rate can be programmed to operate with each preset reference. Since the new ramp rate is selected with the new reference, the deceleration applies towards the selected preset.

If Pr **2.09** is set such that separate reverse deceleration's are required, this parameter becomes a forward deceleration selector and is only able to select the four forward deceleration rates. If deceleration rate 5 is selected, deceleration rate 1 will be used, and so on up to deceleration 8.

2.21	**Deceleration rate 1 / Forward deceleration rate 1**		
2.22	**Deceleration rate 2 / Forward Deceleration rate 2**		
2.23	**Deceleration rate 3 / Forward deceleration rate 3**		
2.24	**Deceleration rate 4 / Forward deceleration rate 4**		
2.25	**Deceleration rate 5 / Reverse deceleration rate 1**		
2.26	**Deceleration rate 6 / Reverse deceleration rate 2**		
2.27	**Deceleration rate 7 / Reverse deceleration rate 3**		
2.28	**Deceleration rate 8 / Reverse deceleration rate 4**		
RW	Uni		
OL ⇕	0 to 3,200.0 s/100 Hz	⇨	10*
VT ⇕	0 to 3,200 s/1,000 rpm	⇨	2
SV ⇕	0 to 32.000 s/1,000 rpm	⇨	0.2

*Default setting of 60s on Unidrive VTC

The drive can be set up to either have eight acceleration and deceleration rates which are used in both the forward and reverse direction, or have four acceleration and deceleration rates in each of the four areas; forward acceleration, forward deceleration, reverse acceleration, and reverse deceleration; selectable by bit Pr **2.09**.

Open loop
The ramp rates are expressed as time for a change of 100Hz on the ramp output. Therefore with a programmed ramp time of 5 seconds the ramp output will reach 50Hz from 0 in 2.5 seconds.

Closed loop
Ramp rates are expressed as the time in seconds for a change of 1000rpm on the ramp output. There are two ranges for the ramp rate parameters selectable by Pr **2.27**, 0 to 3200.0s (s/1,000rpm) and 0 to 32.000s (s/1,000rpm, ms ramp range).

2.29	**Jog deceleration rate**		
RW	Uni		
OL ⇕	0 to 3,200.0 s/100 Hz	⇨	0.2
VT ⇕	0 to 3,200 s/1,000 rpm	⇨	0
SV ⇕	0 to 32.000 s/1,000 rpm	⇨	0

Set up for the required deceleration rate when jogging.

2.30	**Rev acceleration selector**		
2.31	**Rev deceleration selector**		
RW	Uni		P
⇳ 0 to 4		⇨ 0	

When Pr **2.09** is set to 1 for separate reverse acceleration and deceleration, these parameters are used to select reverse acceleration and deceleration ramp rates as follows:

0 Ramp rate selection by terminal input
1 Reverse ramp rate 1 selected
2 Reverse ramp rate 2 selected
3 Reverse ramp rate 3 selected
4 Reverse ramp rate 4 selected

When Pr **2.30** is set to 0 the reverse acceleration ramp rate selected depends on the state of bit Pr **2.38** and Pr **2.39**, and similarly when Pr **2.31** is set to 0 the reverse deceleration ramp rate selected depends on the state of bit Pr **2.40** and Pr **2.41**. These bits are for control by digital inputs such that ramp rates can be selected by external control. The ramp rate selected depends on the binary code generated by these bits as follows:

Pr 2.39, Pr 2.41	Pr 2.38, Pr 2.40	Ramp rate selected
0	0	1
0	1	2
1	0	3
1	1	4

See Figure 4-2 *Menu 2 logic diagram* on page 54 for more information.

2.32	**Forward acceleration select bit 0 (LSB)**		
2.33	**Forward acceleration select bit 1**		
2.34	**Forward acceleration select bit 2 (MSB)**		
2.35	**Forward deceleration select bit 0 (LSB)**		
2.36	**Forward deceleration select bit 1**		
2.37	**Forward deceleration select bit 2 (MSB)**		
2.38	**Reverse acceleration select bit 0 (LSB)**		
2.39	**Reverse acceleration select bit 1 (MSB)**		
2.40	**Reverse deceleration select bit 0 (LSB)**		
2.41	**Reverse deceleration select bit 1 (MSB)**		
RO	Bit		
⇳ 0 or 1		⇨ 0	

These bits are provided for control by logic input terminals for external ramp selection (see Pr **2.22** to Pr **2.25** on page 60).

4.3 Menu 3: Speed feedback / frequency slaving

Open loop

Menu 3 controls frequency slaving, which is where F+D (Frequency and Direction) signals from another drive (master) are used to define the reference frame position for this drive (slave). Frequency monitoring functions for normal and slaving control are provided in menu 3.

Closed loop

Closed-loop mode also includes a speed controller. The speed reference from menu 2 and the feedback to the drive, or small option module feedback device, are fed into a PID controller to produce a torque demand at the output. Speed monitoring functions are also provided in menu 3.

Table 4-3 Menu 3 single line descriptions

Parameter		Range(⇕)		Default(⇨)			Type			
		OL	CL	OL	VT	SV				
3.01	OL> Slave frequency-demand CL> Final speed demand	±1,000.0 Hz	±30,000 rpm				RO	Bi		P
3.02	Speed feedback {**0.10**}		Pr **1.06**				RO	Bi		P
3.03	Speed error		±30,000 rpm				RO	Bi		P
3.04	Speed loop output		$\pm I_{MAX}$ % *				RO	Bi		P
3.05	Zero-speed threshold	0 to 20.0 Hz	0 to 200 rpm	1	5		RW	Uni		
3.06	At-speed lower limit	0 to 1,000.0 Hz	0 to 30,000 rpm	1	5		RW	Uni		
3.07	At-speed upper limit	0 to 1,000.0 Hz	0 to 30,000 rpm	1	5		RW	Uni		
3.08	Over-speed threshold	0 to 1,000.0 Hz	0 to 30,000 rpm	1,000	2,000	4,000	RW	Uni		
3.09	Absolute at-speed detect mode	0 or 1		0			RW	Bit		
3.10	Speed-loop proportional gain {**0.07**}		0 to 32,000		200		RW	Uni		
3.11	Speed-loop integral gain {**0.08**}		0 to 32,000		100		RW	Uni		
3.12	Speed-loop derivative gain {**0.09**}		0 to 32,000		0		RW	Uni		
3.13	Frequency slaving *enable*	0 or 1		0			RW	Bit		
3.14	Slaving ratio numerator	0 to 1.000		1			RW	Uni		
3.15	Slaving ratio denominator	0.001 to 1.000		1			RW	Uni		
3.16	Frequency output *enable*	0 or 1		0			RW	Bit		
3.17	Frequency scaling ratio *select bit 1*	0 or 1		1			RW	Bit		
3.18	Frequency scaling ratio *select bit 2*	0 or 1		0			RW	Bit		
3.19	Hard speed reference		±[Pr **1.06**]		0		RW	Bi		
3.20	Hard speed reference *select*		0 or 1		0		RW	Bit		
3.21	No. of encoder lines / Pulses per revolution	256 to 10,000 Encoder lines / Pulses per rev	256 to 5,000 Encoder lines / Pulses per rev	1,024		4,096	RW	Uni		
3.22	Frequency input *select*	0 or 1		1	0		RW	Bit		
3.23	Encoder supply voltage *select*	0 or 1		0			RW	Bit		
3.24	Encoder termination *disable*	0 or 1		0			RW	Bit		
3.25	Encoder phasing test *enable* {**0.40**}		0 or 1			0	RW	Bit		
3.26	Encoder 1 speed	±30,000 rpm	±30,000 rpm				RO	Bi		P
3.27	Encoder 1 position	0 to 16,383 revs / 16,384	0 to 16,383 revs / 16,384				RO	Uni		P
3.28	Phase position		0 to 6,143 rev / 6143				RW	Uni	S	P
3.29	Over-speed threshold mode *select*	0 or 1		0			RW	Bit		
3.30	Speed feedback filter		0 to 10.0 ms		0		RW	Uni		
3.31	Servo phasing fail (ENCPH9) detection disable		0 or 1			0	RW	Bit		

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

* For definition of $\pm I_{MAX}$ %, see section *Current limits* on page 75.

Figure 4-3 Menu 3 Open-loop logic diagram

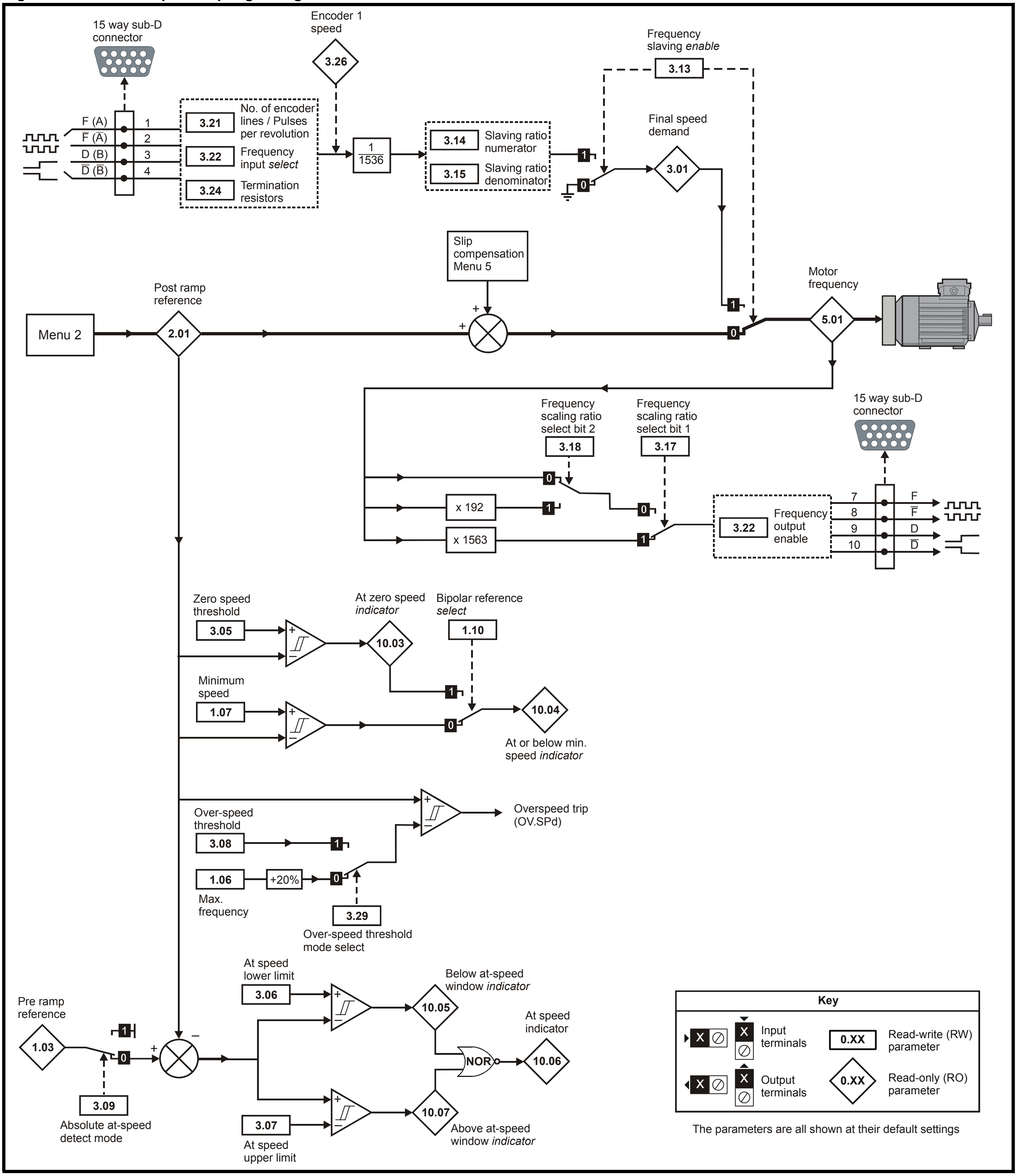
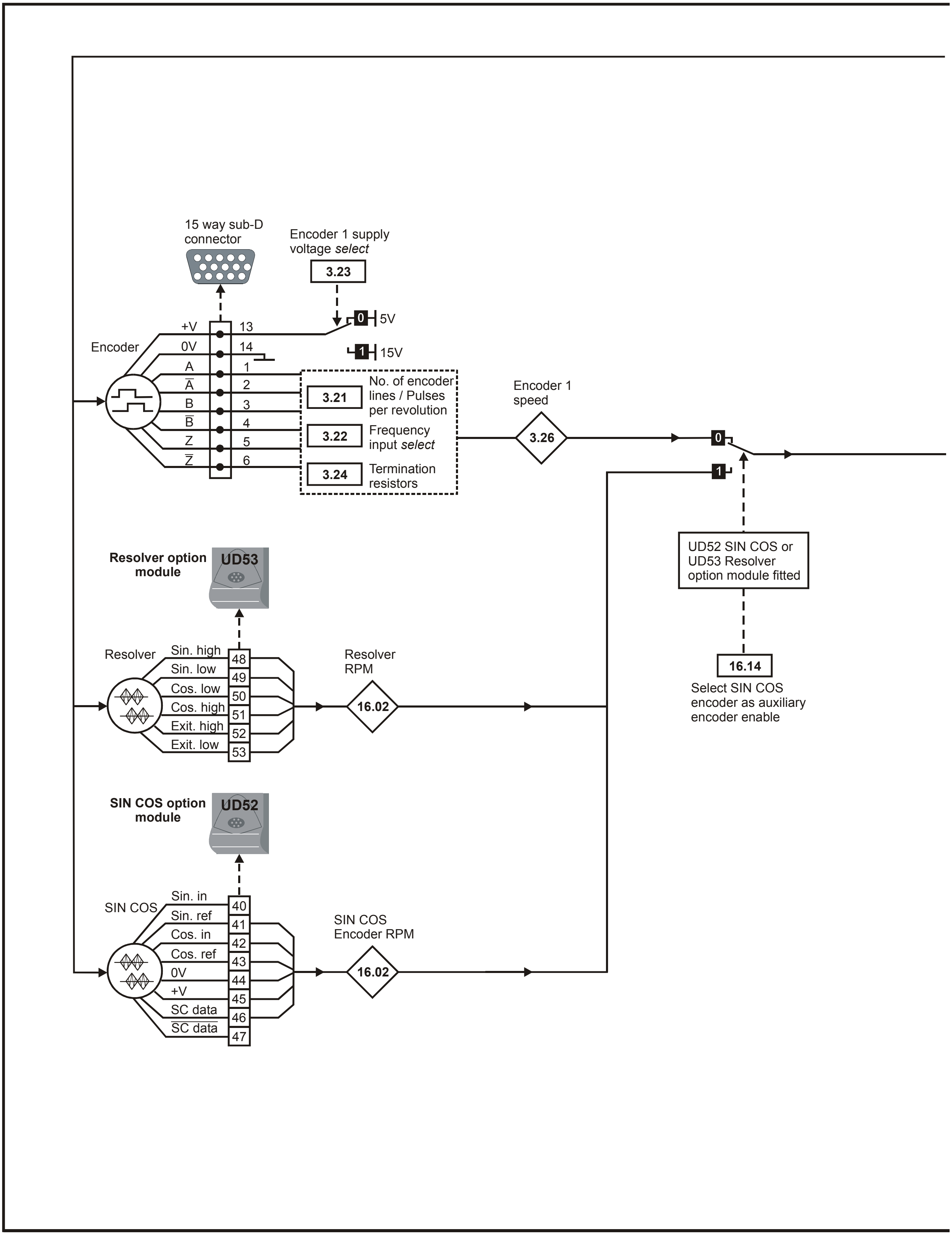
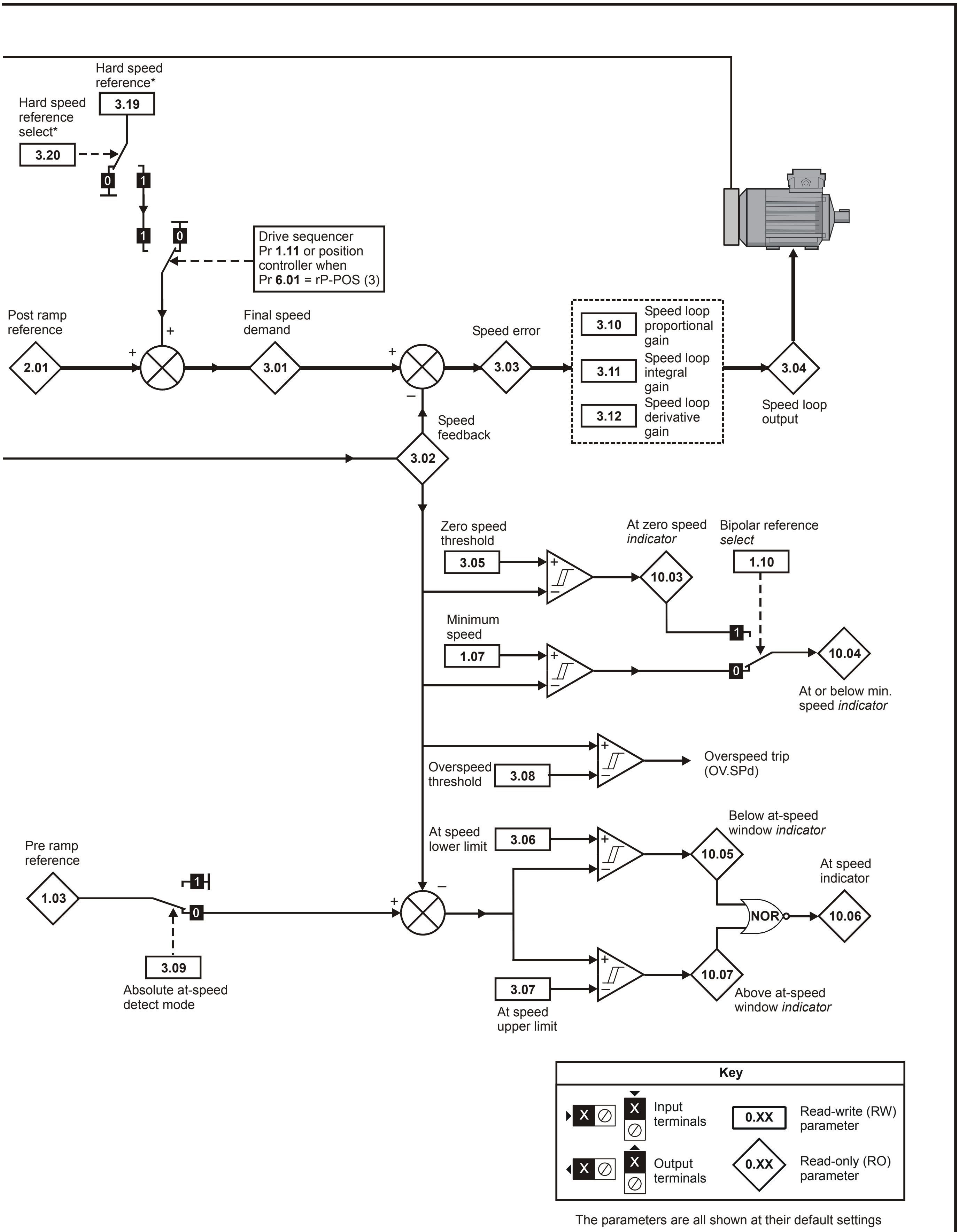


Figure 4-4 Menu 3 Closed-loop logic diagram





* For more information, refer to Pr **3.19** and Pr **3.20** on page 71 descriptions..

Menu 3 parameter descriptions

3.01		Slave frequency demand		
RO		Bi		P
OL	⇕	±1,000.0 Hz	⇨	

The slave frequency demand is only relevant if the drive is operating in frequency slaving mode, in other modes this parameter reads as 0.0. The value shown in slaving mode is the fundamental drive output frequency.

The frequency slaving mode is used to lock the fundamental frequency produced at the drive output with an external frequency applied to the main drive encoder input. This could be used for example to keep the shafts of two synchronous machines in lock, by feeding the F and D output from the master drive into the encoder input of the slave drive. Alternatively the two machines could be operated so that the shafts rotate with an exact ratio, i.e. as though the shafts were connected by gears. (See Pr **3.14** and Pr **3.15** on page 70.)

The source for frequency slaving mode may be A/B quadrature encoder signals or F and D. With the latter care must be taken to ensure that the D set-up time (10µs) is observed or pulses may be lost. The drive will not count pulses whilst it is disabled (this parameter will show 0.0), but will maintain lock once enabled even if the direction of rotation reverses.

In frequency slaving mode the drive current limits are not active, however, the drive peak limit is active and will try and limit the drive current to the magnitude limit by modifying the output voltage away from the defined V to F (Voltage to Frequency) characteristic. If synchronous machines are used and the current required exceeds the drive magnitude limit the slave machine will probably pole slip.

3.01		Final speed demand		
RO		Bi		P
CL	⇕	±30,000.0 rpm	⇨	

Final speed demand at the input to the speed regulator formed by the sum of the ramp output and the hard speed reference (if the hard speed reference is enabled). If the drive is disabled this parameter will show 0.0.

3.02		Speed feedback		
RO		Bi		P
CL	⇕	±30,000.0 rpm	⇨	

The speed feedback may be derived from the main drive encoder or from an alternative feedback device via a small option module, see section 4.16 *Menu 16: Small option module set-up* for further details. If a small option module containing a resolver interface is fitted to the drive the resolver feedback will be selected automatically. If a SINCOS encoder small option module is fitted it may be used to derive the main feedback (see Pr **16.14** on page 205).

3.03		Speed error		
RO		Bi		P
CL	⇕	±30,000.0 rpm	⇨	

The speed error is the difference between the final speed demand and the speed feedback after modification by the speed regulator feedback branch. A detailed description of the speed regulator is given with Pr **3.10**.

3.04		Speed loop output		
RO		Bi		P
CL	⇕	$\pm I_{MAX}$%	⇨	

The output of the speed regulator forms a torque demand which is used to define the torque producing current in the machine (see Pr **3.10** to Pr **3.12** on page 68).

3.05		Zero-speed threshold		
RW		Uni		
OL	⇕	0 to 20.0 Hz	⇨	1
CL	⇕	0 to 200 rpm	⇨	5

Open loop
If the motor frequency (Pr **5.01**) is at or below the level defined by this parameter in either direction the Zero speed flag (Pr **10.03**) is 1, otherwise the flag is 0.

Closed loop
If the speed feedback (Pr **3.02**) is at or below the level defined by this parameter in either direction the Zero speed flag (Pr **10.03**) is 1, otherwise the flag is 0.

3.06	At-speed lower limit		
3.07	**At-speed upper limit**		
RW	Uni		
OL ⇳	0 to 1,000.0 Hz	⇨	1
CL ⇳	0 to 30,000 rpm	⇨	5

Defines the lower and upper threshold for at-speed detection. See Pr **3.09** for more details.

3.08	Over-speed threshold		
RW	Uni		
OL ⇳	0 to 1,000.0 Hz	⇨	1,000.0
VT ⇳	0 to 30,000 rpm	⇨	2,000
SV ⇳		⇨	4,000

Defines the frequency (open loop) or speed (closed loop) above which the drive will trip due to overspeed. See Pr **3.29** on page 74 for details of the open-loop overspeed trip set-up.

3.09	Absolute at-speed detect mode		
RW	Bit		
⇳	0 or 1	⇨	0

Open loop

The at-speed detector sets the at-speed flag (Pr **10.06**) if the motor frequency (Pr **5.01**) is within the 'at speed band'. The speed detector operates on the modulus of frequency. The at speed detector has two alternative modes selected by this parameter. Bits Pr **10.05** and Pr **10.07** indicate if the speed is above or below the required band, a speed equal to either speed boundary is taken as within the 'at speed-band'.

Pr 3.09 = 0 reference window mode

The at speed band is from (reference - lower limit) to (reference + upper limit). The reference is the pre-ramp reference (Pr **1.03**). The detector operates with modulus of the frequency values, and so it operates in the same way in either direction. The at speed flag is active when the following is true:

|Pr **5.01**| ≥ (|Pr **1.03**| - Pr **3.06**) AND |Pr **5.01**| ≤ (|Pr **1.03**| + Pr **3.07**)

Pr 3.09 = 1 absolute window mode

The at-speed band is from the lower limit to the upper limit. Again the modulus of the frequency is used, and so it operates in the same way in either direction. The at-speed flag is active when the following is true:

|Pr **5.01**| ≥ Pr **3.06** AND |Pr **5.01**| ≤ Pr **3.07**

Closed loop

The at-speed detector sets the at-speed flag (Pr **10.06**) if the speed feedback (Pr **3.02**) is within the 'at-speed band'. The speed detector operates on the modulus of speed. The at-speed detector has two alternative modes selected by this parameter. Bits Pr **10.05** and Pr **10.07** indicate if the speed is above or below the required band, a speed equal to either speed boundary is taken as within the 'at speed-band'.

Pr 3.09 = 0 reference window mode

The at-speed band is from (reference - lower limit) to (reference + upper limit). The reference is the pre-ramp reference (Pr **1.03**). The detector operates with modulus of the speed values, and so it operates in the same way in either direction. The at-speed flag is active when the following is true:

|Pr **3.02**| ≥ (|Pr **1.03**| - Pr **3.06**) AND |Pr **3.02**| ≤ (|Pr **1.03**| + Pr **3.07**)

Pr 3.09 = 1 absolute window mode

The at-speed band is from the lower limit to the upper limit. Again the modulus of the speed is used, and so it operates in the same way in either direction. The at-speed flag is active when the following is true:

|Pr **3.02**| ≥ Pr **3.06** AND |Pr **3.02**| ≤ Pr **3.07**

3.10	Speed-loop proportional gain		
RW	Uni		
CL ⇳	0 to 32,000	⇨	200

3.11	Speed-loop itegral gain		
RW	Uni		
CL ⇳	0 to 32,000	⇨	100

3.12	Speed-loop derivative gain		
RW	Uni		
CL ⇳	0 to 32,000	⇨	0

WARNING

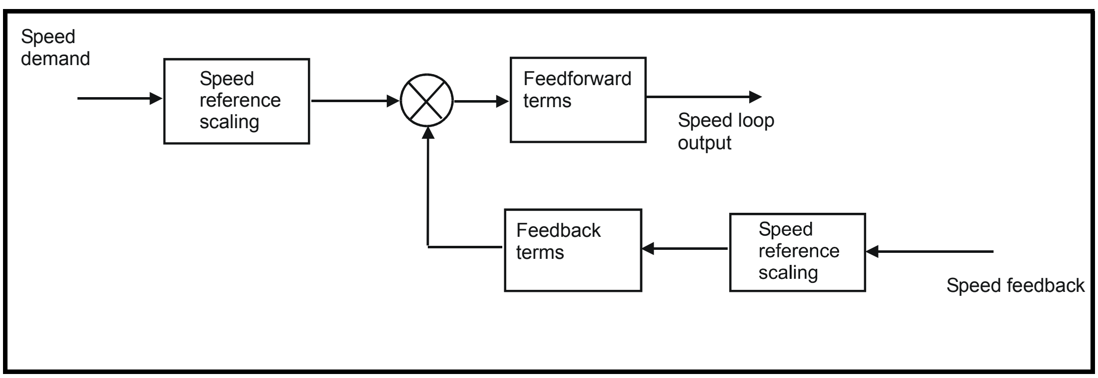
If the speed loop I gain (Pr **3.11**) is set to zero and later increased, a large output transient will result causing the drive to accelerate under full current.

The over speed trip threshold (Pr **3.08**) must be set to a suitable level to prevent the output from reaching a level where mechanical damage could result.

The closed loop speed proportional gain has a minimum internal value of 1.

The speed loop consists of a PID (Proportional, Integral and Derivative) controller that uses the speed demand (Pr **3.01**) and the speed feedback (Pr **3.02**) to produce an output value (Pr **3.04**) that is used in deriving the torque demand. The speed loop operates with a sample time of 345µs with a switching frequency of 3, 6 or 12kHz, or a sample time of 460µs with a switching frequency of 4.5 or 9kHz.

In the following description equations are given to calculate the scaling of speed demand and feedback so that the speed loop may be analysed for different systems. From the results it may appear that the resolution is very low, however, the processor in the drive operates to a far greater accuracy.



Speed feedback scaling:
The speed feedback can either come from an encoder so that the speed feedback used by the controller is the number of pulses counted over one sample period, or from a resolver so that the speed feedback is the difference in angle over one sample period. Although the sample time varies with the switching frequency the speed loop gains are modified internally to achieve the same overall response. Whatever the actual number of encoder pulses or resolver difference the drive automatically modifies the result so that the input appears to come from a device with 16,384 pulses per revolution. The number of pulses counted over a sample period can be calculated as follows:

Number of pulses = 16,384 x 345µs x (speed in rpm / 60)

For example if the speed is 3,000rpm the internal value of speed feedback is 16,384 x 345µs x (3,000rpm / 60) = 282.

Speed reference scaling:
The drive scales the speed reference demand so that the correct speed is produced in rpm.

Speed loop output scaling:
The speed loop output becomes a demand in 'torque' units, which provided the machine is operating below a speed where field weakening is necessary, is the active or torque producing current demand for the drive. Above base speed the torque demand is modified to compensate for field weakening with an induction motor, (see section 4.4 *Menu 4: Current control*). The speed loop output parameter (Pr **3.04**) has a range from -200% to 200%, giving a torque producing current as a percentage of the full load value set up by the user.

For example:

Induction machine
Rated current = 50A
Power factor = 0.85
Assuming no field weakening
Rated active current = 50 x 0.85 = 42.5A
At 100% torque, active current = 42.5A

Servo machine
Rated current = 50A
Rated active current = 50A
At 100% torque, active current = 50A

Although the drive shows the speed loop output as a percentage for user convenience this cannot be used to determine the system gain. This must be done with absolute levels based on the drive hardware current scaling. The speed loop output can in theory vary between -2,046 and +2,046, representing a range between the overcurrent trip levels, although the current limits will keep the actual current demand below this level. The speed loop output should be converted to a proportion of rated torque producing current by including the following gain:

(Overcurrent trip level in amps / 2046) / rated active current

Feedforward terms:
The feedforward block takes the speed error and calculates the speed loop output using a proportional term and an integral term. If it is assumed that the feedback terms are a simple gain of unity the output of the speed loop is given by:

Speed loop output = Kp/16 x speed error + Ki/256 x Σ speed error

Where:

speed error = speed demand - speed feedback
Kp = Pr **3.10**(Proportional gain)
Ki = Pr **3.11**(Integral gain)

If Ki = 0 then the control loop will have only a proportional gain, and so there must be some speed error in order to produce an output from the speed loop. As the required machine load is increased, so the required torque must be increased therefore the speed loop output must increase. This means that the machine will slow down as load is applied. The change of speed with load is referred to as regulation. In theory the amount of regulation depends on the proportional gain, the higher the gain the less the regulation. If the gain is too high however, the control loop could begin to oscillate and produce an unwanted sinusoidal speed ripple. However with a digital system it is more likely that the system will become 'noisy' before the stability limit is reached. The speed loop output will have superimposed noise and the machine will vibrate. Generally the proportional gain can be increased up to a level just below the point where the machine vibrates noticeably. Usually the worst point for machine noise is at zero speed. If a SINCOS encoder is used as the main feedback device the stability limit may be reached without excessive noise because the feedback resolution is higher.

The integral term (Ki/256 x Σ speed error) is provided to prevent speed regulation. The error is added up over a period of time and used to produce the necessary speed loop output without any error. Because it takes time to accumulate the necessary value the integral term is slower than the proportional term. Although the speed demand and feedback will become equal this does not occur instantaneously. If the integral term is too high the speed will normally include an unwanted sinusoidal component. Therefore the gain can be increased up to a level below this limit. It should be noted that the proportional gain helps to prevent oscillations due to the integral term, and so both gains should be as high as possible.

Feedback terms:
So far it has been assumed that the feedback term is a gain of unity. However the feedback term includes a differential term and is given by:

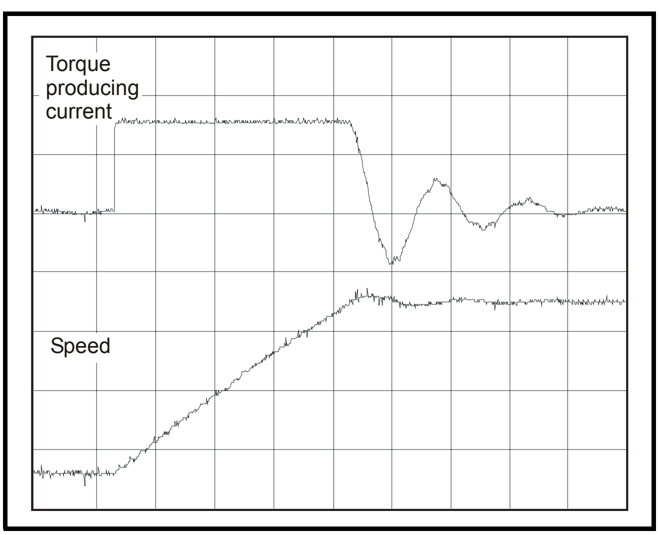
Feedback terms output = speed feedback + Kd x d(speed feedback)/dt

Where:

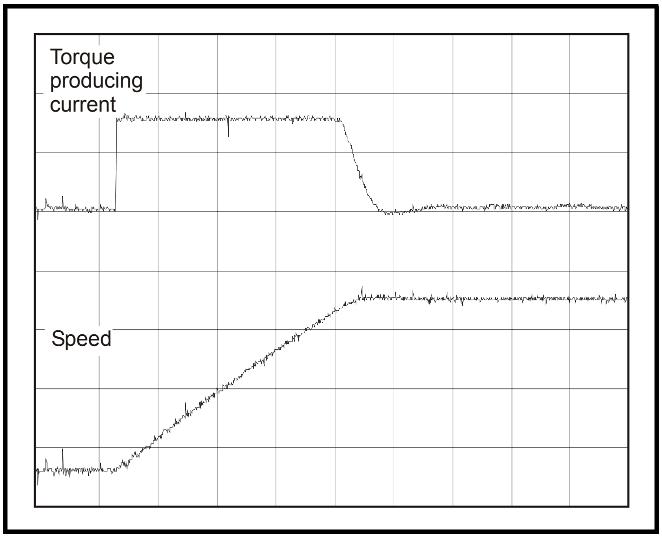
Kd = Pr **3.12**(Derivative gain)

The actual value of Kd cannot be given in a simple form, but the effect of the differential term is proportional to Pr **3.12**. If Pr **3.12** = 0, the differential term has no effect and the feedback gain is unity.

If the feedback gain is unity some overshoot can occur when the speed reaches the demanded value due to the integral term building up a value at the start of the acceleration as shown below:



This effect can be reduced by increasing the differential gain (Pr **3.12**) to obtain a response as shown below. However, if the gain is too high the machine will become noisy in a similar way to that when the proportional gain is too high.



3.13	Frequency slaving enable				
RW		Bit			
OL	⇕	0 or 1	⇨	0	

Frequency slaving as described in Pr **3.01** is enabled by this parameter. Frequency slaving can be enabled or disabled even when the drive is enabled. The change from slaving to normal operation will result in the frequency ramping from the slaving frequency to the demanded frequency using whichever ramp rate that is applicable to normal operation. The change from normal operation to slaving will result in an instantaneous change to the slaving frequency. Therefore the slaving frequency should be similar to the demanded frequency before the change is made.

3.14	Slaving ratio numerator				
RW		Uni			
OL	⇕	0.000 to 1.000	⇨	1.000	

3.15	Slaving ratio denominator				
RW		Uni			
OL	⇕	0.001 to 1.000	⇨	1.000	

The slave frequency input can be scaled before it defines the slave frequency demand (Pr **3.01**) as follows:

F and D input

Pr **3.01** = (input frequency / 1,536) x (Pr **3.14** / Pr **3.15**)

The numerator and denominator can be adjusted whilst the drive is running without causing jumps in angle. However if the change in ratio causes a large change in frequency the transient current could activate the peak limit or trip the drive. The input is divided by 1,536 so that it is compatible with another Unidrive which is supplying 1,536 times its own output frequency. However both CD2 and CDE produce 192 times their output frequencies. To make Unidrive compatible with CD2 or CDE the ratio simply needs to be increased by a factor of 4. It should be noted that the maximum input frequency is 205kHz and that if frequencies higher than this are used pulses may be lost. Whatever ratio is used the drive will limit the slaving frequency demand to 1kHz.

The frequency slaving mode is primarily designed for locking the outputs of drives operating in the open loop mode. However it is possible to use A and B signals from an encoder as the slaving reference. The effective input frequency is given by:

2 x (speed in rpm / 60) x encoder lines

As 1,536 = 256 x 6, the effect of this division can be cancelled out exactly if an encoder with a power of 2 lines per revolution is used.

3.16		Frequency output enable		
RW		Bit		
OL	⇳	0 or 1	⇨	0

The frequency output is in the form of F and D signals. At a change of direction the following sequence occurs for x192 and x1,536 modes to prevent loss of pulses.

F pulses	No F pulses	D changes at the start of this period. No F pulses	No F pulses	F pulses

Each period is 345µs if the switching frequency is 3, 6 or 12kHz, or 460µs if the switching frequency is 4.5 or 9kHz. The frequency output may be enabled and disabled whilst the drive is running without problems.

3.17		Frequency scaling ratio select bit 1		
RW		Bit		
OL	⇳	0 or 1	⇨	1

3.18		Frequency scaling ratio select bit 2		
RW		Bit		
OL	⇳	0 or 1	⇨	0

The frequency of the F and D output is either x1, x192 or x1,536 of the fundamental drive output frequency. The multiplication factor is defined by bits Pr **3.17** and Pr **3.18** as follows:

Pr 3.17	Pr 3.18	Ratio
0	0	x1
0	1	x192
1	0	x1,536
1	1	x1,536

3.19		Hard speed reference		
RW		Bi		
CL	⇳	[Pr **1.06**]	⇨	0

The range of this parameter is limited depending on the maximum speed expected which is the maximum magnitude from Pr **1.06** or Pr **1.07**.

The hard speed reference is a reference value which does not pass through the ramp system (menu 2). It is added to the normal post ramp speed reference. Its value may be written from the keypad, via serial comms, from an analog input or from an encoder input. This parameter can also be used by the position controller (menu 13) as the speed correction input.

This parameter is similar to the analog input parameters (Pr **1.36** and Pr **1.37**) in that if an analog input programmed in voltage mode is directed to it, the scan rate of that analog input is increased (See section 4.1 *Menu 1: Speed references and limits*). The scaling will be the same as for bipolar mode on Pr **1.36** and Pr **1.37**. It is also possible to obtain a fast update rate if an encoder input is used to derive this speed reference.

3.20		Hard speed reference select		
RW		Bit		
CL	⇳	0 or 1	⇨	0

Enables connection of the hard speed reference.

3.21		No. of encoder lines / Pulses per revolution		
RW		Uni		
OL	⇳	256 to 10,000 Encoder lines / Pulses per rev	⇨	1,024
VT	⇳	256 to 5,000 Encoder lines / Pulses per rev	⇨	1,024
SV	⇳		⇨	4,096

Open loop

To obtain correct values in Pr **3.26** (encoder 1 input rpm) and Pr **3.27** (encoder 1 position) the number of lines/pulses per revolution must be set up correctly. The rpm and position values are also used in menu 13 for position control and the revolution counter, and these will not operate correctly if this parameter is not set up. The input may come from a quadrature encoder if Pr **3.22** = 0, or non-quadrature encoder if Pr **3.22** = 1. The parameter value is limited to 5,000 if Pr **3.22** = 0, or 10,000 if Pr **3.22** = 1.

Closed loop
As for the open loop drive the values in Pr **3.26** and Pr **3.27** will only be correct if the number of line/pulses is set up correctly. Also the position control and revolution counter will only operate correctly if this parameter is set up.

If the drive encoder is used to derive speed feedback, it is important to set up the encoder lines/pulses per rev so that the machine will run at the correct rpm set via the speed demand.

The parameter value is limited to 5,000 if Pr **3.22** = 0, or 10,000 if Pr **3.22** = 1. The maximum motor speed that can be defined by Pr **1.06** and Pr **1.07** is limited depending on the value of this parameter as given below:

If Pr **3.22** = 0:
Maximum speed reference = 5,000 x 3,000 / Pr **3.21**

If Pr **3.22** = 1
Maximum speed reference = 10,000 x 3,000 / Pr **3.21**

It should be noted that although the encoder used may have more than 4,096 lines per revolution, the internal motor control calculations including speed feedback calculations only use 4,096 lines. Therefore the motor control performance cannot be improved from the level obtainable with a 4,096 line encoder, by using an encoder with more lines.

3.22		Frequency input select		
RW		Bit		
OL	⇳	0 or 1	⇨	1
CL	⇳		⇨	0

Open loop
Normally the encoder input is used for frequency slaving, and so Pr **3.22** should be set to 1 so that F and D mode is active. It is however possible to feed the frequency slaving system with quadrature A and B signals. In this case Pr **3.22** should be set to 0.

Closed loop
Normally the drive encoder input is used to derive speed feedback from an encoder giving A/B quadrature signals, and so this parameter is normally set to 0. However if required the encoder interface can receive F and D signals (Pr **3.22** = 1).

3.23	Encoder supply voltage select		
RW	Bit		
⇳	0 or 1	⇨	0

The supply voltage from the drive to the encoder 1 connector can be either +5V (Pr **3.23** = 0) or +15V (Pr **3.23** = 1). Care should be taken not to change this parameter if a +5V encoder is being used, or else the encoder may be damaged.

3.24	Encoder termination disable		
RW	Bit		
⇳	0 or 1	⇨	0

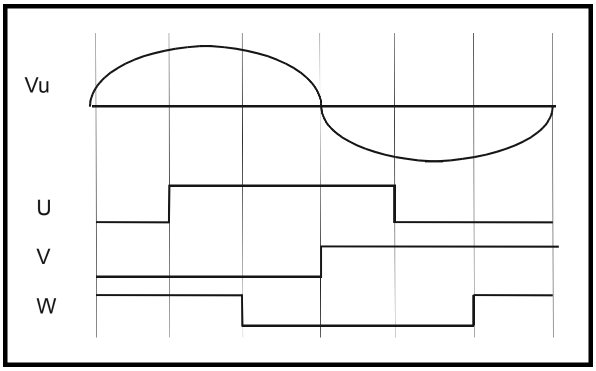
If Pr **3.24** = 0 the encoder 1 inputs are terminated with 120R. Normally termination is required if the incoming signals are connected to one drive only. However, if the signals are connected to several drives the termination should only be present on the furthest drive from the source of the signals.

3.25		Encoder phasing test enable		
RW		Bit		
SV	⇳	0 or 1	⇨	0

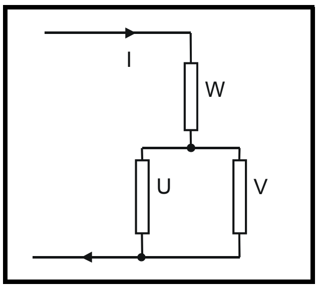
The alignment between the encoder used for feedback from a servo machine supplied by the drive is important for the control algorithms to work correctly. The required alignment is as follows:

Encoder

If the machine is rotated in the forwards direction (i.e. Vu leads Vv by 120deg and Vv leads Vw by 120deg) the relationship between the commutation signals and Vu should be as shown below.



A static test can also be done to check the alignment by passing a DC current through the machine as shown below. The U commutation signal should be toggling from high to low, the V signal should be low and the W signal should be high.



If the encoder is not aligned it is possible for the drive to check the alignment and to make the necessary compensation. This test can be initiated by setting Pr **3.25** (and is only performed if the enable is active). During the test the drive will rotate the motor slowly in the forwards direction. Once the test has been completed Pr **3.25** is automatically reset by the drive. **If any load is applied to the machine during the phasing test the phase measured by the drive could be incorrect.** It is conventional for a motor to rotate in the clockwise direction (looking from the motor shaft end, i.e. opposite end to the encoder) when the forwards direction is selected. The direction of rotation could be opposite depending on the encoder type, and connections. A motor fitted with a RENCO RCH20 encoder or Stegmann CDD50 DiCoder should rotate in the correct direction if the connections are made correctly. The phasing test only requires the drive to be enabled, it will be carried out even if the RUN input to the drive sequencer is not active. If the run input is active during the phasing test the drive could start immediately at the end of the test (depending on the sequencing mode). If the RUN is not active the drive will enter the RDY state at the end of the test. The level of current used for the test and the speed at which the motor is rotated can be controlled by Pr **5.27**. If Pr **5.27** = 0, half rated motor current is used and a fast test is performed (suitable for most motors which do not have high inertia loads). If Pr **5.27** = 1, full rated current is used and a slow test is performed (suitable for motors with very high inertia loads).

3.26	**Encoder 1 speed**		
RO	Bi		P
⇳	±30,000 rpm	⇨	

This parameter will show the rpm of the machine connected to the encoder 1 input provided Pr **3.21** and Pr **3.22** have been set up correctly.

3.27	**Encoder 1 position**		
RO	Uni		P
⇳	0 to 16,383 revs / 16,384	⇨	

This parameter gives the encoder position counted from the point when the drive was powered up, or if an index marker is detected the position relative to the point where the marker is detected.

3.28		**Phase position**		
RW		Uni	S	P
CL	⇳	0 to 6,143 rev / 6,143	⇨	

The result of the encoder phasing test (see Pr **3.25** on page 72) is the phase offset required to allow the servo algorithms to operate correctly. This parameter shows the offset value in electrical units which vary from 0 to 6,143 (unlike the normal mechanical units which vary from 0 to 16,383). As this is saved at power-down the offset applies from the point when the test is done until the test is repeated. Loading of default parameters does not affect this value, and so this will not reset the phase position. Care should be taken when putting values directly into this parameter, because incorrect phasing can cause torque to be produced in the wrong direction. Under speed control this causes the motor to accelerate rapidly until it trips when overspeed is detected. If this parameter is changed when using feedback from a small option module to control the motor, the change of phasing will have an immediate effect on the motor phasing whether the motor is running or disabled. If the main drive encoder is used for feedback to control the motor, a change of this parameter will only affect the motor phasing when the drive has been disabled and is then enabled.

3.29		Over-speed threshold mode select			
RW		Bit			
OL	⇳	0 or 1	⇨	0	

When this parameter is set to zero then the overspeed threshold in both forward and reverse directions is equal to the full scale frequency +20%. (Full scale frequency is defined by Pr **1.06** or the modulus of Pr **1.07** which ever is the greater.) If the speed exceeds this value the drive will trip on overspeed. This allows the drive to operate up to full scale with some margin for slip compensation. Note that there is an upper limit on drive output frequency of 1,000.0Hz and so if the rated frequency is any value above 800Hz then the trip frequency will be 1,000Hz. Thus above 800Hz there is a progressively reducing overspeed margin.

When this parameter is set to one the overspeed trip level is defined by the overspeed threshold Pr **3.08**. If the drive exceeds this value in either forward or reverse direction the drive will trip on overspeed. The default value for Pr **3.08** in open loop is 1,000Hz.

If Pr **3.29** = 1 and Pr **3.08** = 1,001 then all overspeed trips are effectively disabled as the actual output frequency can never reach the trip threshold. (This parameter can only have a value of 0 on a Unidrive VTC.)

3.30		Speed feedback filter			
RW		Uni			
CL	⇳	0 to 10.0 ms	⇨	0	

A window filter is provided on the speed feedback. The feedback is taken over a sliding window of the length specified by this parameter. This is useful in applications where the load inertia is high and a very high proportional gain is required for the speed controller. If the speed feedback is not filtered, the current demand can include a very high level of ripple. Although this has little effect of the load it can affect the integral hold function of the speed loop because the current limits can become active.

3.31		Servo phasing fail (ENCPH9) detection disable			
RW		Bit			
SV	⇳	0 or 1	⇨	0	

If this bit is left at zero the drive will attempt to detect incorrect servo phasing giving ENCPH9 trip if this is detected. This trip may be disabled if required by setting this bit parameter to 1.

4.4 Menu 4: Current control

Open-loop

In open-loop mode a current controller is provided to give current limiting in frequency control mode and a torque controller in torque control mode. The active current is controlled by modification of the drive output frequency. Menu 4 provides parameters to set-up the current controller. Additional voltage based current control is provided to limit transients (peak-limit), but there are no user setable parameters to control this.

Closed-loop

In closed-loop modes the output of the speed controller is a torque demand, which is translated into a torque producing current demand. The output of the flux controller for a closed-loop vector drive is a flux producing current demand. These current demands form the reference values for two current controllers operating in a rotating reference frame that provide voltage demands for the drive inverter. Menu 4 provides all the parameters to operate the current controllers.

Current limits

Within the drive there are two over-riding current limits; maximum drive current amd maximum current limit defined as:

Maximum drive current is the maximum controllable r.m.s phase current
For open-loop control this is 150% x drive rated current
For closed-loop control this is 175% x drive rated current
(For size 5 the maximum is 150% x drive rated current in all modes)

Maximum current limit is equivalent to the maximum active current allowed by the drive for a given power factor setting.
For sizes 1 to 4:
Open-loop maximum active current = drive rated current x 150% x power factor
Closed-loop maximum active current = drive rated current x 175% x power factor

For size 5:
maximum active current = module rated current x 120% x power factor x no. of modules

Size 5 module rated current is given as the level for HVAC applications. Therefore 120% overload is possible if the motor rated current is equal to the drive rated current. For industrial applications the maximum drive rated current is stated lower to allow for 150% overload.

Then maximum current limit = maximum active current / Pr **5.07**, when Pr **5.07** is the motor rated current.

The default setting for the current limit parameters are 150% x motor rated current for open loop and closed loop vector modes and 175%* x motor rated current for servo mode. *150% for Unidrive size 5.

There are three parameters which control the current limits:

- Pr **4.05** *Motoring current limit*: power flowing from the drive to the motor
- Pr **4.06** *Regen current limit*: power flowing from the motor to the drive
- Pr **4.07** *Symmetrical current limit*: current limit for both motoring and regen operation

The lowest of either the motoring and regen current limit or the symmetrical current limit applies.

The maximum setting of these parameters depends on the ratio of motor rated current to drive rated current and the power factor.

The drive can be oversized to permit a higher current limit setting to provide higher accelerating torque as required up to a maximum of 400%.

Please note that too high a setting of these parameters can cause permanent damage to a servo motor by demagnetising the rotor.

The maximum current limits ($I_{MAX}\%$) available for each mode of operation, are calculated from the following equations.

Open loop

$$I_{MAX}\% = \left(\sqrt{\left(\left(\frac{\left(1.597^2 \times \left(\frac{Pr\ 11.32}{Pr\ 5.07}\right)^2 - 1\right)}{Pr\ 5.10^2}\right) + 1\right)} - \left(\frac{0.156 \times Pr\ 11.32}{Pr\ 5.10 \times Pr\ 5.07}\right)\right) \times 100$$

The above equation gives a value less than 150% if Pr **5.10** >0.93. The maximum current limit value used by the drive is 150% if the calculated value is less than 150%.

Closed loop vector

$$I_{MAX}\% = \sqrt{\left(\left(\frac{\left(1.597^2 \times \left(\frac{Pr\ 11.32}{Pr\ 5.07}\right)^2 - 1\right)}{Pr\ 5.10^2}\right) + 1\right)} \times 100$$

Servo

$$I_{MAX}\% = \left(1.767 \times \left(\frac{Pr\ 11.32}{Pr\ 5.07}\right)\right) \times 100$$

Unidrive VTC

$$I_{MAX}\% = \sqrt{\left(\left(\frac{\left(1.203^2 \times \left(\frac{Pr\ 11.32}{Pr\ 5.07}\right)^2 - 1\right)}{Pr\ 5.10^2}\right) + 1\right)} \times 100$$

Table 4-4 Menu 4 single line descriptions

Parameter		Range(⇕) OL	Range(⇕) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
4.01	Motor current magnitude	0 to I_{MAX} A					RO	Uni		P
4.02	Motor active-current {**0.13**}	± I_{MAX} A					RO	Bi		P
4.03	Torque demand	± I_{MAX} %					RO	Bi		P
4.04	Current demand	± I_{MAX} %					RO	Bi		P
4.05	Motoring current limit	0 to I_{MAX} %		150*		175	RW	Uni		
4.06	Regenerating current limit	0 to I_{MAX} %		150*		175	RW	Uni		
4.07	Symmetrical current limit {**0.06**}	0 to I_{MAX} %		150*		175	RW	Uni		
4.08	Torque reference	± I_{MAX} %		0			RW	Bi		
4.09	Torque reference offset	± I_{MAX} %		0			RW	Bi		
4.10	Torque reference offset *enable*	0 or 1		0			RW	Bit		
4.11	Torque mode *selec*tor {**0.17**}	0 to 1	0 to 4	0			RW	Uni		P
4.12	Current-demand filter time-constant		0 to 250 ms		0		RW	Uni		
4.13	Current-loop proportional gain	0 to 30,000		20	150	130	RW	Uni		
4.14	Current-loop integral gain	0 to 30,000		40	2,000	1,200	RW	Uni		
4.15	Motor thermal time-constant	0 to 400.0 s		89.0		7.0	RW	Uni		
4.16	Motor protection mode *select*	0 or 1		0			RW	Bit		
4.17	Motor magnetizing current	± I_{MAX} A					RO	Bi		P
4.18	Over-riding current limit	0 to I_{MAX} %					RO	Uni		P
4.19	Overload accumulator	0 to 100 %					RO	Uni		P
4.20	Percentage torque current	± I_{MAX} %					RO	Bi		P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

* These parameters have a default setting of 120% in Unidrive VTC.

Types of current range

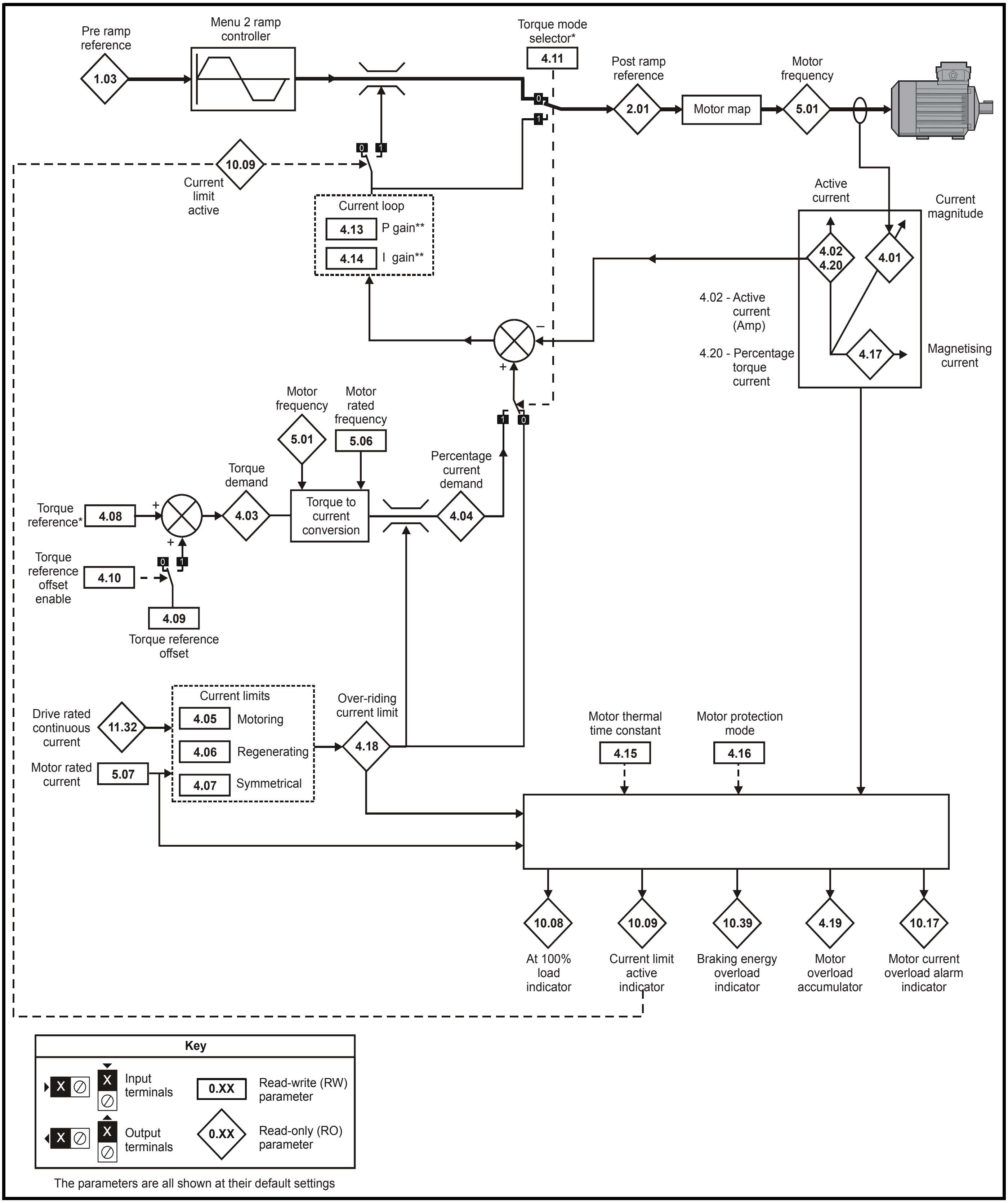
FLC Full load current of the drive (maximum continuous output current up to 40^{o}C ambient temperature). Displayed in Pr **11.32** {**0.33**}.

I_{MAX} A Maximum overload output current of the drive up to 40^{o}C ambient temperature, derived as follows:

Size 1 to 4: OL> 150% x FLC
CL> 175% x FLC
Size 5: 150% x FLC

I_{MAX} % See section *Current limits* on page 75 for the definition of I_{MAX}%.

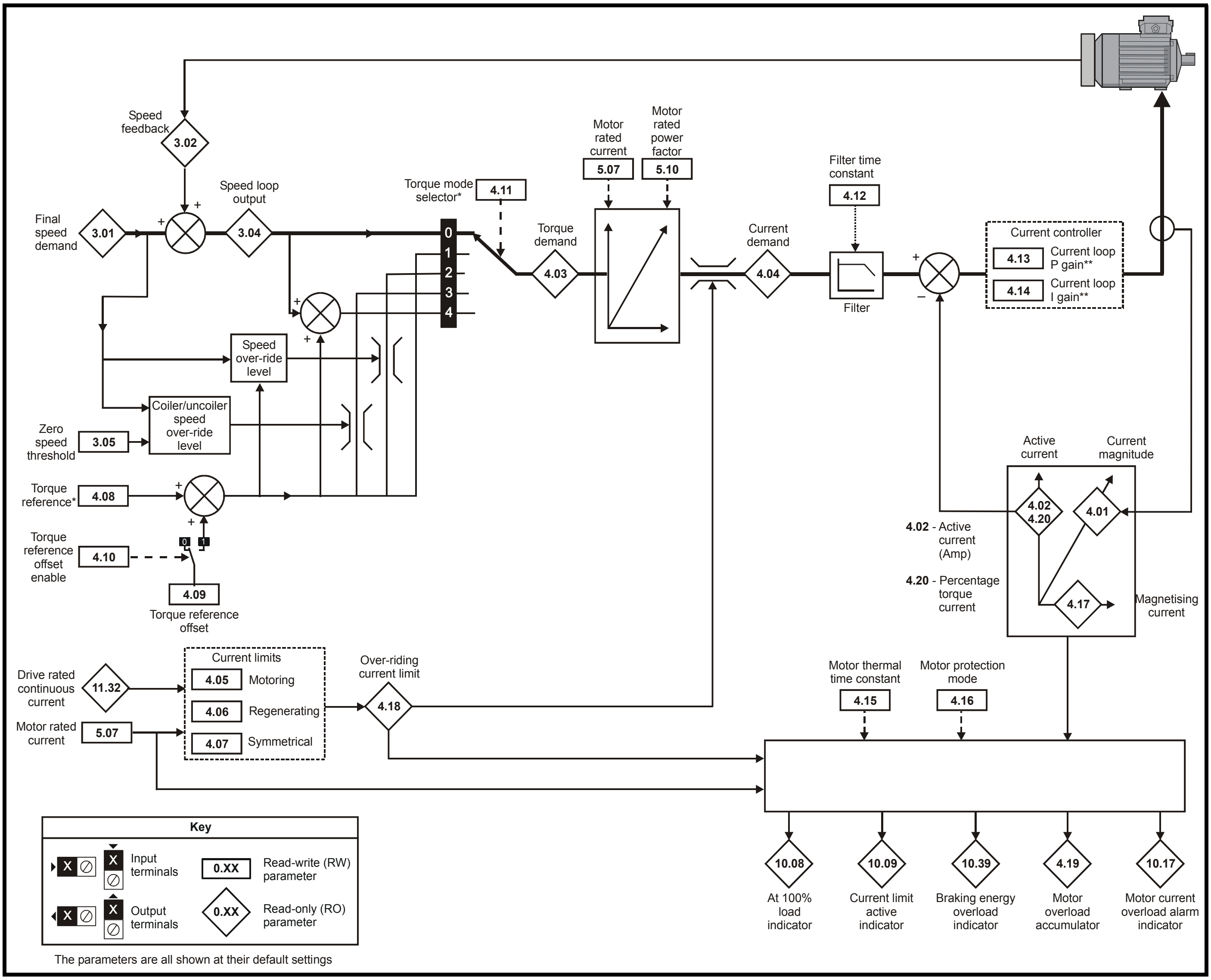
Figure 4-5 Menu 4 Open-loop logic diagram



* For more information, please refer to Pr **4.11** on page 82.

** For more information, please refer to Pr **4.13** on page 84 and Pr **4.14** on page 84.

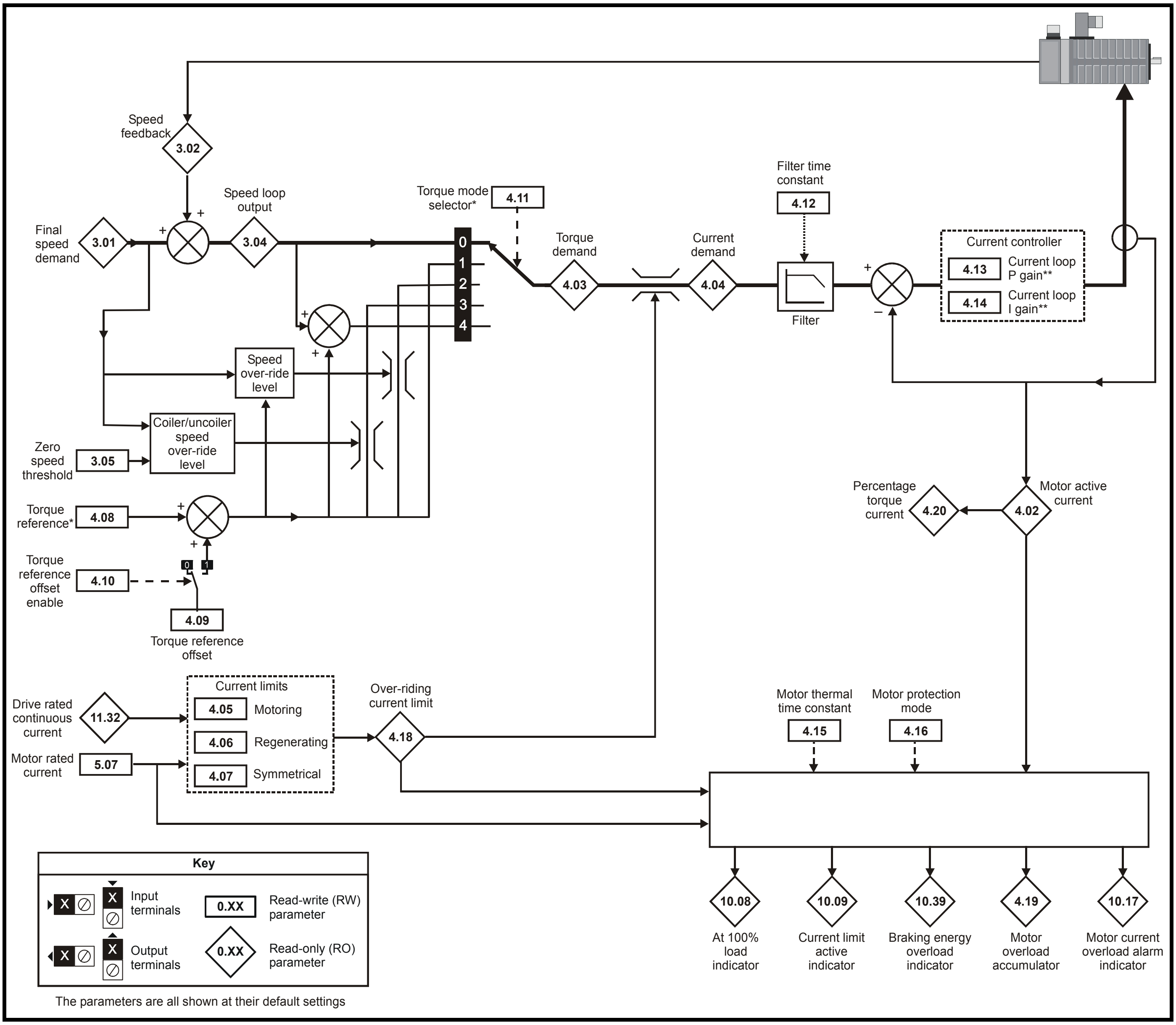
Figure 4-6 Menu 4 Closed-loop vector logic diagram



* For more information, please refer to Pr **4.11** on page 82.

** For more information, please refer to Pr **4.13** on page 84 and Pr **4.14** on page 84.

Figure 4-7 Menu 4 Servo logic diagram



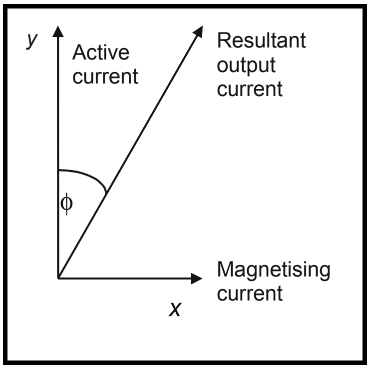
* For more information, please refer to Pr **4.11** on page 82.

** For more information, please refer to Pr **4.13** on page 84 and Pr **4.14** on page 84.

Menu 4 parameter descriptions

4.01	Motor current magnitude		
RO	Uni		P
⇕	0 to I_{MAX} A	⇨	

This parameter is the rms current from each output phase of the drive. The phase currents consist of an active component and a magnetising component. The three phase currents can be combined to form a resultant current vector as shown below:



The magnitude given in Pr **4.01** is proportional to the length of the resultant output current vector.

The magnetic flux in an induction motor, whether operating under open loop or closed loop vector control, must come from the drive and is produced by the magnetising current. This means that the power factor (cos f) will not be unity, but generally in the range from 0.8 to 0.9 for a machine operating with rated load.

The magnetic flux in a servo motor comes from the magnets on the rotor, and so the drive does not have to supply a current to generate flux. The drive will attempt to hold the power factor as close to unity as possible.

4.02	Motor active-current		
RO	Bi		P
⇕	$\pm I_{MAX}$ A	⇨	

The diagram above shows the magnetising and active current vectors. These are represented in x and y axes of a reference frame. Pr **4.02** gives the active current which is proportional to the length of the vector in the y axis and equivalent to the active phase current value in amps.

Open loop
If the drive operates with fixed boost the y axis is aligned with the output voltage. Therefore the magnetising current represents the reactive component of current leaving the drive and the active current represents the real component of current leaving the drive. Therefore the active current produces torque and supplies the losses in the motor.

If the drive operates in vector mode (see Pr **5.14** on page 95) the x axis is aligned with the stator flux in the steady state, and so the active current should be proportional to the torque produced by the machine. The active current will give a good indication of the machine torque over most of the frequency range, however, the accuracy is reduced below 10Hz. This method of control gives only moderate transient performance and the active current does not necessarily give a good indication of motor torque under transient conditions.

In both cases the relationship between the active current and motor torque will change once the maximum drive output voltage or the rated voltage of the motor set by Pr **5.09** is reached, whichever is the lowest. (Generally the maximum drive output voltage will be just below the r.m.s. line supply voltage.) Once one of these limits is reached the voltage is held constant and the motor flux reduces with frequency. This is referred to as field weakening or constant power operation. In this region the relationship between torque and active current is approximately as follows, where K is a constant related to the motor:

Torque = K x active current x frequency at voltage limit / actual frequency

Normally the point at which the voltage limit is reached is close to the rated frequency of the motor.

Closed loop Vector
The x axis of the reference frame is aligned with the rotor flux of the motor. The active current is the torque producing current and will give a good indication of the torque being produced by the machine at all speeds up to a level just below base speed. Above this speed the motor flux is reduced with increasing speed (field weakening or constant power operation). Field weakening must be applied, either because the drive cannot produce any more voltage, or because the rated voltage of the motor has been reached (as set by Pr **5.02**). In the field weakening range the relationship between torque and active current is approximately as follows, where K is a constant related to the motor:

Torque = K x active current x speed at voltage limit / actual speed

Normally the point at which the voltage limit is reached is close to the rated speed of the motor (see Pr **5.20** on page 97).

Servo
The x axis of the reference frame is aligned with the rotor flux of the motor. The active current is the torque producing current and will give a good indication of the torque being produced by the motor. The drive does not field weaken a servo motor, and so the motor cannot operate at a voltage above the point where the drive cannot produce anymore voltage.

4.03	Torque demand		
RO	Bi		P
⇳	$\pm I_{MAX}$ %	⇨	

Open-loop
The torque demand is the sum of the torque reference (Pr **4.08**) and the torque offset (Pr **4.09**), if enabled. The units of the torque demand are % of rated torque. 100% rated torque is defined by the settings of the drive parameters as shown in the following example:

Motor rated current (Pr **5.07**) = 50A
Motor rated power factor (Pr **5.10**) = 0.85

Assuming frequency is below the point where the voltage limit is reached

Rated active current = 50 x 0.85 = 42.5A
At 100% torque, active current = 42.5A

A positive value of torque demand indicates motoring torque in the positive direction, or regenerating torque in the reverse direction. A negative value indicates regenerative torque in the positive direction and motoring torque in the reverse direction.

Closed-loop
The torque demand can be derived either from the speed loop output or programmed separately depending on the value of Pr **4.11**. The units of the torque demand are % of rated torque, where 100% rated torque is defined by the user in the same way as for the open loop drive. A positive value of torque demand indicates motoring torque in the positive direction, or regenerating torque in the reverse direction. A negative value indicates regenerative torque in the positive direction and motoring torque in the reverse direction.

4.04	Current demand		
RO	Bi		P
⇳	$\pm I_{MAX}$ %	⇨	

Open-loop
The current demand is derived from the torque demand. Provided the motor is not field weakened the torque and current demands are the same. In field weakening the current demand is increased with reduced flux :

Pr **4.04** = Pr **4.03** x frequency / rated frequency

The current demand is subject to the current limits.

Closed-loop vector
The current demand is derived from the torque demand. Provided the motor is not field weakened the torque and current demands are the same. In the field weakening range the current demand is increased with reduced flux unless Pr **5.28** = 1. The level of flux is derived from the motor model within the drive controllers.

Pr **4.04** = Pr **4.03** x flux / rated flux

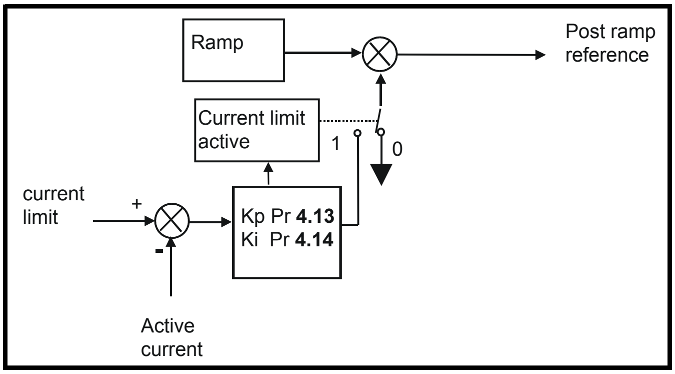
Servo
The current demand and torque demand are the same because field weakening is not possible.

4.05	Motoring current limit			
4.06	Regenerating current limit			
4.07	Symmetrical current limit			
RW	Uni			
OL	⇳	0 to I_{MAX} %	⇨	150
VT	⇳	0 to I_{MAX} %	⇨	150
SV	⇳	0 to I_{MAX} %	⇨	175

The motoring current limit applies in either direction when the machine is producing motoring torque. Similarly the regenerating current limit applies in either direction when the machine is producing regenerating torque. The symmetrical current limit can override either motoring or regenerating current limit if it is set at a lower value than either limit. The maximum current limit value depends on the level set for the motor rated current (Pr **5.07**). The maximum value allowed for the motor rated current is the drive rated current. The drive uses the following methods to try to maintain the currents within the specified limits:

Open loop

In frequency control mode (Pr **4.11** = 0), the drive output frequency is modified if necessary to keep the active current within the current limits as shown below:



The current limits are compared with the active current and if the current exceeds a limit the error value passes through the PI controller to give a frequency component which is used to modify the ramp output. The direction of the modification is always to reduce the frequency to zero if the active current is over the motoring limit, or to increase the frequency towards the maximum if the current is over the regenerating limit. Even when the current limit is active the ramp still operates, therefore the proportional and integral gains (Pr **4.13** and Pr **4.14**) must be high enough to counter the effects of the ramp. For a method of setting the gains see Pr **4.13** and Pr **4.14** on page 84.

In torque control mode the current demand is limited by the current limits. For operation of this mode see Pr **4.11**.

Closed loop

The current demand input to the current controllers is limited by the current limits.

4.08	**Torque reference**		
RW	Bi		
⇳	$\pm I_{MAX}$ %	⇨	0

Parameter for main torque reference. If connected to an analog input on this drive this parameter is updated every 345µs for 3, 6 and 12kHz switching frequency, and every 460µs for 4.5 and 9kHz switching frequency. This does not apply to the analog inputs of the 'Additional I/O Module'.

4.09	**Torque reference offset**		
RW	Bi		
⇳	$\pm I_{MAX}$ %	⇨	0

Parameter for an offset to be added to the main torque reference. If connected to an analog input the value this is updated every 5.5ms for 3, 6 and 12kHz switching frequency, and every 7.4ms for 4.5 and 9kHz switching frequency. Therefore the main torque reference should be used in applications where fast updating is required.

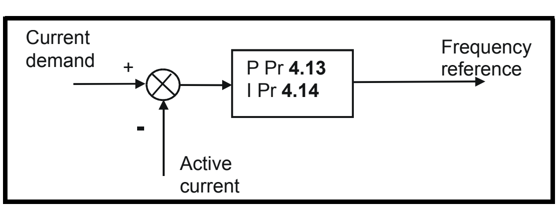
4.10	**Torque reference offset enable**		
RW	Bit		
⇳	0 or 1	⇨	0

If set the torque offset is added to the torque reference.

4.11		**Torque mode selector**		
RW		Uni		P
OL	⇳	0 to 1	⇨	0
CL	⇳	0 to 4	⇨	

Open loop

If this parameter is 0 normal frequency control is used. If this parameter is set to 1 the current demand is connected to the current PI controller giving closed loop torque/current demand as shown below. The current error is passed through proportional and integral terms to give a frequency reference which is limited to the range -maximum frequency to +maximum frequency as defined by Pr **1.06**.

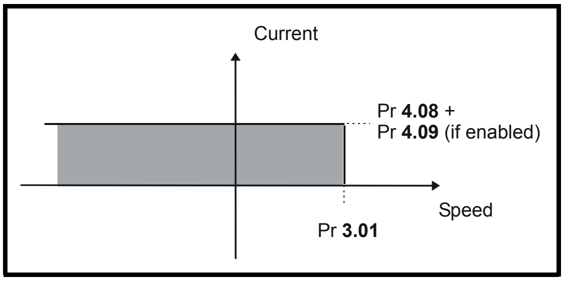


Closed loop
The value of this parameter refers to the switches TM0 to TM3 shown on the menu 4 diagram. Only one of the switches can be closed at a time.

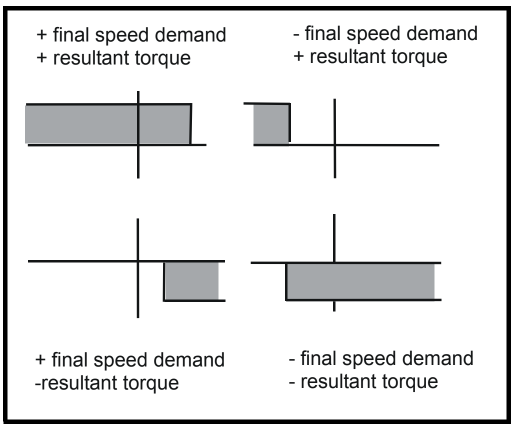
0: Speed control mode
The torque demand is equal to the speed loop output.

1: Torque control
The torque demand is given by the sum of the torque reference and the torque offset, if enabled. The speed is not limited in any way, however, the drive will trip at the overspeed threshold if runaway occurs.

2: Torque control with speed override



The output of the speed loop defines the torque demand, but is limited between 0 and the resultant torque reference (Pr **4.08** + Pr **4.09** (if enabled)). The effect is to produce an operating area as shown above if the final speed demand and the resultant torque reference are both positive. The speed controller will try and accelerate the machine to the final speed demand level with a torque demand defined by the resultant torque reference. However, the speed cannot exceed the reference because the required torque would be negative, and so it would be clamped to zero.



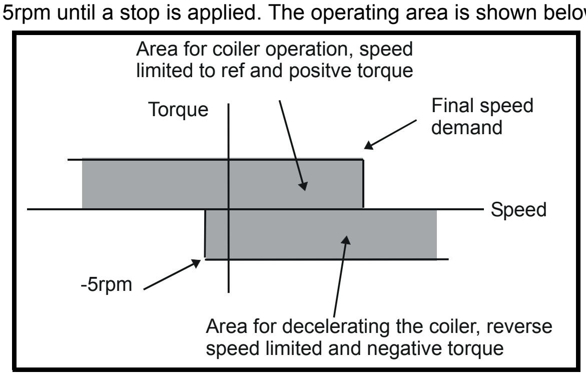
Depending on the sign of the final speed demand and the resultant torque the four areas of operation shown here are possible.

This mode of operation can be used where torque control is required, but the maximum speed must be limited by the drive. In this mode ramps are not active whilst the drive is in the run state. When the drive is taken out of the run state, but not disabled, the appropriate stopping mode is used. It is recommended that only coast or stopping without ramps is used. If ramp stop mode is used the drive changes to speed control mode to ramp to stop with a reference defined by the user speed demand. This causes the speed to increase towards the reference and then ramp to stop.

3: Coiler/uncoiler mode
Positive final speed demand: a positive resultant torque will give torque control with a positive speed limit defined by the final speed demand. A negative resultant torque will give torque control with a negative speed limit of -5rpm.

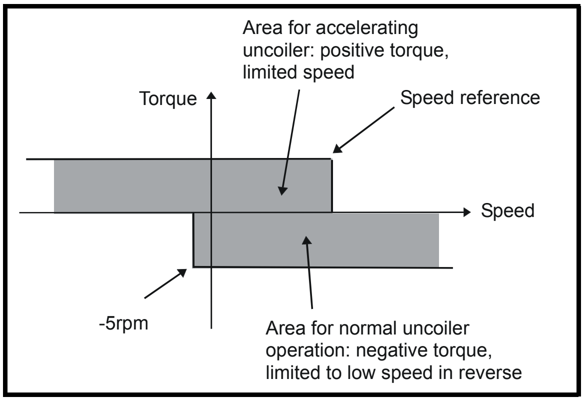
Negative final speed demand: a negative resultant torque will give torque control with a negative speed limit defined by the final speed demand. A positive resultant torque will give torque control with a positive speed limit of +5rpm.

Example of coiler operation
This is an example of a coiler operating in the positive direction. The final speed demand is set to a positive value just above the coiler reference speed. If the resultant torque demand is positive the coiler operates with a limited speed, so that if the material breaks the speed does not exceed a level just above the reference. It is also possible to decelerate the coiler with a negative resultant torque demand. The coiler will decellerate down to -5rpm until a stop is applied. The operating area is shown below:



Example of uncoiler operation

This is an example for an uncoiler operating in the positive direction. The final speed demand should be set to a level just above the maximum normal speed. When the resultant torque demand is negative the uncoiler will apply tension and try and rotate at 5rpm in reverse, and so take up any slack. The uncoiler can operate at any positive speed applying tension. If it is necessary to accelerate the uncoiler a positive resultant torque demand is used. The speed will be limited to the final speed demand. The operating area is the same as that for the coiler and is shown below:



In this mode ramps are not active whilst the drive is in the run state. When the drive is taken out of the run state, but not disabled, the appropriate stopping mode is used. It is recommended that only coast or stopping without ramps is used. If ramp stop mode is used the drive changes to speed control mode to ramp to stop with a reference defined by the user speed demand. This causes the speed to increase towards the reference and then ramp to stop.

4: Speed control with torque feed-forward

The drive operates under speed control, but a torque value may be added to the output of the speed controller. This can be used to improve the regulation of systems where the speed loop gains need to be low for stability.

4.12	Current-demand filter time-constant			
RW	Uni			
CL	⇳	0 to 250 ms	⇨	0

It is possible for the output of the speed loop to include some noise due to the digital nature of the speed loop inputs. A first order filter, with a time constant defined by this parameter, is provided on the current demand to reduce acoustic noise and vibration produced as a result of this noise. The filter introduces a lag in the speed loop, and so the speed loop gains may need to be reduced to maintain stability as the filter time constant is increased.

4.13	Current-loop proportional gain			
RW	Uni			
OL	⇳	0 to 30,000	⇨	20
VT	⇳		⇨	150
SV	⇳		⇨	130

4.14	Current-loop integral gain			
RW	Uni			
OL	⇳	0 to 30,000	⇨	40
VT	⇳		⇨	2,000
SV	⇳		⇨	1,200

Open-loop

These parameters control the proportional and integral gains of the current controller used in the open loop drive. As already mentioned the current controller either provides current limits or closed loop torque control by modifying the drive output frequency. The control loop is also used in its torque mode during mains loss, or when the controlled mode standard ramp is active and the drive is decelerating, to regulate the flow of current into the drive. Although the default settings have been chosen to give suitable gains for less demanding applications it may be necessary for the user to adjust the performance of the controller. The following is a guide to setting the gains for different applications.

Current limit operation

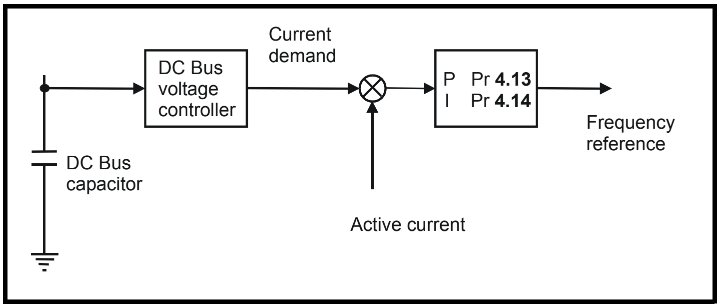
The current limits will normally operate with an integral term only, particularly below the point where field weakening begins. The proportional term is inherent in the loop. The integral term must be increased enough to counter the effect of the ramp which is still active even in current limit. For example, if the drive is operating at constant frequency and is overloaded the current limit system will try to reduce the output frequency to reduce the load. At the same time the ramp will try to increase the frequency back up to the demand level. If the integral gain is increased too far the first signs of instability will occur when operating around the point where field weakening begins. These oscillations can be reduced by increasing the proportional gain. A system has been included to prevent regulation because of the opposite actions of the ramps and the current limit. This can reduce the actual level that the current limit becomes active by 12.5%. This still allows the current to increase up to the current limit set by the user. However the current limit flag (Pr **10.09**) will could become active up to 12.5% below the current limit depending on the ramp rate used.0

Torque control

Again the controller will normally operate with an integral term only, particularly below the point where field weakening begins. The first signs of instability will appear around base speed, and can be reduced by increasing the proportional gain. The controller can be less stable in torque control mode rather than when it is used for current limiting. This is because load helps to stabilise the controller, and under torque control the drive may operate with light load. Under current limit the drive is often under heavy load unless the current limits are set at a low level.

Mains loss and controlled standard ramp

The DC bus voltage controller becomes active if mains loss detection is enabled and the drive supply is lost or controlled standard ramp is being used and the machine is regenerating. The DC bus controller attempts to hold the DC bus voltage at a fixed level by controlling the flow of current from the drive inverter into its DC bus capacitors. The output of the DC bus controller is a current demand which is fed into the current PI controller as shown below:



The DC bus voltage controller cannot be adjusted, but it may be necessary to adjust the current controller gains to obtain the required performance. If the gains are not suitable it is best to set up the drive in torque control first. Set the gains to a value that does not cause instability around the point at which field weakening occurs. Then revert back to open loop speed control in standard ramp mode. To test the controller the supply should be removed whilst the motor is running. It is likely that the gains can be increased further if required because the DC bus voltage controller has a stabilising effect, provided that the drive is not required to operate in torque control mode.

Closed-loop

The P and I gains are used in the voltage based current controller. The default values give satisfactory operation with most motors. However it may be necessary to change the gains especially for low inductance motors. The following procedure should be used:

Unless a particularly high bandwidth is required the proportional gain (Pr **4.13**) should be set to a value of 1,800 x L x Drive rated current.

Drive rated current is given in Pr **11.32**.

L is the motor inductance.

For a servo motor this is half the phase to phase inductance that is normally specified by the manufacturer. For an induction motor this is the per phase total leakage inductance (Ls'). This is the inductance value stored in Pr **5.24** after the auto-tune test is carried out. If Ls' cannot be measured it can be calculated (see Pr **5.24** on page 98). This will give a response with minimum overshoot after a step change of current reference and a current loop bandwidth of approximately 500Hz. If some overshoot can be tolerated then gain can be increased by a factor of 1.5, giving a bandwidth of 800Hz and 12.5% overshoot after a step change of current reference.

The integral gain (Pr **4.14**) should be set to a value of 0.044 x (Pr **4.13**) x R / L.

L is the motor inductance as defined previously

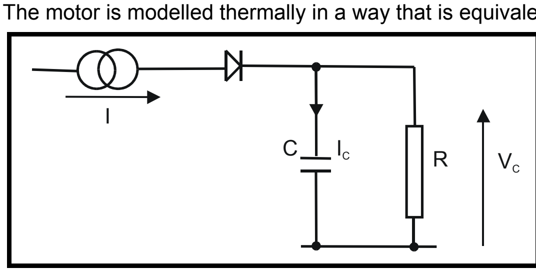
R is the per phase stator resistance of the motor. This is half the resistance measured between two phases.

4.15		**Motor thermal time-constant**		
RW		Uni		
OL	⇳	0 to 400.0 s	⇨	89.0
VT	⇳		⇨	
SV	⇳		⇨	7.0

NOTE

The thermal model is active in regen mode using a rated current equal to the rated current of the drive and the thermal time constant is fixed at 89.0s.

The motor is modelled thermally in a way that is equivalent to the electrical circuit shown below:



$I_C = CdV_C/dt = I - V_C/R$

The response of this circuit to a step of I is:

$V_C = RI\,(1 - e^{-t/\tau})$

If the voltage is replaced with the temperature of the relevant point in the motor, I with a value proportional to heat input (i.e. I^2) and R with a constant:

$Temp = KI^2\,(1 - e^{-t/\tau})$

t is the thermal time constant of the motor given by Pr **4.15**. The trip threshold is defined by 105% of motor rated current (i.e. Pr **5.07** x 1.05).

The drive will trip if the following is true:

(Pr **5.07** x $1.05)^2 = I^2\,(1 - e^{-t/\tau})$

Therefore time to trip with 150% rated current = -Pr **4.15** ln(1 - 105^2 / 150^2). If Pr **4.15** = 89s, the time to trip = 60s.

If a different value for the time constant is required it can be calculated as follows:

1. The motor thermal time constant can be used directly.
2. A specific overload time and current level can be used, i.e. 60s at 150%

   Pr **4.15** = -time to trip / ln(1 - 105^2 / 150^2) = 89
3. If the reset time from an overload is assumed to be the time it takes for the motor to cool to within 1% of the ambient temperature, this can be taken as 5 times the thermal time constant.

There are two alternative modes of operation for motor thermal protection defined by Pr **4.16**.

4.16	**Motor protection mode select**		
RW	Bit		
⇕ 0 or 1		⇨ 0	

See also Pr **4.15** on page 85.

Pr **4.16** = 0:trip when threshold reached

Pr **4.16** = 1:reduction of the current limit to keep the rated current below 100% when the trip level is reached. 5% hysteresis will be included in this case. If the drive is supplying an induction motor, open or closed loop, the level to which the current limit will be reduced will be based on the user parameter defining power factor.

4.17	**Motor magnetizing current**		
RO	Bi		P
⇕ $\pm I_{MAX}$ A		⇨	

This parameter is proportional to the length of the vector in the x axis of the reference frame and is equivalent to the magnetising current in each output phase in amps.

4.18	**Over-riding current limit**		
RO	Uni		P
⇕ 0 to I_{MAX} %		⇨	

The current limit applied at any time depends on whether the drive is motoring or regenerating and also on the level of the symmetrical current limit. Pr **4.18** gives the limit level that applies at any instant.

4.19	**Overload accumulator**		
RO	Uni		P
⇕ 0 to 100 %		⇨	

When the total current level is above 105% motor rated current (Pr **5.07** x 1.05) the overload accumulator increases, until it reaches 100% when the drive will give an Ixt trip or apply a restriction on the current limit. The level of the accumulator is given by:

Accumulator = (I^2 / (Pr **5.07** x $1.05)^2$) x $(1 - e^{-t/\tau})$ x 100%

τ = value entered in Pr **4.15**.

NOTE

If the motor rated current parameter (Pr **5.07**) is modified the overload accumulator is reset to zero. This allows the drive to be used with more than one motor of different ratings (each connected in turn with suitable parameter changes made each time without powering the drive down) without producing overload trips when the drive has been running with a large motor and then a smaller motor is connected.

4.20	**Percentage torque current**		
RO	Bi		P
⇕ $\pm I_{MAX}$ %		⇨	

This parameter displays the actual torque producing current (Pr **4.02**) as a percentage of rated torque producing current.

4.5 Menu 5: Machine control

Open loop

Menu 5 includes slip compensation and the main inverter control blocks. The post ramp frequency reference (after current limits) or the slaving frequency demand are the inputs to this stage. The output controls inverter switching.

Closed loop

Menu 5 includes the motor map parameters for closed-loop vector control of an induction motor or servo motor. These are used to locate the motor flux so that the torque producing current (and flux producing current for the induction motor) can be applied correctly. The motor map parameters are also used in flux control of an induction motor in the field weakening range.

Limits on parameters based on voltage and power are given for the standard (i.e. medium voltage) Unidrive.

Table 4-5 Menu 5 single line descriptions

Parameter			Range(⇕)		Default(⇨)			Type			
			OL	CL	OL	VT	SV				
5.01	Motor frequency		±[Pr **1.06**]					RO	Bi		P
5.02	Motor voltage		200V drive: 0 to 264 V 400V drive: 0 to 528 V					RO	Uni		P
5.03	Total motor power		± P_{MAX} kW					RO	Bi		P
5.04	Estimated motor speed	{**0.10**}	± 6000 rpm					RO	Bi		P
5.05	DC bus voltage		200V drive: 0 to 415 V 400V drive: 0 to 830 V					RO	Uni		P
5.06	Motor - rated frequency	{**0.47**}	0 to 1000.0 Hz		EUR> 50, USA> 60			RW	Uni		
5.07	Motor - rated current	{**0.46**}	0 to FLC A		FLC			RW	Uni		
5.08	Motor - rated speed	{**0.45**}	0 to 6,000 rpm	0 to 30,000 rpm	0	EUR> 1,450 USA> 1,770		RW	Uni		
5.09	Motor - rated voltage	{**0.44**}	200V drive: 0 to 240 V 400V drive: 0 to 480 V		200V drive: 220 400V drive: EUR> 400 USA> 460		0	RW	Uni		
5.10	Motor - rated power factor	{**0.43**}	0 to 1.000		0.920			RW	Uni	S	P
5.11	Motor - number of poles	{**0.42**}	2 to 32		4		6	RW	Txt		P
5.12	Magnetizing current test *enable*	{**0.40**}	0 or 1		0			RW	Bit		P
5.13	Dynamic V/f *select*	{**0.09**}	0 or 1		0			RW	Bit		
5.14	Voltage mode *selector*	{**0.07**}	Ur_S (0), Ur_I (1), Ur (2), Fd (3)		Ur_I (1)*			RW	Uni		P
5.15	Boost voltage	{**0.08**}	0 to 25.0 %		3			RW	Uni		
5.16	Jog boost-voltage		0 to 25.0 %		3			RW	Uni		
5.17	Stator resistance		0 to 32.000 Ω		0			RW	Uni	S	P
5.18	PWM switching frequency *selector*	{**0.41**}	3 kHz (0), 4.5 kHz (1), 6 kHz (2), 9 kHz (3), 12 kHz (4)		3 (0)**			RW	Txt		
5.19	High-stability space-vector modulation *enable*		0 or 1		0			RW	Bit		
5.20	Quasi square-wave *enable*		0 or 1		0			RW	Bit		
5.21	Field-gain reduction *enable*			0 or 1		1		RW	Bit		
5.22	Maximum speed x10 *select*		0 or 1		0			RW	Bit		
5.23	Voltage offset		0 to 25.5 V		0			RO	Uni	S	P
5.24	Motor leakage inductance			0 to 320.00 mH		0		RW	Uni	S	P
5.25	Output frequency doubling *select*		0 or 1		0			RW	Bit		
5.26	Cross-coupling compensation *enable*			0 or 1		0		RW	Bit		
5.27	Slip compensation *enable*		0 or 1		1			RW	Bit		
	Auto-optimize rated speed *enable*			VT> 0 or 1		0		RW	Bit		
	Phasing test for motors with high inertia loads			SV> 0 or 1			0	RW	Bit		
5.28	Field-weakening gain compensation *disable*			VT> 0 or 1		0		RW	Bit		
5.29	Motor saturation breakpoint 1			0 to 100 %		50		RW	Uni		P
5.30	Motor saturation breakpoint 2			0 to 100 %		75		RW	Uni		P
5.31	Voltage-controller gain		0 to 30		1			RW	Uni		P
5.32	Motor full load speed fine trim		0 to 0.99 rpm		0			RW	Uni		P
5.33	Thermal model-protection *enable*		0 or 1		1			RW	Bit		

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

* This parameter has a default setting of Fd (3) in the VTC variant.

** This parameter has a default setting of 9kHz (3) in the LFT variant.

Power rating

$$P_{MAX} = \sqrt{3} \times I_{MAX} \times \frac{\text{Pr } 5.09}{1000}$$

For definition of I_{MAX}, see section *Types of current range* on page 76.

NOTE

Where a parameter is represented by a text value, the value in brackets in the range column is the setting used for serial communications.

Figure 4-8 Menu 5 Open-loop logic diagram

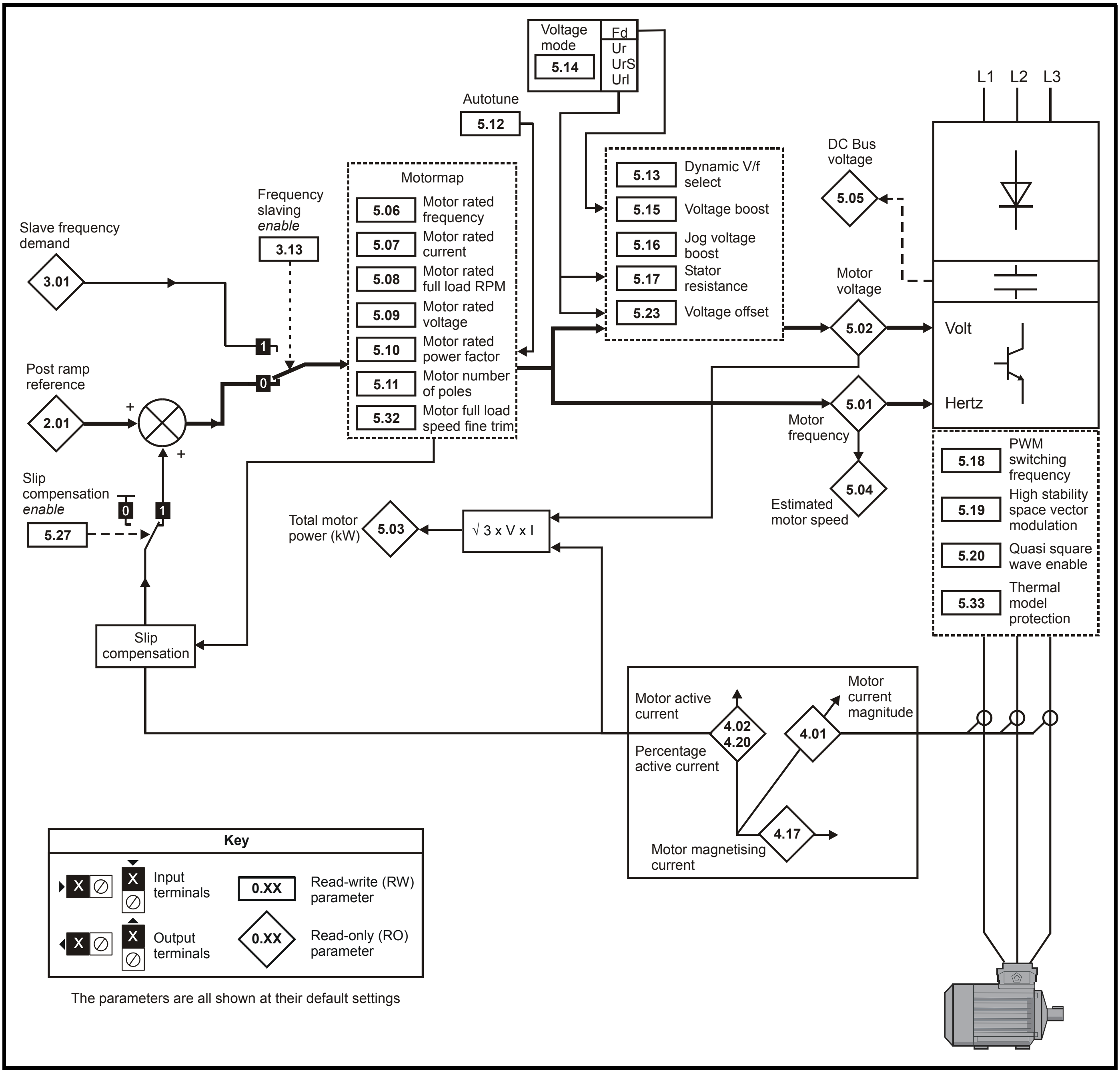


Figure 4-9 Menu 5 Closed-loop vector logic diagram

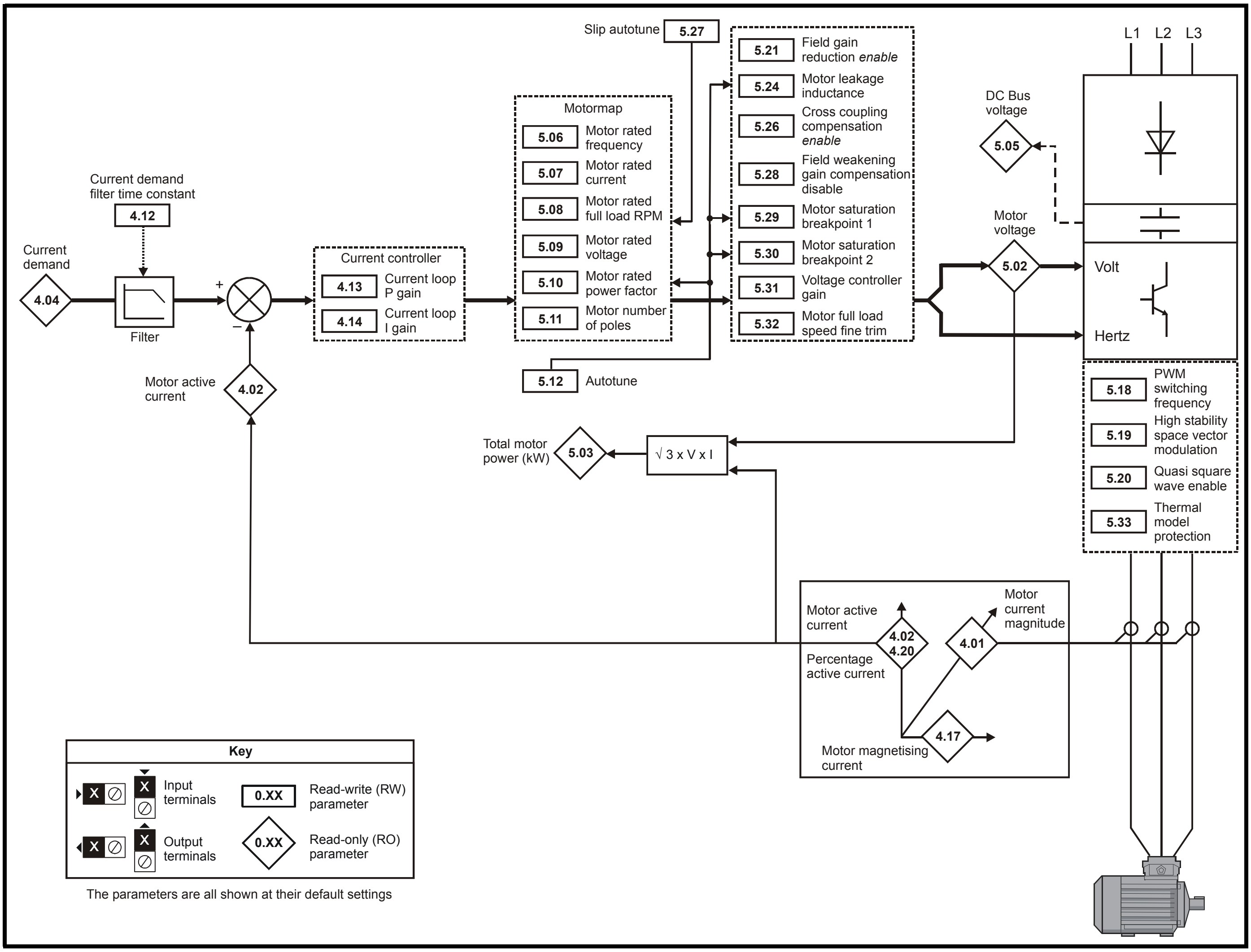
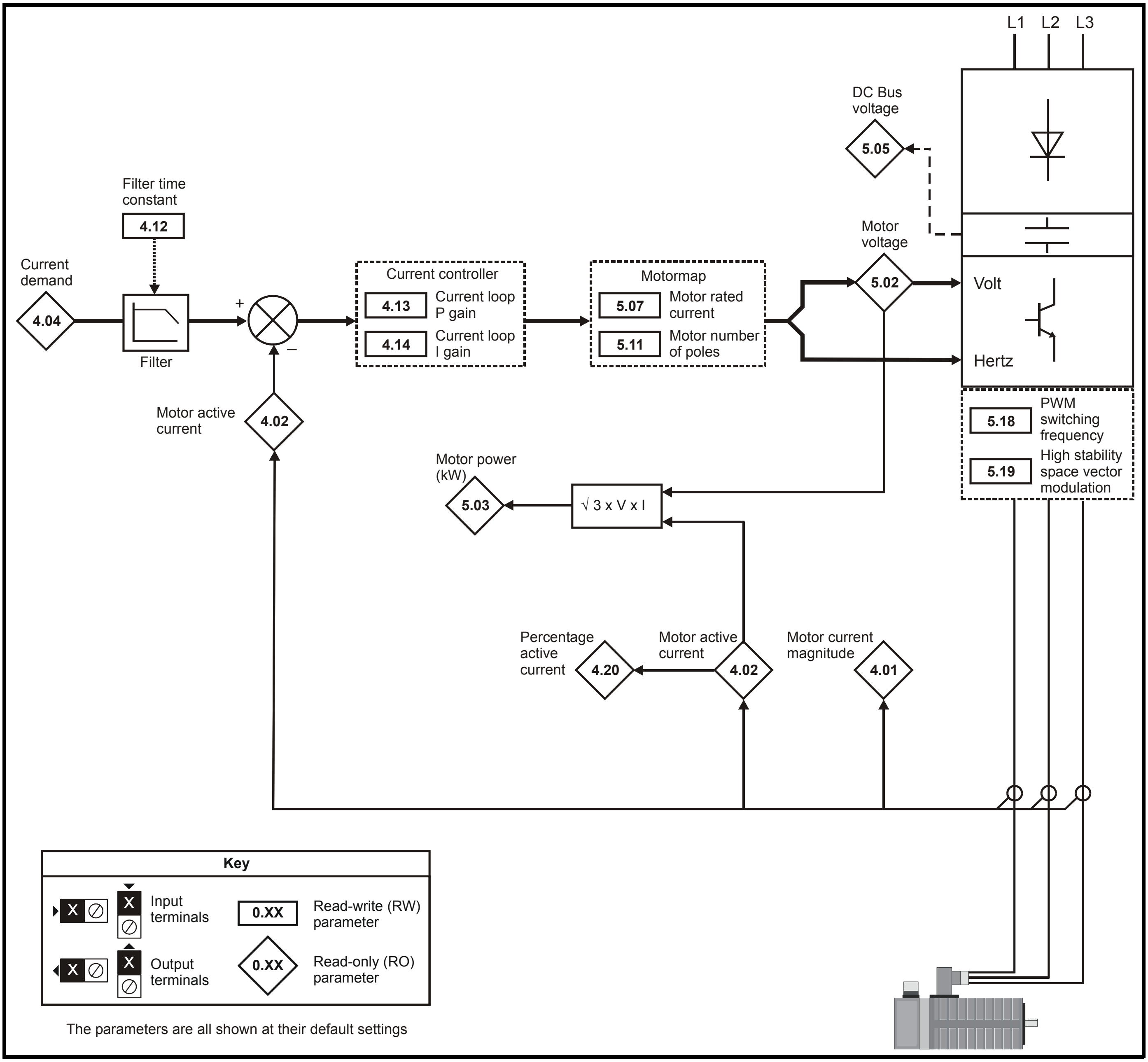


Figure 4-10 Menu 5 Servo logic diagram



Menu 5 parameter descriptions

5.01	**Motor frequency**		
RO	Bi		P
OL ⇳	±[Pr **1.06**] Hz	⇨	

The range of this parameter is the maximum magnitude of Pr **1.06** and Pr **1.07** plus whatever is added or subtracted for the slip compensation.

This parameter gives the output frequency of the drive, i.e. the sum of the post ramp reference and the slip compensation:

Pr **2.01** + rated slip frequency x Pr **4.02** / 100% active current

Pr **2.01** is limited to the maximum frequency defined by Pr **1.06**, but the final frequency can exceed this by the slip compensation frequency.

5.02	**Motor voltage**		
RO	Uni		P
⇳	0 to 528 V	⇨	

Modulus of the r.m.s. fundamental line voltage at the inverter output. If this parameter is used to produce an analog output via menu 7, the full scale output corresponds to rated motor voltage (except servo which is maximum possible motor voltage, i.e. 480V for a medium voltage drive).

5.03	**Total motor power**		
RO	Bi		P
⇳	±P_{MAX} kW	⇨	

Total output power of the drive (positive for power flow out of the drive output terminals). The range of this parameter is √3 x MAX_I x Pr **5.09** / 1,000 with quasi-square operation not enabled (Pr **5.20** = 0). MAX_I is the maximum current that the drive can produce, i.e. 150% of drive rated current for open loop, 175% of drive rated current for closed-loop and regen, 120% drive rated current for all modes when using size 5. If quasi-square operation is enabled the range is given by √3 x MAX_I x 830V x 0.78 / 1,000. (In servo mode Pr **5.09** is not used, and so the maximum possible value of this parameter is used in the calculations above, i.e. 480V for a medium voltage drive). If this parameter is used to produce an analog output via menu 7, the full scale output corresponds to the maximum value described above.

5.04	**Estimated motor speed**		
RO	Bi		P
OL ⇳	±6,000 rpm (Pr **5.22** = 0) ±60,000 rpm (Pr **5.22** = 1)	⇨	

The motor rpm is calculated from the post ramp reference (Pr **2.01**) for normal operation, or the slave frequency demand (Pr **3.01**) if frequency slaving is being used. The speed of rotation is calculated as follows:

rpm = 60 x frequency / no. of pole pairs
= 60 x Pr **2.01** / (Pr **5.11** / 2)
or = 60 x Pr **3.01** / (Pr **5.11** / 2)

If frequency slaving is being used there will be an error due to the slip frequency. However, in normal operation the result will be reasonably accurate provided that the slip compensation has been set up correctly with the rated full load rpm parameter (Pr **5.08**).

For closed loop operation the speed feedback is given in Pr **3.01**.

5.05	**DC bus voltage**		
RO	Uni		P
⇳	0 to 830 V	⇨	

Voltage across the internal DC bus of the drive.

5.06	**Motor rated frequency**		
RW	Uni		
OL ⇳	0 to 1,000.0 Hz	⇨	EUR> 50 USA> 60
VT ⇳	0 to 1,000.0 Hz	⇨	EUR> 50 USA> 60
SV ⇳	0 to 1,000.0 Hz	⇨	

Open loop

The motor rated frequency and the motor rated voltage (Pr **5.09**) are used to define the voltage to frequency characteristic applied to the drive (see Pr **5.09** on page 93). The motor rated frequency is also used in conjunction with the motor full load rpm to calculate the rated slip for slip compensation (see Pr **5.08** on page 92). This parameter is limited to 250Hz on a Unidrive VTC.

Closed loop vector
The motor rated frequency is used in conjunction with the motor full load rpm to calculate the rated slip of the machine for the vector control algorithm (see Pr **5.08**). It is also used during the magnetising current test in conjunction with the motor rated voltage to set up the drive to determine the rated magnetising current (see Pr **5.09** on page 93).

5.07	**Motor rated current**		
RW	Uni		
⇳	0 to FLC A	⇨	FLC

The motor rated current should be set at the machine nameplate value for rated current. See Pr **5.18** on page 96 for limits on drive switching frequency for different rated current levels.

Open loop
This value is used in the following:

Current limits,see Pr **4.05** to Pr **4.07** on page 81
Ixt system, see Pr **4.15** on page 85
Vector mode voltage control, see Pr **5.14** on page 95
Slip compensation, see Pr **5.08**
Dynamic V to f control, see Pr **5.13** on page 95

Closed loop vector
This value is used in the following:

Current limits,see Pr **4.05** to Pr **4.07** on page 81
Ixt system, see Pr **4.15** on page 85
Vector control algorithm, see Pr **5.08**

Servo
This value is used in the following:

Current limits,see Pr **4.05** to Pr **4.07** on page 81
Ixt system, see Pr **4.15** on page 85

	5.08	**Motor rated speed**		
	RW	Uni		
OL	⇳	0 to 6,000 rpm (Pr **5.22** = 0) 0 to 60,000 rpm (Pr **5.22** = 1)	⇨	0
VT	⇳	0 to 30,000 rpm	⇨	EUR> 1,450 USA> 1,770

The rated full load rpm is used with the motor rated frequency to calculate the rated slip of induction machines in Hz. (For fine trim in 0.01rpm units see Pr **5.32** on page 101.)

Open loop
The rated full load rpm is used with the motor rated frequency to calculate the rated slip of induction machines in Hz.

rated slip (Hz) = rated motor frequency - (no. of pole pairs x motor full load rpm / 60)
= Pr **5.06** - ((Pr **5.11** / 2) x Pr **5.08** / 60)

The rated slip is used to calculate the frequency adjustment required to compensate for slip from the following equation;

slip compensation = rated slip x active current / rated active current
Where:
rated active current = motor rated current x power factor
= Pr **5.07** x Pr **5.10**

If Pr **5.08** is set to 0 slip compensation is disabled. If slip compensation is required this parameter should be set to the nameplate value, which should give the correct rpm for a hot machine. Sometimes it will be necessary to adjust this when the drive is commissioned because the nameplate value may be inaccurate. Slip compensation will operate correctly both below base speed and within the field weakening region. Slip compensation is normally used to prevent droop in the motor shaft speed as load is applied. If the motor full load speed is set below the synchronous speed the slip compensation will increase the output frequency with a motoring load and decrease the frequency with a regenerative load both operating in the forward direction. The opposite is true for reverse operation.

The rated full load rpm can also be set higher than synchronous speed to deliberately introduce speed droop. In this case a motoring load in the forward direction will decrease the output frequency. This can be useful to aid load sharing with mechanically coupled motors.

Closed loop vector
Motor full load rpm is used with motor rated frequency to determine the full load slip of the motor which is used by the vector control algorithm. In correct setting of this parameter has the following effects:

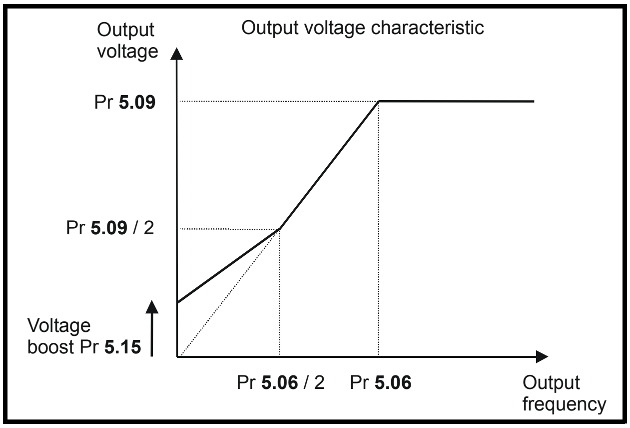
- Reduced efficiency of motor operation
- Reduction of maximum torque available from the motor
- Reduced transient performance
- Inaccurate control of absolute torque in torque control modes

The nameplate value is normally the value for a hot machine, however, some adjustment may be required when the drive is commissioned if the nameplate value is inaccurate. Either a fixed value can be entered in this parameter or an optimisation system may be used to automatically adjust this parameter (see Pr **5.27** on page 100).

5.09		Motor rated voltage			
RW		Uni			
OL	⇳	0 to 480 V	⇨	EUR> 400 USA> 460	
VT	⇳		⇨		

Open loop

This voltage is used in conjunction with the motor rated frequency (Pr **5.06**) to define the voltage to frequency characteristic applied to the machine. If fixed boost is selected (Pr **5.14** = 3) the following characteristic is used.



If vector mode is selected (Pr **5.14** = 0, 1 or 2) a linear characteristic is used from 0Hz to rated frequency, and then a constant voltage above rated frequency. When the drive operates between rated frequency/50 and rated frequency/4, full vector based stator resistance (Rs) compensation is applied. However there is a delay of 0.5s when the drive is enabled during which only partial vector based compensation is applied to allow the machine flux to build up. When the drive operates between rated frequency/4 and rated frequency/2 the Rs compensation is gradually reduced to zero as the frequency increases. For the vector modes to operate correctly the stator resistance (Pr **5.17**), motor rated power factor (Pr **5.10**) and voltage offset (Pr **5.24**) are all required to be set up accurately.

Closed loop vector

The rated voltage is used by the field controller to limit the voltage applied to the machine. Normally this is set to the nameplate value. So that current control can be maintained it is necessary for the drive to leave some 'headroom' between the machine terminal voltage and the maximum available drive output voltage. This headroom is set at 5% of maximum available drive output voltage. Therefore the maximum voltage applied to the motor is the rated voltage or the headroom limit, whichever is the lower.

The rated voltage is also used in conjunction with the motor rated frequency (05.06) during the magnetising current test (see Pr **5.12** on page 94) and in the calculations required for automatic optimisation of the rated motor slip. It is important, therefore that the correct rated voltage for the motor is used. In some applications it may be necessary to restrict the voltage applied to the motor to a level lower than the rated voltage. The rated frequency (Pr **5.06**) must be adjusted to maintain the ratio of rated voltage and frequency given on the motor nameplate. The rated frequency will then be different to the nameplate value, and so the rated speed must be changed from the nameplate value to maintain the same rated slip.

5.10		Motor rated power factor			
RW		Uni		S	P
OL	⇳	0 to 1.000	⇨	0.920	
VT	⇳		⇨		

Open loop

The power factor is used in conjunction with the motor rated current (Pr **5.07**) to calculate the rated active current and magnetising current of the motor. The rated active current is used extensively to control the drive and the magnetising current is used in vector mode Rs compensation. It is important that this parameter is set up correctly.

Closed loop vector

The power factor is used in conjunction with the motor rated current (Pr **5.07**) to calculate the rated active current and the magnetising current of the motor. These currents are used in the vector control algorithms, therefore it is important that the rated power factor is set up correctly. It is possible for the drive to measure the magnetising current of the machine automatically, then provided the motor rated current (Pr **5.07**) has been set to the correct value, this parameter will be set automatically. For details on this test see Pr **5.12** on page 94.

The "power factor" measured and used by the drive is $\cos(i_{torque} / i_{rated})$.

Where:

i_{torque} is the rated torque producing current
i_{rated} is the rated current

The power factor given by the motor manufacturer is cos(i_{real} / i_{rated}).

Where:

i_{real} is the current in phase with the supply voltage

The manufacturers' power factor will tend to be worse than that measured by the drive because of the motor leakage inductance.

5.11		Motor - number of poles		
RW		Txt		P
OL	⇕	2 to 32	⇨	4
VT	⇕		⇨	
SV	⇕		⇨	6

Set to the no. of poles for the machine being used.

5.12		Magnetising current test enable		
RW		Bit		P
OL	⇕	0 or 1	⇨	0
VT	⇕		⇨	

NOTE

It is important that the motor is at standstill before this test is carried out. Also as soon as this parameter is set to 1 and the drive is enabled the machine will begin to rotate. Pressing the stop/reset button on the front of the drive can be used to cause the motor to coast to a rest at any point during this test. If the forward limit switch (Pr **6.35**) becomes active it will also stop the test.

NOTE

It is important to note that the motor rated voltage (Pr **5.09**) and motor rated frequency (Pr **5.06**) are used in conjunction with the inductance values measured by this test to perform automatic optimisation of the rated full load slip. Therefore the test must be repeated if Pr **5.06** or Pr **5.09** are modified.

If this parameter is set to 1 and the drive enable is active, the drive will perform a series of tests on the motor:

- Standstill test to measure total leakage inductance. The motor must be at standstill before this test. (Closed-loop only)
- Accelerate the motor up to $^2/_3$ x rated frequency in the forward direction to measure the rated magnetising current (the frequency is less if sufficient DC bus voltage is not available to operate at this level without field weakening). The rated magnetising current is used to set up the motor rated power factor. The motor must be unloaded for this test.
- Run at $^2/_3$ x rated frequency for 30 seconds to measure the saturation characteristic of the motor. The motor must be unloaded for this test. (Closed-loop only)

Open loop

In this mode only the magnetising current test is performed. Once the test is complete Pr **5.12** is reset. If the power factor value set up as a result of this test is not accurate (i.e. because the motor is loaded), the voltage setting and hence the flux level at low frequencies will be incorrect.

Closed loop

In this mode all of the tests described above are carried out as well as the feedback encoder being checked, once the test is complete parameter Pr **5.12** is reset.

The total leakage inductance is used for automatic adjustment of the motor rated speed (see Pr **5.27** on page 99). If the value of total leakage inductance is incorrect this will affect the performance of the optimiser. Total leakage inductance is also used for current cross coupling (see Pr **5.26** on page 99).

The magnetising current (power factor and rated motor current) is used to set the level of magnetising current and flux in the motor. This should be set correctly for good performance.

The saturation characteristic is used to determine the level of motor flux in the field weakening region. If this parameter is not set correctly the performance of the drive will be affected in speed control and the torque accuracy will be affected in torque control.

During the test the following trips can occur:

ENCPH5 - A signal missing
ENCPH6 - B signal missing
ENCPH7 - A/B phase reversed
ENCPH8 - Test stopped before completion

5.13		Dynamic V/f select		
RW		Bit		
OL	⇳	0 or 1	⇨	0

Setting this bit enables dynamic V to f mode which is intended for applications where power loss should be kept to a minimum under low load conditions. The rated frequency used to derive the voltage to frequency characteristic of the drive is varied with load:

if |active current| < 0.7 x rated active current
motor rated frequency = Pr **5.06** x (2 - (active current / (0.7 x rated active current)))

else if |active current| ≥ 0.7 x rated active current
motor rated frequency = Pr **5.06**

Although the rated frequency varies the value shown as Pr **5.06** does not vary from that set by the user.

5.14		Voltage mode selector		
RW		Uni		P
OL	⇳	Ur_S (0), Ur_I (1), Ur (2), Fd (3)	⇨	Ur_I (1)*

*Default for this parameter is Fd (3) on a Unidrive VTC

This parameter selects the voltage control mode used by the open loop drive. This falls into two categories: vector mode (0 = Ur_S, 1 = Ur_I and 2 = Ur) and fixed boost (3). The voltage characteristics for these two modes have been covered in the description of Pr **5.09**.

The difference between the three versions of vector mode is the method used to determine the stator resistance and the voltage offset.

Ur_S mode (0)
The stator resistance (Pr **5.17**) and the voltage offset (Pr **5.23**) are measured each time the drive is enabled. Both Pr **5.17** and Pr **5.23** are read only. This test can only be done with a stationary machine where the flux has decayed to zero. Therefore this mode should only be used if the machine is guaranteed to be stationary each time the drive is enabled. To prevent the test from being done before the flux has decayed there is a period of 2 seconds after the drive has been in the inhibit or ready state during which the test would is not done if the drive is re-enabled. In this case, previously measured values are used. This is the preferred version of vector mode because the stator resistance varies with temperature.

Ur_I mode (1)
The stator resistance and the voltage offset are measured each time the drive is powered up only. Both Pr **5.17** and Pr **5.23** are read only. This test can only be done with a stationary machine where the flux has decayed to zero. Therefore this mode should only be used if the machine is guaranteed to be stationary at power-up. Note: if the drive is not enabled at power-up this test will not be performed.

Ur mode (2)
The stator resistance and voltage offset are not measured. Both Pr **5.17** and Pr **5.23** are read/write. This version should be used if either of the above versions cannot be used. The resistance of the machine and cabling can be measured, but will not include "resistance" effects within the drive. The voltage offset (see Pr **5.23** on page 98) is a function of the drive and cannot be measured by the user. Therefore the best method to obtain these parameter is to use mode 0 or 1 during commissioning, and then to switch to mode 2 for normal operation.

Fd mode (3)
Fixed boost mode. Neither the stator resistance or the voltage offset are used, instead the boost volatge is applied as defined by Pr **5.15** and Pr **5.09**.

5.15		Boost voltage		
RW		Uni		
OL	⇳	0 to 25.0 %	⇨	3.0
VT	⇳		⇨	

Open loop
The boost level for the fixed boost characteristic is defined by this parameter.

Closed loop vector
Fixed boost is used during the magnetising current test. The level of boost is defined by this parameter.

5.16		Jog boost voltage		
RW		Uni		
OL	⇳	0 to 25.0 %	⇨	3.0

If the jog preset speed is active in fixed boost mode, this boost level is used instead of the normal boost level set by Pr **5.15**.

5.17	Stator resistance				
RW	Uni		S		P
OL	⇳	0 to 32.000 Ω	⇨	0.000	

This parameter stores the stator resistance of the machine for vector mode operation. Although it is designated as read/write, it is read only if vector modes 0 or 1 are selected with Pr **5.14**. If the drive cannot achieve the necessary current levels to measure the stator resistance in Ur_S or Ur_I modes (e.g. there is no motor connected to the drive), an rS trip will occur and the value in Pr **5.17** remains unchanged. If the necessary current level can be achieved, but the calculated resistance exceeds the maximum values for the particular drive size, an rS trip will occur and Pr **5.17** will contain the maximum allowed value. The maximum value can be calculated from the following formula:

$Rs_{max} = V_{DCfull\_scale} / I_{full\_scale} / 2$

Where:

V_{DCfull_scale} = 830V for 400V drives
I_{full_scale} = Drive rated current x √2 / 0.47

5.18	PWM switching frequency selector		
RW	Txt		
⇳	3 kHz (0), 4.5 kHz (1), 6 kHz (2), 9 kHz (3), 12 kHz (4)	⇨	0 (3*)

*This parameter has a default setting of 9kHz (3) in the LFT variant.

The drive modulator uses space vector modulation with a switching frequency defined by this parameter. The sampling frequency of all control systems within the drive are based on the switching frequency as follows.

Table 4-6 Voltage based current control (peak limits for open loop and current control for closed loop drives)

Switching frequency kHz	Control frequency kHz
3	3
4.5	4.5
6	6
9	4.5
12	6

Table 4-7 Open loop drive current control and closed loop drive speed closed loop drives)

Switching frequency kHz	Control frequency kHz
3	3
4.5	2.25
6	3
9	2.25
12	3

The drive can model the temperature of the junctions of the IGBT's in the inverter (see also Pr **5.33** on page 101 and Pr **7.32** on page 118) and give trip Oh1 if this temperature is too high. If this thermal model protection is enabled any switching frequency can be used up to rated drive current except where a zero is shown in the table below. If a zero is shown then the switching frequency is not available for that drive size.

If thermal model protection is not enabled then the switching frequency is restricted depending on the motor rated current set in Pr **5.07** as shown in the table below. If the switching frequency is limited then the current limits are also derated so that the maximum drive current is restricted to 150% of the value shown in the table for open-loop mode and 175% of the value shown for closed-loop modes (including the regen unit mode).

<table>
<tr><th rowspan="2">Drive size</th><th rowspan="2">Rated power
kW</th><th colspan="5">Current rating</th></tr>
<tr><th>3kHz
A</th><th>4.5kHz
A</th><th>6kHz
A</th><th>9kHz
A</th><th>12kHz
A</th></tr>
<tr><td>UNI1401</td><td>0.75</td><td colspan="5">2.1</td></tr>
<tr><td>UNI1402</td><td>1.1</td><td colspan="5">2.8</td></tr>
<tr><td>UNI1403</td><td>1.5</td><td colspan="5">3.8</td></tr>
<tr><td>UNI1404</td><td>2.2</td><td colspan="4">5.6</td><td>4.5</td></tr>
<tr><td>UNI1405</td><td>4</td><td colspan="2">9.5</td><td>8.5</td><td>7.0</td><td>5.5</td></tr>
<tr><td>UNI2401</td><td>5.5</td><td colspan="4">12.0</td><td>11.7</td></tr>
<tr><td>UNI2402</td><td>7.5</td><td colspan="3">16.0</td><td>14.2</td><td>11.7</td></tr>
<tr><td>UNI2403</td><td>11</td><td>25.0</td><td>21.7</td><td>18.2</td><td>14.2</td><td>11.7</td></tr>
<tr><td>UNI3401</td><td>15</td><td colspan="3">34.0</td><td>28.0</td><td>23.0</td></tr>
<tr><td>UNI3402</td><td>18.5</td><td colspan="2">40.0</td><td>37.0</td><td>28.0</td><td>23.0</td></tr>
<tr><td>UNI3403</td><td>22</td><td colspan="2">46.0</td><td>40.0</td><td>32.0</td><td>26.6</td></tr>
<tr><td>UNI3404</td><td>30</td><td>60.0</td><td>47.0</td><td>40.0</td><td>32.0</td><td>26.7</td></tr>
<tr><td>UNI3405</td><td>37</td><td>70.0</td><td>56.0</td><td>46.0</td><td>35.0</td><td>28.0</td></tr>
<tr><td>UNI4401</td><td>45</td><td colspan="2">96.0</td><td>88.0</td><td>70.0</td><td>0</td></tr>
<tr><td>UNI4402</td><td>55</td><td>124.0</td><td>104.0</td><td>88.0</td><td>70.0</td><td>0</td></tr>
<tr><td>UNI4403</td><td>75</td><td>156.0</td><td>124.0</td><td>105.0</td><td>80.0</td><td>0</td></tr>
<tr><td>UNI4404</td><td>90</td><td>180.0</td><td>175.0</td><td>145.0</td><td>110.0</td><td>0</td></tr>
<tr><td>UNI4405</td><td>110</td><td>202.0</td><td>175.0</td><td>145.0</td><td>110.0</td><td>0</td></tr>
<tr><td>Size 5</td><td>132 / 160
per module</td><td>240 / 300
per module</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>

The drive will thermally protect itself in ambient temperatures up to 40°C. Above this temperature some derating must be applied.

5.19	**High-stability space-vector modulation enable**		
RW	Bit		
⇳ 0 or 1		⇨ 0	

Open loop

Normally the drive will use space vector modulation to produce the IGBT control signals. High stability space vector modulation offers three advantages in an open loop drive, but the acoustic noise produced by the machine may increase slightly.

- It is possible for instability to occur around motor rated frequency/2 on light load. The drive uses deadtime compensation to reduce this effect, however, it is still possible that some machines will be unstable. To prevent this, high stability space vector modulation should be enabled by setting this parameter.
- As the output voltage approaches the maximum available from the drive pulse deletion occurs. This can cause unstable operation with a lightly or fully loaded machine. High stability space vector modulation will reduce this effect.
- High stability space vector modulation gives also a small reduction in drive heat loss.

Closed loop

Normally the drive will use space vector modulation to produce the IGBT control signals. The only advantage of high stability space vector modulation is the small reduction in drive heat loss. The acoustic noise produced by the machine may increase slightly.

5.20	**Quasi square-wave enable**		
RW	Bit		
⇳ 0 or 1		⇨ 0	

Open loop

The maximum modulation level of the drive is normally limited to unity. If the motor rated voltage is set at the same level as the supply voltage some pulse deletion will occur as the drive output voltage approaches the rated voltage level. If Pr **5.22** is set to 1 the modulator will allow over modulation, so that as the output frequency increases beyond the rated frequency the voltage continues to increase above the rated voltage. The modulation depth will increase beyond unity; first producing trapezoidal and then quasi-square waveforms. This can be used for example to obtain high output frequencies (up to 1kHz) with a low switching frequency (i.e. 3kHz), which would not be possible with space vector modulation limited to unity modulation depth. The disadvantage is that the machine current will be distorted as the modulation depth increases above unity, and will contain a significant amount of low order harmonics of the fundamental output frequency.

Closed loop

This feature can also be enabled with closed loop drives to obtain a higher output voltage. The maximum voltage possible with a closed-loop vector drive, still allowing for headroom for current control to operate, is higher with quasi-square operation.

When a closed-loop vector control is used with this parameter set at 0, the output voltage of the converter is theoretically limited to 90% of the supply voltage. In practice various voltage drops within the drive will reduce this further. This margin is to allow the current controllers to operate correctly in the field weakening range. As the speed approaches the rated value the drive beings field weakening. The torque produced by the motor may be limited below the expected value at rated speed, because the voltage is first clamped to its maximum limit at a speed below rated speed. To overcome this limitation Pr **5.20** can be set to 1, however odd multiple harmonics of the fundamental may be increased above the level produced with Pr **5.20** equal to 0.

5.21		Field-gain reduction enable		
RW		Bit		
CL	⇳	0 or 1	⇨	1

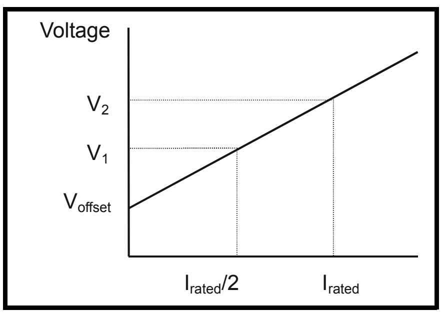
The closed loop vector drive field controller has a gain defined by the drive from the rated current and voltage of the machine. However it is possible by setting this parameter to a 1 to reduce this gain by a factor of 2 if instability problems occur in the field weakening range.

5.22		Maximum speed x10 select		
RW		Bit		
OL	⇳	0 or 1	⇨	0

This bit affects the way the drive holds Pr **5.04** and Pr **5.08** in memory. If Pr **5.22** = 0, values up to 6,000rpm can be used with a resolution of 1rpm. If Pr **5.22** = 1, values up to 60,000rpm can be used with a resolution of 10rpm. This only applies to the open loop drive. All speed parameters for the closed loop drive are held with a resolution of 1rpm.

5.23		Voltage offset		
RO		Uni	S	P
OL	⇳	0 to 25.5 V	⇨	

The stator resistance test is carried out at half and full rated motor current. A current is applied in the y axis of the reference frame with zero frequency, and so DC current flows in all three phases of the machine. The results are as shown below.



The gradient of the line gives the stator resistance, cabling resistance and resistance effects within the drive. The units are converted to ohms before being stored in Pr **5.17**.

The drive must produce a voltage before any current flows, shown as Voffset. This includes IGBT voltage drops etc. To obtain good performance at low frequencies where the machine terminal voltage is small this offset must be taken into account. The value shown in Pr **5.23** is given in volts, representing the voltage that would be applied on the U phase output as a DC level. The voltages on the other two phases would be $-V_{offset}/2$. It is not possible for the user to measure this voltage easily, and so the automatic measurement procedure should be used, see Pr **5.14** on page 95.

5.24		Motor leakage inductance		
RW		Uni	S	P
CL	⇳	0 to 320.00 mH	⇨	0

Closed loop vector

The value of inductance stored in this parameter should be the total leakage inductance (L_s') of the motor. The value can be measured at the start of the magnetising current test and stored in this parameter. Alternatively the user can modify the value. The range of this parameter will change with the size of the drive. For standard voltage drives the range is 0.01 to 320.00 for 11kW and below, and 0.001 to 32.000 for 15kW and above.

The total leakage inductance can be calculated from the steady state per phase equivalent circuit of the motor:

$L_s' = L1 + (L_2.L_m / (L_2 + L_m))$

L_s' is used for automatic optimisation of the rated speed (see Pr **5.27** on page 99) and for current cross coupling compensation (see Pr **5.26** on page 99).

Servo
The value of inductance stored in this parameter should be the total phase inductance (half the phase to phase inductance). The inductance is used for cross coupling compensation (see Pr **5.26** on page 99). The value is not automatically measured, and so the correct value must be entered by the user if cross coupling compensation is required.

5.25		**Output frequency doubling select**		
RW		Bit		
OL	⇳	0 or 1	⇨	0

If this bit is set the change of reference frame angle per sample is doubled. This will result in the motor output frequency being twice the displayed value. If this bit is set the maximum open loop output frequency will go up from 1,000Hz to 2,000Hz. No other changes are made, and so slip comp, ramps etc. will need to be re-scaled.

Example:
The real machine is 4 pole, 2000Hz, 400V, 60,000 rpm, full load speed 58,000 rpm, and the desired maximum speed is 40,000 rpm with a trip at 50,000 rpm. Acceleration is to be 500Hz / sec.

Menu 1:

Maximum frequency (Pr **1.06**) should be set to 0.5 x 2,000 x 40,000 / 60,000 = 667Hz

Menu 2:

The ramp times (Pr **2.11** to Pr **2.29**) need to be set at 0.5 x 0.2 sec per 100Hz = 0.1

Menu 3:

The over-speed trip threshold (Pr **3.08**) should be set at 0.5 x 2,000 x 50,000 / 60,000 = 833Hz

Menu 5:

The rated motor voltage (Pr **5.09**)400V
The rated frequency (Pr **5.06**)0.5 x 2,000 = 1,000Hz
The full load speed is (Pr **5.08**)0.5 x 58,000 = 29,000rpm
The motor poles (Pr **5.11**)4 POLE

Extreme caution should be exercised when setting this bit as the actual machine speed will be double that indicated.

5.26		**Cross-coupling compensation enable**		
RW		Bit		
CL	⇳	0 or 1	⇨	0

Closed-loop vector
When an induction motor is operated in closed-loop vector mode the flux and torque are controlled by two separate currents similar to the field and armature currents of a d.c. machine. Under all conditions these currents independently control the flux and torque. Under transient conditions there is cross-coupling between the axes that represent flux and torque. The main effect will be that the flux controlling current will change with torque demand. This effect is most significant when using a 3kHz switching frequency, at higher switching frequencies the current controllers are fast to eliminate this effect. Thus this parameter is only available with a 3kHz switching frequency.

Servo
Cross coupling also occurs in servo motors. This effect is worse with high speed (6,000rpm) motors and could in some cases cause over current trips. If cross coupling compensation is required, the user must enter the phase inductance in Pr **5.24** and set Pr **5.26** to 1.

5.27		**Slip compensation enable**		
RW		Bit		
OL	⇳	0 or 1	⇨	1

The level of slip compensation is set by the rated frequency and rated speed parameters. Slip compensation is not automatically enabled, but is only active when this parameter is set to 1.

5.27		**Auto-optimise rated speed enable**		
RW		Bit		
VT	⇳	0 or 1	⇨	0

The motor rated full load rpm parameter (Pr **5.08**) in conjunction with the motor rated frequency parameter (Pr **5.06**) defines the full load slip of the motor. The slip is used in the motor model for closed-loop vector control. The full load slip of the motor varies with rotor resistance which can vary significantly with motor temperature. When this parameter is set the drive can automatically sense if the value of slip defined by Pr **5.06** and Pr **5.08** has been set incorrectly or has varied with motor temperature. If the value is incorrect Pr **5.08** is automatically adjusted. Pr **5.08** is not saved at power-down, and so when the drive is powered-down and up again it will return to the last value saved by the user. If the new value is required at the next power-up it must be saved by the user. Automatic optimisation is not carried out below rated speed / 8. Automatic optimisation requires some load on the machine to operate (not operational below rated load / 8), and so if the motor full load slip is unknown and the auto-tuning method is being used to determine this value the motor should be run under a significant load. For automatic optimisation to operate the correct value of motor total leakage inductance must be stored in Pr **5.24**.

At high output frequencies the voltages measured by the drive can be displaced from the real motor voltages. The drive compensates for this displacement, but as the frequency increases it becomes difficult for this to be done accurately. If the voltages are displaced from the real voltages the optimisation of the motor rated rpm can become inaccurate or even diverge from the real value. If this occurs it is suggested that a threshold detector from menu 12 is used to disable the optimiser at higher speeds.

5.27		**Phasing test for motors with high inertia loads**		
RW		Bit		
SV	⇳	0 or 1	⇨	0

With the default value of this parameter (0), a normal phasing test is performed when initiated by Pr **3.25** (or the relevant menu 16 parameter). When this parameter is set to 1, a low speed high current phasing test is performed when initiated by Pr **3.25** (or the relevant menu 16 parameter). See Pr **3.25** on page 72 for more details.

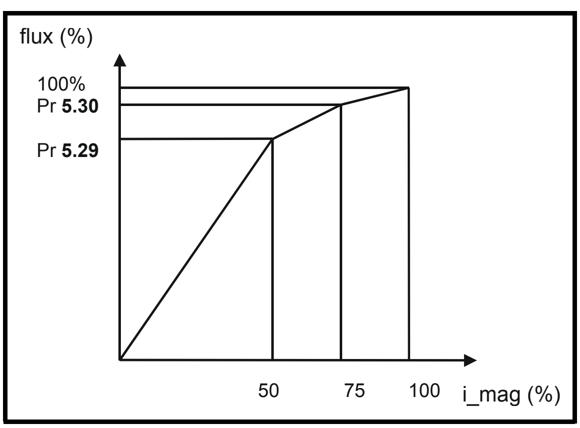
5.28		**Field-weakening gain compensation disable**		
RW		Bit		
VT	⇳	0 or 1	⇨	0

When the flux in the motor is reduced below its rated level the level of torque producing current required for a given amount of shaft torque is higher than the rated level. This same effect occurs in a DC machine where the armature current needs to be increased for a given amount of torque if the field current is reduced. Normally the drive automatically provides the necessary increase in torque producing current as the motor flux reduces in the field weakened (constant power range). In speed control the compensation prevents gain reduction at higher speeds. In torque control the compensation maintains the torque at the correct level for a given torque demand. In some applications using speed control it may be desirable to have a reduction of gain as the motor flux is reduced to maintain stability. If this is required Pr **5.28** should be set.

5.29		**Motor saturation breakpoint 1**		
RW		Uni		P
VT	⇳	0 to 100 %	⇨	50

5.30		**Motor saturation breakpoint 2**		
RW		Uni		P
VT	⇳	0 to 100 %	⇨	75

The rated level of flux in most induction motors causes saturation. Therefore the flux against flux producing current characteristic is non-linear. The effects of saturation are to cause a step increase in torque when operating in torque mode as the speed increases into the field weakening region. The drive can include the effects of saturation by representing the flux producing current to flux characteristic as a series of three lines as shown below:



If Pr **5.29** and Pr **5.30** have their defaults values of 50 and 75, the characteristic becomes one line and there will be a linear relationship between the drive estimate of flux and the flux producing current. If Pr **5.29** and Pr **5.30** are increased above 50 and 75 the drive estimate of flux can included the effect of saturation. It is unlikely that information will be available to set up these parameters, and so the values are determined during the mag current test. These parameters are not saved at power-down, and so if the new values are required the user must save parameters before power-down.

5.31	**Voltage-controller gain**		
RW	Uni		P
⇳ 0 to 30		⇨ 1	

This parameter controls the gain of the voltage controller used for mains loss and standard ramp control. If the parameter is set to 1 the gain used is suitable for applications where the drive is used alone. Higher values are intended for applications where the DC bus of each drive is connected in parallel and the drive is used as a master for mains loss control. This is intended for use in applications where each drive is locked together using open-loop frequency slaving. (If motors are locked together using digital-locking, using a master for mains loss control, it is unlikely that the system will be stable during mains loss unless the power rating of the master is much higher than the combined rating of the slaves. This is due to the lag created by the master motor inertia.)

5.32	**Motor full load speed fine trim**		
RW	Uni		P
OL ⇳	0 to 0.99 rpm	⇨	0
VT ⇳		⇨	

This parameter provides a fine trim for the full load rated speed in 0.01rpm units. The full load rated speed is given by Pr **5.08** + Pr **5.32**. The trim allows more accurate setting of the rated speed for larger motors where the full load slip may be quite small. The rated speed optimiser changes this parameter as well as Pr **5.08**.

5.33	**Thermal model-protection enable**		
RW	Bit		
⇳ 0 or 1		⇨ 1	

If this bit is set the drive will protect itself using a thermal model. The protection system assumes that the ambient temperature is 40°C. An estimate of the maximum IGBT case temperature is made using the drive output current and switching frequency. This calculation includes the thermal time constant of the drive heatsink. An estimate of the IGBT junction temperature is made based on the calculated case temperature and an instantaneous temperature drop using the drive output current and switching frequency. The estimated IGBT junction temperature is displayed in Pr **7.32**. If the temperature exceeds 145°C the switching frequency is reduced if this is possible. The allowed changes are 12kHz to 6kHz, 6kHz to 3kHz, and 9kHz to 4.5kHz. The switching frequency Pr **5.18** will not change. Reducing the switching frequency reduces the drive losses and the junction temperature displayed in Pr **7.32** will also reduce. If the load condition persists the junction temperature will continue to rise. If it again rises above 145°C the drive will initiate an Oh1 trip. Every second the drive will attempt to restore the switching frequency to the level set in Pr **5.18**. The switching frequency will remain at the level in Pr **5.18** until the junction temperature again rises above 145°C again. Thermal model protection is the only option for the stand-alone regen unit.

4.6 Menu 6: Sequencing logic

The drive sequencer has a number of states which are indicated in the four digit window on the display in status mode. The various states are:

inh	Inhibit - The output bridge is inactive because the drive is disabled, a coast stop is in progress, or the drive is inhibited following a trip reset
rdy	Ready - The drive is enabled and ready for a start command, output bridge is inactive
StoP	The drive is enabled and ready for a start command, output bridge is active holding zero speed
SCAN	The drive is trying to synchronise its output frequency with rotational speed of the motor (open loop only)
run	The drive is running
ACUU	An AC Under voltage has been detected and the drive is trying to ride through the condition by absorbing power from the load
dEC	The drive is decelerating following a stop command
dc	Injection braking current is being applied to the machine
POS	Orientation stop is taking place
triP	The drive has tripped, the fault code is present in the upper six digit window
act	Regen mode input converter active

If the drive is in regen mode some of the strings have different meanings. See Chapter 2 *Unidrive keypad and display* on page 4.

Table 4-8 Menu 6 single line descriptions

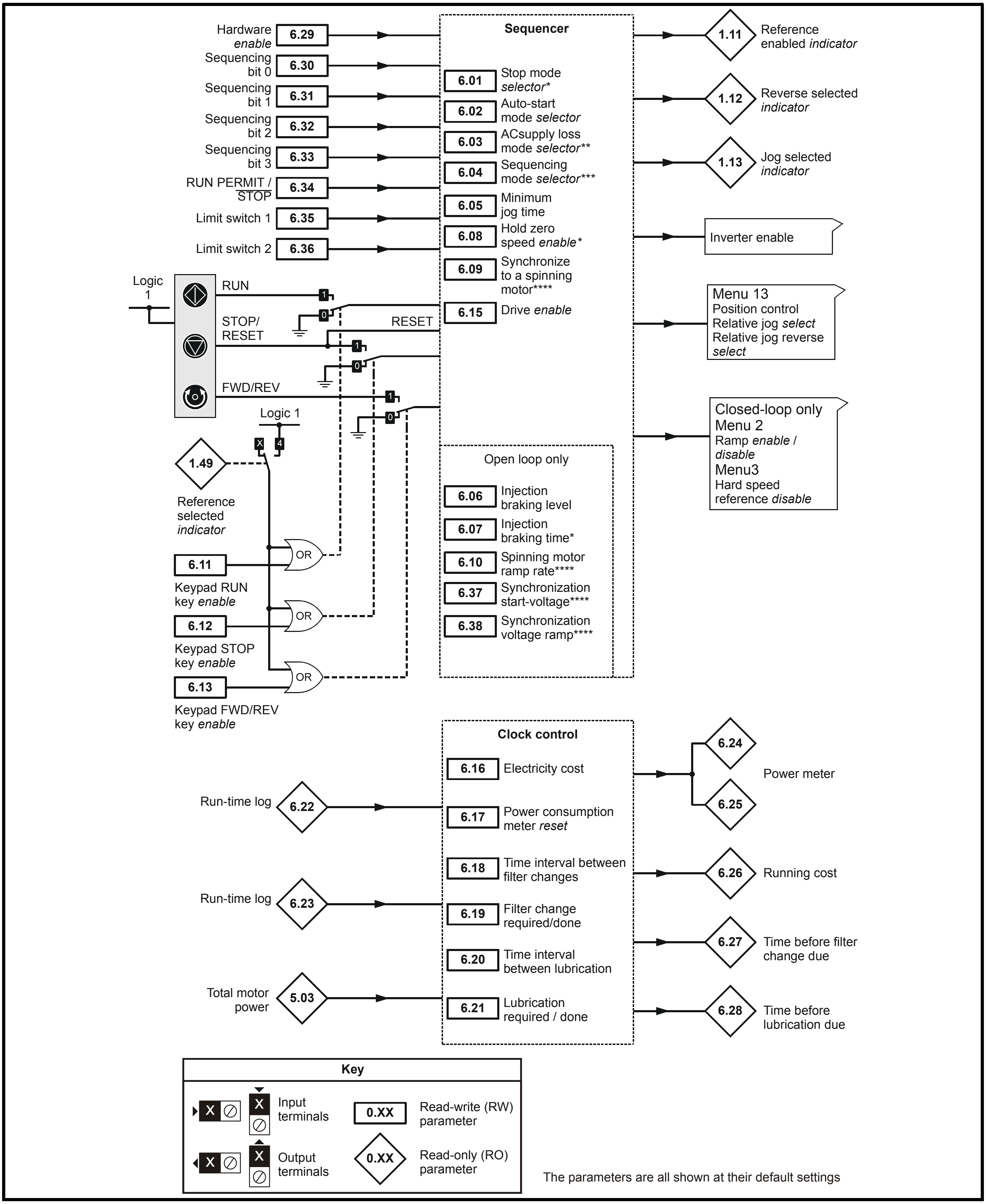
Parameter			Range(⇕)		Default(⇨)			Type			
			OL	CL	OL	VT	SV				
6.01	Stop mode *selector*	{**0.16**}	COASt (0), rP (1), rP-dcI (2), dcI (3), td.dcI (4)	COASt (0), rP (1), no.rP (2), rP-POS (3)	rP (1)		no.rP (2)	RW	Txt		
6.02	Auto-start mode *selector*		diS (0), ALYS (1), Pd.dP (2)		diS (0)			RW	Txt		
6.03	AC supply loss mode *selector*		diS (0), StoP (1), ridE.th (2)		diS (0)			RW	Txt		P
6.04	Sequencing mode *selector*		0 to 4		4			RW	Uni		P
6.05	Minimum jog time		0 to 25.0 s		0.0			RW	Uni		
6.06	Injection braking level		0 to 100.0 %FLC		100.0			RW	Uni		
6.07	Injection braking time		0 to 25.0 s		5.0			RW	Uni		
6.08	Hold zero speed *enable*		0 or 1		0		1	RW	Bit		
6.09	Synchronise to a spinning motor	{**0.39**}	0 or 1		0	1		RW	Bit		
6.10	Synchronisation ramp rate		0 to 25.0 s/100Hz		5			RW	Uni		
6.11	Keypad run key *enable*		0 or 1		0			RW	Bit		
6.12	Keypad stop key *enable*		0 or 1		0			RW	Bit		
6.13	Keypad fwd/rev key *enable*		0 or 1		0			RW	Bit		
6.15	Drive *enable*		0 or 1		1			RW	Bit		
6.16	Electricity cost / kWh		0 to 600.0 Currency/kWh		0			RW	Uni		
6.17	Power consumption meter *reset*		0 or 1		0			RW	Bit		
6.18	Time interval between filter changes		0 to 30,000 hr		0			RW	Uni		
6.19	Filter change required/done		0 or 1		1			RW	Bit		
6.20	Time interval between lubrication		0 to 30,000 hr		0			RW	Uni		
6.21	Lubrication required/done		0 or 1		1			RW	Bit		
6.22	Run-time log		0 to 30.365 years.days					RO	Uni	S	P
6.23	Run-time log		0 to 23.59 hr min					RO	Uni	S	P
6.24	Power meter		0 to 30,000 MWh					RO	Uni	S	P
6.25	Power meter		0 to 999.9 kWh					RO	Uni	S	P
6.26	Running cost		0 to 32,000 Currency/hr					RO	Uni	S	P
6.27	Time before filter change due		0 to 30,000 hr					RO	Uni	S	P
6.28	Time before lubrication due		0 to 30,000 hr					RO	Uni	S	P
6.29	Hardware *enable*		0 or 1					RO	Bit		P
6.30	Sequencing bit 0		0 or 1		0			RW	Bit		
6.31	Sequencing bit 1		0 or 1		0			RW	Bit		
6.32	Sequencing bit 2		0 or 1		0			RW	Bit		
6.33	Sequencing bit 3		0 or 1		0			RW	Bit		
6.34	Run permit / not stop		0 or 1		0			RW	Bit		
6.35	Limit switch 1		0 or 1					RO	Bit		
6.36	Limit switch 2		0 or 1					RO	Bit		
6.37	Spinning motor start-voltage		0 to 100.0 %		25			RW	Uni		
6.38	Spinning motor voltage-ramp		0 to 2.5 s		0.25			RW	Uni		

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

NOTE

Where a parameter is represented by a text value, the value in brackets in the range column is the setting used for serial communications.

Figure 4-11 Menu 6 logic diagram



* For more information, refer to Pr **6.01** on page 104, Pr **6.07** on page 107 and Pr **6.08** on page 107.

** For more information, refer to Pr **6.03** on page 105.

*** For more information, refer to Pr **6.04** on page 105.

**** For more information, refer to Pr **6.09**, Pr **6.10** on page 107, Pr **6.37** and Pr **6.38** on page 110 descriptions.

Menu 6 parameter descriptions

6.01		Stop mode selector		
RW		Txt		
OL	⇕	COASt (0), rP (1), rP-dcI (2), dcI (3), td.dcI (4)	⇨	rp (1)
VT	⇕	COASt (0), rP (1), no.rP (2), rP-POS (3)	⇨	rp (1)
SV	⇕	COASt (0), rP (1), no.rP (2), rP-POS (3)	⇨	no.rp (2))

Open Loop

0 COASt Coast stop
1 rP Ramp stop
2 rP-dcI Ramp stop + 1 second DC injection
3 dcI Injection braking stop with detection of zero speed
4 td.dcI Timed injection braking stop

Stopping is in two distinct phases: decelerating to stop, and stopped.

Stopping mode	Phase 1	Phase 2	Comments
0: Coast	Inverter disabled	Drive cannot be re-enabled for 2s	Delay in phase 2 allows rotor flux to decay in induction motors
1: Ramp	Ramp down to zero frequency	Wait for 1s with inverter enabled	
2: Ramp + 1s DC	Ramp down to zero frequency	Inject DC at level specified by Pr **6.06** for 1s	
3: DC with zero speed detection	Low frequency current injection with detection of low speed before next phase	Inject DC at level specified by Pr **6.06** for 1s	The drive automatically senses low speed and therefore it adjusts the injection time to suit the application. If the injection current level is too small the drive will not sense low speed (normally a minimum of 50-60% is required)
4: Timed injection braking stop	Inject DC at level specified by Pr **6.06** for time specified by Pr **6.07** - 1s	Inject DC at level specified by Pr **6.06** for 1s	The minimum total injection time is 1s for phase 1 and 1s for phase 2, i.e. 2s in total

Once modes 3 or 4 have begun the drive must go through the ready state before being restarted either by stopping, tripping, or being disabled.

Closed loop

0 COASt Coast stop
1 rP Ramp stop
2 no.rP Stop without ramps
3 rP-POS Stop and orientate

In the closed loop mode the two stopping phases do not exist and the ready state is entered as soon as the single stopping action is complete.

Stopping mode	Action	Comments
0: Coast	Inhibits the inverter	
1: Ramp	Stop with ramp	
2: No ramp	Stop with no ramp	
3: Stop and orientate	Stops with ramp and then rotates to a preset position	The position system controlled by menu 13 is used to orientate the motor. **Pr 13.08 must be set up correctly for use, and the hard speed reference enabled, Pr 3.19.**

6.02		Auto-start mode selector		
RW		Txt		
⇕	diS (0), ALYS (1), Pd.dP (2)		⇨	diS (0)

0 diS Disabled
1 ALYS Always
2 Pd.dP Power Down dependant

This parameter has no effect in sequencing modes 2 to 4 because they are not latching modes and require the run input to be closed for the drive to run.

0: disabled
The drive will never automatically start at power up, or after auto-reset of a trip.

1: always
The drive will always start at power up, or after a trip reset providing the drive is enabled and the stop terminal is not open.

2: power down dependant
The drive remembers its state when the power is removed. If the drive was running when the power went off then it will restart when power is re-applied (subject to the drive being enabled and the stop terminal being closed). Also if the drive is tripped then it will restart after a trip reset (again subject to the drive being enabled and the stop terminal being closed).

NOTE

Auto-start does not operate after a trip reset from the keypad stop/reset key.

6.03	**AC supply loss mode selector**		
RW	Txt		P
⇳	diS (0), StoP (1), ridE.th (2)	⇨	diS (0)

0 diS Disabled

1 StoP Stop

2 ridE.th Ride through

0: Disabled
There is no mains loss detection and the drive operates normally only as long as the DC bus voltage remains within specification (above 320V for a standard medium voltage Unidrive).

1: Stop open-loop
The action taken by the drive is the same as for ride through mode, except the ramp down rate is at least as fast as the deceleration ramp setting and the drive will continue to decelerate and stop even if the mains is re-applied. If normal or timed injection braking is selected the drive will use ramp mode to stop on loss of the supply. For injection braking or ramp with DC injection modes, DC current will be applied to the motor for 1s after it has stopped. (Unless the mains has been reapplied the drive is likely trip UU before or during the 1s injection period.)

1: Stop Closed Loop
The speed reference is set to zero and the ramps are disabled allowing the drive to decelerate the motor to a stop under current limit. If the mains is re-applied whilst the motor is stopping any run signal is ignored until the motor has stopped. If the current limit value is set very low the drive may trip UU before the motor has stopped. This is only available with software version V03.01.01 or later.

2: Ride through
The drive detects mains loss when the DC bus voltage falls below a specific level (sizes1 to 4: 410V, size5: 420V for a standard medium voltage Unidrive). The drive then enters a mode where a closed-loop controller attempts to hold the DC bus level at a specific level (sizes1 to 4: 390V, size5: 400V for a standard medium voltage Unidrive). This causes the motor to decelerate at a rate that increases as the speed falls. If the mains is re-applied it will force the d.c. link voltage above the detection threshold and the drive will continue to operate normally.

In open-loop mode the output of the mains loss controller is a current demand that is fed to the frequency changing current controller and therefore the gain Pr **4.13** and Pr **4.14** must be set up for optimum control. See Pr **4.13** and Pr **4.14** on page 84 for set-up details.

In closed-loop mode the output of the mains controller is also a current demand that is fed directly to the current loop. If the settings of Pr **4.13** and Pr **4.14** are suitable for normal operation, they should need no adjustment. See Pr **4.13** and Pr **4.14** on page 84 for set-up details.

6.04	**Sequencing mode selector**		
RW	Uni		P
⇳	0 to 4	⇨	4

There are four sequencing modes available as shown below. Any terminal can be used for any of the functions provided in each mode (see sequencing bits below).

NOTE

By default the Unidrive uses sequencing mode 4(Wire Proof PLC mode), where the necessary terminals are assigned as required. If any other sequencing mode is enabled the corresponding sequencing bits (Pr **6.30** to Pr **6.34**) must also be programmed for particular use (see section 4.8 *Menu 8: Digital I/O*).

0 CD type interface

1 Mentor type interface

2 Wire proof mode

3 PLC mode

4 Wire proof PLC mode

Sequencing mode 0: CD type

Run permit or /Stop(Pr **6.34**)	Run permit or 'not stop' input
Sequencing bit 0 (Pr **6.30**)	Run (latching)
Sequencing bit 1(Pr **6.31**)	Jog
Sequencing bit 2(Pr **6.32**)	Reverse
Sequencing bit 3(Pr **6.33**)	Not used

In this mode it also possible to enable the keypad switches, see Pr **6.11** to Pr **6.13** on page 108. If any are enabled the corresponding sequence bit controlled from one of the terminal inputs is ignored. Any jog command received will only be accepted in the ready or Stop states. Run commands override jog commands.

Sequencing mode 1: Mentor type

Run permit or /Stop(Pr **6.34**) Run permit or 'not stop' input

Sequencing bit 0 (Pr **6.30**)Run forward (latching)

Sequencing bit 1(Pr **6.31**)Jog forward

Sequencing bit 2(Pr **6.32**)Run reverse (latching)

Sequencing bit 3(Pr **6.33**)Jog reverse

The drive run key can also latch a run state if it is enabled and the fwd/rev key can change direction if it is enabled (unless one of the sequencing bits is being held in which case they have priority). The stop key can also stop the drive if it is enabled and a run condition is not being forced by the sequencing bits. Any jog command received will only be accepted in the ready or Stop states. Run commands override jog commands.

Sequencing mode 2: Wire Proof Mode

Run permit or /Stop(Pr **6.34**) Run permit or 'not stop' input

Sequencing bit 0 (Pr **6.30**)Run forward

Sequencing bit 1(Pr **6.31**)Jog

Sequencing bit 2(Pr **6.32**)Run reverse

Sequencing bit 3(Pr **6.33**)Not used

In this mode the run permit bit, and either sequencing bit 0 or 2 (but not both) must be at 1 before the drive will run. This requires that at least 3 terminals must be made active on the drive, the drive enable input and 2 others programmed to control the run permit bit and one of the sequencing bits. If forward and reverse are selected at the same time the drive will stop after a delay of 60ms.

To jog forward or reverse the jog sequencing bit must be active together with the appropriate direction sequencing bit. Any jog command received will only be accepted in the ready or Stop states. (i.e. the jog input must be active before the run input). . (A 70ms delay is included in de-activation of jog in the open-loop mode so that if run and jog are removed together the drive does not go into the run mode temporarily and start to accelerate to the run reference before stopping.) Because this mode requires terminals to be held in an active state at all times, the run, stop, and fwd/rev keys on the drive are not responded to even if they are enabled.

Sequencing mode 3: PLC Mode

Run permit or /Stop(Pr **6.34**) Not used

Sequencing bit 0 (Pr **6.30**)Run

Sequencing bit 1(Pr **6.31**)Jog

Sequencing bit 2(Pr **6.32**)Forward/Reverse

Sequencing bit 3(Pr **6.33**)Not used

The drive will respond to the sequencing bits as it finds them in this mode.

To jog forward or reverse the jog sequencing bit must be active together with the run bit and the appropriate direction selected. Any jog command received will only be accepted in the ready or Stop states (i.e. the jog input must be active before the run input). As with mode 2 this mode requires terminals to be held active and therefore the run, stop, and fwd/rev keys on the drive are not responded to even if they are enabled.

Sequencing mode 4: Wire Proof PLC Mode

Run permit or /Stop(Pr **6.34**) Not used

Sequencing bit 0 (Pr **6.30**)Run forward

Sequencing bit 1(Pr **6.31**)Jog

Sequencing bit 2(Pr **6.32**)Run Reverse

Sequencing bit 3(Pr **6.33**)Not used

In this mode either sequencing bit 0 or 2 must be at 1 before the drive will run. All inputs are non latching and when not asserted the drive will stop immediately using the mode defined by the stopping mode. If both forward and reverse are active then the drive will stop. If the drive is operating in open-loop mode there is a 60ms delay after both forwards and reverse are closed before a stop is initiated.

To jog forward or reverse the jog sequencing bit must be active together with the appropriate direction sequencing bit. Any jog command received will only be accepted in the ready or Stop states. (A 70ms delay is included in de-activation of jog in the open-loop mode so that if run and jog are removed together the drive does not go into the run mode temporarily and start to accelerate to the run reference before stopping.) Because this mode requires terminals to be held in an active state at all times, the run, stop, and fwd/rev keys on the drive are not responded to even if they are enabled.

6.05	Minimum jog time			
RW	Uni			
⇳	0 to 25.0 s		⇨	0.0

This parameter can be used to define a minimum jog period such that a machine will move by a fixed amount when a jog pulse is received. It is not operational in sequencing modes 2 and 3 because removing the jog input and leaving the run active causes the drive to select its normal run reference.

6.06		Injection braking level		
RW		Uni		
OL	⇳	0 to 100.0 %FLC	⇨	100.0

In open loop drives this parameter defines the current level used for injection braking.

(For definition of maximum current limit see section 4.4 *Menu 4: Current control* .)

6.07		Injection braking time		
RW		Uni		
OL	⇳	0 to 25.0 s	⇨	5.0

This parameter defines the low frequency braking time for phase 1 of stopping during a stop using stopping mode 4 in open loop drives (see Pr **6.01** on page 104).

6.08		Hold zero speed enable		
RW		Bit		
OL	⇳	0 or 1	⇨	0
VT	⇳		⇨	
SV	⇳		⇨	1

When this bit is set the drive will hold torque at standstill when not in the running state rather than disabling the output bridge. The drive status will be 'StoP' when the drive is at standstill rather than 'rdy'.

6.09		Synchronise to a spinning motor		
RW		Bit		
OL	⇳	0 or 1	⇨	0
VT	⇳		⇨	1
SV	⇳		⇨	

Open Loop

The drive performs a sequence of operations to determine the motor frequency before attempting to run the motor with full voltage applied. These tests are carried out with a voltage defined by Pr **6.37**. The frequency is first set to maximum frequency in the direction in which the drive last ran. The frequency is ramped to zero at a rated defined by Pr **6.10**. If the machine frequency is not detected, the frequency is set to maximum in the other direction and the test is repeated. If the frequency is detected at any point the test is stopped, the voltage is ramped up at a rate defined by Pr **6.37** and then the drive runs normally. If the frequency is not detected the drive starts from 0Hz. If the drive is powered down the previous direction of operation is not stored, and so the test begins in the forward direction.

It is important that if spinning start is selected then the Voltage Mode, Pr **5.14**, must be set to 'Fd' and not left in the default value of 'Ur_I' (value 1).

Closed Loop

The ramp output is set to the actual motor speed when the drive is commanded to start.

6.10		Synchronisation ramp rate		
RW		Uni		
OL	⇳	0 to 25.0 s/100Hz	⇨	5.0

This parameter defines the rate at which the frequency is changed when trying to synchronise the motor speed. Motors and loads with very low inertias will require this parameter to be set low to ensure the speed is detected, while motors and loads with large inertias may require the parameter to be increased to prevent over voltage trips.

6.11	Keypad run key enable		
RW	Bit		
⇕ 0 or 1		⇨ 0	

This parameter enables the Run switch on the drive. In keypad mode this parameter has no effect because this key is automatically enabled.

6.12	Keypad stop key enable		
RW	Bit		
⇕ 0 or 1		⇨ 0	

This parameter enables the Stop switch on the drive. In keypad mode this parameter has no effect because this key is automatically enabled.

6.13	Keypad fwd/rev key enable		
RW	Bit		
⇕ 0 or 1		⇨ 0	

This parameter enables the Fwd/Rev switch on the drive. In keypad mode the forward/reverse key is not active unless this parameter is set.

6.15	Drive enable		
RW	Bit		
⇕ 0 or 1		⇨ 1	

Setting this parameter to 0 will disable the drive. It must be at 1 for the drive to run.

6.16	Electricity cost / kWh		
RW	Uni		
⇕ 0 to 600.0 Currency/kWh		⇨ 0	

When this parameter is set up correctly for the local currency, Pr **6.26** will give an instantaneous read out of running cost.

6.17	Power consumption meter reset		
RW	Bit		
⇕ 0 or 1		⇨ 0	

Used to reset Pr **6.24** and Pr **6.25** back to zero.

6.18	Time interval between filter changes		
RW	Uni		
⇕ 0 to 30,000 hr		⇨ 0	

If the user wishes the drive to measure the running time between filter changes on a machine and flag the user when a change is due, this parameter should be set up to define the running time interval between the changes.

6.19	Filter change required / done		
RW	Bit		
⇕ 0 or 1		⇨ 0	

During the running of the drive, Pr **6.27** is reduced until such a time that it reaches 0, at which point this parameter will be set to 1 to inform the user that a filter change is required. When the user has changed the filter, resetting this parameter to 0 will indicate to the drive that the change has been done at which time it will reload Pr **6.27** with the value of Pr **6.18**.

Pr **6.27** can be updated with the value of Pr **6.18** at any time by setting and clearing this parameter manually.

6.20	Time interval between lubrication		
RW	Uni		
⇕ 0 to 30,000 hr		⇨ 0	

If the user wishes the drive to measure the running time between lubrication requirements on a machine and flag the user when lubrication is due, this parameter should be set up to define the running time interval between lubrication.

6.21	Lubrication required / done		
RW	Bit		
⇳ 0 or 1		⇨ 0	

During the running of the drive, Pr **6.28** is reduced until such a time that it reaches 0 at which point this parameter will be set to 1 to inform the user that lubrication is required. When the user has lubricated the machine, resetting this parameter to 0 will indicate to the drive that the lubrication has been done at which time it will reload Pr **6.28** with the value of Pr **6.20**.

Pr **6.28** can be updated with the value of Pr **6.20** at any time by setting and clearing this parameter manually.

6.22	Run-time log		
RO	Uni	S	P
⇳ 0 to 30.365 years.days		⇨	

Together with the next parameter the drive records the amount of time the drive has been running since it left the manufacturing plant.

6.23	Run-time log		
RO	Uni	S	P
⇳ 0 to 23.59 hr.min		⇨	

Together with the previous parameter the drive records the amount of time the drive has been running since it left the manufacturing plant.

6.24	Power meter		
RO	Uni	S	P
⇳ 0 to 30,000 MWh		⇨	

Drive power consumption meter. This can be reset to zero by setting Pr **6.17**.

6.25	Power meter		
RO	Uni	S	P
⇳ 0 to 999.9 kWh		⇨	

Drive power consumption meter. This can be reset to zero by setting Pr **6.17**.

6.26	Running cost		
RO	Uni	S	P
⇳ 0 to 32,000 Currency/hr		⇨	

Instantaneous read out of the cost/hour of running the drive. This requires Pr **6.16** to be set up correctly. The displayed cost needs to be scaled depending on the drive size as follows:

Size 1 and 2 Multiply display by 1.
Size 3 and 4 Multiply display by 10.
Size 5 Multiply display by 100.

Example:
If the cost/kWh = 123.4 and a Size 3 drive is giving 10kW the running cost display (Pr **6.26**) will show 123, this must be then multiplied by ten to give the actual running cost of 1230/hour.

6.27	Time before filter change due		
RO	Uni	S	P
⇳ 0 to 30,000 hr		⇨	

This parameter indicates the running time remaining before the drive will flag the user to change a filter on the machine. See Pr **6.19** on page 108.

6.28	Time before lubrication due		
RO	Uni	S	P
⇳ 0 to 30,000 hr		⇨	

This parameter indicates the running time remaining before the drive will flag the user to lubricate the machine. See Pr **6.21** on page 109.

6.29	Hardware enable		
RO	Bit		P
⇕ 0 or 1		⇨	

If Pr **8.09** is set to 1, terminal 30 becomes a drive enable input and this parameter will be set to 1 when the terminal is active. If Pr **8.09** is set to 0 then this parameter is always at 1.

6.30	Sequencing bit 0		
6.31	Sequencing bit 1		
6.32	Sequencing bit 2		
6.33	Sequencing bit 3		
6.34	Run permit /stop		
RW	Bit		
⇕ 0 or 1		⇨	0

The drive sequencer uses these bits as inputs rather than looking at terminals directly. This allows the customer to define the use of each drive terminal according to each applications needs.

Although these parameters are R/W, they are volatile and are not stored on power down. Every time the drive powers up they will be reset to 0.

6.35	Limit switch 1		
6.36	Limit switch 2		
RO	Bit		
⇕ 0 or 1		⇨	

These parameters should be used for stopping drives at each end of a traverse.

Pr **6.35** Limit switch 1 (Forward only)
Pr **6.36** Limit switch 2 (Reverse only)

Pr **6.35** if set to 1 will stop the drive when it is operating in forward direction and Pr **6.36** will stop the drive when it is operating in the reverse direction. Input terminals should be routed to control these parameters if the feature is required. In open-loop mode the stop will be initiated within 5.5ms [7.4ms] of the terminal being made active. In closed-loop modes the maximum software delay is only 345µs [460µs]. The input hardware also includes a delay of approximately 500µs, therefore the total delay from a change at the input to initiating a stop is less than 1ms. (To achieve a fast response and allow full programmability the drive must monitor the limit switch inputs in the speed controller task as well as the slow user task. If the limit switch for the opposite direction of rotation to the actual direction of rotation is activated it will cause a momentary reduction of speed, but the motor will not stop. This should never happen in practice anyway.) The direction of operation is derived as follows:

Open-loop

Pre-filter reference > 0.1Hzforward limit switch active
Pre-filter reference <-0.1Hzreverse limit switch active
Pre-filter reference = 0.0Hzboth limit switches active

(If the precision reference is used the direction of operation is derived from the reference rounded to the nearest 0.1Hz.)

Closed-loop

Pre-filter reference+hard speed reference > 1rpmforward limit switch active
Pre-filter reference+hard speed reference <-1rpmreverse limit switch active
Pre-filter reference+hard speed reference = 0rpmboth limit switches active
(If the precision reference is used the direction of operation is derived from the reference rounded to the nearest 1rpm. The hard speed reference is only included if it is enabled, i.e. Pr **3.20** = 1.)

6.37	Spinning motor start-voltage		
RW	Uni		
OL ⇕ 0 to 100.0 %		⇨	25.0

Defines the voltage applied during a spin start as the % of voltage that would be applied in normal operation. Setting this value too high causes the drive to current limit, setting it too low will give problems detecting low motor speeds.

6.38	Spinning motor voltage-ramp		
RW	Uni		
OL ⇕ 0 to 2.5 s		⇨	0.25

When the software has detected the motor speed it ramps the drives output voltage from the level programmed in Pr **6.37** to its normal operating voltage. This parameter determines the time interval for this change in voltage. Setting the time too short will cause excessive current transients in the machine as the voltage rises, while setting it too long may cause the drive to loose synchronisation if the motor is decelerating quite quickly.

4.7 Menu 7: Analog I/O

Unidrive has three analog inputs and two analog outputs. All inputs and outputs can be configured for voltage mode operation over ±10V, or current loop mode with a maximum current of 20mA. In addition analog input three can be configured as a motor thermistor input. Both the analog inputs and outputs have a normal sample rate of 5.5ms for 3, 6 and 12kHz, and 7.4ms for 4.5 and 9kHz, (abbreviated as a sample rate of 5.5ms [7.4ms]).

For infomation on obtaining faster update rates see the following:

Frequency control - section 4.1 *Menu 1: Speed references and limits*
Speed control - section 4.1 *Menu 1: Speed references and limits*
Torque control - Pr **4.08** on page 82
Frequency/speed/torque outputs - Pr **7.30** on page 117

Analog input 1 uses a v to f converter to convert from analog to digital values. This input has a resolution of 12 bits plus sign, except for speed control via Pr **1.36** and Pr **1.37** where the long term resolution is effectively infinite. This is because the integral term within the speed loop holds the difference in the pulse count from the v to f converter and the motor encoder.

Analog inputs 2 and 3 use A to D converters to convert from analog to digital values. These inputs have a resolution of 10 bits plus sign.

Name	Terminal Number	Direction	Mode
Ain 1	5 positive, 6 negative	Input	Voltage / Current
Ain 2	7	Input	Voltage / Current
Ain 3	8	Input	Voltage / Current or Thermistor
Aout 1	9	Output	Voltage / Current
Aout 2	10	Output	Voltage / Current

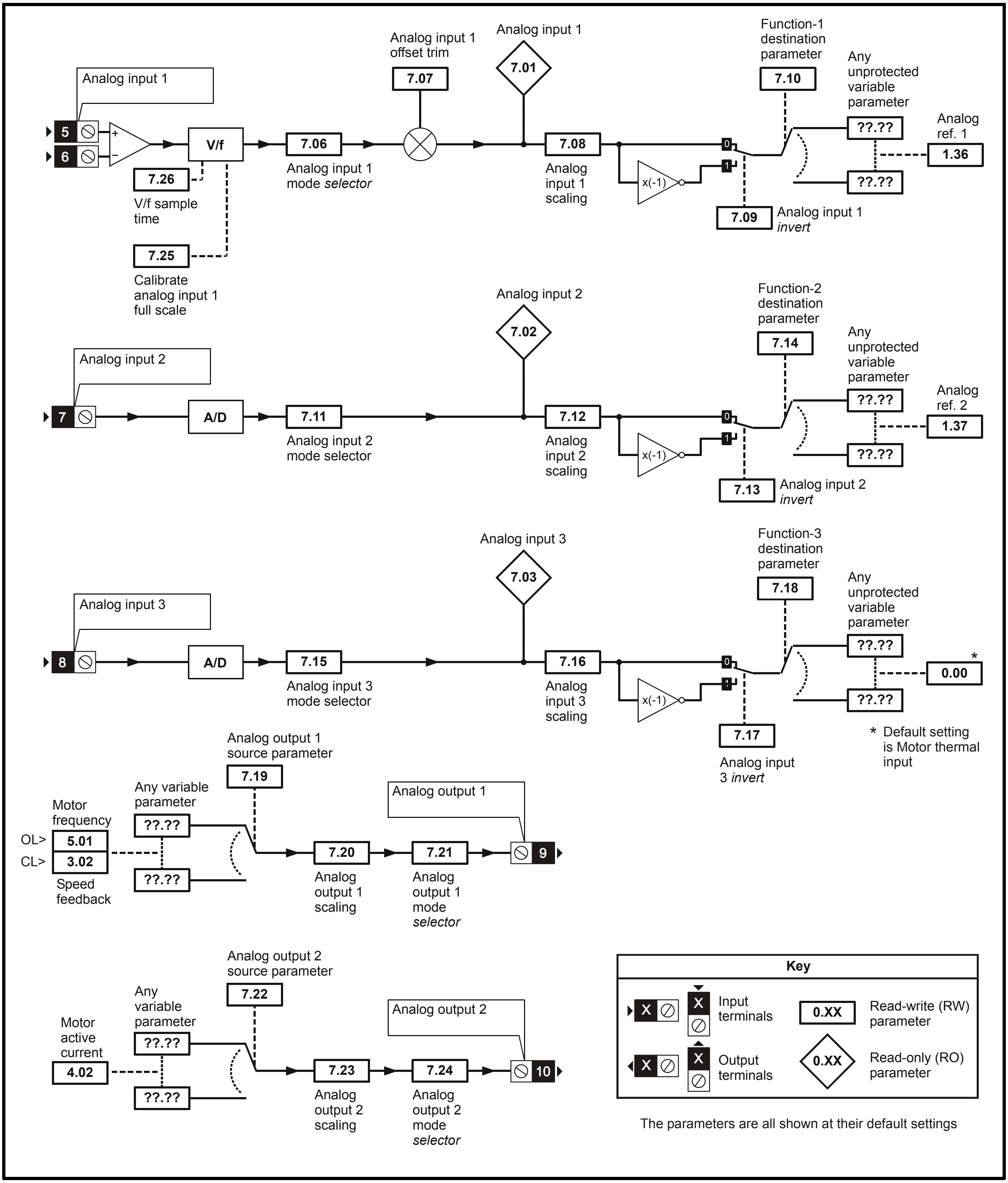
Table 4-9 Menu 7 single line descriptions

Parameter		Range(⇕)		Default(⇨)			Type			
		OL	CL	OL	VT	SV				
7.01	Analog input 1	±100.0 %					RO	Bi		P
7.02	Analog input 2	±100.0 %					RO	Bi		P
7.03	Analog input 3	±100.0 %					RO	Bi		P
7.04	Heatsink temperature	0 to 100 °C					RO	Uni		P
7.05	Control board temperature	0 to 100 °C					RO	Uni		P
7.06	Analog input 1 mode *selector* {**0.24**}	VOLt (0), 0 - 20 (1), 20 - 0 (2), 4 - 20.tr (3), 20 - 4.tr (4), 4 - 20.Lo (5), 20 - 4.Lo (6), 4 - 20.Pr (7), 20 - 4.Pr (8)		VOLt (0)			RW	Txt	R	
7.07	Analog input 1 offset trim	±10.000 %		0			RW	Bi		P
7.08	Analog input 1 scaling	0 to 4.000		1.000			RW	Uni		
7.09	Analog input 1 *invert*	0 or 1		0			RW	Bit		
7.10	Analog input 1 destination parameter	Pr **0.00** to Pr **20.50**		Pr **1.36**			RW	Uni	R	P
7.11	Analog input 2 mode *selector* {**0.25**}	(as Pr **7.06**)		VOLt (0)			RW	Txt	R	
7.12	Analog input 2 scaling	0 to 4.000		1			RW	Uni		
7.13	Analog input 2 *invert*	0 or 1		0			RW	Bit		
7.14	Analog input 2 destination parameter {**0.26**}	Pr **0.00** to Pr **20.50**		Pr **1.37**			RW	Uni	R	P
7.15	Analog input 3 mode *selector*	VOLt (0), 0 - 20 (1), 20 - 0 (2), 4 - 20.tr (3) , 20 - 4.tr (4), 4 - 20.Lo (5) , 20 - 4.Lo (6), 4 - 20.Pr (7), 20 - 4.Pr (8), th.SC (9), th (10)		EUR> th (10), USA> VOLt (0)			RW	Txt	R	
7.16	Analog input 3 scaling	0 to 4.000		1.000			RW	Uni		
7.17	Analog input 3 *invert*	0 or 1		0			RW	Bit		
7.18	Analog input 3 destination parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
7.19	Analog output 1 source parameter	Pr **0.00** to Pr **20.50**		Pr **5.01**	Pr **3.02**		RW	Uni	R	P
7.20	Analog output 1 scaling	0 to 4.000		1			RW	Uni		
7.21	Analog output 1 mode *selector*	VOLt (0), 0 - 20 (1), 4 - 20 (2)		VOLt (0)			RW	Txt	R	P
7.22	Analog output 2 source parameter	Pr **0.00** to Pr **20.50**		Pr **4.02**			RW	Uni	R	P
7.23	Analog output 2 scaling	0 to 4.000		1.000			RW	Uni		
7.24	Analog output 2 mode *selector*	VOLt (0), 0 - 20 (1), 4 - 20 (2)		VOLt (0)			RW	Txt	R	P
7.25	Calibrate analog input 1 full scale	0 or 1		0			RW	Bit		
7.26	V/f sample time		0 to 5.0 ms		4.0		RW	Uni		
7.27	Analog input 1 current-loop loss *indicator*	0 or 1					RO	Bit		P
7.28	Analog input 2 current-loop loss *indicator*	0 or 1					RO	Bit		P
7.29	Analog input 3 current-loop loss *indicator*	0 or 1					RO	Bit		P
7.30	Analog output set-up *enable*	0 or 1		0			RW	Bit		
7.31	UD78 large option module fitted *indicator*	0 or 1					RO	Bit		P
7.32	IGBT junction temperature	0 to 150 °C					RO	Uni		P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

NOTE Where a parameter is represented by a text value, the value in brackets in the range column is the setting used for serial communications.

Figure 4-12 Menu 7 logic diagram



The parameters are all shown at their default settings

Menu 7 parameter descriptions

7.01	**Analog input 1**		
7.02	**Analog input 2**		
7.03	**Analog input 3**		
RO	Bi		P
⇕	±100.0 %	⇨	

These parameters display the level of the analog signal present at their respective terminals. Parameter range is ±100.0% for voltage inputs or 0 - 100.0% for any of the current loop input modes.

7.04	**Heatsink temperature**		
RO	Uni		P
⇕	0 to 100.0 °C	⇨	

This parameter displays the temperature currently being measured on the heat sink. If this level reaches 94ºC the drive will trip and will not allow a reset until the temperature falls below 90ºC. This parameter is updated even when the drive is tripped.

7.05	**Control board temperature**		
RO	Uni		P
⇕	0 to 100.0 °C	⇨	

The ambient temperature around the control board is displayed here. If this measurement reaches 95ºC the drive will trip and will not allow a reset until the temperature falls below 90ºC. This parameter is updated even when the drive is tripped.

7.06	**Analog input 1 mode selector**		
RW	Txt	R	
⇕	VOLt (0), 0 - 20 (1), 20 - 0 (2), 4 - 20.tr (3), 20 - 4.tr (4), 4 - 20.Lo (5), 20 - 4.Lo (6), 4 - 20.Pr (7), 20 - 4.Pr (8)	⇨	VOLt (0)

Each of the 3 analog inputs can be set up for different types of control signals via these input mode parameters.

0	VOLt	Voltage input
1	0 - 20	0 - 20 mA
2	20 - 0	20 - 0 mA
3	4 - 20.tr	4 - 20 mA, Trip on loss
4	20 - 4.tr	20 - 4 mA, Trip on loss
5	4 - 20.Lo	4 - 20 mA, Min (or low) speed on loss
6	20 - 4.Lo	20 - 4 mA, Min (or low) speed on loss
7	4 - 20.Pr	4 - 20 mA, Previous speed on loss
8	20 - 4.Pr	20 - 4 mA, Previous speed on loss

In 4-20mA or 20-4mA modes the threshold for current loop loss is 3mA.

7.07	**Analog input 1 offset trim**		
RW	Bi		P
⇕	±10.000 %	⇨	0

This parameter can be used to trim out any offset in the users reference signal.

7.08	**Analog input 1 scaling**		
RW	Uni		0
⇕	0.000 to 4.000	⇨	1.000

This parameter can be used to scale an input if so desired. However in most cases it is not necessary as each input is automatically scaled such that for 100.0% input the destination parameter will be at maximum.

7.09	**Analog input 1 invert**				
RW	Bit				
⇳	0 or 1	⇨	0		

This parameter can be used to invert an input reference if so desired.

7.10	**Analog input 1 destination parameter**				
RW	Uni	R	P		
⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **1.36**		

The parameters which each analog input is required to control are programmed here. Only non-bit parameters which are not protected can be controlled by analog inputs. If a non valid parameter is programmed the input is not routed anywhere. After modification of these parameters the destination is only changed when the stop/reset key is pressed (or the drive powered-down and up again).

7.11	**Analog input 2 mode selector**				
RW	Txt	R			
⇳	VOLt (0), 0 - 20 (1), 20 - 0 (2), 4 - 20.tr (3), 20 - 4.tr (4), 4 - 20.Lo (5), 20 - 4.Lo (6), 4 - 20.Pr (7), 20 - 4.Pr (8)	⇨	VOLt (0)		

Each of the 3 analog inputs can be set up for different types of control signals via these input mode parameters.

0	VOLt	Voltage input
1	0 - 20	0 - 20 mA
2	20 - 0	20 - 0 mA
3	4 - 20.tr	4 - 20 mA, Trip on loss
4	20 - 4.tr	20 - 4 mA, Trip on loss
5	4 - 20.Lo	4 - 20 mA, Min (or low) speed on loss
6	20 - 4.Lo	20 - 4 mA, Min (or low) speed on loss
7	4 - 20.Pr	4 - 20 mA, Previous speed on loss
8	20 - 4.Pr	20 - 4 mA, Previous speed on loss

In 4-20mA or 20-4mA modes the threshold for current loop loss is 3mA.

7.12	**Analog input 2 scaling**				
RW	Uni				
⇳	0.000 to 4.000	⇨	1.000		

This parameter can be used to scale an input if so desired. However in most cases it is not necessary as each input is automatically scaled such that for 100.0% input the destination parameter will be at maximum.

7.13	**Analog input 2 invert**				
RW	Bit				
⇳	0 or 1	⇨	0		

This parameter can be used to invert an input reference if so desired.

7.14	**Analog input 2 destination parameter**				
RW	Uni	R	P		
⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **1.37**		

The parameters which each analog input is required to control are programmed here. Only non-bit parameters which are not protected can be controlled by analog inputs. If a non valid parameter is programmed the input is not routed anywhere. After modification of these parameters the destination is only changed when the stop/reset key is pressed (or the drive powered-down and up again).

7.15	**Analog input 3 mode selector**		
RW	Txt	R	
⇳	VOLt (0), 0 - 20 (1), 20 - 0 (2), 4 - 20.tr (3), 20 - 4.tr (4), 4 - 20.Lo (5), 20 - 4.Lo (6), 4 - 20.Pr (7), 20 - 4.Pr (8), th.SC (9), th (10)	⇨	EUR> th (10)* USA> VOLt (0)

*In Regen Pr **7.15** = 0, voltage mode input.

Each of the 3 analog inputs can be set up for different types of control signals via these input mode parameters.

0	VOLt	Voltage input
1	0 - 20	0 - 20 mA
2	20 - 0	20 - 0 mA
3	4 - 20.tr	4 - 20 mA, Trip on loss
4	20 - 4.tr	20 - 4 mA, Trip on loss
5	4 - 20.Lo	4 - 20 mA, Min (or low) speed on loss
6	20 - 4.Lo	20 - 4 mA, Min (or low) speed on loss
7	4 - 20.Pr	4 - 20 mA, Previous speed on loss
8	20 - 4.Pr	20 - 4 mA, Previous speed on loss
9	th.SC	Thermistor with trip on short circuit detection (Ain 3 only)
10	th	Thermistor without short circuit detection (Ain 3 only)

In 4-20mA or 20-4mA modes the threshold for current loop loss is 3mA.

7.16	**Analog input 3 scaling**		
RW	Uni		
⇳	0.000 to 4.000	⇨	1.000

This parameter can be used to scale an input if so desired. However in most cases it is not necessary as each input is automatically scaled such that for 100.0% input the destination parameter will be at maximum.

7.17	**Analog input 1 invert**		
RW	Bit		
⇳	0 or 1	⇨	0

This parameter can be used to invert an input reference if so desired.

7.18	**Analog input 3 destination parameter**		
RW	Uni	R	P
⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **0.00**

The parameters which each analog input is required to control are programmed here. Only non-bit parameters which are not protected can be controlled by analog inputs. If a non valid parameter is programmed the input is not routed anywhere. After modification of these parameters the destination is only changed when the stop/reset key is pressed (or the drive powered-down and up again).

7.19		**Analog output 1 source parameter**		
RW		Uni	R	P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **5.01**
VT	⇳		⇨	Pr **3.02**
SV	⇳		⇨	

The default in Regenmode is Pr **15.01**.

The parameters required to be output to the 2 analog outputs should be programmed in these parameters. Only non-bit parameters can be programmed as a source. If a non valid parameter is programmed the output value is taken as 0. After modification of these parameters the source is only changed when the stop/reset key is pressed (or the drive powered-down and up again).

7.20	Analog output 1 scaling		
RW	Uni		
⇳ 0.000 to 4.000		⇨ 1.000	

Again user defined scaling is provided but as with inputs, automatic scaling is carried out such that when the source parameter is at its maximum value the DAC output will be at maximum.

7.21	Analog output 1 mode selector		
RW	Txt	R	P
⇳ VOLt (0), 0 - 20 (1), 4 - 20 (2)		⇨ VOLt (0)	

This parameter can configure the DAC outputs in three different ways.

0 VOLtOutput range ±10V.
1 0 - 20Output range 0 - 20 mA.
2 4 - 20Output range 4 - 20 mA.

In modes 1 and 2 negative values in a source parameter will be treated as zero.

7.22	Analog output 2 source parameter		
RW	Uni	R	P
⇳ Pr **0.00** to Pr **20.50** Menu.parameter		⇨ Pr **4.02**	

The default in Regen mode is Pr **15.03**.

The parameters required to be output to the 2 analog outputs should be programmed in these parameters. Only non-bit parameters can be programmed as a source. If a non valid parameter is programmed the output value is taken as 0. After modification of these parameters the source is only changed when the stop/reset key is pressed (or the drive powered-down and up again).

7.23	Analog output 2 scaling		
RW	Uni		
⇳ 0.000 to 4.000		⇨ 1.000	

Again user defined scaling is provided but as with inputs, automatic scaling is carried out such that when the source parameter is at its maximum value the DAC output will be at maximum.

7.24	Analog output 2 mode selector		
RW	Txt	R	P
⇳ VOLt (0), 0 - 20 (1), 4 - 20 (2)		⇨ VOLt (0)	

This parameter can configure the DAC outputs in three different ways.

0 VOLtOutput range ±10V.
1 0 - 20Output range 0 - 20 mA.
2 4 - 20Output range 4 - 20 mA.

In modes 1 and 2 negative values in a source parameter will be treated as zero.

7.25	Callibrate analog input 1 full scale		
RW	Bit		
⇳ 0 or 1		⇨ 0	

Setting this bit will cause the drive to adjust its own scale factor such that the required maximum is reached at the input level at the time calibration takes place. This parameter is cleared by the software when the calibration is complete.

The input voltage or current when calibration is called for must be greater than 25% of the drives normal full scale input (2.5V or 5mA). Once a calibration has been done the result will be used until the calibration is redone or cancelled (the calibration result is stored on power down). To cancel a previously set-up calibration such that the drive has the standard full scale value, a calibration should be called for with less than 15% of the drives normal full scale input applied.

7.26		**V/f sample time**		
RW		Uni		
CL	⇕	0 to 5.0 ms	⇨	4.0

This parameter affects the low speed performance and the speed of response to a changing speed demand. Low values give good dynamic response but noisy operation at low speeds and high values give smooth low speed operation but a poorer dynamic response. A compromise must be made between low speed operation and good dynamic response. This parameter is only used in the special case described under analog input modes where the destination is Pr **1.36**, Pr **1.37**, or Pr **3.19**.

7.27	**Analog input 1 current-loop loss indicator**		
7.28	**Analog input 2 current-loop loss indicator**		
7.29	**Analog input 3 current-loop loss indicator**		
RO	Bit		P
⇕	0 or 1	⇨	

If analog input 1, 2 or 3 is programmed for 4-20mA or 20-4mA current loop, with any of the hold, trip, or min on loss modes, then if the current is less than 3mA the current loop loss bit will be set. In any other input mode, or if the current is greater than 3mA then the bit will be cleared.

7.30	**Analog output short cut enable**		
RW	Bit		
⇕	0 or 1	⇨	0

The analog outputs are controlled with a 5.5 or 7ms sample rate, see Pr **7.21** and Pr **7.24** on page 116. To allow the drive speed and current loops to be set-up, speed (closed-loop) or frequency (open-loop), and the torque producing current can be accessed via the analog outputs at a sample rate of 345µs or 460µs This function is enabled by setting Pr **7.30**. The scalings are as follows:

Frequency
If the maximum frequency is between -100Hz and +100Hz then +/-10V corresponds to +/-125Hz, otherwise +/-10V corresponds to +/-1000Hz.

Speed
The speed signal is derived directly from the encoder feedback. A 4096 line encoder will give 5.5V for 3,000rpm. A 1024 line encoder gives 5.5V output for 12,000rpm. If the number of encoder lines is changed the voltage level will change accordingly. (SINCOS at high speeds may overflow.)

Torque producing current
+/-10V corresponds to +/-full scale current for the drive.

7.31	**UD78 large option module fitted indicator**		
RO	Bit		P
⇕	0 or 1	⇨	

If a UD78 large option module is fitted to the drive this bit is set to 1, if not it is 0. The UD78 has the following features:

High precision analog input
If the UD78 is fitted AN1 on the drive no longer functions, but is replaced by the input on this module. It will function in the same way as AN1 on the drive. It has a fixed calibration level, such that 9.8V gives full scale, or may be calibrated with a user defined voltage by setting Pr **7.25**. The UD78 should not be removed whilst the drive is powered-up. However if it is removed, either the drive processor will detect a bus error giving a hardware trip, or if the processor is able to continue running, an AN1.DIS trip will be given. This can only be reset after the drive has been powered-down and up again.

Auxiliary power supply
The drive control electronics can be supplied from a 24V power supply via the UD78. The auxiliary supply is only used when the main drive supply voltage falls below approximately 230Vac (320V on the DC bus). The auxiliary supply is then used until the main supply voltage rises to approximately 320V (450V on the Dc bus), at which point the drive will return to using its own switch mode power supply. When the auxiliary supply becomes the active supply all power-down parameters are saved. Until the main supply rises again to the point where the main switch mode power supply is used parameters cannot be saved and the drive cannot be enabled. When the auxiliary supply is being used the alarm code LO.PS is displayed. There is a 5s delay when the drive is initially powered-up via a UD78 to allow all the electronics to stabilise. There is also a 5s delay when the mains power is applied to a drive running off a UD78 supply before the drive can be enabled.

ANSI comms
An ANSI comms interface is provided with RS485 hardware only.

7.32	IGBT junction temperature			
RO	Uni		P	
⇕	0 to 150 °C	⇨		

This parameter displays the calculated junction temperature IGBT's within the drive. The temperature is calculated based on an ambient of 40°C. Therefore the minimum value of this parameter is 40°C when thermal modelling is enabled. When thermal modelling is disabled this parameter is held at 0.

4.8 Menu 8: Digital I/O

Unidrive has seven digital input / output terminals, of which three are bi-directional, and four input only. Terminals F1 to F6 are fully programmable for source, destination and polarity. When in output mode F1 to F3 can have open collector, or active pull-up outputs. The Enable / Trip input is a dedicated input which can be used either as an enable input or as an external trip input. If both features are required then terminal 30 should be used as the drive enable and one of the other inputs should be programmed to control the External trip bit Pr **10.32** (an inversion on the input logic will be required to prevent a trip when the input terminal is active). Note that in Regen mode the functions of terminals F1, F2 and F5 are fixed and can not be changed by the user. Digital inputs and outputs are updated every 8ms. If any changes of source or destination are made no action is taken by the drive until the stop/reset key is pressed or the drive is powered-down and up again.

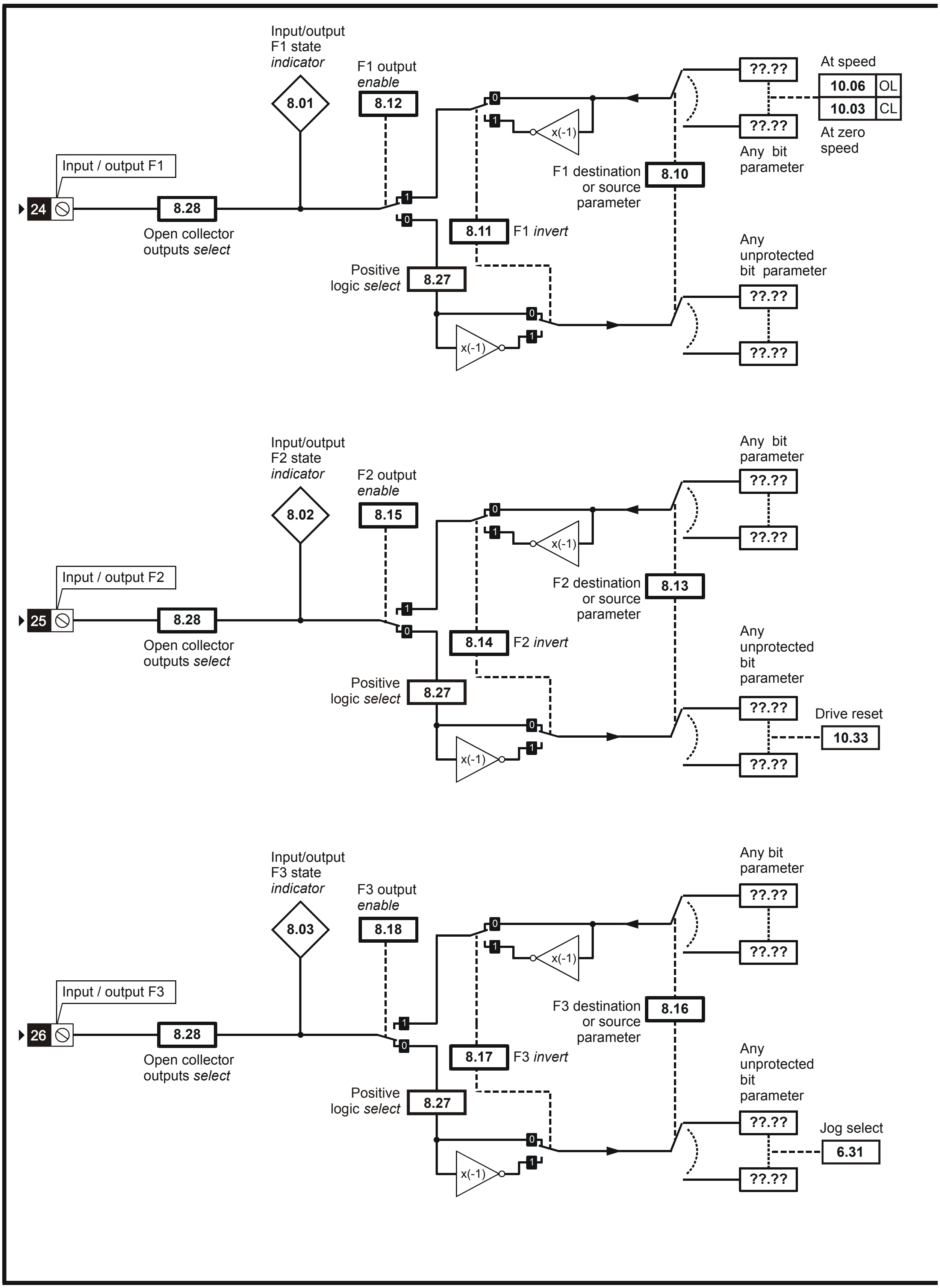
Name	'F' Number	Terminal Number	Direction
Dio 1	F1	24	Input / Output
Dio 2	F2	25	Input / Output
Dio 3	F3	26	Input / Output
Din 1	F4	27	Input
Din 2	F5	28	Input
Din 3	F6	29	Input
Enable / Trip	-	30	Input

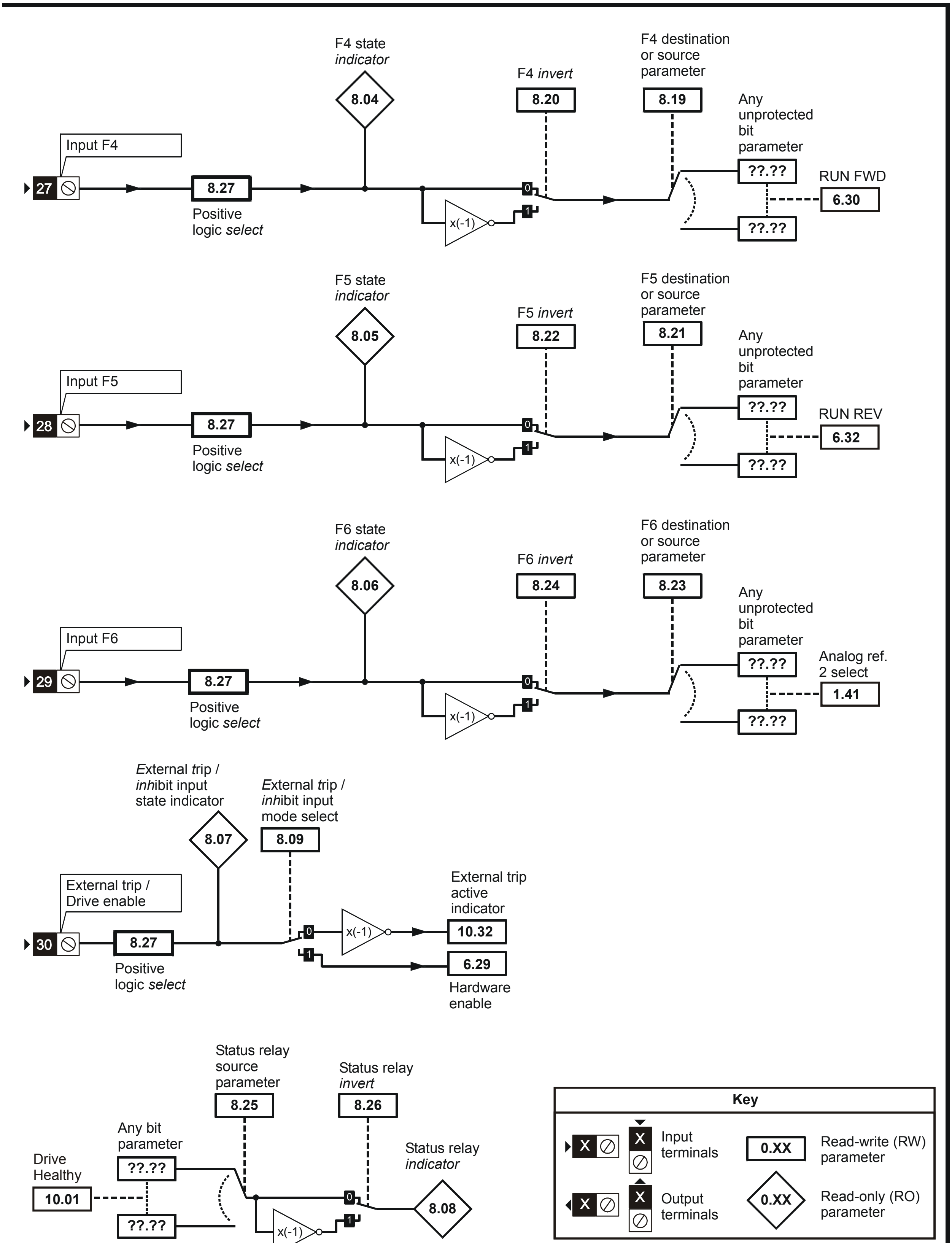
Table 4-10 Menu 8 single line descriptions

Parameter		Range(⇕)		Default(⇨)			Type			
		OL	CL	OL	VT	SV				
8.01	Digital input/output F1 *state*	0 or 1					RO	Bit		P
8.02	Digital input/output F2 *state*	0 or 1					RO	Bit		P
8.03	Digital input/output F3 *state*	0 or 1					RO	Bit		P
8.04	Digital input F4 *state*	0 or 1					RO	Bit		P
8.05	Digital input F5 *state*	0 or 1					RO	Bit		P
8.06	Digital input F6 *state*	0 or 1					RO	Bit		P
8.07	Terminal 30 *state*	0 or 1					RO	Bit		P
8.08	Status relay output *indicator*	0 or 1					RO	Bit		P
8.09	Terminal 30 function *select*	0 or 1		0	1		RW	Bit		
8.10	F1 destination or source parameter	Pr **0.00** to Pr **20.50**		Pr **10.06**	Pr **10.03**		RW	Uni	R	P
8.11	F1 *invert*	0 or 1		0			RW	Bit		
8.12	F1 output *enable*	0 or 1		1			RW	Bit	R	
8.13	F2 destination or source parameter	Pr **0.00** to Pr **20.50**		Pr **10.33**			RW	Uni	R	P
8.14	F2 *invert*	0 or 1		0			RW	Bit		
8.15	F2 output *enable*	0 or 1		0			RW	Bit	R	
8.16	F3 destination or source parameter	Pr **0.00** to Pr **20.50**		Pr **6.31**			RW	Uni	R	P
8.17	F3 *invert*	0 or 1		0			RW	Bit		
8.18	F3 output *enable*	0 or 1		0			RW	Bit	R	
8.19	F4 destination parameter	Pr **0.00** to Pr **20.50**		Pr **6.30**			RW	Uni	R	P
8.20	F4 *invert*	0 or 1		0			RW	Bit		
8.21	F5 destination parameter	Pr **0.00** to Pr **20.50**		Pr **6.32**			RW	Uni	R	P
8.22	F5 *invert*	0 or 1		0			RW	Bit		
8.23	F6 destination parameter	Pr **0.00** to Pr **20.50**		Pr **1.41**			RW	Uni	R	P
8.24	F6 *invert*	0 or 1		0			RW	Bit		
8.25	Status relay source parameter	Pr **0.00** to Pr **20.50**		Pr **10.01**			RW	Uni	R	P
8.26	Status relay *invert*	0 or 1		0			RW	Bit		
8.27	Positive logic *select*	0 or 1		0			RW	Bit	R	P
8.28	Open-collector outputs *select*	0 or 1		0			RW	Bit	R	P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

Figure 4-13 Menu 8 logic diagram





This logic diagram applies only when all parameters are at their default settings

Menu 8 parameter descriptions

8.01	**Digital input / output F1 state**		
8.02	**Digital input / output F2 state**		
8.03	**Digital input / output F3 state**		
RO	Bit		P
⇳ 0 or 1		⇨	

These parameters indicate the input state of the terminals if they are set up as inputs, or the output state if they are set up as outputs. For inputs 0 = in-active, 1 = active; and for outputs a 1 will cause the terminal to sink current, and a 0 will cause the terminal to drive current.

8.04	**Digital input F4 state**		
8.05	**Digital input F5 state**		
8.06	**Digital input F6 state**		
RO	Bit		P
⇳ 0 or 1		⇨	

These parameters indicate the state of inputs F4 to F6, 0 = in-active, 1 = active.

8.07	**Terminal 30 state**		
RO	Bit		P
⇳ 0 or 1		⇨	

This parameter indicates the state of the Enable/Trip input terminal, 0 = in-active, 1 = active.

8.08	**Status relay output indicator**		
RO	Bit		P
⇳ 0 or 1		⇨	

This parameter indicates the state of the drive relay, 0 = de-energised, 1 = energised.

8.09	**Terminal 30 function select**		
RW	Bit		
OL ⇳	0 or 1	⇨	0
CL ⇳		⇨	1

The default value in Regen mode is 1.

Terminal 30 of the drive can be configured as either a drive enable input or an external trip input.

This parameter should be set up for the required input function. When the terminal is being used as an external trip, the Hardware enable (Pr **6.29**) is set to 1.

8.10	**F1 destination or source parameter**		
RW	Uni	R	P
OL ⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **10.06**
CL ⇳		⇨	Pr **10.03**

This parameter should be programmed with either:

1. The destination parameter for when terminal 24 is an input
2. The source parameter for when terminal 24 is an output.

Only bit parameters can be programmed into this parameter.

If a non valid parameter is programmed:

1. An input is not routed anywhere
2. An output will drive current

After modification of this parameter the source / destination is only changed when a reset is performed (or the drive is powered down and then up again).

8.11	**F1 invert**			
RW	Bit			
⇳	0 or 1	⇨	0	

This invert parameter is used to change the sense of terminal 24.

Setting this parameter to a 1 causes the input sense to the destination parameter to be inverted or the output sense from the source parameter to be inverted.

8.12	**F1 output enable**			
RW	Bit	R		
⇳	0 or 1	⇨	1	

This parameter is for enabling terminal 24 as an output.

A setting of 1 is for an output and a setting of 0 is for an input.

8.13	**F2 destination or source parameter**			
RW	Bit	R	P	
⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **10.33**	

This parameter should be programmed with either:

1. The destination parameter for when terminal 25 is an input
2. The source parameter for when terminal 25 is an output.

Only bit parameters can be programmed into this parameter.

If a non valid parameter is programmed:

1. An input is not routed anywhere
2. An output will drive current

After modification of this parameter the source / destination is only changed when a reset is performed (or the drive is powered down and then up again).

8.14	**F2 invert**			
RW	Bit			
⇳	0 or 1	⇨	0	

This invert parameter is used to change the sense of terminal 25.

Setting this parameter to a 1 causes the input sense to the destination parameter to be inverted or the output sense from the source parameter to be inverted.

8.15	**F2 output enable**			
RW	Bit	R		
⇳	0 or 1	⇨	0	

This parameter is for enabling terminal 25 as an output.

A setting of 1 is for an output and a setting of 0 is for an input.

8.16	**F3 destination or source parameter**			
RW	Bit	R	P	
⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **6.31**	

This parameter should be programmed with either:

1. The destination parameter for when terminal 26 is an input
2. The source parameter for when terminal 26 is an output.

Only bit parameters can be programmed into this parameter.

If a non valid parameter is programmed:

1. An input is not routed anywhere
2. An output will drive current

After modification of this parameter the source / destination is only changed when a reset is performed (or the drive is powered down and then up again).

8.17	F3 invert			
RW	Bit			
⇳	0 or 1	⇨	0	

This invert parameter is used to change the sense of terminal 26.

Setting this parameter to a 1 causes the input sense to the destination parameter to be inverted or the output sense from the source parameter to be inverted.

8.18	F3 output enable			
RW	Bit	R		
⇳	0 or 1	⇨	0	

This parameter is for enabling terminal 26 as an output.

A setting of 1 is for an output and a setting of 0 is for an input.

8.19	F4 destination parameter			
RW	Bit	R	P	
⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **6.30**	

This parameter should be programmed with the destination parameter for terminal 27.

Only bit parameters can be programmed into this parameter.

If a non valid parameter is programmed the input is not routed anywhere

After modification of this parameter the destination is only changed when a reset is performed (or the drive is powered down and then up again).

8.20	F4 invert			
RW	Bit			
⇳	0 or 1	⇨	0	

This invert parameter is used to change the sense of terminal 27.

Setting this parameter to a 1 causes the input sense to the destination to be inverted.

8.21	F5 destination parameter			
RW	Bit	R	P	
⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **6.32**	

This parameter should be programmed with the destination parameter for terminal 28.

Only bit parameters can be programmed into this parameter.

If a non valid parameter is programmed the input is not routed anywhere

After modification of this parameter the destination is only changed when a reset is performed (or the drive is powered down and then up again).

8.22	F5 invert			
RW	Bit			
⇳	0 or 1	⇨	0	

This invert parameter is used to change the sense of terminal 28.

Setting this parameter to a 1 causes the input sense to the destination to be inverted.

8.23	F6 destination parameter			
RW	Bit	R	P	
⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **1.41**	

This parameter should be programmed with the destination parameter for terminal 29.

Only bit parameters can be programmed into this parameter.

If a non valid parameter is programmed the input is not routed anywhere

After modification of this parameter the destination is only changed when a reset is performed (or the drive is powered down and then up again).

8.24	**F6 invert**		
RW	Bit		
⇳ 0 or 1		⇨ 0	

This invert parameter is used to change the sense of terminal 29.

Setting this parameter to a 1 causes the input sense to the destination to be inverted.

8.25	**Status relay source parameter**		
RW	Bit	R	P
⇳ Pr **0.00** to Pr **20.50** Menu.parameter		⇨ Pr **10.01**	

This parameter should be programmed with the source parameter for the status relay on terminals 1 and 2.

Only bit parameters can be programmed into this parameter.

If a non valid parameter is programmed the output will be open.

After modification of this parameter the source is only changed when a reset is performed (or the drive is powered down and then up again).

8.26	**Status relay invert**		
RW	Bit		
⇳ 0 or 1		⇨ 0	

This invert parameter is used to change the sense of terminals 1 and 2.

Setting this parameter to a 1 causes the output sense from the source parameter to be inverted.

8.27	**Positive logic select**		
RW	Bit	R	P
⇳ 0 or 1		⇨ 0	

This parameter changes the logic polarity on digital inputs. In its default state the input polarity is negative logic which requires digital inputs to be pulled low (<5V) to activate the input. When this parameter is set to 1 the input polarity is positive logic and digital inputs must be driven high (>15V) to activate the input. Note that the drive must be disabled and then reset before changing this parameter will take effect.

Please see note at the beginning of this menu.

WARNING

If positive logic is selected and the +24V from the drive supply is overloaded causing the drive status to display 'OP.OULd', use of the same +24V for the external trip control may cause inconsistent results. The drive may trip on either 'OP.OULd' or 'Et' dependant upon which condition is detected first.

8.28	**Open-collector outputs select**		
RW	Bit	R	P
⇳ 0 or 1		⇨ 0	

The high side driving on the three digital outputs can be disabled by setting this parameter. This allows outputs of a number of drives to be connected together in a wired OR configuration.

NOTE

The wired OR configuration is only possible if Negative logic is being used.

4.9 Menu 9: Programmable logic

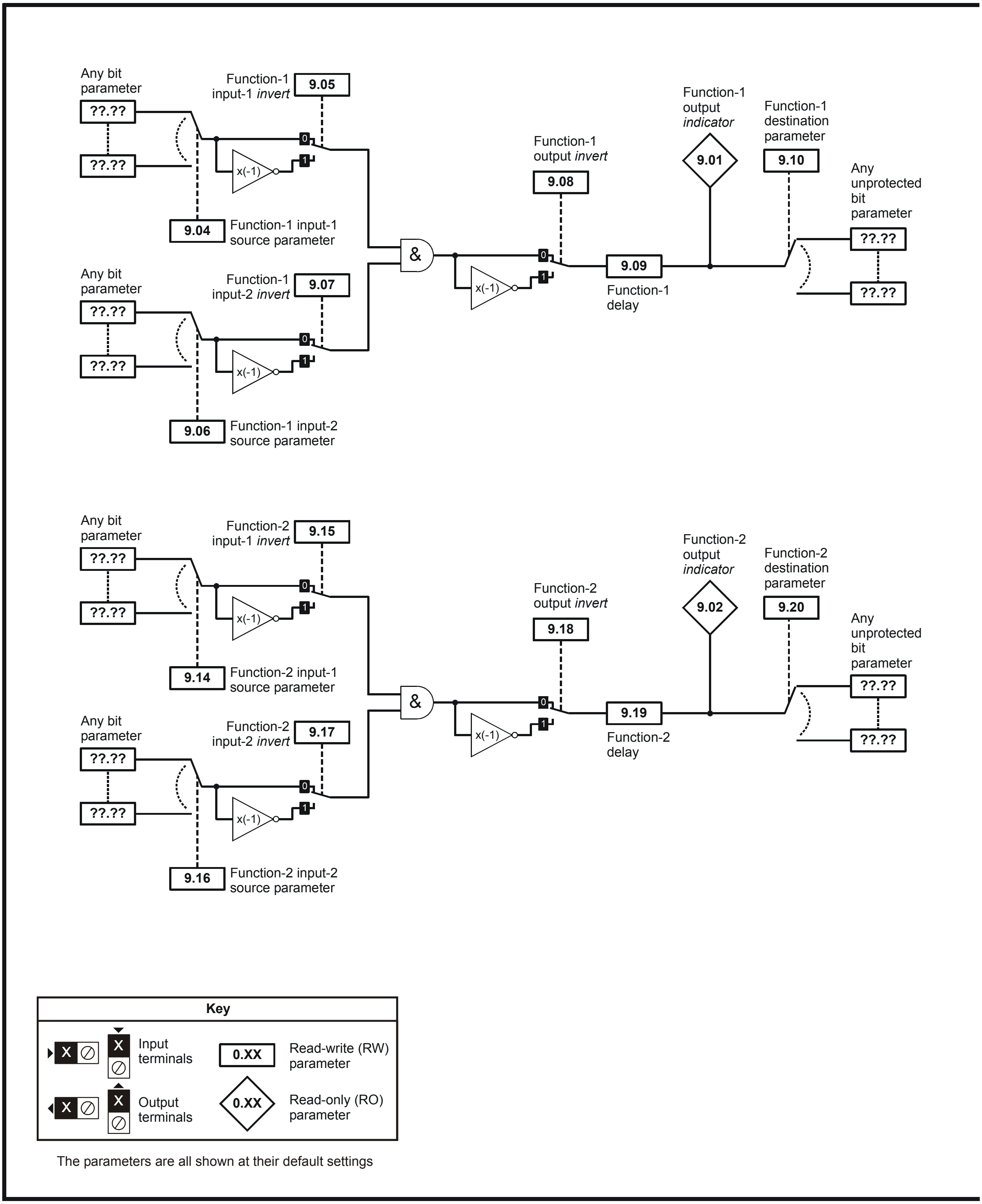
This menu contains two programmable logic functions which can each be used to generate a signal or action which cannot be achieved with the drives standard parameter set. An example of such a case might be in an application where a stall signal is required. The inputs could be Pr **10.03** (Zero speed) and Pr **10.09** (Current limit) with an appropriate delay programmed to ensure that the output signal does not change through momentary impulses on the input signals. Menu 9 also contains a programmable motorised pot which can be used to control any unprotected non-bit variable within the drive. There is also a binary sum block which calculates the binary weighted sum of three bits. This block is useful for applications such as changing torque mode from digital inputs. Viewing the Figure 4-14 will help in understanding the functions of the following parameters.

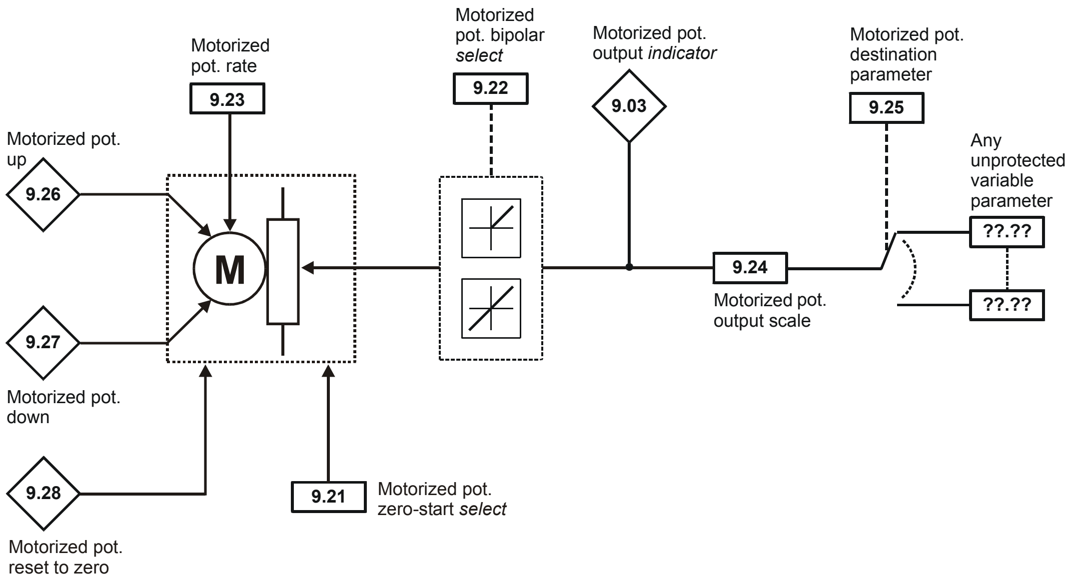
Table 4-11 Menu 9 single line descriptions

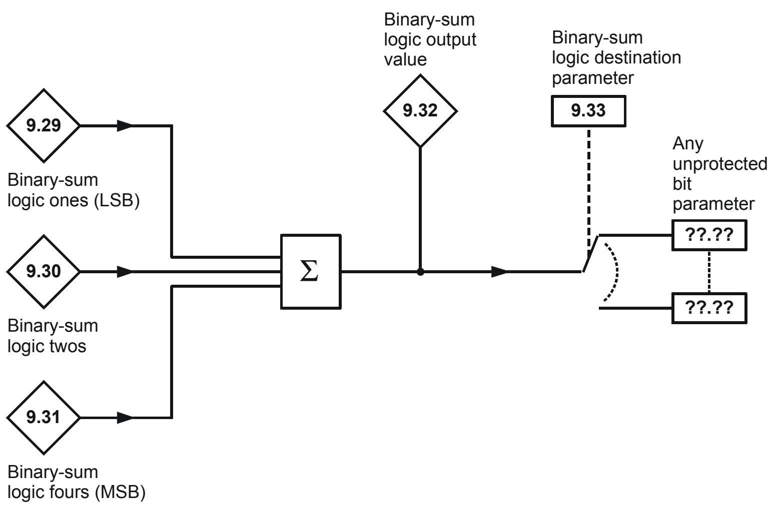
Parameter		Range(⇕)		Default(⇨)			Type			
		OL	CL	OL	VT	SV				
9.01	Prog.-logic function 1 output *indicator*	0 or 1					RO	Bit		P
9.02	Prog.-logic function 2 output *indicator*	0 or 1					RO	Bit		P
9.03	Motorized pot. output *indicator*	±100.0 %					RO	Bi	S	P
9.04	Prog.-logic function 1 input 1 source parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
9.05	Prog.-logic function 1 input 1 *invert*	0 or 1		0			RW	Bit		
9.06	Prog.-logic function 1 input 2 source parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
9.07	Prog.-logic function 1 input 2 *invert*	0 or 1		0			RW	Bit		
9.08	Prog.-logic function 1 output *invert*	0 or 1		0			RW	Bit		
9.09	Prog.-logic function 1 delay	0 to 25.0 s		0			RW	Uni		
9.10	Prog.-logic function 1 destination parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
9.14	Prog.-logic function 2 input 1 source parameter	Pr **0.00** to Pr **20.50**		0			RW	Uni		P
9.15	Prog.-logic function 2 input 1 *invert*	0 or 1		0			RW	Bit		
9.16	Prog.-logic function 2 input 2 source	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
9.17	Prog.-logic function 2 input 2 *invert*	0 or 1		0			RW	Bit		
9.18	Prog.-logic function 2 output *invert*	0 or 1		0			RW	Bit		
9.19	Prog.-logic function 2 delay	0 to 25.0 s		0			RW	Uni		
9.20	Prog.-logic function 2 destination parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
9.21	Motorised pot. zero-start *select*	0 or 1		0			RW	Bit		
9.22	Motorised pot. bipolar *select*	0 or 1		0			RW	Bit		
9.23	Motorised pot. rate	0 to 250 s		20			RW	Uni		
9.24	Motorised pot. output scale factor	0 to 4.000		1			RW	Uni		
9.25	Motorised pot. destination	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
9.26	Motorised pot. up	0 or 1					RO	Bit		
9.27	Motorised pot. down	0 or 1					RO	Bit		
9.28	Motorised pot. reset	0 or 1					RO	Bit		
9.29	Binary-sum logic ones (MSB)	0 or 1					RO	Bit		
9.30	Binary-sum logic twos	0 or 1					RO	Bit		
9.31	Binary-sum logic fours	0 or 1					RO	Bit		
9.32	Binary-sum logic output value	0 to 7					RO	Uni		P
9.33	Binary-sum logic destination parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

Figure 4-14 Menu 9 logic diagram




Motorized pot. rate
9.23
Motorized pot. bipolar select
9.22
Motorized pot. output indicator
9.03
Motorized pot. destination parameter
9.25
Motorized pot. up
9.26
M
Any unprotected variable parameter
??.??
9.24
??.??
Motorized pot. output scale
9.27
Motorized pot. down
9.28
9.21
Motorized pot. zero-start select
Motorized pot. reset to zero


Binary-sum logic output value
Binary-sum logic destination parameter
9.32
9.33
9.29
Any unprotected bit parameter
Binary-sum logic ones (LSB)
??.??
9.30
Σ
??.??
Binary-sum logic twos
9.31
Binary-sum logic fours (MSB)

Menu 9 parameter descriptions

9.01	**Programmable-logic function 1 output indicator**		
9.02	**Programmable-logic function 2 output indicator**		
RO	Bit		P
⇕	0 or 1	⇨	

These parameters indicate the output state of the two programmable logic functions. The output of a logic function can be routed to a terminal, if required, by setting the appropriate digital output source in menu 8 to output one of these parameters.

9.03	**Motorised pot. output indicator**		
RO	Bi	S	P
⇕	±100.0 %	⇨	

Indicates the level of the motorised pot prior to scaling. If Pr **9.21** is set to 1 this parameter is set to 0 at power up.

9.04	**Programmable-logic function 1 input 1 source parameter**		
RW	Uni		P
⇕	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **0.00**

Source parameters define the parameters to be input to the programmable logic functions. Only bit parameters can be programmed as inputs. If both inputs to a programmable logic function are non valid parameters, the logic output will always be at 0. If only one of the inputs is non valid, the input to the AND gate for that input is taken as 1 such that the valid input passes through the function.

9.05	**Programmable-logic function 1 input 1 invert**		
RW	Bit		
⇕	0 or 1	⇨	0

Invert parameters can be used to change the sense of the source or destination parameters.

9.06	**Programmable-logic function 1 input 2 source parameter**		
RW	Uni		P
⇕	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **0.00**

Source parameters define the parameters to be input to the programmable logic functions. Only bit parameters can be programmed as inputs. If both inputs to a programmable logic function are non valid parameters, the logic output will always be at 0. If only one of the inputs is non valid, the input to the AND gate for that input is taken as 1 such that the valid input passes through the function.

9.07	**Programmable-logic function 1 input 2 invert**		
9.08	**Programmable-logic function 1 output invert**		
RW	Bit		
⇕	0 or 1	⇨	0

Invert parameters can be used to change the sense of the source or destination parameters.

9.09	**Programmable-logic function 1 delay**		
RW	Uni		
⇕	0.0 to 25.0 s	⇨	0.0

The delays on the logic functions are on 0 to 1 transitions only such that there is a delay on the output becoming active but not on the output becoming inactive. The delay parameters are primarily there to ensure that the output condition is a genuine condition (by being present for a period of time) and not just a temporary one.

9.10	**Programmable-logic function 1 destination parameter**		
RW	Uni	R	P
⇳ Pr **0.00** to Pr **20.50** Menu.parameter		⇨ Pr **0.00**	

Destination parameters define the parameter each of the logic functions is to control. Only Bit parameters which are not protected can be controlled by the logic functions. If a non valid parameter is programmed the outputs are not routed anywhere.

9.14	**Programmable-logic function 2 input 1 source parameter**		
RW	Uni		P
⇳ Pr **0.00** to Pr **20.50** Menu.parameter		⇨ Pr **0.00**	

Source parameters define the parameters to be input to the programmable logic functions. Only bit parameters can be programmed as inputs. If both inputs to a programmable logic function are non valid parameters, the logic output will always be at 0. If only one of the inputs is non valid, the input to the AND gate for that input is taken as 1 such that the valid input passes through the function.

9.15	**Programmable-logic function 2 inpt 1 invert**		
RW	Bit		
⇳ 0 or 1		⇨ 0	

Invert parameters can be used to change the sense of the source or destination parameters.

9.16	**Programmable-logic function 2 input 2 source parameter**		
RW	Uni		P
⇳ Pr **0.00** to Pr **20.50** Menu.parameter		⇨ Pr **0.00**	

Source parameters define the parameters to be input to the programmable logic functions. Only bit parameters can be programmed as inputs. If both inputs to a programmable logic function are non valid parameters, the logic output will always be at 0. If only one of the inputs is non valid, the input to the AND gate for that input is taken as 1 such that the valid input passes through the function.

9.17	**Programmable-logic function 2 inpt 2 invert**		
9.18	**Programmable-logic function 2 output invert**		
RW	Bit		
⇳ 0 or 1		⇨ 0	

Invert parameters can be used to change the sense of the source or destination parameters.

9.19	**Programmable-logic function 2 delay**		
RW	Uni		
⇳ 0.0 to 25.0 s		⇨ 0.0	

The delays on the logic functions are on 0 to 1 transitions only such that there is a delay on the output becoming active but not on the output becoming inactive. The delay parameters are primarily there to ensure that the output condition is a genuine condition (by being present for a period of time) and not just a temporary one.

9.20	**Programmable-logic function 2 destination parameter**		
RW	Uni	R	P
⇳ Pr **0.00** to Pr **20.50** Menu.parameter		⇨ Pr **0.00**	

Destination parameters define the parameter each of the logic functions is to control. Only Bit parameters which are not protected can be controlled by the logic functions. If a non valid parameter is programmed the outputs are not routed anywhere.

9.21	**Motorised pot. zero-start select**		
RW	Bit		
⇳ 0 or 1		⇨ 0	

If this parameter is set then the motorised pot output will be set to zero each time the drive powers up. Otherwise the motorised pot output will be at the same level at power up as it was when power was removed.

9.22	**Motorised pot. bipolar select**		
RW	Bit		
⇕ 0 or 1		⇨ 0	

When this bit is set to 0 the motorised pot output is limited to positive values only (0 to 100.0%). Setting it to 1 allows negative outputs also (-100.0% to +100.0%).

9.23	**Motorised pot. rate**		
RW	Uni		
⇕ 0 to 250 s		⇨ 20	

This parameter defines the time taken for the motorised pot function to ramp from 0 to 100.0 %. Twice this time will be taken to adjust the output from -100.0% to +100.0%.

9.24	**Motorised pot. output scale factor**		
RW	Uni		
⇕ 0.000 to 4.000		⇨ 1.000	

This parameter can be used to restrict the output of the motorised pot to operate over a reduced range so that it can be used as a trim, for example. There is an automatic scaling such that when this parameter is set to 1.000, a 100% level on the motorised pot will cause the programmed destination parameter to be at its maximum value.

9.25	**Motorised pot. destination**		
RW	Uni	R	P
⇕ Pr **0.00** to Pr **20.50** Menu.parameter		⇨ Pr **0.00**	

This needs to be set up with the parameter that the motorised pot is to control. Only non-bit parameters which are not protected can be controlled by the motorised pot function. If a non valid parameter is programmed the output is not routed anywhere. If the motorised pot is to control speed then it is suggested that one of the preset speed parameters is entered here. If the motorised pot is to trim speed then it is suggested that the offset parameter (Pr **1.04**) is entered here.

9.26	**Motorised pot. up**		
9.27	**Motorised pot. up**		
RO	Bit		
⇕ 0 or 1		⇨	

Two input terminals must be programmed to control these parameters to implement the motorised pot.

9.28	**Motorised pot. reset**		
RO	Bit		
⇕ 0 or 1		⇨	

When this bit is active (=1) the motorised pot is reset to zero %.

9.29	**Binary-sum logic ones (MSB)**		
9.30	**Binary-sum logic twos**		
9.31	**Binary-sum logic fours**		
RO	Bit		
⇕ 0 or 1		⇨	

Input terminals or logic functions must be programmed to control these parameters to implement the binary sum function.

9.32	**Binary-sum logic output value**		
RO	Uni		P
⇕ 0 to 7		⇨	

Indicates the binary sum calculated from the three input bits. The value is calculated as follows:

Fours	Twos	Ones	Binary sum
Pr 9.31	**Pr 9.30**	**Pr 9.29**	**Pr 9.32**
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

9.33	**Binary-sum logic destination parameter**		
RW	Uni	R	P
⇕ Pr **0.00** to Pr **20.50** Menu.parameter		⇨	Pr **0.00**

This needs to be set up with the parameter that the binary sum is to control. Only non-bit parameters which are not protected can be controlled by the binary sum function. If a non valid parameter is programmed the output is not routed anywhere. If the parameter that the binary sum value is routed to has a maximum value of less than 7 then the destination parameter will be limited to the correct value independently of Pr **9.32**.

4.10 Menu 10: Status flags / trip log

This menu contains bit parameters that indicate the status of the drive, the trip log which holds the last ten trips and the dynamic brake parameters.

Table 4-12 Menu 10 single line descriptions

Parameter		Range(⇕)		Default(⇨)			Type			
		OL	CL	OL	VT	SV				
10.01	Drive normal *indicator*	0 or 1					RO	Bit		P
10.02	Drive running *indicator*	0 or 1					RO	Bit		P
10.03	At zero speed *indicator*	0 or 1					RO	Bit		P
10.04	At or below min. speed *indicator*	0 or 1					RO	Bit		P
10.05	Below at-speed window *indicator*	0 or 1					RO	Bit		P
10.06	At speed *indicator*	0 or 1					RO	Bit		P
10.07	Above at-speed window *indicator*	0 or 1					RO	Bit		P
10.08	At 100% load *indicator*	0 or 1					RO	Bit		P
10.09	Current-limit active *indicator*	0 or 1					RO	Bit		P
10.10	Motor regenerating *indicator*	0 or 1					RO	Bit		P
10.11	Dynamic brake active *indicator*	0 or 1					RO	Bit		P
10.12	Dynamic brake alarm *indicator*	0 or 1					RO	Bit		P
10.13	Direction demanded *indicator*	0 or 1					RO	Bit		P
10.14	Direction running *indicator*	0 or 1					RO	Bit		P
10.15	AC supply loss *indicator*	0 or 1					RO	Bit		P
10.16	Motor thermistor over-temperature *indicator*	0 or 1					RO	Bit		P
10.17	Motor current overload alarm *indicator*	0 or 1					RO	Bit		P
10.18	Heatsink temperature alarm *indicator*	0 or 1					RO	Bit		P
10.19	Ambient temperature alarm *indicator*	0 or 1					RO	Bit		P
10.20	Last trip	0 to 200					RO	Txt	S	P
10.21	Second last trip	0 to 200					RO	Txt	S	P
10.22	Third last trip	0 to 200					RO	Txt	S	P
10.23	Fourth last trip	0 to 200					RO	Txt	S	P
10.24	Fifth last trip	0 to 200					RO	Txt	S	P
10.25	Sixth last trip	0 to 200					RO	Txt	S	P
10.26	Seventh last trip	0 to 200					RO	Txt	S	P
10.27	Eighth last trip	0 to 200					RO	Txt	S	P
10.28	Ninth last trip	0 to 200					RO	Txt	S	P
10.29	Tenth last trip	0 to 200					RO	Txt	S	P
10.30	Max. full-power braking time	0 to 400.0 s		0			RW	Uni		
10.31	Max. full-power braking interval	0 to 25.0 min		0			RW	Uni		
10.32	External trip active *indicator*	0 or 1					RO	Bit		
10.33	Drive reset	0 or 1		0			RW	Bit		
10.34	Number of auto- reset attempts	0 to 5		0			RW	Uni		
10.35	Auto-reset time delay	0 to 25.0 s		1.0			RW	Uni		
10.36	Hold drive healthy until last auto-reset attempt *select*	0 or 1		0			RW	Bit		
10.37	Stop drive on non-important trips	0 or 1		0			RW	Bit		
10.38	User trip	0 to 200		0			RW	Uni		P
10.39	Braking-energy overload accumulator	0 to 100.0 %					RO	Uni		P
10.40	Status word	0 to 32,767					RO	Uni		P
10.41	UD78 auxiliary power supply active *indicator*	0 or 1					RO	Bit		P
10.42	IGBT junction temperature above 135 °C *indicator*	0 or 1					RO	Bit		P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

NOTE

Where a parameter is represented by a text value, the value in brackets in the range column is the setting used for serial communications.

Menu 10 parameter descriptions

10.01	Drive normal indicator		
RO	Bit		P
⇕	0 or 1	⇨	

The drive has not tripped. If Pr **10.36** is set to 1, this bit will be at 1 in a tripped state if an auto reset is going to occur. Once the programmed number of auto resets have occurred the next trip will cause this bit to be cleared.

10.02	Drive running indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set if the inverter output is active.

10.03	At zero speed indicator		
RO	Bit		P
⇕	0 or 1	⇨	

On the open loop drive this bit is set to 1 when the absolute value of the ramp output is at or below the zero speed threshold as defined by Pr **3.05**. On closed loop drives the speed feedback is monitored rather than the ramp output.

10.04	At or below min. speed indicator		
RO	Bit		P
⇕	0 or 1	⇨	

In bipolar mode (Pr **1.10** = 1) this parameter is the same as zero speed (Pr **10.03**).

In unipolar mode this parameter is set if the absolute value of the ramp output or speed feedback is at or below (minimum speed + 0.5Hz), or (minimum speed + 5rpm). Minimum speed is defined by Pr **1.07**.

Parameter is only set if drive is running.

10.05	Below at-speed window indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set when the absolute value of the ramp output or speed feedback is below the 'At speed' window as defined by Pr **3.06** and Pr **3.09**. Parameter is only set if drive is running.

10.06	At-speed indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set when the absolute value of the ramp output or speed feedback is within the 'At speed' window as defined by Pr **3.06**, Pr **3.07** and Pr **3.09**. Parameter is only set if drive is running.

10.07	Above at-speed window indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set when the absolute value of the ramp output or speed feedback is above the 'At speed' window as defined by Pr **3.07**, and Pr **3.09**. Parameter is only set if drive is running.

10.08	At 100% load indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set if active current is greater or equal to rated active current.

Rated active current = Pr **5.07** x Pr **5.10**

10.09	Current-limit active indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set if the normal current limit is active.

10.10	Motor regenerating indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set if the output bridge is transferring power from the motor to the DC Bus.

10.11	Dynamic brake active indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set when power is being transferred from the motor to the optional braking resistor, if fitted.

10.12	Dynamic brake alarm indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set when the dynamic brake is active and the braking energy accumulator is greater than 75%.

10.13	Direction demanded indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set if the pre-ramp reference is negative (reverse), and is reset if the pre-ramp reference is positive (forward).

10.14	Direction running indicator		
RO	Bit		P
⇕	0 or 1	⇨	

On the open loop drive this bit is set if the post-ramp reference is negative (reverse), or reset if post-ramp reference is positive (forward). On the closed loop drive the speed feedback is monitored rather than the post-ramp reference.

10.15	AC supply loss indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set to indicates a loss of input supply to the drive

10.16	Motor thermistor over-temperature indicator		
RO	Bit		P
⇕	0 or 1	⇨	

The parameter is set to indicate that the motor operating temperature has been exceeded.

10.17	Motor current overload alarm indicator		
RO	Bit		P
⇕	0 or 1	⇨	

This parameter is set if the motor current is larger than 105% of the programmed motor rated current and the overload accumulator is greater than 75% to warn that if the motor current is not reduced the drive will trip on an Ixt overload.

10.18	Heatsink temperature alarm indicator		
RO	Bit		P
⇕ 0 or 1		⇨	

This parameter is set if the heat sink temperature is greater than 90°C.

10.19	Ambient temperature alarm indicator		
RO	Bit		P
⇕ 0 or 1		⇨	

This parameter is set if the ambient temperature is greater than 90°C.

10.20	Last trip		
10.21	Second last trip		
10.22	Third last trip		
10.23	Fourth last trip		
10.24	Fifth last trip		
10.25	Sixth last trip		
10.26	Seventh last trip		
10.27	Eigth last trip		
10.28	Ninth last trip		
10.29	Tenth last trip		
RO	Txt		P
⇕ 0 to 200		⇨	

Contains the last 10 drive trips. Pr **10.20** is the most recent trip and Pr **10.29** the oldest. When a new trip occurs all the parameters move down one, the current trip is put in 10.20 and the oldest trip is lost off the bottom of the log. Possible trips are:

Table 4-13 Trip indications

Trip	Diagnosis
AN1.diS	**UD78> Servo large option module displaced**
37	UD78 Servo large option module was displaced or removed. Ensure that the module is fitted correctly.
cL1	**Current signal loss on analog input 1**
27	Loss of signal current on Analog input 1 (terminals 5 and 6), when configured for 4 to 20mA trip on loss current signal input. (Trip level 3mA.)
cL2	**Current signal loss on analog input 2**
28	Loss of signal current on Analog input 2 (terminal 7), when configured for 4 to 20mA trip on loss current signal input. (Trip level 3mA.)
cL3	**Current signal loss on analog input 3**
29	Loss of signal current on Analog input 3 (terminal 8), when configured for 4 to 20mA trip on loss current signal input. (Trip level 3mA.)
ConF n	**Configuration has changed to n modules**
150 to 158	No. of modules has changed to **n** modules (size 5 only). Check DIP switches on control module correspond with the slide switch address settings on the power modules. Save parameters to clear this trip on next power-up.
EEF	**EEPROM Fault**
31	Fault in the internal EEPROM causing loss of parameter values. This trip can only be reset by loading default parameters and saving parameters.
ENC.OUL	**Encoder power supply overload**
10	Check encoder power supply wiring and encoder current requirement Maximum current = 300mA @ 15V and 5V
ENC.PH1	**Encoder phase 1 trip**
11	Encoder U phase commutation signal missing or the motor did not rotate.
ENC.PH2	**Encoder phase 2 trip**
12	Encoder V phase commutation signal missing.
ENC.PH3	**Encoder phase 3 trip**
13	Encoder W phase commutation signal missing.

Trip	Diagnosis
ENC.PH4	**Encoder phase 4 trip**
14	Encoder U V W commutation signals connected incorrectly.
ENC.PH5	**Encoder phase 5 trip**
15	Encoder A channel signal missing.
ENC.PH6	**Encoder phase 6 trip**
16	Encoder B channel signal missing.
ENC.PH7	**Encoder phase 7 trip**
17	Encoder A and B channel signals connected incorrectly. Resolver or SINCOS encoder, SIN and COS connections connected incorrectly or the phase sequence of the motor is reversed.
ENC.PH8	**Encoder phase 8 trip**
18	Autotune or servo phasing offset test failed, or was interrupted. This can be caused by the following: • Wrong test for operating mode • Limit switch operated • Drive tripped on another trip (a reset of the ENC.PH8 trip will show the actual trip) • A reset signal given during the test.
ENC.PH9	**Encoder phase 9 trip**
181	Servo phasing incorrect causing reverse torque to be produced. This can be caused by the following: • Incorrect encoder/resolver feedback connections. • Incorrect phase offset value. Check connections and perform phase offset test. Spurious ENC.PH9 trips can be seen in very dynamic applications. This trip can be disabled by setting Pr **3.31** = 1. Caution should be used before setting this parameter in case there is a genuine fault with the encoder feedback.
Et	**External Trip**
6	OL> **External trip** signal applied to terminal 30. Remove the trip signal, or connect together terminals 30 and 31, and then reset the drive.
FSH.20	**UD55> Flash Menu 20**
187	The selected parameter set in the UD55 small option module does not contain values for Menu 20 parameters (which relate to a specific large option module), but a large option module is fitted in the destination drive. Consequently, there are no values of Menu 20 parameters to be copied to the destination drive.
FSH.ACC	**UD55> Flash Access**
185	Write-access to the UD55 cloning small option module has not been enabled. Consequently, no values have been copied to the UD55. To enable write-access, connect together terminals 40 and 41 on the UD55.
FSH.cPr	**UD55> Flash Compare**
189	This trip is initiated when a parameter set stored in the UD55 cloning small option module has been compared to the parameter set in the drive and differences have been found.
FSH.dAt	**UD55> Flash Data**
183	No data has been found in the selected parameter set in the UD55 cloning small option module. Consequently, no values have been copied to the destination drive.
FSH.Err	**UD55> Flash Error**
182	The memory of the UD55 cloning small option module has been found to be corrupt. If the trip has occurred at power-up, the memory is automatically reformatted and all the parameter sets are erased. If the trip occurs after power-up, the memory and parameter-sets are unaffected. See the *UD55 User Guide*.
FSH.LO	**UD55> Flash Large Option Module**
186	The selected parameter set in the UD55 cloning small option module contains values for Menu 20 parameters (which relate to a specific large option module), but the related module is not fitted in the destination drive. Consequently, values of Menu 20 parameters have not been copied to the destination drive.
FSH.rn9	**UD55> Flash Rating**
188	The current rating or voltage rating of the destination drive is different from that relating to the selected parameter set in the UD55 cloning small option module. Consequently, all parameter values have been copied to the destination drive except rating dependent parameters which are listed in *Transferring parameter sets between drives of different ratings* in the *UD55 User Guide*.
FSH.TYP	**UD55> Flash Type**
184	The operating mode of the destination drive is different from that related to the selected parameter-set in the UD55 cloning small option module. Consequently, no values have been copied to the destination drive. Either select an appropriate parameter set, or change the operating mode of the destination drive.

Trip	Diagnosis
It.AC	**[I x t] thermal overload in the motor**
20	The [I x t] thermal overload accumulator for the motor has reached 100% (see the **OVLd** alarm). Pr **4.19** displays the level of the overload accumulator. This can be caused by the following: • Excessive load or increased load applied to the motor (check mechanics) • Loss of motor phase • CL> Noise on speed feedback signals • CL> Loose feedback device mechanical coupling • SV> Phase offset value incorrect (Encoder Pr **3.28**, SINCOS encoder or resolver Pr **16.09**). Perform a phase offset test , or enter the correct value for phase offset. See Pr **4.19** on page 86.
It.br	**[I x t] thermal overload in the braking resistor**
19	The [I x t] thermal overload accumulator for the braking-resistor motor has reached 100% (see the **br.rS** alarm). Pr **10.39** displays the level of the overload accumulator. See Pr **10.30** and Pr **10.31** in the *Unidrive Advanced User Guide*. Increase the power rating of the braking resistor and change Pr **10.30** and Pr **10.31**.
L1.SYNC	**Synchronisation to the AC supply failed**
39	Regeneration sinusoidal rectifier failed to synchronise to the AC supply. Ensure that the AC supply voltage and frequency are within the specified limits. Ensure power connections are correct.
OA	**Control PCB over temperature**
23	The ambient temperature around the control PCB has reached the over temperature threshold of 95°C (203°F) (see the **Air** alarm). Check cubicle / drive fans are still functioning correctly Check cubicle ventilation paths Check cubicle door filters Check ambient temperature Reduce drive switching frequency
Oh1	**IGBT junction over temperature (based on the drive thermal model)**
21	IGBT junction temperature (based on the drive's thermal model) has reached the over temperature threshold of 145°C (293°F) and the drive was unable to reduce the switching frequency further. **Pr 7.32** displays the estimated IGBT junction temperature calculated by the drive. Reduce drive switching frequency Reduce duty cycle Decrease acceleration / deceleration rates Reduce motor load
Oh2	**Heatsink over temperature**
22	Heatsink temperature (detected by thermistor) has reached the over temperature threshold of 94°C (201°F) (see the **hot** alarm). Check cubicle / drive fans are still functioning correctly Check cubicle ventilation paths Check cubicle door filters Increase ventilation Decrease acceleration / deceleration rates Reduce drive switching frequency Reduce duty cycle Reduce motor load
OI.AC	**Over Current in output stage**
3	Over current threshold on the output of the drive, of 225% of the drive's Full Load Current (FLC), has been reached. (The FLC of the drive is displayed in Pr **11.32**) This can be caused by the following: • Pr **0.03** *Acceleration rate* set too low • Pr **0.04** *Deceleration rate* set too low • Short-circuit at the output of the drive • Break-down of motor insulation (check with Megger) • Incorrect motor map values (Pr **5.06** to Pr **5.11**) • Excessive motor-cable length (increased cable capacitance charging current) • CL> Loss of speed feedback signals • CL> Noise on speed feedback signals • CL> Loose mechanical coupling on speed feedback device • CL> Reduce the values in the speed loop gain parameters (Pr **3.10**, Pr **3.11** and Pr **3.12**) • CL> Reduce the values in the current loop gain parameters (Pr **4.13** and Pr **4.14**) • SV> Phase offset value incorrect (Encoder Pr **3.28**, SINCOS encoder and Resolver Pr **16.09**). Perform a phase offset test. (Pr **3.25**) • OL & VT> If this trip occurs during an autotune (sometimes with large motors), decrease the voltage boost value in Pr **5.15**.

Trip	Diagnosis
OI.AC n	**Over current in the output stage of module n**
118 to 125	Over current threshold in the output of the stage of module **n** of 170% of the drive's Full Load Current (FLC), has been reached (size 5 only). This can be caused by the following: • Pr **0.03** *Acceleration rate* set too low • Pr **0.04** *Deceleration rate* set too low • Short-circuit at the output of the drive • Break-down of motor insulation (check with Megger) • Incorrect motor map values (Pr **5.06** to Pr **5.11**) • Excessive motor-cable length (increased cable capacitance charging current) • CL> Loss of speed feedback signals • CL> Noise on speed feedback signals • CL> Loose mechanical coupling on speed feedback device • CL> Reduce the values in the speed loop gain parameters (Pr **3.10**, Pr **3.11** and Pr **3.12**) • CL> Reduce the values in the current loop gain parameters (Pr **4.13** and Pr **4.14**) • SV> Phase offset value incorrect (Encoder Pr **3.28**, SINCOS encoder and Resolver Pr **16.09**). Perform a phase offset test (Pr **3.25**). • OL & VT> If this trip occurs during an autotune (sometimes with large motors), decrease the voltage boost value in Pr **5.15**.
OI.br	**Over Current in braking transistor**
4	Over current threshold in the braking transistor has been reached. This can be caused by the following: • A short-circuit exists across the braking resistor terminals. • An insulation fault on the braking resistor or associated cables. • The ohmic value of the braking resistor is too low.
OI.dc n	**DC over current trip in module n**
134 to 141	DC instantaneous over current trip in module **n** (size 5 only)
OP.OVLd	**Control terminals output overload**
26	The total current drawn from the user +24V supply (terminal 22) and any digital outputs (terminals 24, 25 and 26) exceeds 240mA.
Ot HS n	**Heatsink over temperature in module n**
102 to 109	Heatsink over temperature threshold has been reached in module **n** (size 5 only); detected by one of the two thermistors in the drive. Ensure that ventilation at the front and rear of the drive is adequate. Check cubicle / drive fans are still functioning correctly. Check cubicle ventilation paths. Check cubicle door filters. Increase ventilation. Decrease acceleration / deceleration rates. Reduce duty cycle. Reduce motor load.
Ot inP	**Input stage over temperature**
101	Input stage over temperature threshold has been reached (size 5 only). Ensure that ventilation at the front and rear of the drive is adequate. Check cubicle / drive fans are still functioning correctly. Check cubicle ventilation paths. Check cubicle door filters. Increase ventilation. Decrease acceleration / deceleration rates. Reduce duty cycle. Reduce motor load.
OU	**Over Volts on the DC bus**
2	Over voltage threshold on the DC bus has been reached. 400V Unidrive: >830Vdc 200V Unidrive LV: >415Vdc This is due to excessive AC supply voltage or excessive regenerated power being returned to the drive that can be caused by the following: • Pr **0.04** *Deceleration rate* set too low. • An external force acting on the motor shaft causing the drive to regenerate. • Braking resistor value is too high. • AC supply voltage too high. • Supply disturbance such as a voltage over-shoot as the supply recovers from a notch induced by a DC drive. • Motor insulation fault.

Trip	Diagnosis
OU n	**Over volts on the DC bus in module n**
126 to 133	Over voltage threshold on the DC bus of module **n** of 830Vdc, has been reached (size 5 only). (The FLC of the drive is displayed in Pr **11.32**) This is due to excessive regenerated power being returned to the drive that can be caused by the following: • Pr **0.04** *Deceleration rate* set too low. • An external force acting on the motor shaft causing the drive to regenerate. • Braking resistor value is too high. • AC supply voltage too high. • Supply disturbance such as a voltage over-shoot as the supply recovers from a notch induced by a DC drive. • Motor insulation fault.
OU.SPd	**Over speed**
7	The motor speed has reached the over speed threshold (Pr **3.08**). This can be caused by the following: • Sudden removal of a large mechanical load from the motor shaft. • Pr **0.04** *Deceleration rate* set too low. • Inappropriate setting for Pr **0.16** *Stop mode selector.* • Pr **0.19** *S-ramp da/dt* set too high. • Pr **3.08** set below the maximum reference obtainable, i.e. set less than Pr **0.02** (or Pr **1.06**). • Speed over-shoot due to high speed loop proportional gain (Pr **3.10**)
Ph	**AC supply phase loss**
32	Loss of an AC supply phase detected by increased ripple on the DC bus. Ensure all 3 input phases are present and balanced. **NOTE** Load level must be between 50 and 100% for the drive to trip under phase loss conditions. The drive will attempt to stop the motor before this trip is initiated.
Prc2	**UD70> Second processor fault**
8	Indicates a trip in the Processor of the UD70 large option module. Possible causes of failure are as follows: • If the watchdog feature is enabled (Pr **17.18** = 1), then this trip indicates the WDOG instruction has not been executed, in the UD70 program, within 200ms of the last execution. See the WDOG command in the UD70 User Guide for more details. • If the watchdog feature is not enabled (Pr **17.18** = 0), then this trip indicates an operating system failure. Contact the supplier of the module.
PS	**Internal power supply fault**
5	Remove any option module and attempt a reset (to verify if the trip is caused by the option module). Check integrity of interface ribbon cables and connections (size 5 only). Hardware fault - return drive to supplier.
PS n	**Internal power supply fault in module n (size 5 only)**
110 to 117	Check integrity of interface ribbon cables and connections (size 5 only). Hardware fault - return drive to supplier.
rS	**Incorrect stator resistance value**
33	Incorrect measurement of stator resistance due to the following: • One or more motor phases disconnected when the measurement was being made • Motor too small for the drive If required, set Pr **0.07** (or Pr **5.14**) *Voltage mode* at **Ur** and enter the value of stator resistance in parameter Pr **5.17**.
SCL	**Serial Communications loss**
30	Loss of serial communications when slaving drives or using the universal remote keypad. Ensure that the communications device is working correctly and the interconnections are correctly made.
SEP	**UD5x> Small option module fault**
9	Indicates a trip in the UD5x small option module. Possible causes of failure are as follows: • UD50 Additional I/O> The total current drawn from digital outputs (terminals 48, 49 & 50) has reached the over current threshold. • UD52 Sin-cos> Encoder power supply overloaded or short circuit (terminals 44 & 45). • UD53 Resolver> Connections to the UD53 have not been made correctly or a wire break between the resolver and the UD53.
SEP.diS	**UD5x> Small option module displaced**
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 Pr **xx.00** at **1000** and press the (**STOP/RESET)** button.

Trip	Diagnosis
SEP EC	**UD52> SINCOS encoder communications failure**
35	Communications between SIN-COS encoder and UD52 small option module have failed. Absolute position information will not be obtained. Possible causes of failure are as follows: • Incorrect serial communications connections (terminals 46, 47). • DC supply to the encoder is not connected (terminals 44, 45) or has failed. • Incorrect DC supply voltage for the encoder (Pr **16.15**). After rectifying the fault, remove, and then re-apply the AC supply to the drive in order to obtain absolute position information.
SEP EF	**UD52> Sincos encoder fault**
36	Internal fault within the SINCOS encoder. Contact the encoder or motor supplier.
St GL	**Spurious trip**
34	Unrecognised trip on power-up (size 5 only). Hardware fault, contact the supplier of the drive.
SuP.LSS	**Regen supply loss**
190	The drive in Regen mode has detected AC supply loss. Check all three supply phases are present and at the correct level.
th	**Motor thermistor over temperature**
24	The motor thermistor has detected excessive motor temperature or the thermistor or associated wiring is open-circuit. Set Pr **7.15** = volt and save parameters to disable this function.
thS	**Motor thermistor short circuit**
25	The motor thermistor or wiring is short circuit. Set Pr **7.15** = volt and save parameters to disable this function.
tr XX	**UD70 run time trips**
40 to 69	**XX** indicates the trip code number. Trip Code Description 40 Unknown Error 41 Parameter does not exist 42 Parameter write failed: parameter is read only 43 Parameter read failed: parameter is write only 44 Parameter write failed: parameter value is over range 45 Virtual parameter access failed: IOLINK is not running 46 to 48 Internal error 49 Wrong system loaded 50 Maths error in the program, e.g. divide by zero, overflow, etc. 51 DPL array index is out of range 52 User generated trip from control word 53 DPL program incompatible 54 DPL overload – a task has run of time 55 RS485 trip (mode 3, mode 4, etc.) 56 Option module and system-file are incompatible 57 Illegal operating system call 58 to 59 Internal error 60 to 69 High-speed communications option generated trips See the UD70 and/or the relevant high-speed communications option User guides for more information.
tr XX	**User trips 70 to 99, 159 to 179, 191 to 200**
70 to 99, 159 to 179, 191 to 200	Trip codes defined by the user. **XX** indicates the trip code number. For use with the UD70 Application modules by writing the trip code to **Pr 10.38**.
UFLt n	**Unidentified trip on module n**
142 to 149	Unidentified fault on power-up in module **n** (size 5 only)
UU	**Under Volts**
1	Under voltage threshold on the DC bus has been reached 400V Unidrive: <350Vdc 200V Unidrive LV: <160Vdc This also occurs when the AC supply has been removed. Ensure that the AC supply is above the minimum level. 400V Unidrive: >380Vac -10% (342Vac) 200V Unidrive LV: >200Vac -10% (180Vac)

Table 4-14 Serial communications look-up table

No.	Trip	No.	Trip	No.	Trip
1	UU	22	Oh2	110 to 117	PS1 to PS8
2	OU	23	OA	118 to 125	OI.AC1 to OI.AC8
3	OI.AC	24	th	126 to 133	OU1 to OU8
4	OI.br	25	thS	134 to 141	OI.dc1 to OI.dc8
5	PS	26	OP.OVLd	142 to 149	UFLt1 to UFLt8
6	Et	27	cL1	150 to 158	ConF1 to ConF8
7	OU.SPd	28	cL2	159 to 179	tr159 to tr179
8	Prc2	29	cL3	180	SEP.diS
9	SEP	30	SCL	181	ENC.PH9
10	ENC.OUL	31	EEF	182	FSH.Err
11	ENC.PH1	32	Ph	183	FSH.dAt
12	ENC.PH2	33	rS	184	FSH.TYP
13	ENC.PH3	34	St GL	185	FSH.ACC
14	ENC.PH4	35	SEP EC	186	FSH.LO
15	ENC.PH5	36	SEP EF	187	FSH.20
16	ENC.PH6	37	AN1.diS	188	FSH.rn9
17	ENC.PH7	39	L1.SYNC	189	FSH.cPr
18	ENC.PH8	40 to 69	tr40 to tr69	190	SuP.LSS
19	It.br	70 to 99	tr70 to tr99	191 to 200	tr191 to tr200
20	It.AC	101	OtinP		
21	Oh1	102 to 109	OtHS1 to OtHS8		

10.30	Max. full-power braking time		
RW	Uni		
⇕	0.0 to 400.0 s	⇨	0.0

This parameter defines the time period that the braking resistor fitted can stand full braking volts (780V) without damage. The setting of this parameter is used in determining the braking overload trip time.

10.31	Max. full-power braking interval		
RW	Uni		
⇕	0.0 to 25.0 min	⇨	0.0

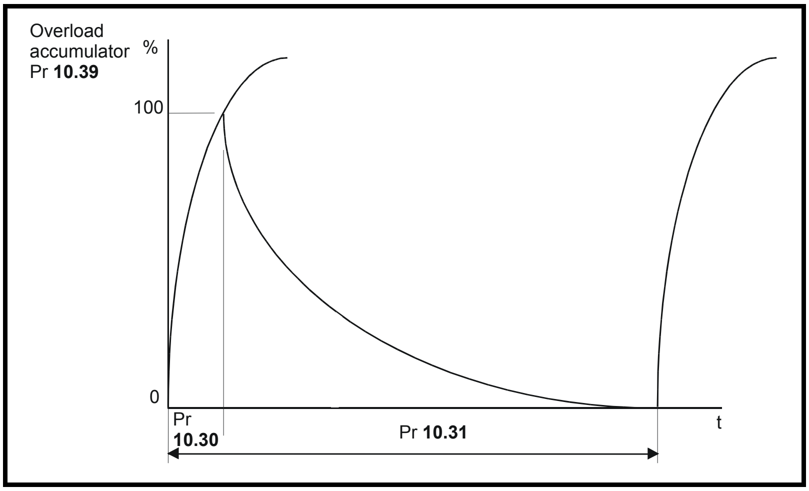
This parameter defines the time period which must elapse between consecutive braking periods of maximum braking power as defined by Pr **10.30**. The setting of this parameter is used in determining the thermal time constant of the resistor fitted. If this parameter is set to 0 then no braking resistor protection is implemented.

Braking resistor protection

The characteristics of a braking resistor are that its temperature rises in proportion to the amount of power being put into it, and falls in proportion to the temperature difference between itself and ambient. This is an exponential characteristic which the drive models to protect the resistor against overload, two parameters being provided for the user to enter the resistor data. Once a resistor has been chosen for the requirement of a particular application, Pr **10.30** and Pr **10.31** should be set up according to the resistor data.

Pr **10.30** should be set up with the time that the resistor can stand 780V across it (short time overload). This is the time for the resistor to reach maximum operating temperature from the expected maximum ambient given the power input that 780V will provide.

Pr **10.31** should be entered with the time period required before a second short time overload can be applied without damage.



Pr **10.31** defines the time for the resistor to fall to ambient temperature but this does not mean that this amount of time is required between braking. The actual period between braking will depend on the amount of energy put into the resistor during a braking period, since the braking resistor accumulator must remain below 100% to prevent a trip (dotted line).

10.32	**External trip active indicator**		
RO	Bit		
⇕ 0 or 1		⇨	

If this flag is set to 1 then the drive will trip (Et). If Pr **8.09** is set to 0 this flag will be set when ever the Enable/Trip terminal is inactive. If the Enable/Trip terminal is required for an enable input and an external trip input is required, another terminal must be programmed to control this flag with an inversion such that the terminal must be active to prevent a trip.

10.33	**Drive reset**		
RW	Bit		
⇕ 0 or 1		⇨	0

A 0 to 1 change on this parameter will cause a drive reset. If a drive reset terminal is required on the drive the required terminal must be programmed to control this bit. If a drive trips on an IGBT over-current trip, either output bridge or braking resistor, the drive cannot be reset for 10 seconds to allow the IGBT to fully recover.

10.34	**Number of auto-reset attempts**		
RW	Uni		
⇕ 0 to 5		⇨	0

If this parameter is set to zero then no auto reset attempts are made. Any other value will cause the drive to automatically reset following a trip for the number of times programmed. Pr **10.35** defines the time between the trip and the auto reset. The reset count is only incremented when the trip is the same as the previous trip, otherwise it is reset to 0. When the reset count reaches the programmed value, any further trip of the same value will not cause an auto-reset.

If there has been no trip for 5 minutes then the reset count is cleared.

Auto reset will not occur on an External trip (Et).

10.35	**Auto-reset time delay**		
RW	Uni		
⇕ 0.0 to 25.0 s		⇨	1

This parameter defines the time between a trip and an auto reset subject to the minimum trip time for IGBT over-current trips.

10.36	**Hold drive healthy until last auto-reset attempt select**		
RW	Bit		
⇕ 0 or 1		⇨	0

If this parameter is 0 then Pr **10.01** (Drive normal) is cleared every time the drive trips regardless of any auto-reset that may occur. When this parameter is set the 'Drive normal' indication is not cleared on a trip if an auto-reset is going to occur.

10.37	Stop drive on non-important trips		
RW	Bit		
⇳ 0 or 1		⇨ 0	

If this parameter is set, the drive will stop before tripping on non important trips. Phase loss trip (Ph) always stops the motor before tripping the drive whatever the setting of this parameter.

Non-important trips are: th, ths, OP.OVLd, cL1, cL2, cL3 and SCL.

10.38	User trip		
RW	Uni		P
⇳ 0 to 200		⇨ 0	

This parameter is used to generate user trips, either from the large option module or over the serial comms, or to reset the drive. Codes are as shown below:

1 to 39
General drive trips that give trip strings listed with Pr **10.20** to Pr **10.29**. (If the parameter is set to 1 and a UD78 option module is not fitted a UU trip is generated. This causes a full UU trip sequence: the power down save parameters are saved and the drive processor is reset as though the drive is powered down and then powered up again.)

40 to 99
User trips that give string trXX, where XX is the trip number. These are used by some predefined UD70 large option module applications. They may also be used for user UD70 applications or to trip the drive via serial communications.

100
If the parameter is set to 100 the drive is reset.

101 to 151
General drive trips related to size 5 Unidrive as listed with Pr **10.20** to Pr **10.29**.

10.39	Braking-energy overload accumulator		
RO	Uni		P
⇳ 0.0 to 100.0 %		⇨	

This parameter gives an indication of braking resistor temperature based on a simple thermal model, see Pr **10.30** and Pr **10.31** on page 143. Zero indicates the resistor is close to ambient and 100% is the maximum temperature (trip level).

10.40	Status word		
RO	Uni		P
⇳ 0 to 32,767		⇨	

This parameter is for use by a serial comms interface. The value of this parameter is the addition of the drive read only bits with binary weighting as follows:

Pr **10.01**	2^{0}	1
Pr **10.02**	2^{1}	2
Pr **10.03**	2^{2}	4
Pr **10.04**	2^{3}	8
Pr **10.05**	2^{4}	16
Pr **10.06**	2^{5}	32
Pr **10.07**	2^{6}	64
Pr **10.08**	2^{7}	128
Pr **10.09**	2^{8}	256
Pr **10.10**	2^{9}	512
Pr **10.11**	2^{10}	1024
Pr **10.12**	2^{11}	2048
Pr **10.13**	2^{12}	4096
Pr **1014**	2^{13}	8192
Pr **10.15**	2^{14}	16384

10.41	UD78 auxiliary power supply active indicator		
RO	Bit		P
⇳	0 or 1	⇨	

This parameter is set if the UD78 large option module is fitted and the drive is running via the UD78 power supply. If the drive is running from its internally derived supplies this parameter is 0.

10.42	IGBT junction temperature above 135°C indicator		
RO	Bit		P
⇳	0 or 1	⇨	

This parameter is set if the IGBT junction temperature calculated from the drive thermal model is above 135°C. See Pr **5.18** on page 96, Pr **5.33** on page 101 and Pr **7.32** on page 118.

4.11 Menu 11: Menu 0 customisation / drive specific ratings

This menu contains parameters for the drive set-up including:

- The contents of menu zero
- Drive type
- Serial communications
- Security

Table 4-15 Menu 11 single line descriptions

Parameter		Range(⇕)		Default(⇨)			Type			
		OL	CL	OL	VT	SV				
11.01	Parameter **0.11** assignment	Pr **0.00** to Pr **20.50**		Pr **1.03**			RW	Uni		P
11.02	Parameter **0.12** assignment	Pr **0.00** to Pr **20.50**		Pr **2.01**			RW	Uni		P
11.03	Parameter **0.13** assignment	Pr **0.00** to Pr **20.50**		Pr **4.02**			RW	Uni		P
11.04	Parameter **0.14** assignment	Pr **0.00** to Pr **20.50**		Pr **1.05**			RW	Uni		P
11.05	Parameter **0.15** assignment	Pr **0.00** to Pr **20.50**		Pr **2.04**			RW	Uni		P
11.06	Parameter **0.16** assignment	Pr **0.00** to Pr **20.50**		Pr **6.01**			RW	Uni		P
11.07	Parameter **0.17** assignment	Pr **0.00** to Pr **20.50**		Pr **4.11**			RW	Uni		P
11.08	Parameter **0.18** assignment	Pr **0.00** to Pr **20.50**		Pr **2.06**			RW	Uni		P
11.09	Parameter **0.19** assignment	Pr **0.00** to Pr **20.50**		Pr **2.07**			RW	Uni		P
11.10	Parameter **0.20** assignment	Pr **0.00** to Pr **20.50**		Pr **1.29**			RW	Uni		P
11.11	Parameter **0.21** assignment	Pr **0.00** to Pr **20.50**		Pr **1.30**			RW	Uni		P
11.12	Parameter **0.22** assignment	Pr **0.00** to Pr **20.50**		Pr **1.31**			RW	Uni		P
11.13	Parameter **0.23** assignment	Pr **0.00** to Pr **20.50**		Pr **1.32**			RW	Uni		P
11.14	Parameter **0.24** assignment	Pr **0.00** to Pr **20.50**		Pr **7.06**			RW	Uni		P
11.15	Parameter **0.25** assignment	Pr **0.00** to Pr **20.50**		Pr **7.11**			RW	Uni		P
11.16	Parameter **0.26** assignment	Pr **0.00** to Pr **20.50**		Pr **7.14**			RW	Uni		P
11.17	Parameter **0.27** assignment	Pr **0.00** to Pr **20.50**		EUR> Pr **8.27**, USA> Pr **6.04**			RW	Uni		P
11.18	Parameter **0.28** assignment	Pr **0.00** to Pr **20.50**		EUR> Pr **4.13**, USA> Pr **1.01**			RW	Uni		P
11.19	Parameter **0.29** assignment	Pr **0.00** to Pr **20.50**		EUR> Pr **4.14**, USA> Pr **8.23**			RW	Uni		P
11.20	Parameter **0.30** assignment	Pr **0.00** to Pr **20.50**		Pr **6.13**			RW	Uni		P
11.21	Parameter **0.30** scaling	0 to 4.000		1			RW	Uni		P
11.22	Initial parameter displayed {**0.38**}	Pr **0.00** to Pr **0.50**		Pr **0.10***			RW	Uni		P
11.23	Serial comms. address {**0.37**}	0 to 9.9 group.unit		1.1			RW	Uni		P
11.24	Serial comms. mode {**0.32**}	ANSI 2 (0), ANSI 4 (1), OUtPUt (2), INPUt (3)		ANSI 4 (1)			RW	Txt	R	P
11.25	Serial comms. baud rate {**0.36**}	4,800 (0), 9,600 (1), 19,200 (2), 2,400 (3) baud		4800 (0)*			RW	Txt		P
11.26	Serial comms two-wire mode delay	0 to 255 ms		0			RW	Uni		
11.27	Serial comms. source/ destination parameter	Pr **0.00** to Pr **20.50**		0			RW	Uni	R	P
11.28	Serial comms. parameter scaling	0 to 4.000		1			RW	Uni		
11.29	Drive software version {**0.50**}	1.00 to 99.99					RO	Uni		P
11.30	User security code {**0.34**}	0 to 255		149			RW	Uni	S	P
11.31	Drive operating mode {**0.48**}	OPENLP (0), CL.VECT (1), SErVO (2), rEGEN (3)					RW	Txt	R	P
11.32	Drive rated current (FLC) {**0.33**}	2.10 to 1920 A					RO	Uni		P
11.33	Drive voltage rating	220 to 690 V					RO	Uni		P
11.34	Drive software build number	0 to 99					RO	Uni		P
11.35	Number of size-5 modules connected	0 to 255					RO	Uni		P
11.36	Drive with slow speed fans	0 or 1		Unidrive & Unidrive VTC: 0 Unidrive LFT: 1			RO	Bit		P
11.37	Macro number {**0.31**}	0 to 9					RO	Uni		
11.38	Cloning module parameter set	0 to 8		0			RW	Uni		
11.39	Cloning module parameter set drive type	OPEN.LP (0), CL.VEct (1), SErVO (2), rEGEN (3), FrEE (4)		4			RO	Txt		P
11.40	Cloning module parameter checksum	0 to 16,383					RO	Uni		P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

* Pr **11.22** and Pr **11.25** have default settings of Pr **0.12** and 9,600 (1) respectively in Unidrive VTC when USA defaults are loaded.

NOTE

Where a parameter is represented by a text value, the value in brackets in the range column is the setting used for serial communications.

Menu 11 parameter descriptions

Pr **11.01** to Pr **11.20** define the parameters that reside in the programmable area in menu 0.

11.01		Pr 0.11 assignment		
RW		Uni		P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **1.03**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.01**

11.02		Pr 0.12 assignment		
RW		Uni		P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **2.01**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.02**

11.03		Pr 0.13 assignment		
RW		Uni		P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **4.02**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.03**

11.04		Pr 0.14 assignment		
RW		Uni		P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **1.05**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.04**

11.05		Pr 0.15 assignment		
RW		Uni		P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **2.04**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.05**

11.06		Pr 0.16 assignment		
RW		Uni		P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **6.01**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.06**

11.07		Pr 0.17 assignment		
RW		Uni		P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **4.11**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.07**

11.08	Pr 0.18 assignment			
RW	Uni			P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **2.06**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.08**

11.09	Pr 0.19 assignment			
RW	Uni			P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **2.07**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.09**

11.10	Pr 0.20 assignment			
RW	Uni			P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **1.29**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.10**

11.11	Pr 0.21 assignment			
RW	Uni			P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **1.30**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.11**

11.12	Pr 0.22 assignment			
RW	Uni			P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **1.31**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.12**

11.13	Pr 0.23 assignment			
RW	Uni			P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **1.32**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.13**

11.14	Pr 0.24 assignment			
RW	Uni			P
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **7.06**
CL	⇳		⇨	
RG	⇳		⇨	Pr **15.14**

11.15	Pr 0.25 assignment				
RW	Uni			P	
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **7.11**	
CL	⇳		⇨		
RG	⇳		⇨	Pr **15.15**	

11.16	Pr 0.26 assignment				
RW	Uni			P	
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **7.14**	
CL	⇳		⇨		
RG	⇳		⇨	Pr **15.16**	

11.17	Pr 0.27 assignment				
RW	Uni			P	
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Eur> Pr **8.27** USA> Pr **6.04**	
CL	⇳		⇨		
RG	⇳		⇨	Pr **15.17**	

11.18	Pr 0.28 assignment				
RW	Uni			P	
OL	⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Eur> Pr **4.13** USA> Pr **1.01**	
CL	⇳		⇨		
RG	⇳		⇨	Pr **15.18**	

11.19	Pr 0.29 assignment		
RW	Uni		P
⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Eur> Pr **4.14** USA> Pr **8.23**

11.20	Pr 0.30 assignment		
RW	Uni		P
⇳	Pr **0.00** to Pr **20.50** Menu.parameter	⇨	Pr **6.13**

11.21	Pr 0.30 scaling		
RW	Uni		P
⇳	0.000 to 4.000	⇨	1.000

If the parameter programmed into position 30 of menu 0 is R/O then a scale factor can be applied to it such that they may indicate some meaningful unit such as cans/hour.

11.22	Initial parameter displayed				
RW	Uni			P	
OL	⇳	Pr **0.00** to Pr **0.50** Menu.parameter	⇨	Pr **0.10***	
CL	⇳		⇨	Pr **0.10**	

*This parameter has a default setting of Pr **0.12** in the Unidrive VTC.

This parameter defines which menu 0 parameters is the power up default.

11.23	Serial comms. address		
RW	Uni		P
⇳ 0.0 to 9.9		⇨ 1.1	

Used in ANSI comms to define the unique address for the drive. Any number in the permitted range 0.0 to 9.9 which has a zero in it should not be used as these are used in addressing groups of drives.

This parameter and all other serial interface parameters (Pr **11.24** to Pr **11.28**) that follow are only effective when the 'Serial Communications' Large option module is fitted.

11.24	Serial comms. mode		
RW	Txt	R	P
⇳ 0 to 3		⇨ ANSI 4 (1)	

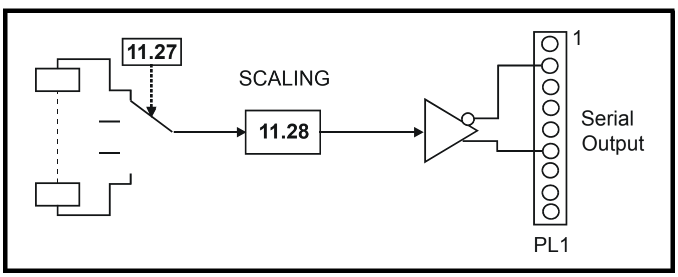
This is the mode of operation of the serial port.

0	ANSI 2	ANSI protocol, two wire, half duplex serial communications.
1	ANSI 4	ANSI protocol, four wire, half duplex serial communications.
2	OUtPUt	Output variable defined by Pr **11.27** (CT protocol)
3	INPUt	Input variable to parameter defined by Pr **11.27** (CT protocol)

In mode 0, ANSI 2 wire, Pr **11.26** can be set to provide a delay in changing from receive to transmit to allow the host time to change to receive. It should be noted that 5ms should be allowed by the host between receiving data from the drive to transmitting data back to the drive to allow the drive to change from transmit to receive mode.

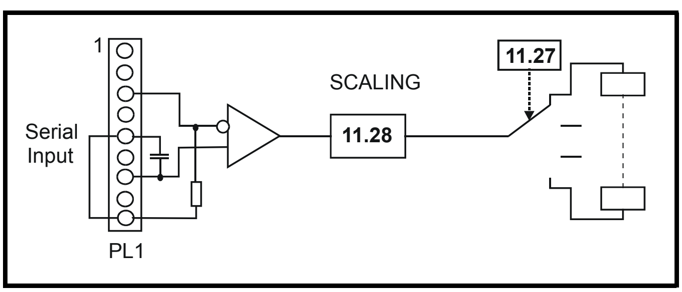
Modes 2 and 3 are for transfer of a variable from one drive to another. In both cases data is transferred at a rate of at least 140Hz. Although the data rate is slightly slower than that of Mentor II and CDE, the protocol and baud rate are identical and it is possible to connect a Unidrive to a Mentor II or CDE for data transfer in either direction.

Mode 2 output variable to another drive.



In the event of the drive tripping a value of zero is transmitted.

Mode 3 input variable from another drive.



Once data has been received in this mode, a comms loss trip will occur if the comms link is lost and the last data received is non zero.

11.25	Serial.comms baud rate		
RW	Txt		P
⇳ 0 to 3		⇨ 4800 (0)*	

*This parameter has a default setting of 9,600 (1) in the Unidrive VTC.

Used in ANSI comms mode (2 or 4 wire) to select the comms port baud rate. Three available options are:

0	4800	4,800 baud
1	9600	9,600 baud
2	19200	19,200 baud
3	2400	2,400 baud

11.26	Serial.comms two wire mode delay		
RW	Uni		
⇳ 0 to 255 ms		⇨ 0	

The ANSI protocol is half duplex, and so it is possible to connect the RX and TX together and the /RX and /TX together and operate the comms with only 2 data connections. If Pr **11.24** is set to "ANSI 2" two wire standard comms is active. Problems can occur with 2 wire mode comms if the drive replies to a request before the device that sent the request has been able to change its buffers from transmit to receive. To avoid this problem a delay, defined by Pr **11.26**, can be introduced between the drive receiving data and then responding. The delay is always at least as long as the value programmed in Pr **11.26**, but may be longer. Although the parameter resolution is 1ms, the actual timing resolution is 5ms: 1ms in the parameter will give a delay of at least 5ms, 4ms gives at least 5ms, 5ms gives at least 5ms, 6ms gives at least 10ms, etc.

11.27	Serial comms. source / destination parameter		
RW	Uni	R	P
⇳ Pr **0.00** to Pr **20.50** Menu.parameter		⇨ Pr **0.00**	

This parameter is used in serial comms modes 1 and 2 to define the parameter being output or input respectively. In comms mode 2 any new value programmed will only be implemented after a drive reset. Only non-bit parameters can be input or output and for inputs the parameter must not be protected. If a non valid parameter is programmed the drive will not input or output data.

11.28	Serial comms. parameter scaling		
RW	Uni		
⇳ 0.000 to 4.000		⇨ 1.000	

Can be used to scale the data being output or input in serial modes 1 or 2. However in most cases it is not necessary as the input or output is automatically scaled such that for a full scale input or output the destination or source parameter will be at its maximum.

11.29	Drive software version		
RO	Uni		P
⇳ 1.00 to 99.99		⇨	

Indicates the version of drive software fitted.

11.30	User security code		
RW	Uni	S	P
⇳ 0 to 255		⇨ 149	

If any number other than 149 is programmed in this parameter a user security will be applied. The parameter value can only be seen while it is being edited, otherwise the value displayed is 149 so that the actual security code cannot be seen. Setting this security code protects all parameters from being adjusted until the correct code has been entered in parameter xx.00. Do not use a code of 0, as 0 is the default value for Pr **xx.00**, the parameter used for unlocking security.

11.31	Drive operating mode		
RW	Txt	R	P
⇳ 0 to 3		⇨	

0 OPEn.LPOpen loop inverter
1 CL.VECtClosed loop vector
2 SErVO Servo
3 REGEnRegen input converter

This parameter defines the drive type as indicated in the default settings. Parameter zero must be set to 1253, the drive type change security value, before this parameter can be changed. When the drive is reset to implement any change in this parameter, the default settings of all parameters will be set according to drive type. The drive type will not be changed if it is currently running a motor.

11.32	Drive rated current		
RO	Uni		P
⇳ 2.10 to 1920.00 A		⇨	

This parameter indicates the drives continuous current rating in amps.

11.33	Drive voltage rating		
RO	Uni		P
⇳	220 to 690 V	⇨	

This parameter indicates the voltage rating of the drive.

11.34	Drive software build number		
RO	Uni		P
⇳	0 to 99	⇨	

The first digit indicates the version of the mask software within the drive processor. This only applies for V3 software and later. The second digit indicates the sub-version of user software store in the memory external to the processor.

11.35	Number of size 5 modules connected		
RO	Uni		P
⇳	0 to 255	⇨	0

When a size 5 drive system is connected the control system checks the configuration switches to determine how many and which units are operating in parallel. The result of this is stored in Pr **11.35** after a trip reset. If the new arrangement of modules is different from the previously saved value of Pr **11.35** a "Conf" trip is given. Resetting the trip will cause the new configuration to be loaded into Pr **11.35** and the system will run. To prevent a repeat of the trip at the next power-up parameters must be saved to save the new value of Pr **11.35**. Each bit in this parameter corresponds to a module, i.e. bit0 = module 1, bit1 = module 2 etc.

11.36	Drive with slow speed fans		
RO	Bit		P
⇳	0 or 1	⇨	

If this parameter is set to 1 the drive is a Unidrive LFT. This parameter cannot be changed by the user.

11.37	Macro number		
RO	Uni		P
⇳	0 to 9	⇨	

Parameter macros are a series of parameter values that can be loaded from drive ROM to produce a drive set up for a particular application. When a parameter macro is loaded, by setting Pr **x.00** to a value between 2001 and 2009 and then resetting the drive, the macro number is written to this parameter. If 2001 is used to load a macro then this parameter is set to 1, etc. When default parameters are loaded this parameter is set to zero, indicating that a macro has not been loaded.

With no macro loaded scrolling completely round menu 0 is possible. Unused parameters are not displayed and the display jumps to the next parameter that exists. If a macro is loaded and this parameter has a non-zero value it is not possible to scroll completely round menu 0. Normally a contiguous block of parameters will exist at the bottom of the menu, i.e. Pr **0.00** to Pr **0.10**, and a contiguous block will exist at the top of the menu, i.e. Pr **0.35** to Pr **0.50**. If a macro is selected with the parameters given as an example, it will not be possible to move above Pr **0.10** with the up key, or down below Pr **0.35** with the down key. This restriction also applies to the use of ACK and BS with ANSII serial communications when scrolling through menu 0.

11.38	Cloning module parameter set		
RW	Uni		
⇳	0 to 8	⇨	0

Pr **11.38**, Pr **11.39** and Pr **11.40** allow the user to view the drive type data and checksum stored in the eight parameter set blocks of a UD55 cloning module when fitted to the drive. Pr **11.38** selects the set to be viewed, 0 = no set selected, 1 = set1.....8 = set8. Once a set has been selected the drive type data stored in the set can be viewed with Pr **11.39** and the checksum with Pr **11.40**.

UD55 at power-up

When a drive is powered up with a UD55 cloning module is fitted, the drive checks that the module is not corrupted. If the data is corrupted a "FSH.Err" trip is produced and the memory in the UD55 reformatted with eight empty parameter sets. This is the only time that the UD55 memory is reformatted. If errors are detected after this point, and even if a "FSH.Err" trip occurs, the memory will not be reformatted automatically.

Reformatting UD55 memory

The UD55 memory can be reformatted at any time by the user by entering 3099 in Pr **x.00** and pressing reset. If UD55 write is enabled, by linking terminals 40 and 41 on the UD55, the memory will be reformatted and Pr **x.00** cleared to 0. If UD55 write in not enabled a "FSH.ACC" trip will be produced and Pr **x.00** cleared to 0..

Transferring parameters from the drive to a UD55

The drive parameter set is saved in the UD55 by entering 300y in Pr **x.00** and pressing reset, where y is the set location required to store the data in the UD55. Data is only saved if the UD55 is write enabled, by linking terminals 40 and 41 on the UD55, otherwise a "FSH.ACC" trip will be produced. Once the parameters have been saved or a trip has occurred Pr **x.00** is cleared to 0.

Transferring parameters from a UD55 to the drive

The drive parameter set is read from the UD55 by entering 400y in Pr **x.00** and pressing reset, where y is the set location of the required data. Either the data is transferred to the drive and/or one of the following trips may be produced and then Pr **x.00** is cleared.

Trip	Description
FSH.DAT	There is not data in the parameter set that should be loaded to the drive. No data is transferred.
FSH.TYP	The drive type for the data set to be loaded to the drive is different from the present drive type. No data is transferred.
FSH.LO	Menu 20 data is present in the parameter set that is to be loaded to the drive, but there is no UD70 (and hence no menu20) in the drive. All data except menu 20 data is transferred to the drive.
FSH.20	No menu 20 data is present in the parameter set that is to be loaded to the drive, but there is a UD70 in the drive. All data except menu 20 data is transferred to the drive.
FSH.rng	The data is being transferred from a drive of one rating to a drive of a different rating (either different voltage or current ratings). All parameters that are normally transferred except those shown below are transferred to the drive. (If the UD55 has been loaded with parameters using V3.1.6 software or earlier the drive rating is not stored in the UD55. Therefore the drive will not trip if the rating is different and will load all parameters including those shown below will be transferred to the drive.)

Pr **2.08**	Standard ramp voltage
Pr **3.28**	Stator resistance
Pr **4.05** to Pr **4.07**	Current limits
Pr **4.08**	Torque reference
Pr **4.09**	Torque offset
Pr **5.07**	Motor rated current
Pr **5.09**	Motor rated voltage
Pr **5.18**	Switching frequency
Pr **5.24**	Motor inductance
Pr **5.33**	Thermal model enable
Pr **6.06**	DC injection braking current
Pr **15.07**	Regen unit voltage setpoint

Comparing UD55 parameters with those in the drive

The comparison is initiated by entering 800y in Pr **x.00** and pressing reset. This compares parameter set y in the UD55 with the drive parameters. This comparison does not include any of the parameters not transferred to the drive given in the table below. If the parameters stored in the UD55 are for a different mode a FSH.TYP trip occurs, if the ratings are different a FSH.rng trip occurs, and if UD70 parameters are only present in one set of parameters a FSH.LO or FSH.20 trip occurs. If non of these trips occur, but the parameters are different a FSH.cpr trip occurs. If the comparison is successful no trip occurs. In all cases Pr **x.00** is cleared after the comparison.

UD55 and other small option modules

When a UD55 is fitted it replaces any small option module that may have been fitted previously. If parameters were last saved in the drive EEPROM with a small option module fitted, other than a UD55, then menu 16 will be present and visible via the keypad when a UD55 is subsequently fitted. (If no small option module is fitted menu 16 will not be visible.) Therefore menu 16 parameters previously saved for the small option module can be transferred to/from the UD55. To prevent incorrect drive operation, because the option module is not present, the drive cannot be enabled when a UD55 is fitted and the drive EEPROM contains a parameter set for a small option module. These parameters can be removed from the drive EEPROM by saving parameters with no small option module fitted.

Avoiding problems with inter-related parameters

The maximum values of some parameters depend on other parameters, i.e. the current limit maximums (Pr **4.05** to Pr **4.07**) depend on the rated current (Pr **5.07**). With software versions before 3.1.7 the parameters values for the dependent parameters, i.e. in this case the current limits, may not be correct after they are transferred from a UD55. With software versions 3.1.7 onwards the parameters are automatically transferred twice from the UD55, and so the resulting values in the drive will be correct.

Parameters not transferred to/from the UD55

Some parameters are not transferred to/from the UD55. This is either because it is not desirable to transfer them (i.e. keypad reference, motorised pot output, user security) or because the values would affect the UD55 checksum (i.e. run time clock, etc). The table below shows parameters that are saved in the UD55 as zero and not transferred to the drive.

Pr **1.17**	Keypad reference
Pr **6.22** & Pr **6.23**	Run time clock
Pr **6.24** & Pr **6.25**	Power meter
Pr **6.27** & Pr **6.28**	Filter and lubrication meters
Pr **7.31**	UD78 fitted
Pr **9.03**	Motorised pot output
Pr **10.20** to Pr **10.29**	Trip log
Pr **10.41**	UD78 powering the drive
Pr **10.42**	IGBT overtemp warning
Pr **11.39**	UD55 drive type
Pr **15.14** to Pr **15.16**	Regen unit controls
User security parameter store	

Possible problems with the parameters from a UD55

The table below describes possible problems that could occur when transferring data with a UD55.

Pr **3.28**	Motor stator resistance	Varies between motors and with motor cabling. The value from the UD55 might not be correct for the new application.
Pr **5.10**	Motor power factor	Varies between motors. The value from the UD55 might not be correct for the new application.
Pr **5.23**	Voltage offset	Varies between drives. The value from the UD55 might not be correct for the new application.
Pr **5.24**	Motor inductance	Varies between motors. The value from the UD55 might not be correct for the new application.
Pr **6.15**	Drive enable	In regen mode this parameter can change between 0 and 1 under drive control.
	Analog or digital input effects	If an analog input is routed to a value that is stored in the UD55 the checksum may vary each time the values are saved in a UD55. If digital inputs are routed to a value that is stored in the UD55 the checksum will vary if the digital input states change.
	An1 or UD78 full scale value	If the source drive has not been user calibrated using Pr **7.25**, the destination drive will not be user calibrated. However, if the source drive has been calibrated the destination drive will have the same user calibration value.

11.39	**Cloning module parameter set drive type**		
RO	Txt		P
⇳	0 to 4	⇨	

0	OPEn.LP	Open loop inverter
1	CL.VECt	Closed loop vector
2	SErVO	Servo
3	REGEn	Regen input converter
4	FrEE	Parameter set is free

Displays the stored drive type saved in the cloning module for the parameter set given by Pr **11.38**.

11.40	**Cloning module parameter checksum**		
RO	Uni		P
⇳	0 to 16,383	⇨	

Displays the parameter checksum stored in the cloning module for the parameter set given by Pr **11.38**.

4.12 Menu 12: Programmable thresholds

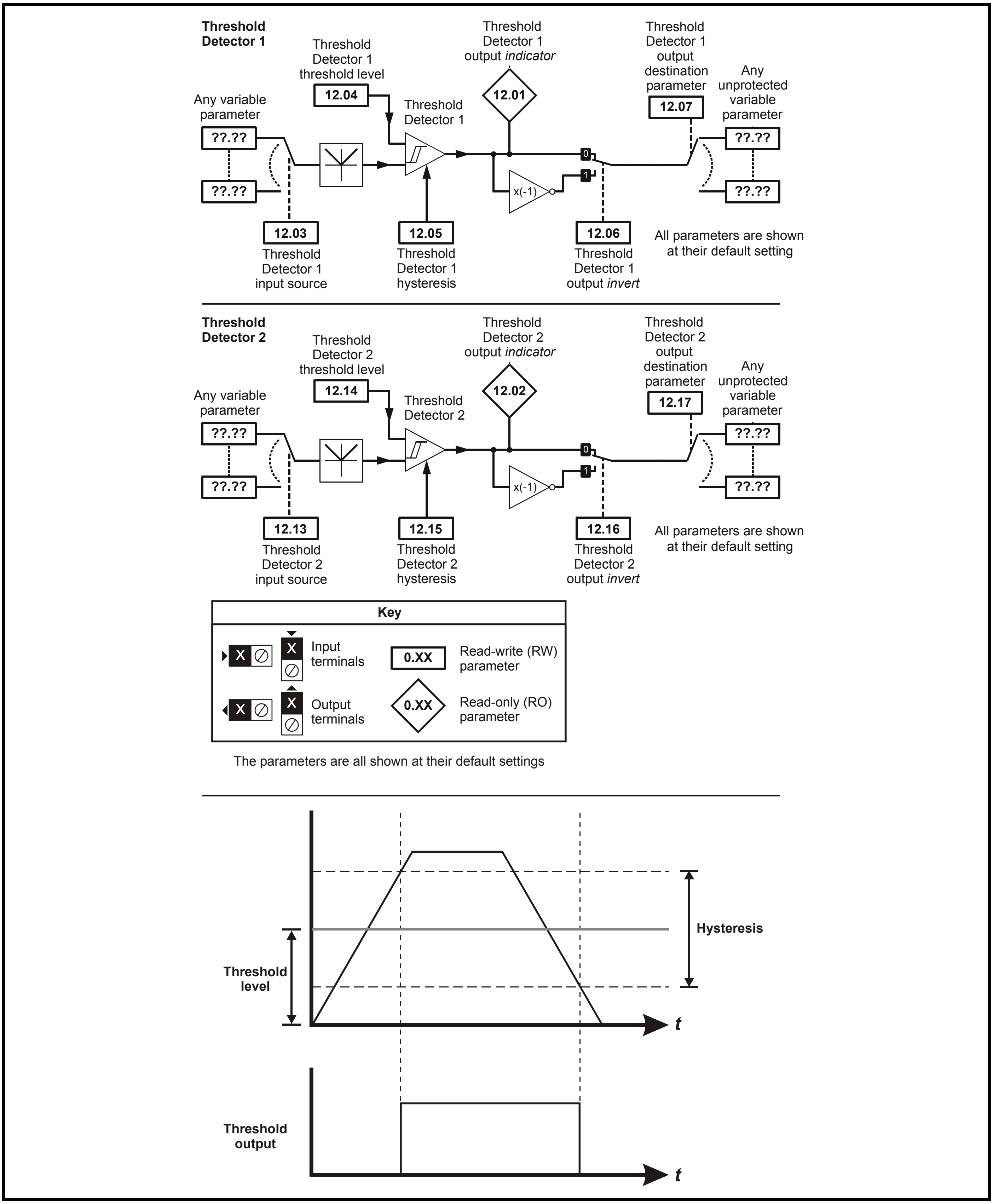
This menu contains two threshold detectors. The threshold detectors allow a parameter to be compared against a threshold value to produce a digital output which has a programmable destination. This function may be used for example for detecting when speed reaches a particular value and switching the ramp rate at that point.

Table 4-16 Menu 12 single line descriptions

Parameter		Range(⇳) OL	Range(⇳) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
12.01	Comparator 1 output *indicator*	0 or 1					RO	Bit		P
12.02	Comparator 2 output *indicator*	0 or 1					RO	Bit		P
12.03	Comparator 1 input source parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
12.04	Comparator 1 threshold level	0 to 100.0 %		0			RW	Uni		
12.05	Comparator 1 hysteresis	0 to 25.0 %		0			RW	Uni		
12.06	Comparator 1 output *invert*	0 or 1		0			RW	Bit		
12.07	Comparator 1 output destination parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
12.13	Comparator 2 input source parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
12.14	Comparator 2 threshold level	0 to 100.0 %		0			RW	Uni		
12.15	Comparator 2 hysteresis	0 to 25.0 %		0			RW	Uni		
12.16	Comparator 2 output *invert*	0 or 1		0			RW	Bit		
12.17	Comparator 2 output destination parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

Figure 4-15 Menu 12 logic diagram



Menu 12 parameter descriptions

12.01	**Comparator 1 output indicator**		
12.02	**Comparator 2 output indicator**		
RO	Bit		P
⇳	0 or 1	⇨	

These parameters indicate whether the input variables are above (1) or below (0) the programmed thresholds.

12.03	**Comparator 1 input source parameter**		
RW	Uni		P
⇳	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**

This parameter defines the variable which is to be used as input to the programmable thresholds. The absolute value of the source variable is taken as input to the threshold comparator. Only non-bit parameters can be programmed as a source. If a non valid parameter is programmed the input value is taken as 0.

12.04	**Comparator 1 threshold level**		
RW	Uni		
⇳	0.0 to 100.0 %	⇨	0.0

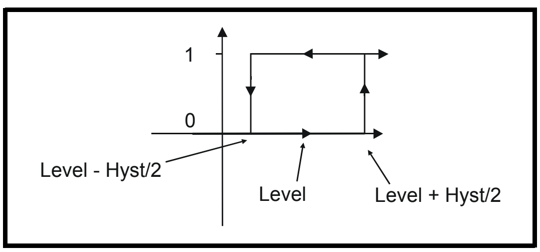
This is the user defined threshold level entered as a percentage of the source maximum.

12.05	**Comparator 1 hysteresis**		
RW	Uni		
⇳	0.0 to 25.0 %	⇨	0.0

Define the band within which no change will occur on the output. The upper limit for switching is therefore (Level + Hyst/2) and the lower level will be (Level - Hyst/2).

NOTE

It is up to the user to ensure that the lower level (Level - Hyst/2) is greater than zero otherwise the comparator output will never return to zero.



12.06	**Comparator 1 output invert**		
RW	Bit		
⇳	0 or 1	⇨	0

The sense of the threshold output can be inverted with this flag.

12.07	**Comparator 1 output destination parameter**		
RW	Uni	R	P
⇳	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**

This parameter defines the destination of the programmable threshold. Only Bit parameters which are not protected can be programmed as threshold outputs. If a non valid parameter is programmed the output is not routed anywhere.

12.13	**Comparator 2 input source parameter**		
RW	Uni		P
⇳	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**

This parameter defines the variable which is to be used as input to the programmable thresholds. The absolute value of the source variable is taken as input to the threshold comparator. Only non-bit parameters can be programmed as a source. If a non valid parameter is programmed the input value is taken as 0.

12.14	Comparator 2 threshold level		
RW	Uni		
⇕ 0.0 to 100.0 %		⇨ 0.0	

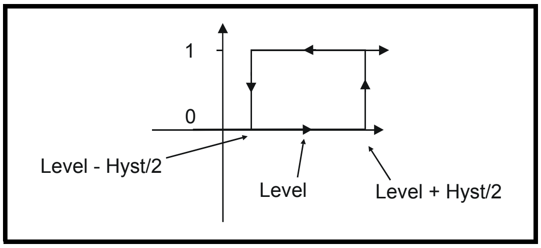
This is the user defined threshold level entered as a percentage of the source maximum.

12.15	Comparator 2 hysteresis		
RW	Uni		
⇕ 0.0 to 25.0 %		⇨ 0.0	

Define the band within which no change will occur on the output. The upper limit for switching is therefore (Level + Hyst/2) and the lower level will be (Level - Hyst/2).

NOTE

It is up to the user to ensure that the lower level (Level - Hyst/2) is greater than zero otherwise the comparator output will never return to zero.



12.16	Comparator 2 output invert		
RW	Bit		
⇕ 0 or 1		⇨ 0	

The sense of the threshold output can be inverted with this flag.

12.17	Comparator 2 output destination parameter		
RW	Uni	R	P
⇕ Pr **0.00** to Pr **20.50**		⇨ Pr **0.00**	

This parameter defines the destination of the programmable threshold. Only Bit parameters which are not protected can be programmed as threshold outputs. If a non valid parameter is programmed the output is not routed anywhere.

4.13 Menu 13: Digital lock / orientation

Menu 13 includes position control for open and closed-loop drives: either digital lock using two position feedback devices or orientation control for a closed-loop drive. When using digital lock position control it is sometimes necessary to move the master and slave relative to each other to change the lock position. This can be done using relative jogging. If the position loop is running in a digital lock mode, the sequencer calls for a normal jog, if a jog command is received in the Ready or Stop states, or a relative jog if a jog command is received while the drive is running. Relative jogging is implemented by the jog reference either being added or subtracted to the digital lock reference.

Table 4-17 Menu 13 single line descriptions

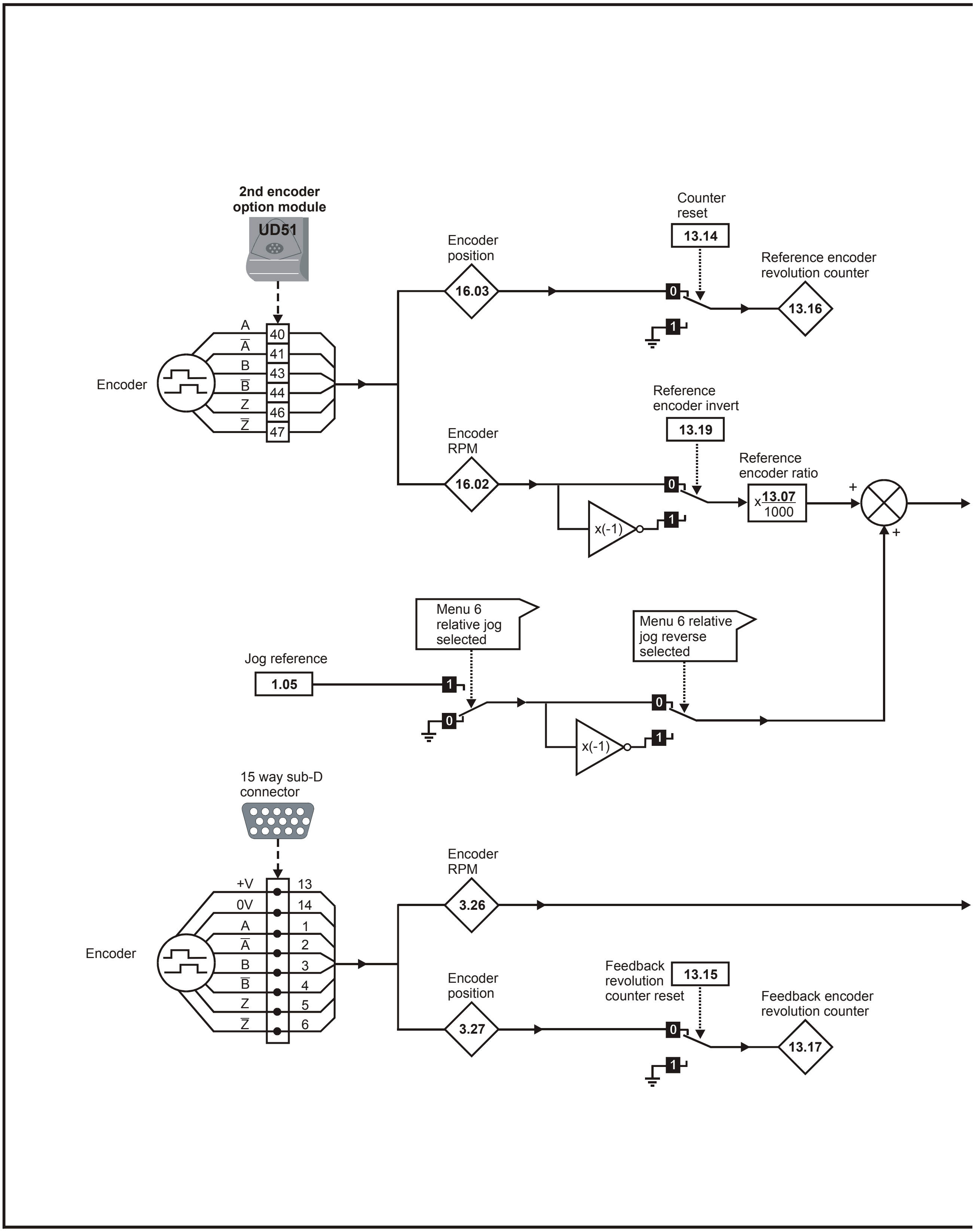
Parameter		Range(⇳)		Default(⇨)			Type			
		OL	CL	OL	VT	SV				
13.01	Position-loop error	±16,384*					RO	Bi		P
13.02	Reference-encoder input	±100.0 %					RO	Bi		P
13.03	Maximum reference speed	0 to 30,000 rpm		1,500		3,000	RW	Uni		
13.04	Reference-encoder scaling	0.000 to 4.000		1			RW	Uni		
13.05	Percentage input *select*		0 or 1		0		RW	Bit		
13.06	Reference input destination parameter	Pr **0.00** to Pr **20.50**		0			RW	Uni	R	P
13.07	Reference-encoder ratio	0 to 4.000		1			RW	Uni		
13.08	Position-loop mode *selector*	0 to 2	0 to 6	0			RW	Uni		
13.09	Position-loop gain	0 to 4.000		0.1			RW	Uni		
13.10	Positioning speed-limit	0 to 250 rpm		150			RW	Uni		
13.11	Orientation position reference		0 to 4095**		0		RW	Uni		
13.12	Orientation acceptance window		0 to 200**		20		RW	Uni		
13.13	Encoder sample time		0 to 5.0 ms		4.0		RW	Uni		
13.14	Reference revolution counter *reset*	0 or 1		0			RW	Bit		
13.15	Feedback revolution counter *reset*	0 or 1		0			RW	Bit		
13.16	Reference-encoder revolution counter	0 to 16,384 revolutions					RO	Bi		P
13.17	Feedback-encoder revolution counter	0 to 16,384 revolutions					RO	Bi		P
13.18	Orientation complete *indicator*		0 or 1				RO	Bit		P
13.19	Reference feedback *invert*	0 or 1		0			RW	Bit		

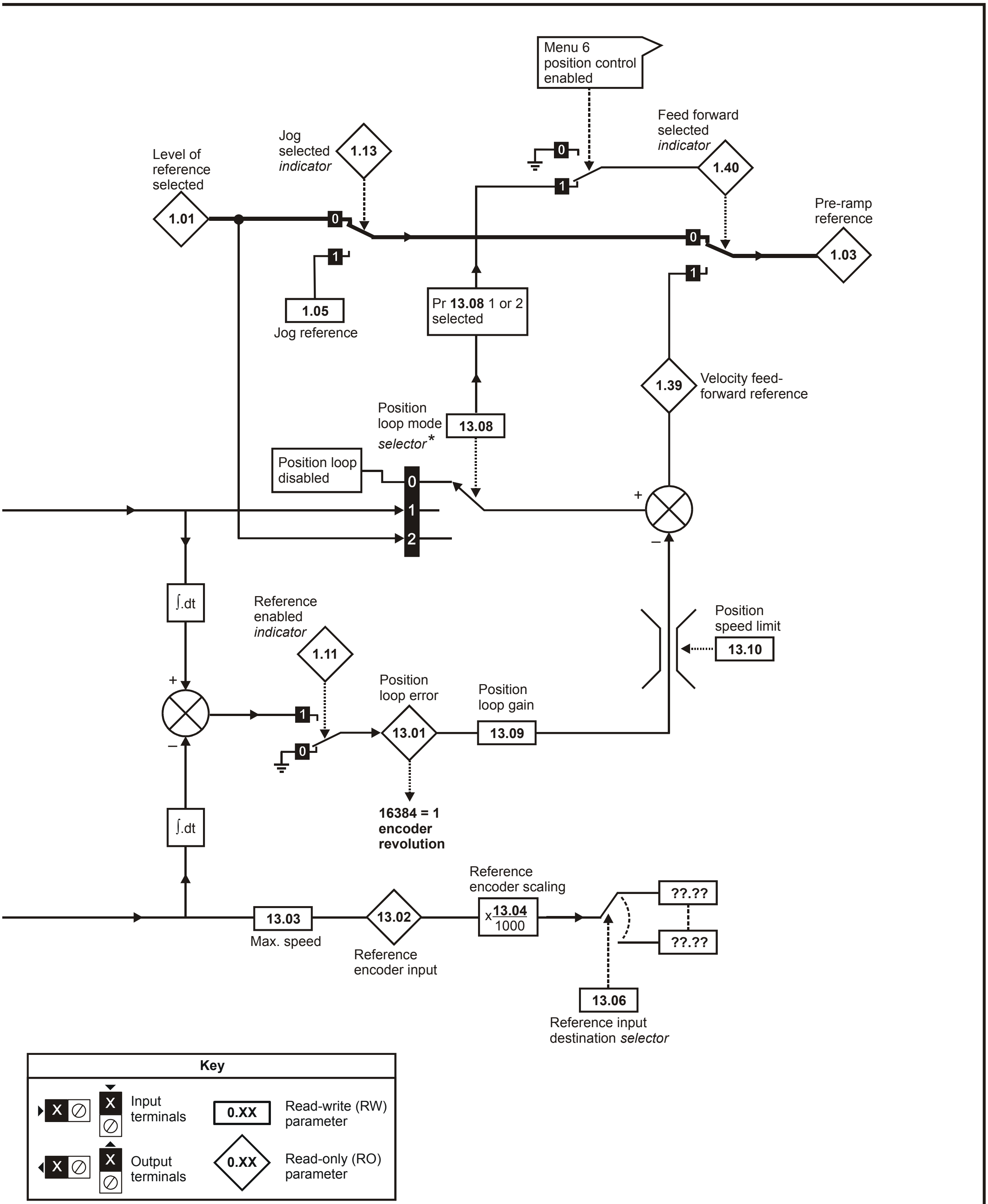
RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

* The range of Pr **13.01** is ±16,384, where 16,384 equals 1 whole revolution. The parameter increments in steps of $^{1}/_{16384}$ parts of a revolution.

** The ranges of Pr **13.11** and Pr **13.12** are 0 to 4095 and 0 to 200 respectively. 200 is equivalent to a part of a revolution and 4095 equals 1 whole revolution. These parameters increment in steps of $^{1}/_{4096}$ parts of a revolution.

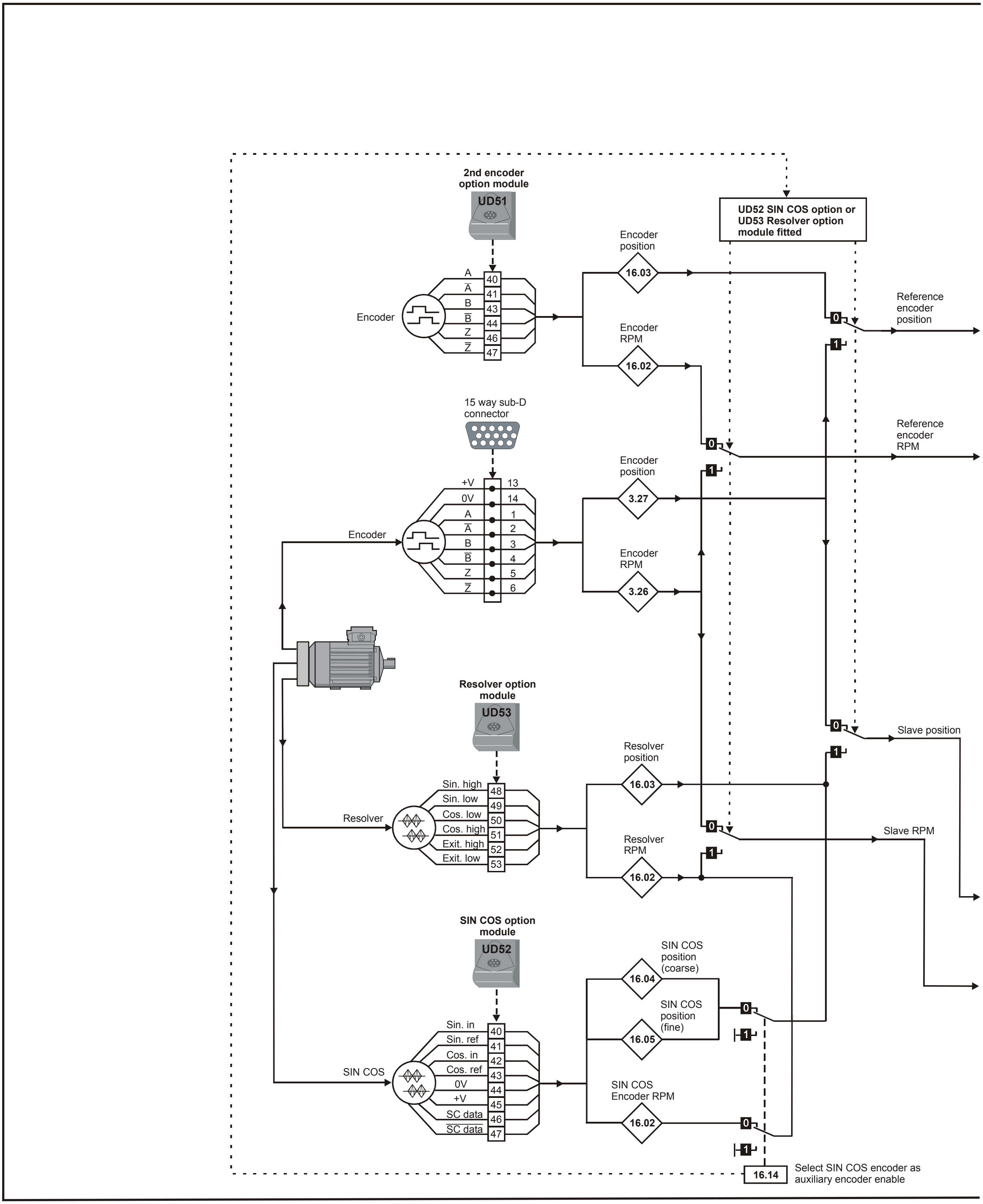
Figure 4-16 Menu 13 Open-loop logic diagram

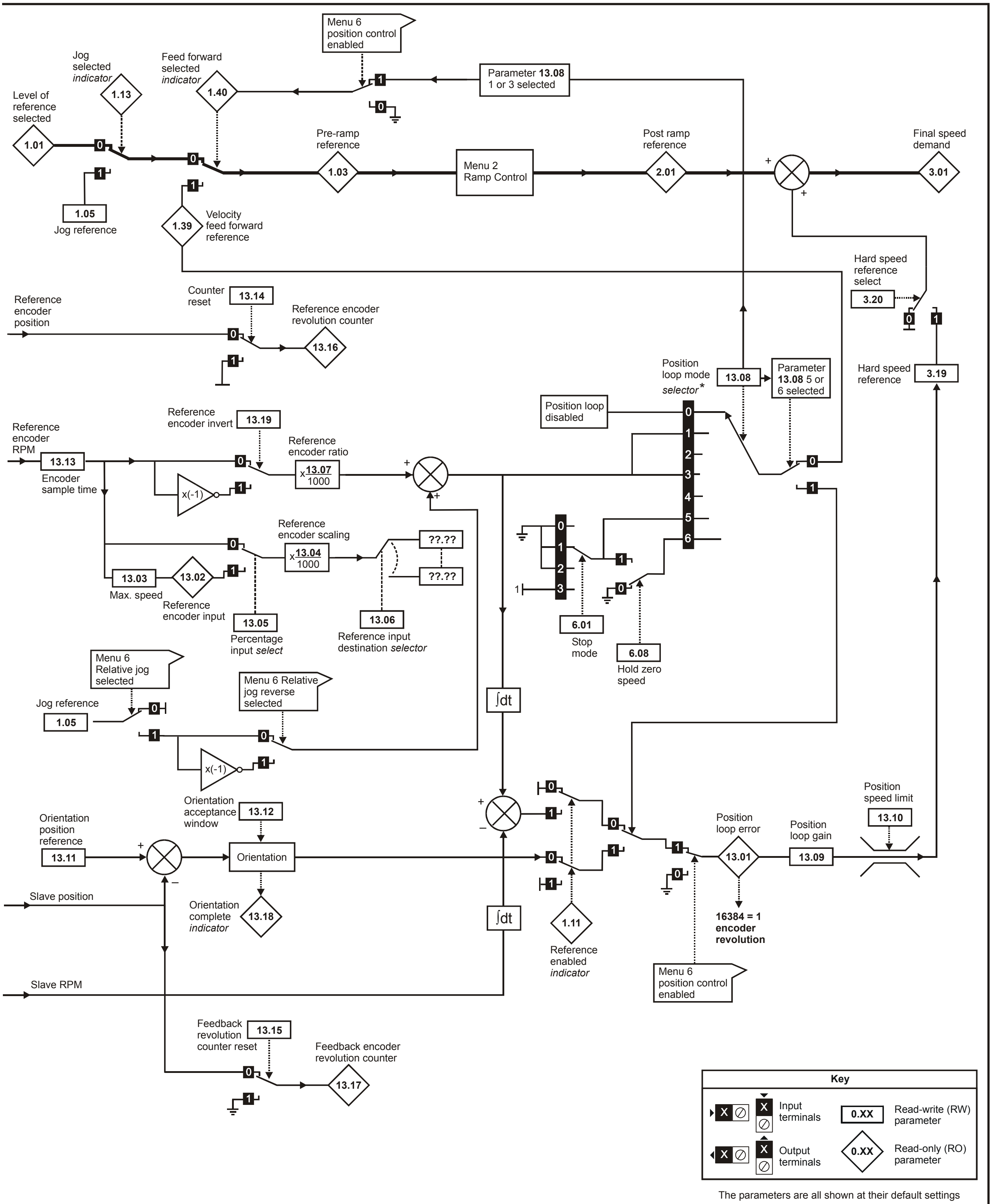




The parameters are all shown at their default settings

Figure 4-17 Menu 13 Closed-loop logic diagram





* For more information, see Pr **13.08** on page 167.

Menu 13 parameter descriptions

13.01	Position loop error		
RO	Bi		P
⇕ ±16,384		⇨	

This parameter monitors the position error when position control is being used. The range of the parameter is ±16,384, where 16,384 equals 1 whole revolution. If the position error is greater than one revolution, the parameter will show a 1 revolution error in the appropriate direction.

13.02	Reference encoder input		
RO	Bi		P
⇕ ±100 %		⇨	

Open loop
This parameter indicates the speed of the encoder 1 input as a percentage of the maximum reference speed programmed in Pr **13.03**.

Closed loop
This parameter indicates the speed of the reference encoder as a percentage of the maximum reference speed programmed in Pr **13.03**.

13.03		Maximum reference speed		
RW		Uni		
OL	⇕	0 to 30,000 rpm	⇨	1,500
VT	⇕		⇨	
SV	⇕		⇨	3,000

Open loop
This parameter should be set up by the user to the maximum rpm expected on the encoder 1 input if the encoder signal is to be used as a reference. When the encoder speed is equal to this value Pr **13.02** will indicate 100% input.

Closed loop
This parameter should be set up by the user to the maximum rpm expected on the reference encoder input if the encoder signal is to be used as a reference. When the encoder speed is equal to this value Pr **13.02** will indicate 100% input.

13.04	Reference encoder scaling		
RW	Uni		
⇕ 0 to 4.000		⇨	1.000

Open loop
Can be used to scale the encoder 1 input when it is being used as a reference alone.

Closed loop
Can be used to scale the reference encoder input when it is being used as a reference alone.

13.05		Percentage input select		
RW		Bit		
CL	⇕	0 or 1	⇨	0

When the reference encoder input is being used as a reference only, the value routed through to the destination can be a percentage of maximum input or actual rpm, this selection is made by setting this parameter.

13.06	Reference input destination parameter		
RW	Uni	R	P
⇕ Pr **0.00** to Pr **20.50**		⇨	Pr **0.00**

This parameter is used to define the destination parameter for an encoder reference. Only non-bit parameters which are not protected can be programmed as destinations. If a non valid parameter is programmed the input is not routed anywhere.

13.07	Reference encoder ratio		
RW	Uni		
⇕ 0.000 to 4.000		⇨	1.000

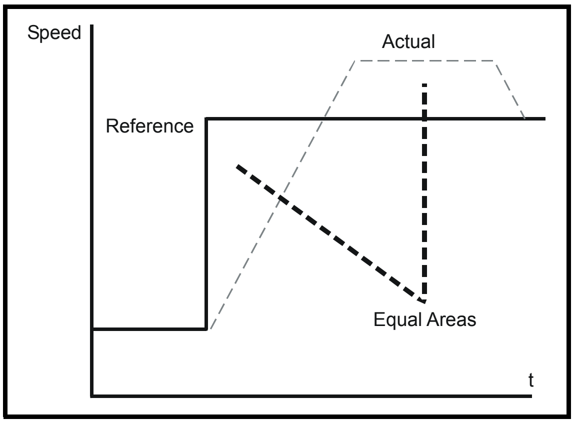
Can be used to scale the reference encoder input to the position loop such that the feedback can run at some ratioed speed to the reference encoder.

13.08		**Position-loop mode selector**		
RW		Uni		
OL	⇳	0 to 2	⇨	0
CL	⇳	0 to 6	⇨	

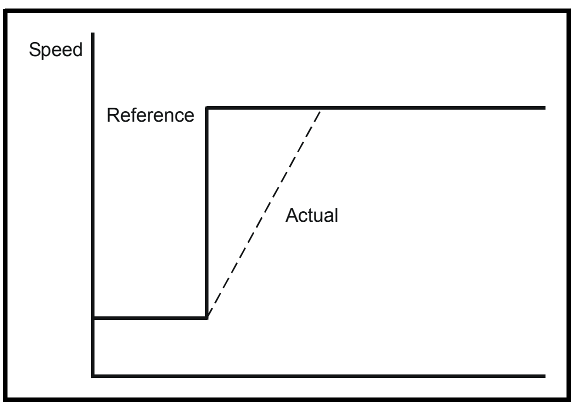
0 Position loop disabled
1 Rigid digital lock with digital Feed Forward
2 Rigid digital lock without digital Feed Forward
3 Non rigid digital lock with digital Feed Forward
4 Non rigid digital lock without digital Feed Forward
5 Orientate on stop command only
6 Orientate on stop command and when enabled

Sets the mode of operation of the position loop.

In rigid lock mode the position error is absolute relative to the time the position loop is closed. This means that if the slave shaft is slowed down due to excessive load, the target position will eventually be recovered by running at a higher speed when the load is removed.



In non rigid lock mode the position loop is only closed when the 'At Speed' condition is met. This allows slippage to occur while the speed loop is not satisfied.



Digital lock can be implemented without digital feed forward, where the input frequency of the encoder being followed is too low to obtain a smooth feed forward term from it. In this case the user can provide an alternative speed reference to be used as the feed forward term and the position loop will provide the velocity correction only. It should be noted that if the alternative feed forward is not correct, the position loop will run with a constant error to provide the difference between the feed forward and the actual speed of the reference encoder. During relative jogging, digital feed forward is always used because the feed forward term has to be adjusted.

Two orientation modes are selectable. In mode 5, the drive orientates following a stop command with orientation stop enabled (see Pr **6.01** on page 104). Mode 6 operates the same as mode 5 but in addition the drive always orientates when it is enabled providing that the 'Hold zero speed' parameter is set (Pr **6.08**). This ensures that the spindle is always in the same position following the drive being enabled.

When orientating from a stop command the drive goes through the following sequence:

1. Ramps are enabled and the motor is decelerated or accelerated to the speed limit programmed in Pr **13.10** in the direction the motor was previously running.
2. When the speed set in Pr **13.10** is reached, ramps are disabled and the motor continues to rotate until the position is found to be close to the target position. At this point the speed demand is set to 0 and the position loop is closed.
3. When the absolute value of speed is less than 2 rpm and the position is within the window defined by Pr **13.12**, the orientation complete signal is given.

13.09	**Position loop gain**		
RW	Uni		
⇳ 0.000 to 4.000		⇨	0.100

The gain applied to the position error to generate the velocity correction term.

13.10	**Position speed limit**		
RW	Uni		
⇳ 0 to 250 rpm		⇨	150

This parameter limits the velocity correction applied by the position loop such that high position loop gains can be used without getting large corrections. On closed loop drives it is also used as a reference during the orientation process.

13.11	**Orientation position reference**		
RW	Uni		
CL ⇳ 0 to 4,095		⇨	0

Defines the encoder position required for orientation. The range of this parameter is 0 to 4095. 4096 equals 1 whole revolution, thus it increments in steps of $^{1}/_{4096}$ parts of a revolution.

13.12	**Orientation acceptance window**		
RW	Uni		
CL ⇳ 0 to 200		⇨	20

The range of this parameter is 0 to 200. 4096 equals 1 whole revolution, thus it increments in steps of $^{1}/_{4096}$ parts of a revolution.

During the orientation process, the orientation complete flag is set when the absolute value of speed is less than 2 rpm and the encoder position is between Pr **13.11** + Pr **13.12** and Pr **13.11** - Pr **13.12**.

13.13	**Encoder sample time**		
RW	Uni		
CL ⇳ 0.0 to 5.0 ms		⇨	4.0

The resolution of speed measurement from an encoder depends on the sampling time the measurement is made over. Increasing the sampling time increases the resolution but also increases the time that a change in input frequency filters through the measurement. A compromise must be made between resolution and good dynamic response.

For a quadrature encoder the resolution of speed measurement is given by:

$$\frac{\text{No. of Enc. lines x 4 * Maximum speed(rpm) x Pr } \mathbf{13.13}}{1{,}000 \times 60}$$

13.14	**Reference revolution counter reset**		
RW	Bit		
⇳ 0 or 1		⇨	0

When this parameter is set Pr **13.16** is reset to 0.

13.15	**Feedback revolution counter reset**		
RW	Bit		
⇳ 0 or 1		⇨	0

When this parameter is set Pr **13.17** is reset to 0.

13.16	**Reference encoder revolution counter**		
RO	Bi		P
⇳ 0 to 16,384 revolutions		⇨	

This variable is incremented for every revolution in the forward direction and decremented for every revolution in the reverse direction. The counter is modulo 16,384.

13.17	**Feedback encoder revolution counter**			
RO	Bi			P
⇳	0 to 16,384 revolutions	⇨		

This variable is incremented for every revolution in the forward direction and decremented for every revolution in the reverse direction. The counter is modulo 16,384.

13.18		**Orientation complete indicator**			
RO		Bit			P
CL	⇳	0 or 1	⇨		

Indicates that the orientation process is complete. Set when the absolute value of speed is less than 2 rpm and the position is within the window defined by Pr **13.12**.

13.19	**Reference feedback invert**			
RW	Bit			
⇳	0 or 1	⇨	0	

If one of the digital lock modes is being used the reference feedback may be inverted by setting this bit.

4.14 Menu 14: Programmable PID function

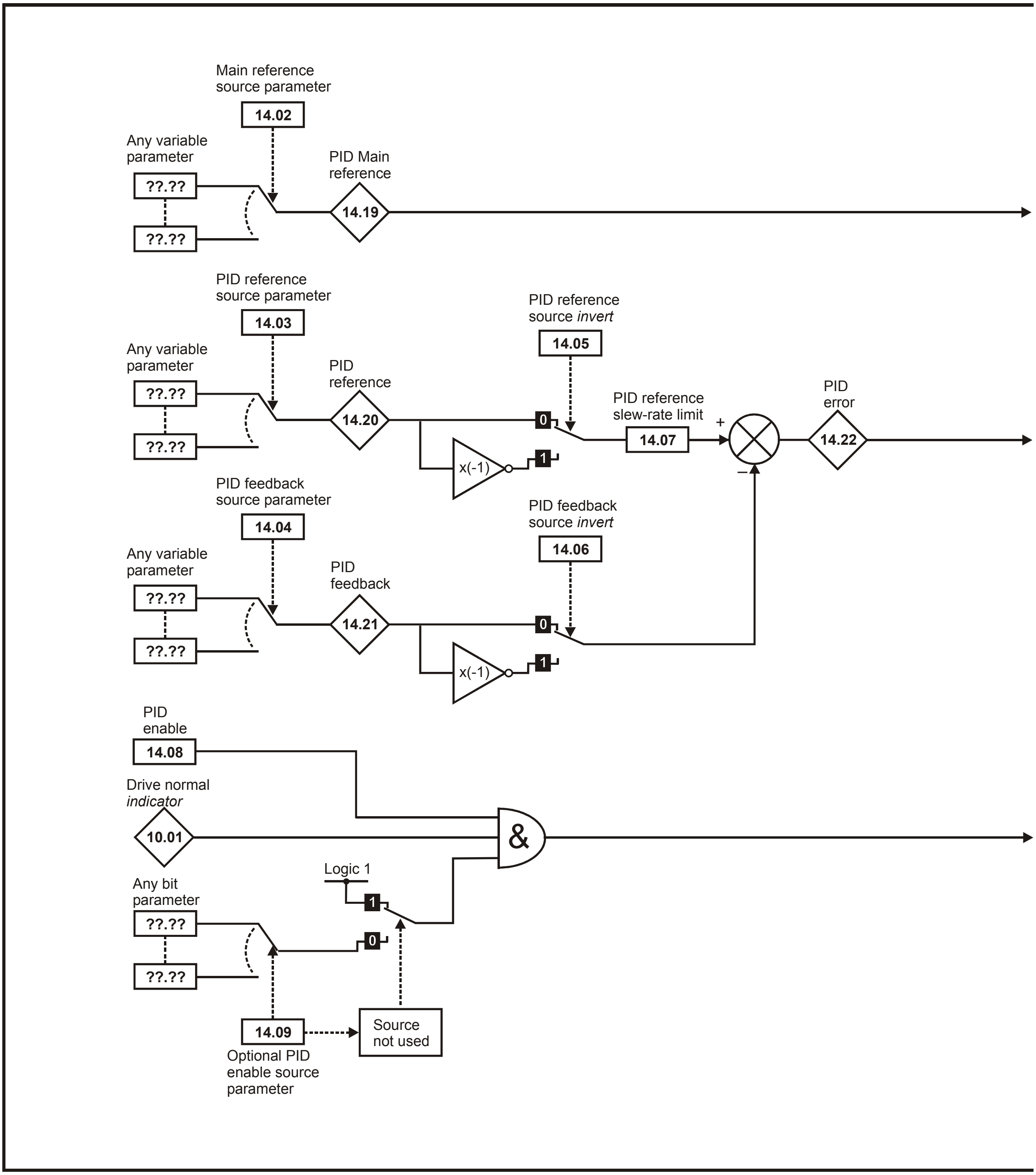
This menu contains a PID controller which has programmable reference and feedback inputs, programmable enable bit, reference slew rate limiting, variable clamp levels and programmable destination. If the PID integral and differential gains are made zero, then menu 14 can be used to sum up to three parameters together and route this to a destination parameter. The sample rate of the PID controller is the same as for the digital inputs, that is 5.5ms when using a switching frequency of 3,6 and 12kHz, and 7.4ms when using a switching frequency of 4.5kHz or 9kHz.

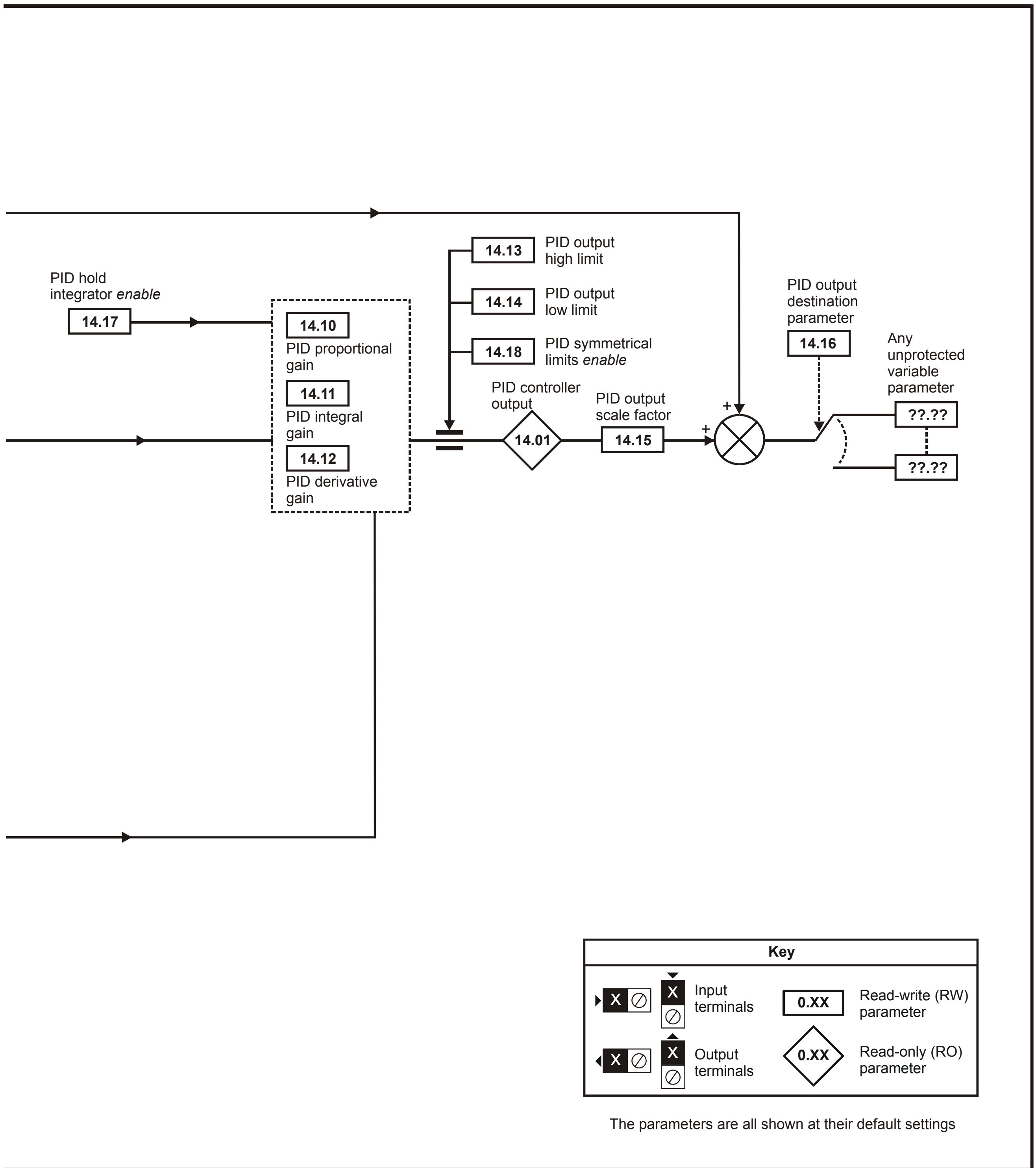
Table 4-18 Menu 14 single line descriptions

Parameter		Range(⇕) OL	Range(⇕) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
14.01	PID controller output	±100.0 %					RO	Bi		P
14.02	Main reference source parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
14.03	PID reference source parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
14.04	PID feedback source parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
14.05	PID reference *invert*	0 or 1		0			RW	Bit		
14.06	PID feedback source *invert*	0 or 1		0			RW	Bit		
14.07	PID reference slew-rate limit	0 to 3,200.0 s		0			RW	Uni		
14.08	PID *enable*	0 or 1		0			RW	Bit		
14.09	Optional PID-enable source parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
14.10	PID proportional gain	0 to 4.000		1			RW	Uni		
14.11	PID integral gain	0 to 4.000		0.5			RW	Uni		
14.12	PID derivative gain	0 to 4.000		0			RW	Uni		
14.13	PID output high limit	0 to 100.0%		100			RW	Uni		
14.14	PID output low limit	±100.0 %		-100			RW	Bi		
14.15	PID output scale factor	0 to 4.000		1			RW	Uni		
14.16	PID output destination parameter	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
14.17	PID hold integrator *enable*	0 or 1		0			RW	Bit		
14.18	PID symmetrical limits *enable*	0 or 1		0			RW	Bit		
14.19	PID main reference	±100.0 %					RO	Bi		P
14.20	PID reference	±100.0 %					RO	Bi		P
14.21	PID feedback	±100.0 %					RO	Bi		P
14.22	PID error	±100.0 %					RO	Bi		P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

Figure 4-18 Menu 14 logic diagram





The parameters are all shown at their default settings

Menu 14 parameter descriptions

14.01	PID controller output		
RO	Bi		P
⇳ ±100.0 %		⇨	

This parameter monitors the output of the PID controller before scaling is applied. Subject to the PID output limits the PID output is given by:

P.e + (I.e / s) + D.e.s

Where:

P, I & D are the programmed gains
e is the input error to the PID (reference - feedback)
s is the Laplace operator

Therefore:

With an error of 100%, if P = 1.000 the output produced by the proportional term is 100%.

With an error of 100%, if I = 1.000 the output produced by the integral term will increase linearly by 100% every second.

With an error that is increasing by 100% per second, if D = 1.000 the output produced by the D term will be 100%.

14.02	Main reference source parameter		
14.03	PID reference source parameter		
14.04	PID feedback source parameter		
RW	Uni		P
⇳ Pr **0.00** to Pr **20.50**		⇨	Pr **0.00**

These parameters define the variables which are to be used as input variables to the PID controller. Only non-bit parameters can be programmed as a source. If a non valid parameter is programmed the input value is taken as 0. All variable inputs to the PID are automatically scaled to variables having the range ±100.0%, or 0 - 100.0% if they are unipolar.

14.05	PID reference invert		
14.06	PID feedback source invert		
RW	Bit		
⇳ 0 or 1		⇨	0

These parameters can be used to invert the PID reference and source variables respectively.

14.07	PID reference slew-rate limit		
RW	Uni		
⇳ 0.0 to 3,200.0 s		⇨	0.0

This parameter defines the time taken for the reference input to ramp from 0 to 100.0% following a 0 to 100% step change in input. Changes from -100.0% to +100.0% will take twice this time.

14.08	PID enable		
RW	Bit		
⇳ 0 or 1		⇨	0

This parameter must be set at 1 for the PID controller to operate, if it is 0 the PID output will be 0.

14.09	Optional PID-enable source parameter		
RW	Uni		P
⇳ Pr **0.00** to Pr **20.50**		⇨	Pr **0.00**

Only bit parameters can be used as an optional PID enable. If a non valid parameter is programmed the input to the AND gate is taken as 1. As with the PID enable above, any optional enable programmed must be at 1 for the PID controller to operate, if it is 0 the PID output will be 0.

14.10	PID proportional gain		
RW	Uni		
⇳ 0.000 to 4.000		⇨	1.000

This is the proportional gain applied to the PID error.

14.11	PID integral gain		
RW	Uni		
⇕ 0.000 to 4.000		⇨ 0.500	

This is the gain applied to the PID error before being integrated.

14.12	PID derivative gain		
RW	Uni		
⇕ 0.000 to 4.000		⇨ 0.000	

This is the gain applied to the PID error before being differentiated.

14.13	PID output high limit		
RW	Uni		
⇕ 0.0 to 100.0 %		⇨ 100.0	

The maximum positive PID output is limited by this parameter. If Pr **4.18** (symmetrical limits enabled) is set to 1 then the magnitude of this parameter also defines a negative low limit.

14.14	PID output low limit		
RW	Bi		
⇕ ±100.0 %		⇨ -100.0	

The maximum negative or minimum positive PID output is limited by this parameter if Pr **4.18** is zero. If Pr **4.18** is 1 this parameter has no effect.

14.15	PID output scale factor		
RW	Uni		
⇕ 0 to 4.000		⇨ 1.000	

The PID output is scaled by his parameter before being added to the main reference. After the addition to the main reference, the output is automatically scaled again to match the range of the destination parameter.

14.16	PID output destination parameter		
RW	Uni	R	P
⇕ Pr **0.00** to Pr **20.50**		⇨ Pr **0.00**	

This needs to be set up with the parameter that the PID controller is to control. Only non-bit parameters which are not protected can be controlled by the PID function. If a non valid parameter is programmed the output is not routed anywhere. If the PID is to control speed then it is suggested that one of the preset speed parameters is entered here. If the PID is to trim speed then it is suggested that the offset parameter (Pr **1.04**) is entered here.

14.17	PID hold integrator enable		
RW	Bit		
⇕ 0 or 1		⇨ 0	

When this parameter is set to 0 the integrator operates normally. Setting this parameter to 1 will cause the integrator value to be held.

14.18	PID symmetrical limits enable		
RW	Bit		
⇕ 0 or 1		⇨ 0	

If this parameter is 0, then Pr **4.13** and Pr **4.14** define the maximum and minimum limits for the PID output. If this parameter is 1, then Pr **4.13** defines the magnitude of a symmetrical positive/negative limit.

14.19	PID main reference		
RO	Bi		P
⇕ ±100.0 %		⇨	

This parameter monitors the PID controller main reference.

14.20	PID reference		
RO	Bi		P
⇳	±100.0 %	⇨	

This parameter monitors the PID controller reference.

14.21	PID feedback		
RO	Bi		P
⇳	±100.0 %	⇨	

This parameter monitors the PID controller feedback.

14.22	PID error		
RO	Bi		P
⇳	±100.0 %	⇨	

This parameter monitors the PID controller error.

4.15 Menu 15: Regen

A Unidrive can be used as a sinusoidal input current power unit to supply one or more Unidrives via their dc buses. When this mode is selected as a drive type in menu 11, menu 15 will appear and can be used to set-up the Unidrive.

Table 4-19 Menu 15 single line descriptions

Parameter			Range(⇕)	Default(⇨)	Type			
			Regen	Regen				
15.01	Supply current magnitude	{**0.11**}	±Maximum drive current A		RO	Bi		P
15.02	Supply voltage	{**0.12**}	400V drive: 0 to 528 V		RO	Uni		P
15.03	Supply power	{**0.13**}	± P_{max} kW		RO	Bi		P
15.04	DC Bus voltage	{**0.14**}	400V drive: 0 to 830 V		RO	Uni		P
15.05	Supply frequency	{**0.15**}	±100 Hz		RO	Bi		P
15.06	Input inductance	{**0.16**}	0.001 to 100 mH		RO	Uni		P
15.07	DC Bus voltage set-point	{**0.17**}	400V drive: 0 to 800 V	400V drive: 700	RW	Uni		
15.08	Switching frequency	{**0.18**}	3 (0), 4.5 (1), 6 (2), 9 (3), 12 (4) kHz	0	RW	Txt		P
15.09	High stability space vector modulation	{**0.19**}	0 or 1	0	RW	Bit		
15.10	Quasi-square operation select	{**0.20**}	0 or 1	0	RW	Bit		
15.11	Sinusoidal rectifier synchronising	{**0.21**}	0 or 1		RO	Bit		P
15.12	Sinusoidal rectifier synchronised	{**0.22**}	0 or 1		RO	Bit		P
15.13	Sinusoidal rectifier phase loss	{**0.23**}	0 or 1		RO	Bit		P
15.14	Close soft start contactor	{**0.24**}	0 or 1		RO	Bit		P
15.15	Soft start contactor is closed	{**0.25**}	0 or 1		RO	Bit		
15.16	Enable motor drive	{**0.26**}	0 or 1		RO	Bit		P
15.17	Line synchronisation trip enable	{**0.27**}	0 or 1	0	RO	Bit		
15.18	Line synchronisation status	{**0.28**}	SYNC (0), Ph Det (1), Fr Lo (2), Fr Hi (3), PLL OI (4), PLL Ph (5)		RO	Txt		P
15.19	Current control proportional gain		0 to 30,000	110	RW	Uni		
15.20	Current control integral gain		0 to 30,000	1,000	RW	Uni		
15.21	Voltage control proportional gain		0 to 30,000	4,000	RW	Uni		
15.22	Enable extra mains loss detection		0 or 1	0	RW	Bit		

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

FLC Full load current of the drive (maximum continuous output current up to 40°C ambient temperature). Displayed in Pr **11.32** {**0.33**}.

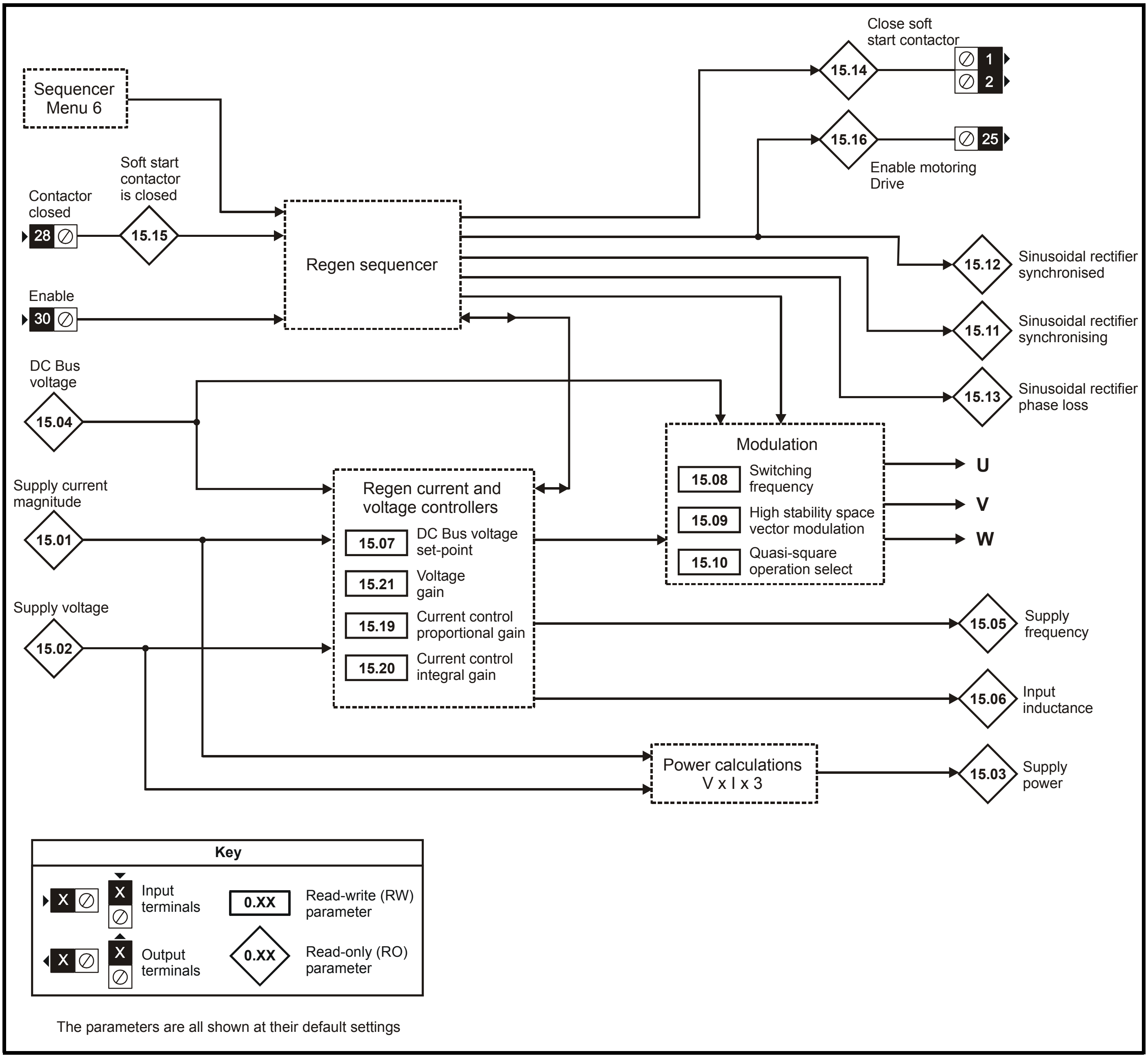
I_{MAX} A For definition of I_{MAX}, see section *Types of current range* on page 76.

P_{MAX} $\sqrt{3} \times I_{MAX} \times \frac{Pr\ 5.09}{1000}$

NOTE

Where a parameter is represented by a text value, the value in brackets in the range column is the setting used for serial communications.

Figure 4-19 Menu 15 logic diagram



Menu 15 parameter descriptions

15.01	Supply current magnitude		
RO	Bi		P
⇳	±Maximum drive current A	⇨	

This parameter gives the rms. phase current from the supply. The sinusoidal rectifier controls the current so that the fundamental current and voltage are in phase at the units terminals. There is a small phase shift across the input inductors, and so the current magnitude and the real component of current are approximately equal. If power is flowing into the sinusoidal rectifier the current magnitude is negative, and if power is flowing out (back into the supply) the current magnitude is positive.

15.02	Supply voltage		
RO	Uni		P
⇳	0 to 528 V	⇨	

When the sinusoidal rectifier unit is active the supply voltage is given by this parameter. If the unit is not active this parameter shows zero.

15.03	Supply power		
RO	Bi		P
⇳	±Max drive current x Pr **5.09** x √3/1000 kW	⇨	

Total supply power of the drive is calculated from the product of the line voltage and current which is equivalent to Pr **15.01** x Pr **15.02** x √3. Note that as the power factor is approximately unity the power is equal to the volt-amperes. The power shown is that flowing out of the drive, hence when power is flowing from the supply to the regen drive Pr **15.03** is negative, and when power is flowing from the regen drive back into the supply Pr **15.03** is positive.

15.04	DC bus voltage		
RO	Uni		P
⇳	0 to 830 V	⇨	

Voltage at the DC output of the unit.

15.05	Supply frequency		
RO	Bi		P
⇳	±100 Hz	⇨	

When the sinusoidal rectifier unit is active this parameter gives the supply frequency. Positive values indicate positive phase sequence and negative values indicate negative phase sequence. If the unit is not active this parameter shows zero.

15.06	Input inductance		
RO	Uni		P
⇳	0.001 to 100.000 mH	⇨	

At power-up this parameter is zero. Each time the unit is enabled the supply inductance is measured and displayed by this parameter. The value given is only approximate, but will give an indication as whether the input inductance is correct for the sinusoidal rectifier unit size. The measured value should include the supply inductance as well as the regen unit input inductance, however, the supply filter capacitance, masks the effect of the supply inductance. Therefore the value measured is the regen unit input inductor value.

15.07	DC bus voltage set-point		
RW	Uni		
⇳	0 to 800 V	⇨	700

The sinusoidal rectifier unit will attempt to hold the DC bus at the level specified by this parameter. The bus voltage must always be higher than the peak of the line to line supply voltage if the unit is to operate correctly. The voltage can be set to a level up to 800V, but this only leaves 30V headroom below the over-voltage trip level. Therefore it is best to use the default value of 700V unless the supply voltage is such that it must be raised above this level.

15.08	Switching frequency		
RW	Txt		P
⇳ 3 (0), 4.5 (1), 6 (2), 9 (3), 12 (4) kHz		⇨ 3 (0)	

This parameter sets the switching frequency and also determines the sample frequency for the control loops. The sampling frequency of the control system is based on the switching frequencies as follows:

Current control

Switching frequency (kHz)	Control frequency (kHz)
3	3
4.5	4.5
6	6
9	4.5
12	6

DC bus voltage control and synchronisation with the supply

Switching frequency (kHz)	Control frequency (kHz)
3	3
4.5	2.25
6	3
9	2.25
12	3

15.09	High stability space vector modulation		
RW	Bit		
⇳ 0 or 1		⇨ 0	

Setting this parameter modifies the IGBT switching pattern so as to reduce the number of switching events. This has the following effects:

- slightly reduced power loss in the regen unit
- increased acoustic noise from the output inductors

15.10	Quasi-square operation select		
RW	Bit		
⇳ 0 or 1		⇨ 0	

This parameter is a duplicate of Pr **5.20**. The rate at which the dc bus voltage can be reduced by the unit depends on the headroom between the bus voltage and the supply voltage. If quasi-square mode is selected this headroom can be effectively increased at some points within a supply cycle. This can give better performance, particularly when the supply voltage is high or the bus voltage set-point is low.

15.11	Sinusoidal rectifier synchronising		
RO	Bit		P
⇳ 0 or 1		⇨	

When the unit is enabled it must detect the phase and frequency of the mains. During this period this bit is set. Once synchronisation has been completed successfully this bit is cleared. If the supply is very severely distorted or a phase is missing the drive will repeatedly attempt to synchronise until it is disabled or the supply is suitable for synchronisation. (If Pr **15.17** is set to 1 the system will only attempt to synchronise for 30s.)

15.12	Sinusoidal rectifier synchronised		
RO	Bit		P
⇳ 0 or 1		⇨	

When the unit has been enabled and successfully synchronised this bit will be set to 1. If the unit is disabled, the unit trips or detects that the mains is lost, this bit will be set to 0.

15.13	**Sinusoidal rectifier phase loss**		
RO	Bit		P
⇳ 0 or 1		⇨	

If a supply phase is not present the sinusoidal rectifier unit will not synchronise when it is enabled. However, if a phase is lost after synchronisation one of the following will occur:

- Lightly loaded: the unit will continue to operate normally.
- Medium load: the unit will continue to operate, but the phase loss bit is set.
- Heavy load: the unit will detect mains loss, disable itself and attempt to re-synchronise.

15.14	**Close soft start contactor**		
RO	Bit		P
⇳ 0 or 1		⇨	

When the regen unit has powered up through the soft start resistor and the dc bus voltage stabilised this bit will change from 0 to 1. When regen mode is selected this bit is always routed to digital input/output F1. The output should be used to energise the soft start contractor coil.

15.15	**Soft start contactor is closed**		
RO	Bit		
⇳ 0 or 1		⇨	

When the close contactor output goes active the soft-start contactor should operate and short out the soft-start resistor. When regen mode is selected this bit parameter is always the destination from digital output F5. This input should be connected to an auxilliary contact on the soft-start contactor so that it follows the state of the contactor. If this input becomes inactive when bit Pr **15.14** is set, then after a 100ms (approx.) delay the drive will inhibit so as to protect the soft-start circuit.

15.16	**Enable motor drive**		
RO	Bit		P
⇳ 0 or 1		⇨	

When the unit has been enabled and successfully synchronised this bit will become active. If the regen units trips or detects that the mains is lost, this bit becomes inactive. When regen mode is selected this bit is always routed to a digital input/output F2. The output should be used to enable the motor drive(s) connected to the d.c. link of the regen unit.

15.17	**Line synchronisation trip enable**		
RO	Bit		
⇳ 0 or 1		⇨	0

When the drive is enabled and the main contactor is closed it will try and synchronise the line supply. If this bit is 0 then the drive will continue to try and synchronise to the line continually until disabled, even if it does not synchronise successfully. If this bit is set to a 1 and the drive has not successfully synchronised after trying for 30 seconds then the drive will trip 'LI.SYNC'.

15.18	**Line synchronisation status**		
RO	Txt		P
⇳ SYNC (0), Ph Det (1), Fr Lo (2), Fr Hi (3), PLL OI (4), PLL Ph (5)		⇨	

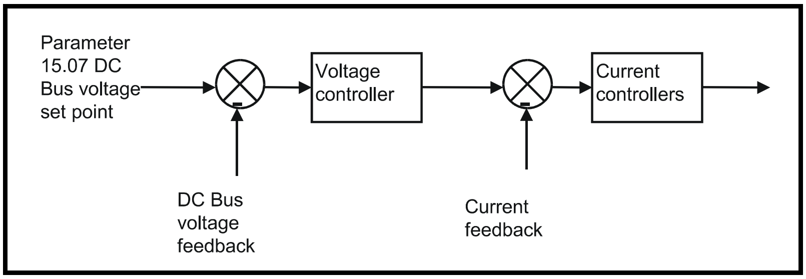
This parameter is the line supply synchronisation status. It is intended to give some diagnostic information if the drive fails to synchronise to the supply. If no attempt to synchronise to the supply has been made since the drive was switched on, if the drive is synchronised to the supply and running, or if it has been running then this parameter will show 'SYNC'. If the drive can not synchronise to the supply then this parameter will show the reason why synchronisation failed. If the drive does fail to synchronise to the supply the most likely reasons are that the supply is very distorted, or there are large voltage notches / spikes on the supply.

0 SYNCSuccessfully synchronised to line supply
1 Ph DetFailed to correctly detect the phasing of the supply
2 Fr LoLine frequency too low
3 Fr HiLine frequency too high
4 PLL OIOver current during final synchronisation of PLL to supply
5 PLL PhPhasing error during final synchronisation of PLL to supply

15.19	Current control proportional gain		
RW	Uni		
⇳	0 to 30,000	⇨	110

15.20	Current control integral gain		
RW	Uni		
⇳	0 to 30,000	⇨	1,000

When the drive is operated as a regen unit it uses a DC bus voltage controller with inner current controllers as shown below.



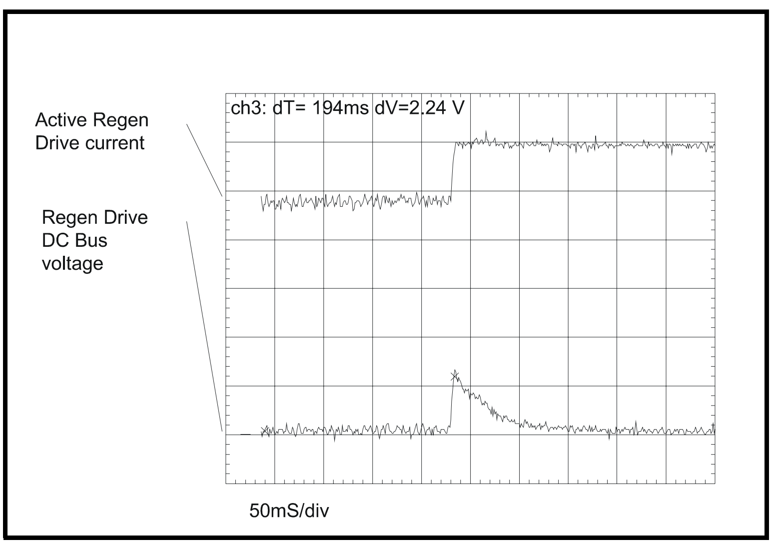
The gains of the voltage and current controllers affect the stability of the regen unit control system and incorrect gain settings can result in over-voltage or over-current trips. (The gain of the voltage controller is set by Pr **15.21**.) In many applications the default gains given for the current controllers will be suitable, however, it may be necessary for the user to change these if the inductance or resistance of the supply plus the regen inductors varies significantly from the expected values.

The most critical parameter for stability is the current controller proportional gain and the required value for this is dependent on the regen unit input inductance. If the inductance of the supply is a significant proportion of the recommended regen inductor (i.e. 60/IDR, where IDR is the drive rated current), then the proportional gain may need to be increased. The supply inductance is likely to be negligible compared to the regen inductor value with small drives, but is likely to be significant with larger drives. The proportional gain should be adjusted so that

Pr **15.19** = 1800 x Total input L x IDR

The current controller integral gain is not so critical, and in a majority of cases the default value is suitable. However, if it is necessary to adjust this parameter a value between 80 x IDR x R and 320 x IDR x R (where R is the supply resistance of one phase) should be used.

Even when the gains are set correctly there will be a transient change of d.c. bus voltage when there is a change in the load on any drive connected to the regen unit. If the power flow from the supply is increased (i.e. more power is taken from the supply or less power is fed back into the supply) the DC bus voltage will fall, but the minimum level will be limited to just below the peak rectified level of the supply provided the maximum rating of the unit is not exceeded. If the power flow from the supply is reduced (i.e. less power is taken from the supply or more power is fed back into the supply) the DC bus voltage will rise. During a rapid transient the bus will rise and then fall as shown below.



The example shown is for a very rapid load change where the torque reference of the motor drive has been changed instantly from one value to another. In most applications where the motor drive is operating under speed control the speed controller may only require a limited rate of change of torque demand, reducing the rate of change of power flow, and also reducing the size of the transient voltage. If the set point voltage (Pr **15.07**) plus the transient rise exceed the over-voltage trip level (830V for a medium voltage drive) the regen unit will trip.

When a 400V motor is operated above base speed from a drive in vector mode, fed from the regen unit supplying a d.c. voltage of 700V, and an instantaneous change of torque is demanded (i.e. -100% to +100%) the peak of the voltage transient (ΔV) is approximately 80V if the current controllers are set up correctly. (Operating with maximum voltage on the motor, i.e. above base speed, gives the biggest transient of power and hence the biggest value of ∆V.)

If ∆V is required for a different load change it can be calculated from

∆V = 80V x load change / 200%

If the motor voltage is not 400V or the DC bus voltage set point is not 700V, ∆V is calculated from

∆V = 80V x (motor voltage / 400) x (700 / DC bus voltage set point)

In some applications, particularly with a high DC bus voltage set point and low switching frequency it may be necessary to limit the rate of change of power flow to prevent over voltage trips. A first order filter on the torque reference of the motor drive (i.e. using Pr **4.12**) is the most effective method to reduce the transient further. (A fixed limit of the rate of change of torque demand is less effective.) The following table gives an approximate indication of the reduction in ∆V for different time constants. As already mentioned the value of ∆V given if for an instantaneous change of torque representing the worst case. In most application where a speed controller is used in the motor drive the transient will already include a filter.

Time constant	∆V
20ms	x 0.75
40ms	x 0.5

15.21	Voltage control proportional gain		
RW	Uni		
⇳ 0 to 30,000		⇨ 4,000	

The voltage controller gain is set to a value that is suitable for most applications. The per unit capacitance of each size of drive is not always the same, and so the drive compensates so that the gain is set for twice the capacitance of an individual drive as this is the normal situation with a regen unit and motor drive of equal rating. The transient voltage with a sudden change of load ∆V is affected proportionally by this parameter. Therefore the gain may be changed when the DC bus capacitance is not equal to twice the regen unit capacitance. However, care must be taken to ensure that the gain is not too high as this can cause excessive ripple in the DC bus voltage.

15.22	Enable extra mains loss detection		
RW	Bit		
⇳ 0 or 1		⇨ 0	

Additional mains loss detection is enabled when this parameter is set to one. This is provided to detect mains loss when the drive is disconnected from the supply and is still active. In some cases when this happens the drive can still run whilst the DC bus capacitors discharge. The drive will produce an output voltage line rms voltage of √2 x Vdc. This may be higher than the nominal supply voltage. If mains loss is detected by the extra main loss detection a “Sup.LSS” trip is initiated.

4.16 Menu 16: Small option module set-up

Menu 16 is only present when a small option module is fitted. On power down the drive remembers which option module is fitted and on power up it checks that the module fitted is the same as was present on power down. If the drive finds a different option module it will load defaults for the new module. If no option module is fitted, menu 16 cannot be accessed by the keypad or by serial comms.

4.16.1 Additional I/O module (UD50)

The additional I/O module (UD50) offers I/O expansion as shown in the table below. The update rate is better than 8ms with all switching frequencies.

Name	Direction	Mode
Ain 4	Input	Voltage
Ain 5	Input	Voltage
Aout 3	Output	Voltage
Dig IO 4 (F7)	Input/output	
Dig IO 5 (F8)	Input/output	
Dig IO 6 (F9)	Input/output	
Dig I 4 (F10)	Input	
Dig I 5 (F11)	Input	
Dig I 6 (F12)	Input	
Relay 2	Output	
Relay 3	Output	

Additional I/O module: connections

40 Relay 2 (N/O)
41 Relay 1 (N/O)
42 Relay common
43 0V
44 DI4
45 DI5
46 DI6
47 0V
48 DIO4
49 DIO5
50 DIO6
51 AI5
52 AI6
53 0V
54 AO3
55 0V (should not be used unless the drive control board is UD90A or later)

Table 4-20 Menu 16 (UD50) single line descriptions

Parameter		Range(⇳) OL	Range(⇳) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
16.01	Option module code	0 to 100		1			RO	Uni		P
16.02	Relay 2 output indicator	0 or 1					RO	Bit		P
16.03	Relay 3 output indicator	0 or 1					RO	Bit		P
16.04	Analog input 4	±100.0 %					RO	Bi		P
16.05	Analog input 5	±100.0 %					RO	Bi		P
16.07	Logic input F7 / Output 7 indicator	0 or 1					RO	Bit		P
16.08	Logic input F8 / Output 8 indicator	0 or 1					RO	Bit		P
16.09	Logic input F9 / Output 9 indicator	0 or 1					RO	Bit		P
16.10	Logic input F10	0 or 1					RO	Bit		P
16.11	Logic input F11	0 or 1					RO	Bit		P
16.12	Logic input F12	0 or 1					RO	Bit		P
16.13	Analog input 4 scaling	0.000 to 4.000		1.000			RW	Uni		
16.14	Analog input 4 invert bit	0 or 1		0			RW	Bit		
16.15	Analog input 4 destination	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.16	Analog input 5 scaling	0.000 to 4.000		1.000			RW	Uni		
16.17	Analog input 5 invert bit	0 or 1		0			RW	Bit		
16.18	Analog input 5 destination	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.19	DAC Output 3 source	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.20	DAC Output 3 scaling	0.000 to 4.000		1.000			RW	Uni		
16.21	F7 input destination / output source	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.22	F7 input/output invert	0 or 1		0			RW	Bit		
16.23	F7 output enable	0 or 1		0			RW	Bit	R	
16.24	F8 input destination / output source	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.25	F8 input/output invert	0 or 1		0			RW	Bit		
16.26	F8 output enable	0 or 1		0			RW	Bit	R	
16.27	F9 input destination / output source	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.28	F9 input/output invert	0 or 1		0			RW	Bit		
16.29	F9 output enable	0 or 1		0			RW	Bit	R	
16.30	F10 input destination	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.31	F10 input invert	0 or 1		0			RW	Bit		
16.32	F11 input destination	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.33	F11 input invert	0 or 1		0			RW	Bit		
16.34	F12 input destination	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.35	F12 input invert	0 or 1		0			RW	Bit		
16.36	Relay 2 source	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.37	Relay 2 output invert	0 or 1		0			RW	Bit		
16.38	Relay 3 source	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni	R	P
16.39	Relay 3 output invert	0 or 1		0			RW	Bit		
16.40	Logic input polarity	0 or 1		0			RW	Bit	R	P
16.41	Open collector outputs	0 or 1		0			RW	Bit	R	P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

Figure 4-20 Menu 16 UD50 logic diagram, part 1

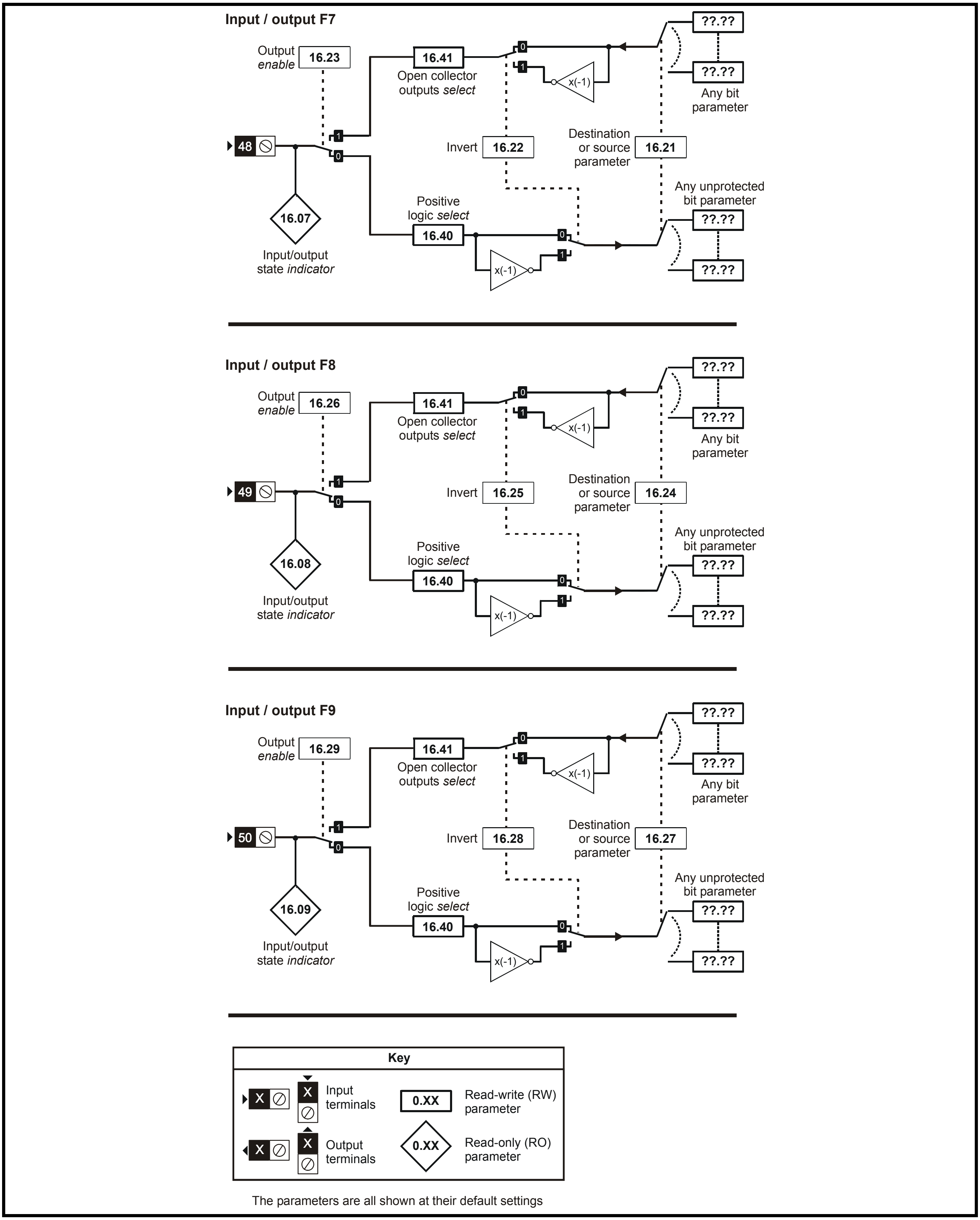
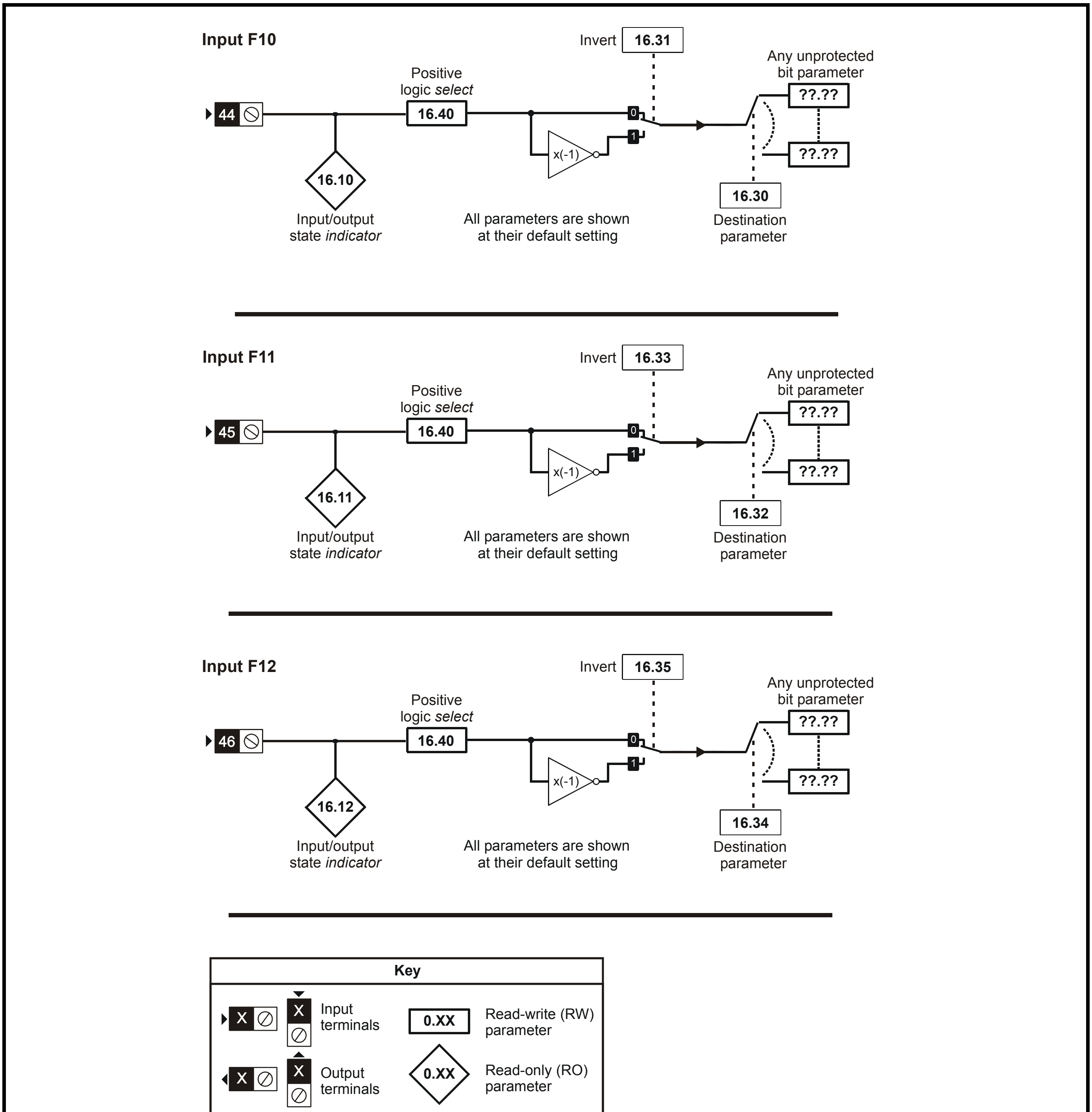


Figure 4-21 Menu 16 UD50 logic diagram, part 2



The parameters are all shown at their default settings

Figure 4-22 Menu 16 UD50 logic diagram, part 3

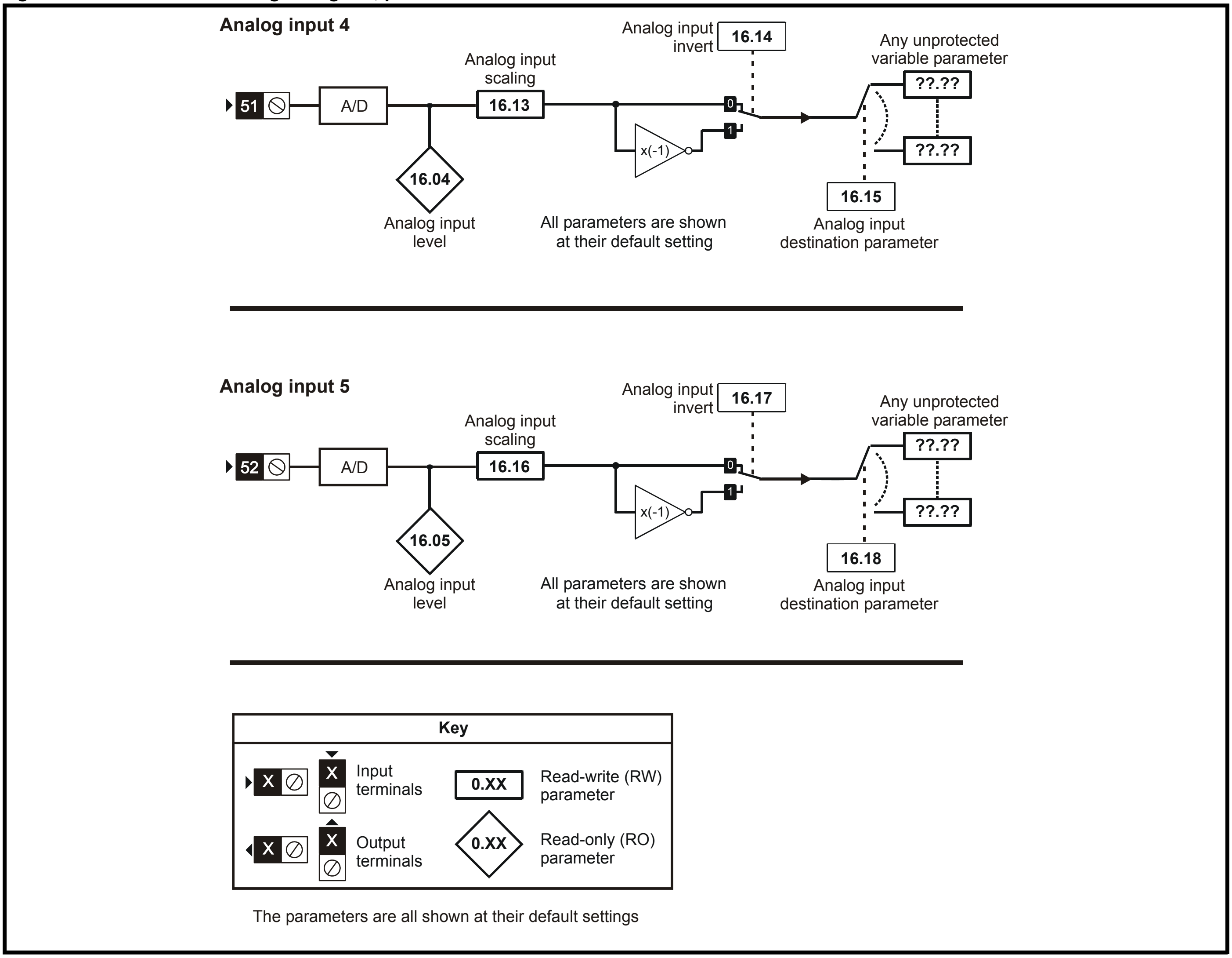
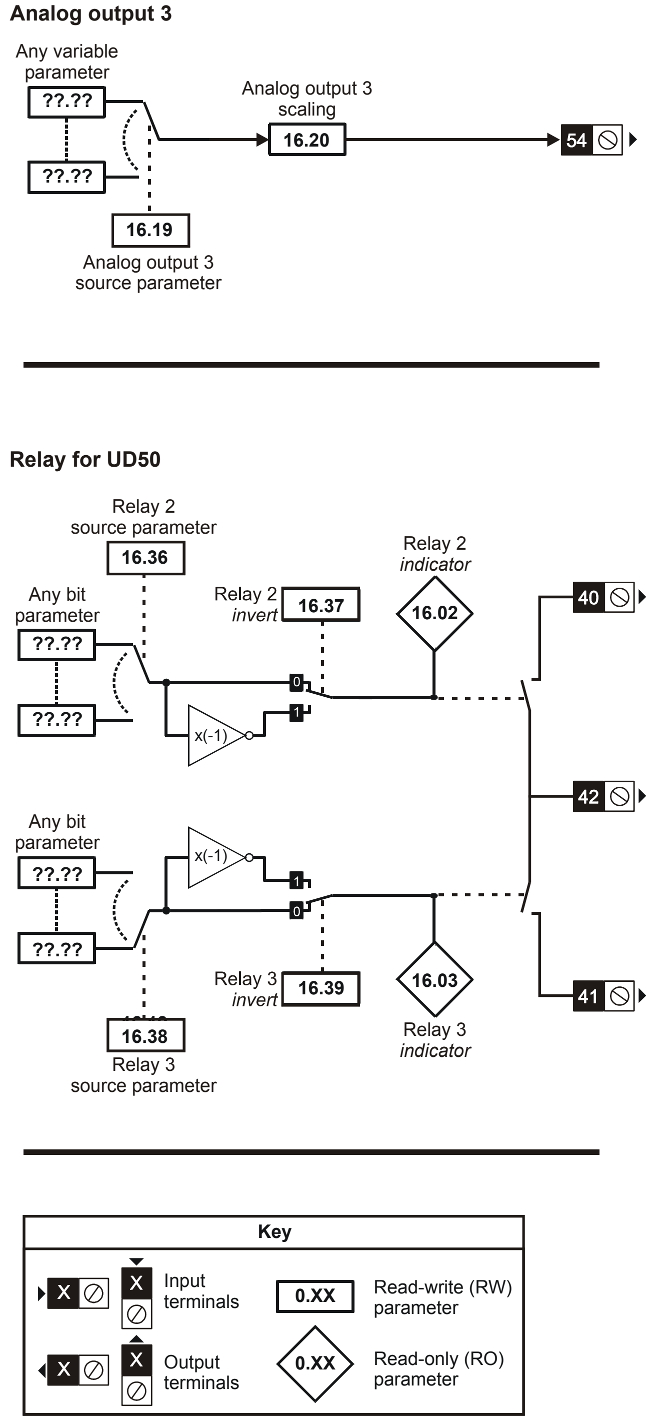


Figure 4-23 Menu 16 UD50 logic diagram, part 4



The parameters are all shown at their default settings

UD50 parameter descriptions

16.01	Option module code		
RO	Uni		P
⇕	0 to 100	⇨	

This parameter will display a code depending on which option module is fitted.

Codes allocated are:

1 Additional I/O module - UD50
2 Second Encoder interface module - UD51
3 Resolver feedback module - UD53
4 SINCOS encoder interface module - UD52

16.02	Relay 2 output indicator		
16.03	Relay 3 output indicator		
RO	Bit		P
⇕	0 or 1	⇨	

These parameters indicates the state of expansion relay's 2 and 3 respectively, 0 = de-energised, 1 = energised.

16.04	Analog input 4		
16.05	Analog input 5		
RO	Bi		P
⇕	±100.0 %	⇨	

These parameters display the level of the analog inputs 4 and 5 respectively. The processor A-D converters are used for these analog inputs, the resolution is 10 bit plus sign.

16.07	Logic input F7 / output 7 indicator		
16.08	Logic input F8 / output 8 indicator		
16.09	Logic input F9 / output 9 indicator		
RO	Bit		P
⇕	0 or 1	⇨	

These parameters indicate the input state of the terminals if they are set up as inputs, or the output state if they are set up as outputs. For inputs 0 = inactive, 1 = active; and for outputs a 1 will cause the terminal to sink current, and a 0 will cause the terminal to drive current.

16.10	Logic input F10		
16.11	Logic input F11		
16.12	Logic input F12		
RO	Bit		P
⇕	0 or 1	⇨	

These parameters indicate the state of inputs F10 to F12, 0 = inactive, 1 = active.

16.13	Analog input 4 scaling		
RW	Uni		
⇕	0.000 to 4.000	⇨	1.000

This parameter can be used to scale an input if so desired. However in most cases it is not necessary as each input is automatically scaled such that for 100.0% input the destination parameter will be at maximum.

16.14	Analog input 4 invert bit		
RW	Bit		
⇕	0 or 1	⇨	0

This parameter can be used to invert an input reference if so desired.

16.15	Analog input 4 destination			
RW	Uni		R	P
⇳	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**	

The parameters which each analog input is required to control are programmed here. If a bit parameter, or a protected parameter is programmed the inputs are not routed anywhere.

16.16	Analog input 5 scaling			
RW	Uni			
⇳	0.000 to 4.000	⇨	1.000	

This parameter can be used to scale an input if so desired. However in most cases it is not necessary as each input is automatically scaled such that for 100.0% input the destination parameter will be at maximum.

16.17	Analog input 5 invert bit			
RW	Bit			
⇳	0 or 1	⇨	0	

This parameter can be used to invert an input reference if so desired.

16.18	Analog input 5 destination			
RW	Uni		R	P
⇳	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**	

The parameters which each analog input is required to control are programmed here. If a bit parameter, or a protected parameter is programmed the inputs are not routed anywhere.

16.19	DAC output 3 source			
RW	Uni		R	P
⇳	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**	

The parameters required to be output to the third analog output should be programmed in this parameter. Only non-bit parameters can be programmed as a source. If a non valid parameter is programmed the output value is taken as 0.

16.20	DAC output 3 scaling			
RW	Uni			
⇳	0.000 to 4.000	⇨	1.000	

Again user defined scaling is provided but as with inputs, automatic scaling is carried out such that when the source parameter is at its maximum value the DAC output will be at maximum.

16.21	F7 input destination / output source			
RW	Uni		R	P
⇳	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**	

Destination parameters define the parameter each of the programmable inputs is to control. Only Bit parameters which are not protected can be controlled by programmable digital inputs. If a non-valid parameter is programmed the input is not routed anywhere.

Source parameters define the parameter to be output on the appropriate terminal or to be used to change the relay state. Only bit parameters can be output to digital outputs. If a non valid parameter is programmed the output terminal will drive current and the relay will stop in the de-energised state.

16.22	F7 input / output invert			
RW	Bit			
⇳	0 or 1	⇨	0	

Invert parameters can be used to change the sense of the destination parameter for the active state on inputs, or to change the output drive sense for the source parameters level on outputs.

16.23	F7 output enable			
RW	Bit		R	
⇕	0 or 1		⇨	0

This parameter is for setting the Input/Output terminals up in the required mode. A logic 1 in this parameter sets the terminal up as an output and a 0 sets it up as an input.

16.24	F8 input destination / output source			
RW	Uni		R	P
⇕	Pr **0.00** to Pr **20.50**		⇨	Pr **0.00**

Destination parameters define the parameter each of the programmable inputs is to control. Only Bit parameters which are not protected can be controlled by programmable digital inputs. If a non-valid parameter is programmed the input is not routed anywhere.

Source parameters define the parameter to be output on the appropriate terminal or to be used to change the relay state. Only bit parameters can be output to digital outputs. If a non valid parameter is programmed the output terminal will drive current and the relay will stop in the de-energised state.

16.25	F8 input / output invert			
RW	Bit			
⇕	0 or 1		⇨	0

Invert parameters can be used to change the sense of the destination parameter for the active state on inputs, or to change the output drive sense for the source parameters level on outputs.

16.26	F8 output enable			
RW	Bit		R	
⇕	0 or 1		⇨	0

This parameter is for setting the Input/Output terminals up in the required mode. A logic 1 in this parameter sets the terminal up as an output and a 0 sets it up as an input.

16.27	F9 input destination / output source			
RW	Uni		R	P
⇕	Pr **0.00** to Pr **20.50**		⇨	Pr **0.00**

Destination parameters define the parameter each of the programmable inputs is to control. Only Bit parameters which are not protected can be controlled by programmable digital inputs. If a non-valid parameter is programmed the input is not routed anywhere.

Source parameters define the parameter to be output on the appropriate terminal or to be used to change the relay state. Only bit parameters can be output to digital outputs. If a non valid parameter is programmed the output terminal will drive current and the relay will stop in the de-energised state.

16.28	F9 input / output invert			
RW	Bit			
⇕	0 or 1		⇨	0

Invert parameters can be used to change the sense of the destination parameter for the active state on inputs, or to change the output drive sense for the source parameters level on outputs.

16.29	F9 output enable			
RW	Bit		R	
⇕	0 or 1		⇨	0

This parameter is for setting the Input/Output terminals up in the required mode. A logic 1 in this parameter sets the terminal up as an output and a 0 sets it up as an input.

16.30	F10 input destination			
RW	Uni		R	P
⇕	Pr **0.00** to Pr **20.50**		⇨	Pr **0.00**

Destination parameters define the parameter each of the programmable inputs is to control. Only Bit parameters which are not protected can be controlled by programmable digital inputs. If a non-valid parameter is programmed the input is not routed anywhere.

16.31	F10 input invert			
RW	Bit			
⇕	0 or 1	⇨	0	

Invert parameters can be used to change the sense of the destination parameter for the active state on inputs, or to change the output drive sense for the source parameters level on outputs.

16.32	F11 input destination			
RW	Uni	R	P	
⇕	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**	

Destination parameters define the parameter each of the programmable inputs is to control. Only Bit parameters which are not protected can be controlled by programmable digital inputs. If a non-valid parameter is programmed the input is not routed anywhere.

16.33	F7 input invert			
RW	Bit			
⇕	0 or 1	⇨	0	

Invert parameters can be used to change the sense of the destination parameter for the active state on inputs, or to change the output drive sense for the source parameters level on outputs.

16.34	F7 input destination / output source			
RW	Uni	R	P	
⇕	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**	

Destination parameters define the parameter each of the programmable inputs is to control. Only Bit parameters which are not protected can be controlled by programmable digital inputs. If a non-valid parameter is programmed the input is not routed anywhere.

16.35	F12 input invert			
RW	Bit			
⇕	0 or 1	⇨	0	

Invert parameters can be used to change the sense of the destination parameter for the active state on inputs, or to change the output drive sense for the source parameters level on outputs.

16.36	Relay 2 source			
RW	Uni	R	P	
⇕	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**	

Source parameters define the parameter to be output on the appropriate terminal or to be used to change the relay state. Only bit parameters can be output to digital outputs. If a non valid parameter is programmed the output terminal will drive current and the relay will stop in the de-energised state.

16.37	Relay 2 output invert			
RW	Bit			
⇕	0 or 1	⇨	0	

Invert parameters can be used to change the sense of the destination parameter for the active state on inputs, or to change the output drive sense for the source parameters level on outputs.

16.38	Relay 3 source			
RW	Uni	R	P	
⇕	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**	

Source parameters define the parameter to be output on the appropriate terminal or to be used to change the relay state. Only bit parameters can be output to digital outputs. If a non valid parameter is programmed the output terminal will drive current and the relay will stop in the de-energised state.

16.39	**Relay 3 output invert**		
RW	Bit		
⇳ 0 or 1		⇨ 0	

Invert parameters can be used to change the sense of the destination parameter for the active state on inputs, or to change the output drive sense for the source parameters level on outputs.

16.40	**Logic input polarity**		
RW	Bit	R	P
⇳ 0 or 1		⇨ 0	

This parameter changes the logic polarity on digital inputs. In its default state the input polarity is negative logic which requires digital inputs to be pulled low (<5V) to activate the input. When this parameter is set to 1 the input polarity is positive logic and digital inputs must be driven high (>15V) to activate the input.

16.41	**Open collector outputs**		
RW	Bit	R	P
⇳ 0 or 1		⇨ 0	

The high side driving on the three digital outputs can be disabled by setting this parameter. This allows the outputs to be connected together in a wired OR configuration.

4.16.2 Second Encoder interface module (UD51)

The second encoder option module (UD51) provides a second encoder interface. The encoder position can be used as a reference for digital locking, or the speed as a reference value for speed, frequency etc. A Frequency and Direction (F and D) or quadrature (A/B) output can be provided from the main drive encoder or the encoder connected to this module. A freeze input is also provided that latches the second encoder position and the main drive encoder position when it is activated. The freeze values are only available to the UD70 large option module if fitted. If the freeze input is not selected the main drive encoder Z signal is present on the freeze terminals.

Second encoder interface module: connections

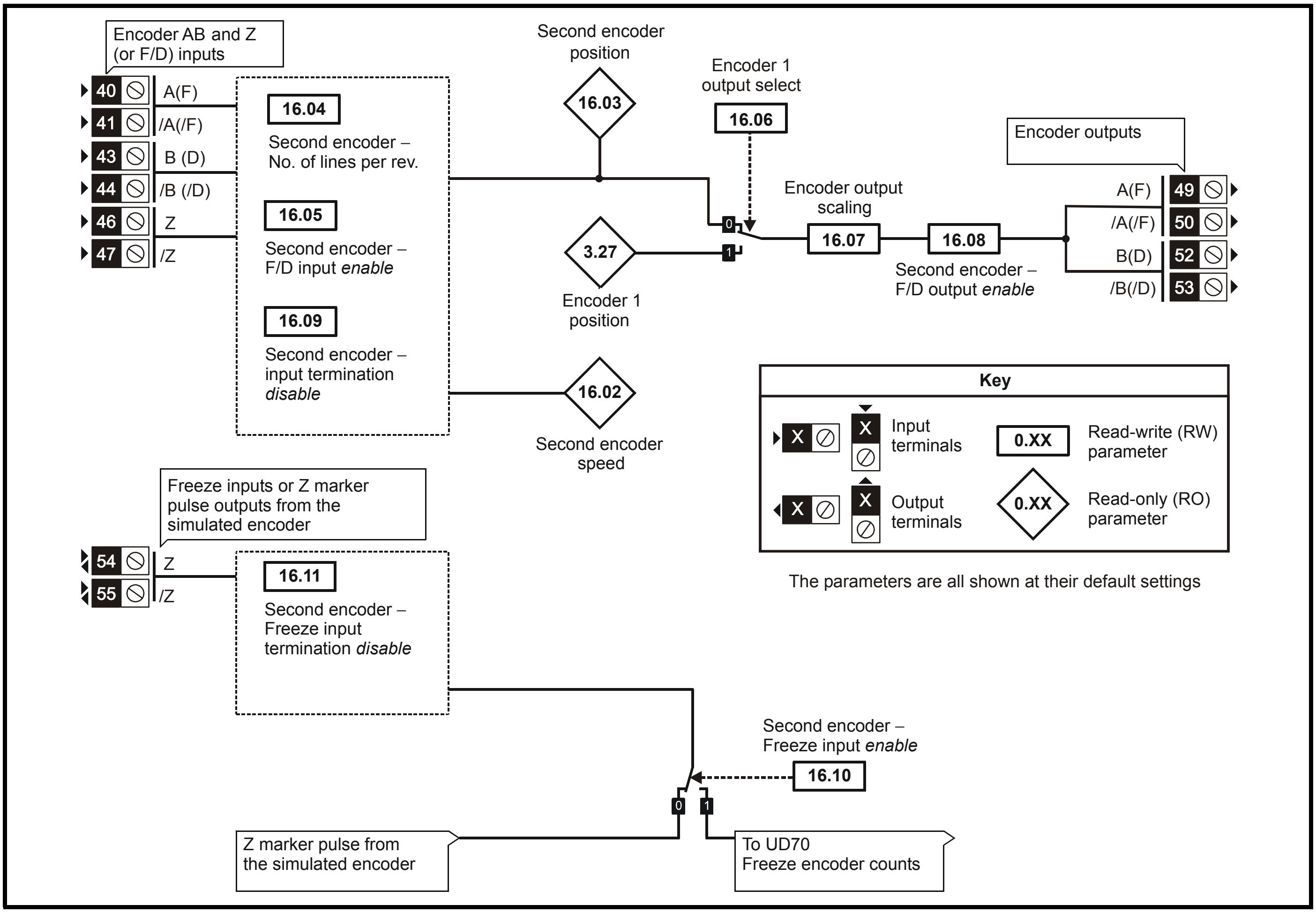
40 +A
41 -A
42 0V
43 +B
44 -B
45 0V
46 +Z
47 -Z
48 0V
49 +FOUT/+AOUT
50 -FOUT/-AOUT
51 0V
52 +DOUT/+BOUT
53 -DOUT/-BOUT
54 +FREEZE_IN or +ZOUT
55 -FREEZE_IN or -ZOUT

Table 4-21 Menu 16 (UD51) single line descriptions

Parameter		Range(⇕) OL	Range(⇕) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
16.01	Option module code	0 to 100		2			RO	Uni		P
16.02	Encoder 2 input rpm	±30,000 rpm					RO	Bi		P
16.03	Encoder 2 position	0 to 16,384 revolutions/16,384					RO	Uni		P
16.04	No. of Encoder lines / Pulses per rev	0 to 10,000 (F+D input, Pr **16.05** = 1) 0 to 5000 (Quadrature input, Pr **16.05** = 0)		1,024			RW	Uni		
16.05	Frequency input select	0 or 1		0			RW	Bit		
16.06	Encoder 1 output select	0 or 1		0			RW	Bit		
16.07	Encoder output scaling	0 to 15 (power of 2)		0			RW	Uni		
16.08	F/D output select	0 or 1		0			RW	Bit		
16.09	Encoder termination disable	0 or 1		0			RW	Bit		
16.10	Enable freeze input (disable Z output)	0 or 1		0			RW	Bit		
16.11	Disable freeze input termination	0 or 1		0			RW	Bit		
16.12	Encoder marker simulation synchronisation disable	0 or 1		0			RW	Bit		
16.13	Encoder marker simulation synchronisation inactive	0 or 1					RO	Bit		P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous)

Figure 4-24 Menu 16 UD51 logic diagram



UD51 parameter descriptions

16.01	Option module code		
RO	Uni		P
⇳	0 to 100	⇨	

This parameter will display a code depending on which option module is fitted.

Codes allocated are:

1 Additional I/O module - UD50
2 Second Encoder interface module - UD51
3 Resolver feedback module - UD53
4 SINCOS encoder interface module - UD52

16.02	Encoder 2 input rpm		
RO	Bi		P
⇳	±30,000 rpm	⇨	

This parameter will show the rpm of the machine connected to the encoder 2 input provided Pr **16.04** and Pr **16.05** have been set up correctly.

16.03	Encoder 2 position		
RO	Uni		P
⇳	0 to 16,384 revolutions / 16,384	⇨	

This parameter gives the encoder position counted from the point when the drive was powered up, or if an index marker is detected the position relative to the point where the marker was detected.

16.04	No. of encoder lines / pulses per rev		
RW	Uni		
⇳	0 to 10,000 (F+D input, Pr **16.05** = 1) 0 to 5,000 (Quadrature input, Pr **16.05** = 0)	⇨	1,024

To obtain correct values in Pr **16.02** (encoder 2 input rpm) and Pr **16.03** (encoder 2 position) the number of lines/pulses per revolution must be set up correctly. The rpm and position values are also used in menu 13 for position control and the revolution counter, and these will not operate correctly if this parameter is not set up. The input may come from a quadrature encoder if Pr **16.05** = 0, or non-quadrature encoder if Pr **16.05** = 1.

16.05	Frequency input select		
RW	Bit		
⇳	0 or 1	⇨	0

When this parameter is set to 0 the second encoder interface decodes quadrature signals. Setting the parameter to 1 allows frequency an direction input instead.

16.06	Encoder 1 output select		
RW	Bit		
⇳	0 or 1	⇨	0

This parameter is used to select the source of the encoder output signals including the Z signal. When at 0 the encoder output signals are derived from the second encoder input and when it is at 1 the encoder output signals are derived from the drives standard encoder input (encoder 1).

16.07	Encoder output scaling		
RW	Uni		
⇳	0 to 15 (power of 2)	⇨	0

This parameter can be used to scale down the encoder output such that the number of pulses / rev is reduced. Scaling can only be done in powers of 2 and the value set here is the power of 2 used. E.g. to divide the encoder output by 16 this parameter should be set to 4 (24 = 16).

16.08	F/D output select		
RW	Bit		
⇕ 0 or 1		⇨	0

The encoder output can be A and B quadrature signals or frequency and direction. Setting this parameter selects F and D output mode.

16.09	Encoder termination disable		
RW	Bit		
⇕ 0 or 1		⇨	0

Setting this parameter disables the termination resistor across the encoder inputs.

NOTE

Older option modules were fitted with a resistor capacitor combination, check issue number of option module.

16.10	Enable freeze input (disable Z output)		
RW	Bit		
⇕ 0 or 1		⇨	0

Setting this parameter enables the freeze input. If the freeze input is not enabled, the encoder simulation Z signal output is present on the freeze terminals.

16.11	Disable freeze input termination		
RW	Bit		
⇕ 0 or 1		⇨	0

Setting this parameter disables the termination across the freeze input.

16.12	Encoder marker simulation synchronisation disable		
RW	Bit		
⇕ 0 or 1		⇨	0

The output marker pulse is derived from the same source as the simulated encoder outputs A and B. The drive can ensure that the encoder simulation A and B signals are produced so that the marker occurs whilst the A and B signals are low (A\ and B\ are high). For this synchronisation system to operate correctly the leading edge of the source marker pulse must occur whilst the source A signal is low. This synchronisation system does not operate with F and D sources.

This bit parameter can be used to disabled the marker synchronisation system. This may be necessary if the source marker pulse leading edge cannot be guarenteed to occur at the correct time, or the if marker signal is noisy which could result in spurious encoder simulation signals. If the system is disabled the phase relationship between the encoder simulation signals and the marker output is not guarenteed when a division ratio is used (i.e. Pr **16.07** is non-zero). If Pr **16.07** is zero the phase relationship between the encoder simulation signals and the marker is the same as the phase relationship of the source.

If the encoder simulation output does not produce an integer number of complete output sequences in one revolution of the source encoder (i.e. in the time between two markers), the encoder simulation signals will be incorrect if the synchronisation system is allowed to operate. One complete sequence is defined as one cycle of A or B for a quadrature output. The drive will automatically disable the system if this is the case. This occurs when the output lines per marker defined by the following equation is not an integer:

Output lines per marker = (Source encoder lines per marker / Pr **16.07**)

16.13	Encoder marker simulation synchronisation inactive		
RO	Bit		P
⇕ 0 or 1		⇨	

The encoder simulation marker synchronisation system can be disabled by the user with Pr **16.12** or the drive can disable the system automatically (see Pr **16.12** on page 199). If the system is enabled Pr **16.13** is zero. If either the drive or the user has disabled this function Pr **16.13** is one.

4.16.3 SINCOS module (UD52)

If the SINCOS interface (UD52) module is fitted the drive will automatically use the speed and position feedback derived from the SINCOS encoder to control the machine operated by the drive. The main drive encoder (Encoder 1) automatically becomes the auxiliary encoder. However this automatic changeover can be overridden if required by setting Pr **16.14**, so that the drive uses Encoder 1 to control the machine and the SINCOS encoder becomes the auxiliary encoder. (See section 4.13 *Menu 13: Digital lock / orientation*). Care should be taken to ensure that other appropriate drive parameters are also modified when Pr **16.14** is changed. **This should not be done when the drive is enabled. The encoder phasing offset for the main drive encoder (Pr 3.28) and for the SINCOS encoder (Pr 16.09) both hold the same value, i.e. the last value set in either parameter manually or by the phasing test. Therefore if Pr 16.14 is changed the phasing offset for the new encoder must be entered manually or by the phasing test.**

A SINCOS encoder produces sinusoidal quadrature outputs instead of the square waveforms produced by a more standard encoder. The small option module converts the sinusoidal signals into square waves and counts the edges to give an incremental position value. This only gives a position value equivalent to four times the number of encoder counts per revolution. The drive also uses the sinusoidal waveforms to interpolate between the edges derived from the square waves to increase the resolution up to 2,048 times the number of counts per revolution (e.g. a 512 line encoder can give a resolution equivalent to 1,048,576 counts per revolution).

The SINCOS encoder interface small option module is designed to operate with single or multi-turn SINCOS encoders and can determine their absolute position within one or many revolutions respectively. The absolute position information is taken by the drive once at power-up via a serial communications link. Once this has been obtained the incremental position changes are used to track the absolute position until the drive is powered-down again. The position displayed by Pr **16.03** to Pr **16.05** is therefore the absolute position which can be read via serial comms or by the large option module for absolute position control.

The position information as shown in Pr **16.04** and Pr **16.05** is used by the drives own speed controller if the SINCOS encoder is selected as feedback to control the machine.

The position information can be used in the functions described in Menu 13. The absolute position value in Pr **16.04** only (16,384 steps per revolution) is used as an input to the menu 13 position control algorithms in the same way as resolver absolute position feedback (the fine position is not used). This allows absolute orientation within one revolution to be performed. Unlike a standard encoder which must rotate past its marker pulse the absolute information for orientation is correct from power-up. Multi-turn absolute orientation is not supported. The digital lock algorithm only uses incremental changes in position from Pr **16.04** and ignores the multi-turn information in Pr **16.05**, therefore only incremental digital lock is performed. Whichever revolution counter is related to the SINCOS encoder (Pr **13.15** or Pr **13.16**) is reset to zero at power-up and is not affected by any multi-turn information or absolute information from the SINCOS encoder.

When a SINCOS encoder is used with an induction machine in closed loop vector mode the absolute position and relative angle between the machine and the encoder are not required for correct operation of the machine control algorithm. The absolute position does not need to be taken via the encoder serial communications link at power-up for the machine to operate, therefore an encoder with only sine and cosine feedback and no serial comms can be used. To prevent a comms error at power-up Pr **16.16** should be set to one.

When a SINCOS encoder is used with a servo machine the absolute position is used by the drive control algorithm. Also the correct relative offset between the machine and the encoder angles must be stored in the offset parameter (Pr **16.09**). Either the encoder can be aligned for zero offset operation (Pr **16.09** = 0), or the drive can be made to carry out a phasing test to measure the required offset angle, or if the offset angle is known it may be entered manually. The offset is then automatically included in the servo drive control algorithm. Absolute position measurement via the encoder serial comms is always required at power-up for correct operation with the SINCOS encoder as the feedback to control a servo motor. Therefore Pr **16.16** must not be set to one unless the SINCOS is being used as the auxiliary feedback (Pr **16.14** = 1).

The SINCOS encoder interface module is designed to operate with encoders with 256, 512, 1,024, 2,048 or 4,096 lines per revolution. The maximum operating frequency is 102.4kHz, i.e. 3,000rpm with a 2,048 line encoder. The serial communications interface supports the Stegmann RS485 two wire interface (SCS60, SCM60, SCS70, SCM70 encoders).

The sinusoidal signals from a SINCOS encoder are sensitive analog signals, and so care must be taken to ensure that electrical noise from the drive/machine does not adversely affect the encoder feedback (i.e. use properly screened control and power cables, input filter etc.).

The SINCOS small option module can cause a number of trips:

SEP Power supply short circuit
SEP ECSINCOS RS485 comms fail
SEP EFSINCOS encoder internal fault

The SEP EC trip indicates that communication with the encoder via the RS485 link is not possible. This could be because the comms link is not connected properly or has a hardware fault. Alternatively the encoder may not be operating because the supply voltage is incorrect, or the power supply is not connected, or the power supply is not active. If an SEP EC trip occurs the drive will not have the absolute position information from the encoder, even if the fault is subsequently rectified. The drive should be powered-down and up again to acquire the absolute position.

SINCOS Module: connections

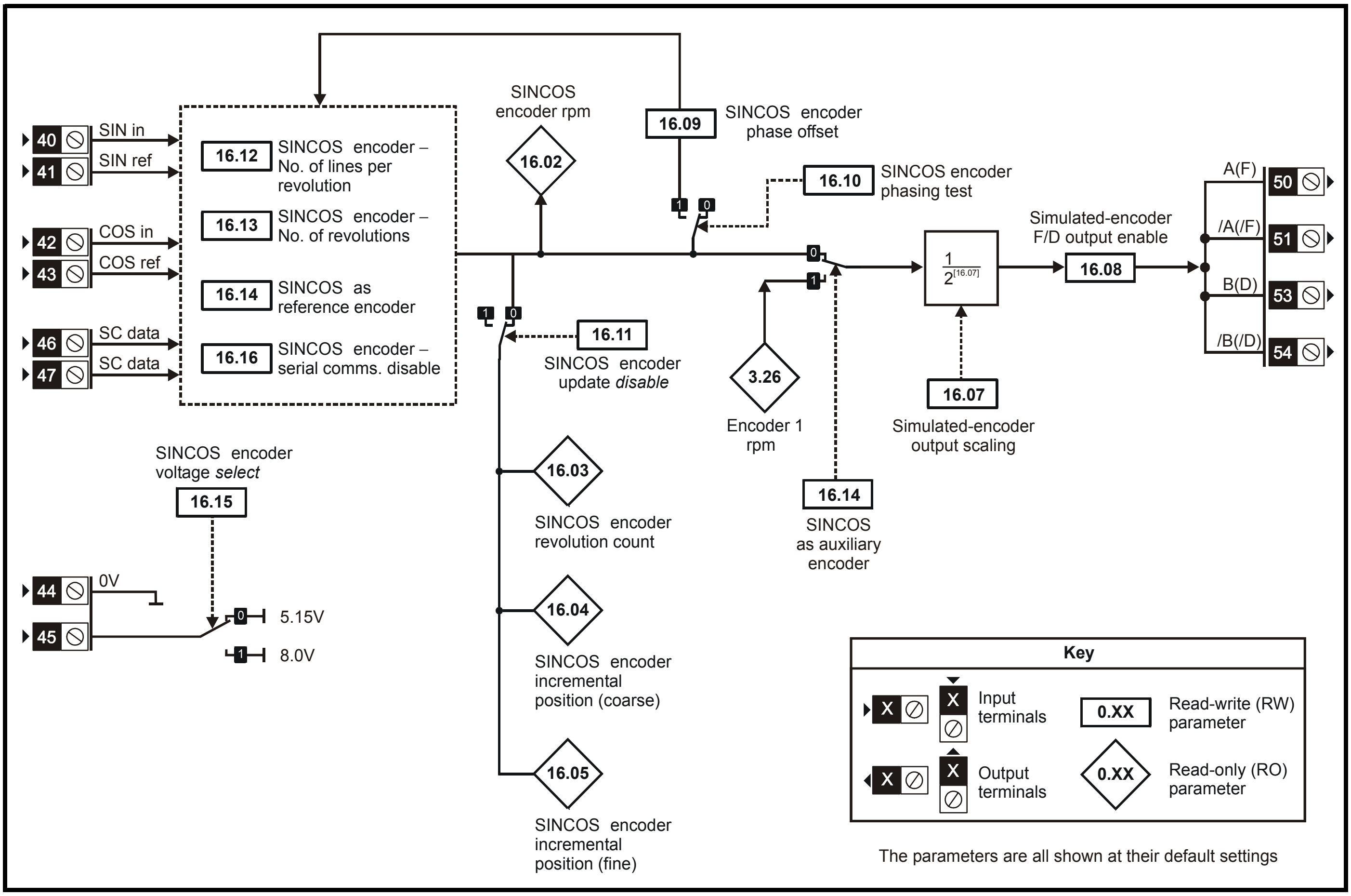
40 +SIN
41 REFSIN
42 +COS
43 REFCOS
44 0V
45 +V
46 +485
47 -485
48 Do not connect
49 Do not connect
50 +FOUT/+AOUT
51 -FOUT/-AOUT
52 0V
53 +DOUT/+BOUT
54 -DOUT/-BOUT
55 0V (should not be used unless drive control board is UD90A or later)

Table 4-22 Menu 16 (UD52) single line descriptions

Parameter		Range(⇳)		Default(⇨)			Type			
		OL	CL	OL	VT	SV				
16.01	Option module code		0 to 100		4		RO	Uni		P
16.02	SINCOS encoder rpm		±30,000 rpm				RO	Bi		P
16.03	SINCOS encoder revolution count		0 to 32,767 revolutions				RO	Uni		P
16.04	SINCOS encoder position		0 to 16,383 revolutions/ 16,384				RO	Uni		P
16.05	SINCOS encoder position fine		0 to 255 revolutions/ 4,194,304				RO	Uni		P
16.06	SINCOS encoder 1 output select		0 or 1		0		RW	Bit		
16.07	SINCOS encoder output scaling		0 to 15 (power of 2)		0		RW	Uni		
16.08	F/D output select		0 or 1		0		RW	Bit		
16.09	Phasing offset		0 to 6143				RW	Uni	S	P
16.10	SINCOS encoder phasing test		0 or 1		0		RW	Bit		
16.11	Update disable		0 or 1		0		RW	Bit		
16.12	Number of encoder lines per revolution		256 (0), 512 (1), 1024 (2), 2048 (3), 4096 (4) encoder lines per revolution		512 (1)		RW	Uni		
16.13	Number of encoder turns		0 to 15 (power of 2)		0		RW	Uni		
16.14	SINCOS as auxiliary encoder		0 or 1		0		RW	Bit		
16.15	SINCOS encoder supply voltage select		0 or 1		0		RW	Bit		
16.16	Serial comms disable		0 or 1		0		RW	Bit		
16.17	Interpolation disable		0 or 1		0		RW	Bit		

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous)

Figure 4-25 Menu 16 UD52 logic diagram



UD52 parameter descriptions

16.01	Option module code		
RO	Uni		P
⇳	0 to 100	⇨	

This parameter will display a code depending on which option module is fitted.

Codes allocated are:

1 Additional I/O module - UD50
2 Second Encoder interface module - UD51
3 Resolver feedback module - UD53
4 SINCOS encoder interface module - UD52

16.02	SINCOS encoder rpm		
RO	Bi		P
⇳	±30,000 rpm	⇨	

Speed of rotation of the SINCOS encoder in rpm. Pr **16.12** must be set up correctly for the speed given by this parameter to be correct.

16.03	SINCOS encoder revolution count		
RO	Uni		P
⇳	0 to 32,767 revolutions	⇨	

This parameter displays the number of turns from the point where the drive powered-up. The maximum value of this parameter before roll-over is defined by Pr **16.13**. Some SINCOS encoders include a facility to count multiple turns. If this type of encoder is fitted this parameter will be preset with the power-up number of turns from the encoder. It will then track the encoder turns until the drive powers-down.

16.04	SINCOS encoder position		
RO	Uni		P
⇳	0 to 16,383 revolutions/16,384	⇨	

The absolute position is given by this parameter in revolutions/16,384. This position is derived from the counted edges of the squares waves produced within the option module and some of the interpolated information.

16.05	SINCOS encoder position fine		
RO	Uni		P
⇳	0 to 255 revolutions/4,194,304	⇨	

The interpolated position information will give higher resolution than can be represented by Pr **16.04**, and so the extra information is displayed by this parameter. The resolution information in excess of 1/16384 of a revolution that is available will depend on the number of encoder lines per revolution. The least significant bit of this parameter would represent smallest detectable position change from a 2,048 line encoder with 2,048 times interpolation, i.e.

Effective counts per revolution = 2,048 x 2,048
Extra counts req. to give full resolution in addition to Pr **16.04** = 2,048 x 2,048 / 16,384 = 256

If a SINCOS encoder with a lower number of counts is used this parameter will change in steps of more than one unit. If a 4,096 line encoder is used the least significant digit of interpolated information is lost.

16.06	SINCOS encoder 1 output select		
RW	Bit		
⇳	0 or 1	⇨	0

This parameter is used to select the source for the encoder simulation output. Pr **16.06** = 1 selects Encoder 1 (the main drive encoder) and Pr **16.06** = 0 selects the SINCOS encoder connected to the small option module. The simulation information is derived only from the counted edges of the SINCOS encoder output and does not include interpolation. No zero pulse information is available with this option module.

16.07	SINCOS encoder output scaling		
RW	Uni		
⇕ 0 to 15 (power of 2)		⇨	0

The ratio between the selected source position and the simulated encoder output is defined by this parameter. The ratio is always a power of two and is 1 / 216.07. E.g. a ratio of 1/16 is produced by setting this parameter to 4.

16.08	F/D output select		
RW	Bit		
⇕ 0 or 1		⇨	0

The encoder output format can be selected as A/B quadrature signals (16.08 = 0) or Frequency and Direction signals (16.08 = 1).

16.09	Phasing offset		
RW	Uni	S	P
⇕ 0 to 6,143		⇨	

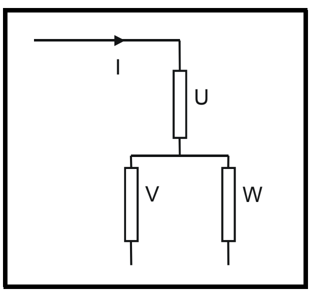
This parameter shows the offset value (see Pr **16.10**) in electrical units from 0 to 6,143 (unlike the normal mechanical position units which vary from 0 to 16,383). As this is saved at power-down the offset applies from the point when the test is done until it is repeated. Loading default parameters does not affect this value, and so the offset is not reset. However changing drive type does reset this parameter to zero.

16.10	SINCOS encoder phasing test		
RW	Bit		
⇕ 0 or 1		⇨	0

For operation with a servo machine either the SINCOS encoder must be aligned for zero offset operation (Pr **16.09** should be zero), or the alignment offset must be calculated by the drive, or the correct offset must be entered manually into Pr **16.09**.

If zero offset alignment is required the alignment of the machine and SINCOS encoder can only be aligned when the encoder is connected to a drive. This cannot be done by observing the encoder waveforms as it can with a conventional encoder or resolver.

DC current should be injected as shown below.



The machine will rotate to one of several positions depending on the number of pole pairs in the machine (i.e. number of poles / 2). The encoder position Pr **16.04** is given by:

n x 16,384 / pole_pairs

Where: 0 ≤ n < pole_pairs

Therefore a six pole machine can stop at three places with Pr **16.04** = 0, 5461 or 10923. With current passing through the machine windings the SINCOS encoder can be adjusted until Pr **16.04** shows one of these values.

If the SINCOS encoder is not aligned for zero offset operation it is possible for the drive to measure the necessary offset and automatically store it in Pr **16.09**. This measurement can be initiated by setting Pr **16.10**, and enabling the drive. The machine will then rotate slowly through part of a revolution. The test must be done with no load on the machine. If any load is applied during the test the offset measured by the drive could be incorrect.

If the SINCOS encoder is not aligned for zero offset operation, but the required offset is known, this may be entered manually into Pr **16.09**.

16.11	Update disable		
RW	Bit		
⇕ 0 or 1		⇨	0

The encoder position value spans three parameters (Pr **16.03** to Pr **16.05**). If the position is read by a large option module or via serial comms the value could change during the read process, which could result in large position errors. If this parameter is zero the position parameters (Pr **16.03** to Pr **16.05**) track the latest position information from the encoder. If this parameter is set to 1 all three position values are held at the last tracked value until the parameter is reset. Therefore whilst updating is disabled the position may be safely read without any risk of large position errors.

16.12	Number of encoder lines per revolution		
RW	Uni		
⇕ 256 (0), 512 (1), 1,024 (2), 2,048 (3), 4,096 (4) encoder lines per revolution		⇨	512 (1)

Number of cycles in the encoder sinewave outputs per revolution. This parameter can only be a power of 2.

16.13	Number of encoder turns		
RW	Uni		
⇕ 0 to 15 (power of 2)		⇨	0

Number of turns that can be measured by the encoder. This parameter is used to ensure that the revolution counter Pr **16.03** is reset at the correct point. The number of turns that can be counted is specified by $2^{\text{Pr } \mathbf{16.13}}$. For single turn encoders this parameter can be set to 0.

16.14	SINCOS as auxiliary encoder		
RW	Bit		
⇕ 0 or 1		⇨	0

Overrides the automatic selection of the SINCOS encoder as the feedback for machine control as described in the first section, Pr **16.14** = 0 no override, Pr **16.14** = 1 override active.

16.15	SINCOS encoder supply voltge select		
RW	Bit		
⇕ 0 or 1		⇨	0

The SINCOS interface can provide a +5V or +8V supply for the encoder. The level is selected by this parameter. Pr **16.15** = 0 gives +5V, Pr **16.15** = 1 gives +8V. Care should be taken not to set this parameter when an encoder requiring a 5V is being used.

16.16	Serial comms disable		
RW	Bit		
⇕ 0 or 1		⇨	0

The drive will not attempt to communicate via serial comms with the encoder if this bit is set. This can only be used with asynchronous machines where absolute position is not required for machine control.

16.17	Interpolation disable		
RW	Bit		
⇕ 0 or 1		⇨	0

The interpolator can be enabled or disabled at any time using this bit parameter. When interpolation is disabled the basic count from the encoder including quadrant information is used to give the position.

4.16.4 Resolver module (UD53)

If the resolver interface module is fitted the drive will automatically use the speed and position feedback derived from the resolver to control the machine operated by the drive. The main drive encoder interface automatically becomes the auxiliary encoder (See section 4.13 *Menu 13: Digital lock / orientation*).

The resolution of the Resolver to Digital (R to D) converter is set up automatically based on the maximum speed parameter (Pr **1.06**) as follows:

Maximum speed (rpm)	Resolution
0 to 3,000	14 bit
3,001 to 12,000	12 bit
12,001 to 30,000	10 bit

When a resolver is used with an induction machine in closed loop vector mode the relative angle between the machine and the resolver is not important. When a resolver is used with a servo machine the relative angle affects the operation of the drive. Either the resolver can be aligned for zero offset operation, or the drive can be made to carry out a phasing test to measure the required offset angle, or if the offset angle is known it may be entered manually. The offset is then automatically included in the servo drive control algorithm. When a resolver is used either with an induction machine in closed loop vector mode or with a servo machine it is important to make the correct connections between the resolver and the small option module. The designation of connections for different resolvers may vary, therefore to avoid problems a detailed description is given below of the convention adopted for Unidrive.

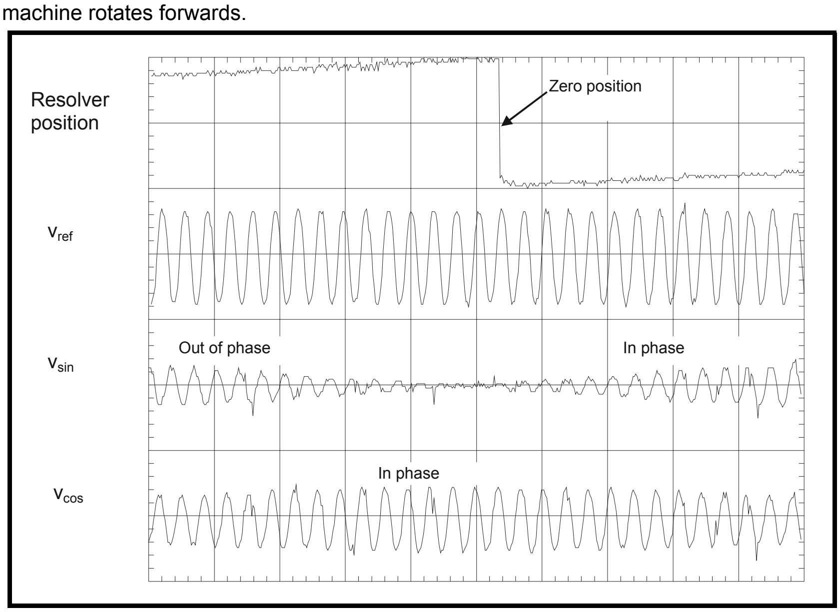
Small option module terminal	Resolver signal	Internal connection
48	SINL	0V via 100R
49	SINH	
50	COSL	0V via 100R
51	COSH	
52	REFH	
53	REFL	0V

v_{sin} = SINH to SINL

v_{cos} = COSH to COSL

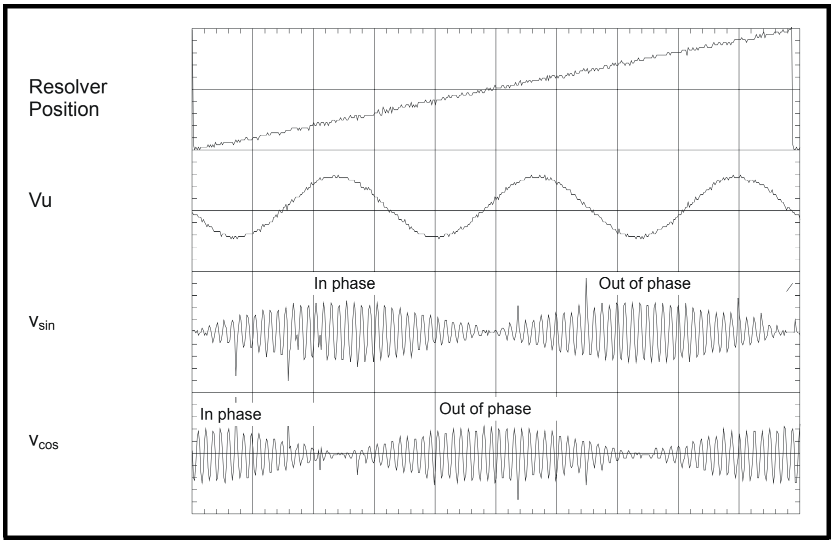
v_{ref} = REFH to REFL

The definition of the machine and resolver rotating forwards is when the output phase sequence from the drive is Vu leading Vv by 120° and Vv leading Vw by 120°. When a resolver test is carried out (see below) the machine will be rotated by the drive in the forwards direction. When the machine is rotating forwards v_{cos} must "lead" v_{sin} by 90°. However, v_{sin} and v_{cos} are amplitude modulated waveforms with v_{ref} as the carrier, and so they appear as an envelope and not waveforms with defined half cycles. This is demonstrated in the waveforms below, showing the resolver voltages and the position as the resolver passes through zero in the forwards direction. If v_{sin} and v_{cos} are considered to be positive when they are in phase with v_{ref} and negative when they are out of phase with v_{ref}, then v_{sin} is at the zero crossing from the negative to positive half cycles at zero position and v_{cos} is at its positive peak. This is the correct phase relationship with v_{cos} "leading" v_{sin}, and the resolver position Pr **16.03** will increase when the machine rotates forwards.



If the resolver output phase relationship is not correct an ENC.PH7 trip will occur during the resolver test for a servo machine, or during the magnetising current test for an induction machine operated in closed loop vector mode.

The waveforms below are with a longer timebase and show the relationship between vsin and vcos and the resolver position. Also included is Vu (drive output voltage) for a six pole machine where the resolver has been aligned for zero offset operation (see Pr **16.05** on page 209).



Resolver module: connections

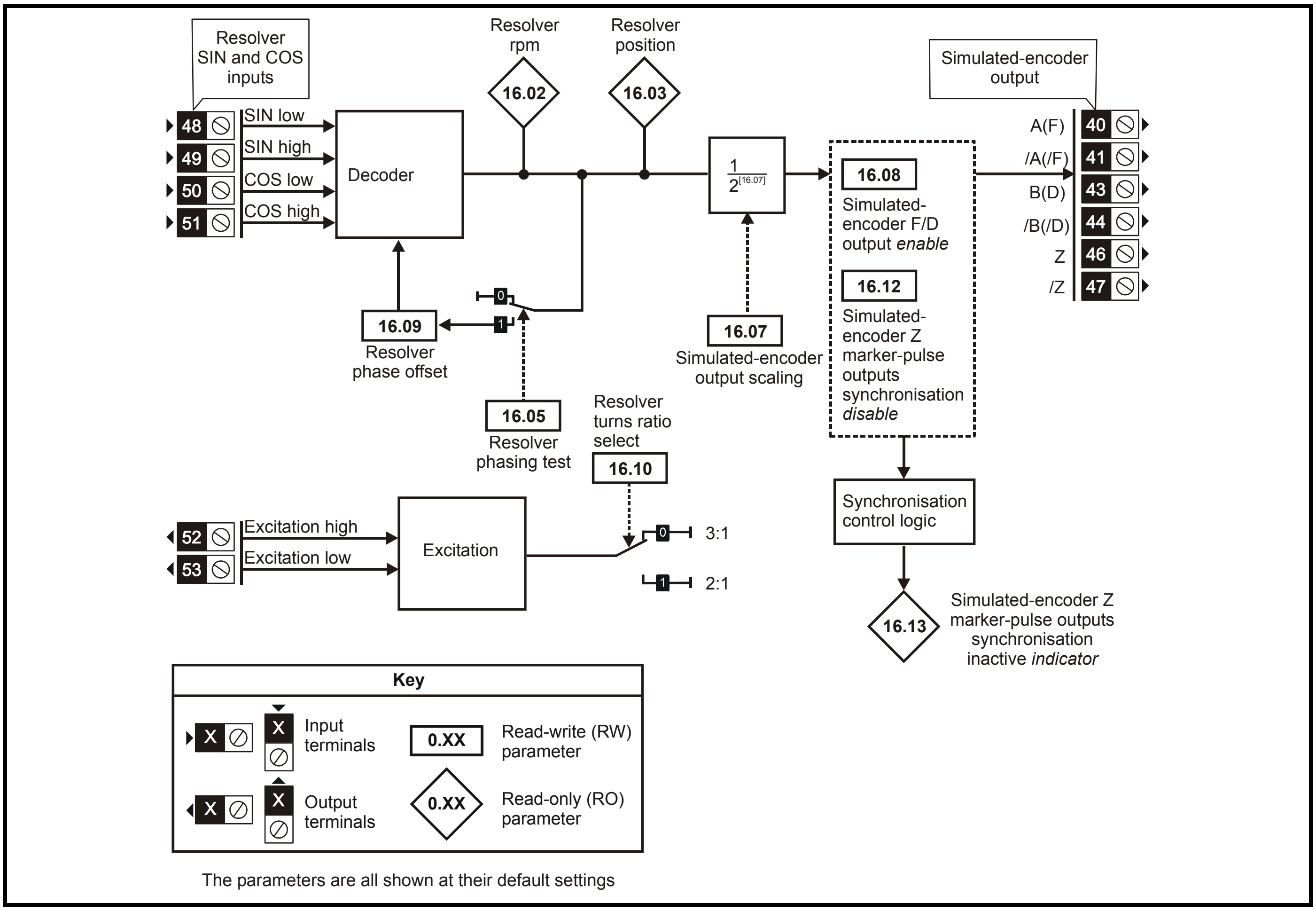
40 +FOUT/+AOUT
41 -FOUT/-AOUT
42 0V
43 +DOUT/+BOUT
44 -DOUT/-BOUT
45 0V
46 +ZOUT (derived from resolver position)
47 -ZOUT
48 SINL
49 SINH
50 COSL
51 COSH
52 REFH
53 REFL
54 0V
55 0V (should not be used unless drive control board is UD90A or later)

Table 4-23 Menu 16 (UD53) single line descriptions

Parameter		Range(⇕) OL	Range(⇕) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
16.01	Option module code		0 to 100		1		RO	Uni		P
16.02	Resolver rpm		±30,000 rpm				RO	Bi		P
16.03	Resolver position		0 to 16,384 revolutions/ 16,384				RO	Uni		P
16.05	Resolver phasing test		0 or 1		0		RW	Bit		
16.06	Encoder select for encoder simulation		0 or 1		0		RW	Bit		
16.07	Encoder output scaling		0 to 15 (power of 2)		0		RW	Uni		
16.08	F/D output select		0 or 1		0		RW	Bit		
16.09	Phasing offset		0 to 6143				RW	Uni	S	P
16.10	Low ratio resolver select		0 or 1		0		RW	Bit		
16.12	Encoder marker simulation synchronisation disable		0 or 1		0		RW	Bit		
16.13	Encoder simulation marker synchronisation inactive		0 or 1				RO	Bit		P

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

Figure 4-26 Menu 16 UD53 logic diagram



UD53 parameter descriptions

16.01	Option module code			
RO	Uni		P	
⇳	0 to 100	⇨		

This parameter will display a code depending on which option module is fitted.

Codes allocated are:

1 Additional I/O module - UD50
2 Second Encoder interface module - UD51
3 Resolver feedback module - UD53
4 SINCOS encoder interface module - UD52

16.02	Resolver rpm				
RO	Bi		P		
CL	⇳	±30,000 rpm	⇨		

Speed of rotation of the resolver in rpm.

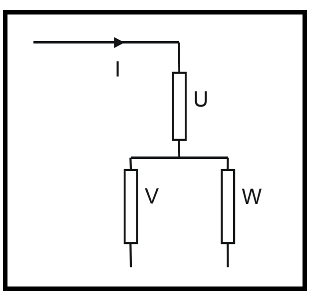
16.03	Resolver position				
RO	Uni		P		
CL	⇳	0 to 16,384 revolutions/16,384	⇨		

Absolute resolver position.

16.05	Resolver phasing test				
RW	Bit				
CL	⇳	0 or 1	⇨	0	

For operation with a servo machine either the resolver must be aligned for zero offset operation (Pr **16.09** should be zero), or the alignment offset must be calculated by the drive, or the correct offset must be entered manually into Pr **16.09**.

If zero offset alignment is required the alignment of the machine and resolver can be tested in one of two ways. The first is to adjust the alignment until the correct relationship between the phase voltage Vu and the resolver outputs is obtained when the machine is rotated as given in the section above. Alternatively a static test can be performed by injecting DC current into the machine as shown below.



The machine will rotate to one of several positions depending on the number of pole pairs in the machine (i.e. number of poles / 2). The resolver position Pr **16.03** is given by

n x 16384 / pole_pairs

Where: $0 \le n <$ pole_pairs

Therefore a six pole machine will stop at three places with Pr **16.03** = 0, 5,461 or 10,923. With current passing through the machine windings the resolver can be adjusted until Pr **16.03** shows one of these values. Alternatively the resolver can be adjusted until v_{sin} is zero and v_{cos} is at its positive peak (i.e. in phase with v_{ref}).

If the resolver is not aligned for zero offset operation it is possible for the drive to measure the necessary offset and automatically store it in Pr **16.09**. This measurement can be initiated by setting Pr **16.05** and enabling the drive. The machine will then rotating slowly through part of a revolution. **The test must be done with no load on the machine. If any load is applied during the test the offset measured by the drive could be incorrect.** The offset value stored is in electrical units (0 to 6,143) and not mechanical units (0 to 16,383).

If the resolver is not aligned for zero offset operation, but the required offset is known, this may be entered manually into Pr **16.09**.

16.06	Encoder select for encoder simulation			
RW	Bit			
CL ⇳	0 or 1	⇨	0	

This parameter is used to select the source for the encoder simulation output signals including the Z signal. When at 0 the encoder output signals are derived from the resolver input and when it is at 1 the encoder output signals are derived from the drives standard encoder input (encoder 1).

16.07	Encoder output scaling			
RW	Uni			
CL ⇳	0 to 15 (power of 2)	⇨	0	

An encoder output may be simulated from the resolver position. The ratio between the resolver position and the simulated encoder output is defined by this parameter. The ratio is always a power of two and is 1 / 216.07. E.g. a ratio of 1/16 is produced by setting this parameter to 4. With issue 4.00 hardware onwards the encoder simulation can be derived from either the resolver or the main drive encoder. With earlier versions only the resolver could be used.

16.08	F/D output select			
RW	Bit			
CL ⇳	0 or 1	⇨	0	

Setting this parameter allows the simulated encoder output to be F/D signals, the default setting gives A/B quadrature signals.

16.09	Phasing offset			
RW	Uni	S	P	
CL ⇳	0 to 6,143	⇨		

This parameter shows the offset value in electrical units from 0 to 6,143 (unlike the normal mechanical position units which vary from 0 to 16,383). As this is saved at power-down the offset applies from the point when the test is done until it is repeated. Loading default parameters does not affect this value, and so the offset is not reset. However changing drive type does reset this parameter to zero.

16.10	Low ratio resolver select			
RW	Bit			
CL ⇳	0 or 1	⇨	0	

With the default setting the option module operates with a standard CT dynamics resolver which has a turns ratio of 3:1 (excitation winding:output windings). If this parameter is set to one the option module operates with resolvers which have a turns ratio of 2:1 (excitation winding:output windings).

16.12	Encoder marker simulation synchronisation disable			
RW	Bit			
CL ⇳	0 or 1	⇨	0	

The output marker pulse is derived from the same source as the simulated encoder outputs A and B. The drive can ensure that the encoder simulation A and B signals are produced so that the marker occurs whilst the A and B signals are low (A\ and B\ are high). For this synchronisation system to operate correctly the leading edge of the source marker pulse must occur whilst the source A signal is low. This synchronisation system does not operate with F and D sources.

This bit parameter can be used to disabled the marker synchronisation system. This may be necessary if the source marker pulse leading edge cannot be guarenteed to occur at the correct time, or the if marker signal is noisy which could result in spurious encoder simulation signals. If the system is disabled the phase relationship between the encoder simulation signals and the marker output is not guarenteed when a division ratio is used (i.e. Pr **16.07** is non-zero). If Pr **16.07** is zero the phase relationship between the encoder simulation signals and the marker is the same as the phase relationship of the source.

If the encoder simulation output does not produce an integer number of complete output sequences in one revolution of the source encoder (i.e. in the time between two markers), the encoder simulation signals will be incorrect if the synchronisation system is allowed to operate. One complete sequence is defined as one cycle of A or B for a quadrature output. The drive will automatically disable the system if this is the case. This occurs when the output lines per marker defined by the following equation is not an integer:

Output lines per marker = (Source encoder lines per marker / Pr **16.07**)

16.13	**Encoder simulation marker synchronisation inactive**			
RO	Bit		P	
CL	⇳	0 or 1	⇨	

The encoder simulation marker synchronisation system can be disabled by the user with Pr **16.12** or the drive can disable the system automatically (see Pr **16.12**). If the system is enabled Pr **16.13** is zero. If either the drive or the user has disabled this function Pr **16.13** is one.

4.17 Menu 17: Large option module set-up

This menu contains the parameters used for controlling the setup of the second processor, 'Large Application Module'.

Table 4-24 Menu 17 single line descriptions

Parameter		**Range(⇳) OL**	**Range(⇳) CL**	**Default(⇨) OL**	**Default(⇨) VT**	**Default(⇨) SV**	**Type**			
17.01	Option module code	0 to 100					RO	Uni		P
17.02	Option module software version	0.00 to 99.99					RO	Uni		P
17.03	DPL line number where trip occurred	0 to 32,000					RO	Uni		P
17.04	Available resource in %	0 to 100 %					RO	Uni		P
17.05	RS485 Address	1 to 99		11			RW	Uni		P
17.06	RS485 Mode	0 to 255		1			RW	Uni		P
17.07	RS485 Baud rate	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 76800 (8)		4800 (4)			RW	Txt		P
17.08	RS485 Parameter pointer 1	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
17.09	RS485 Parameter pointer 2	Pr **0.00** to Pr **20.50**		Pr **0.00**			RW	Uni		P
17.10	Serial scaling factor	0.000 to 4.000		1.000			RW	Uni		
17.11	Clock task tick time	0 to 100 ms		10			RW	Uni		P
17.12	Position controller set-up	0 to 255		0			RW	Uni		P
17.13	Auto-run	0 or 1		1			RW	Bit		
17.14	Global run-time trip enable	0 or 1		0			RW	Bit		
17.15	RS485 Trip enable	0 or 1		0			RW	Bit		
17.16	IO link RS485 synchronisation source	0 or 1		0			RW	Bit		
17.17	Trip if parameter write over-ranges	0 or 1		0			RW	Bit		
17.18	Watchdog trip enable	0 or 1		0			RW	Bit		
17.19	Non-volatile data save request	0 or 1		0			RW	Bit		
17.20	Non-volatile data power down save	0 or 1		0			RW	Bit		
17.21	Enable dumb-terminal mode	0 or 1		0			RW	Bit		
17.22	LOM set-up parameter	0 or 1		0			RW	Bit		
17.23	LOM set-up parameter	0 or 1		0			RW	Bit		
17.24	LOM set-up parameter	0 or 1		0			RW	Bit		
17.25	LOM set-up parameter	0 or 1		0			RW	Bit		
17.26	LOM set-up parameter	0 or 1		0			RW	Bit		
17.27	LOM set-up parameter	0 or 1		0			RW	Bit		
17.28	LOM set-up parameter	0 or 1		0			RW	Bit		

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

NOTE

Where a parameter is represented by a text value, the value in brackets in the range column is the setting used for serial communications.

Menu 17 parameter descriptions

17.01	Option module code		
RO	Uni		P
⇳ 0 to 100		⇨	

This parameter indicates a code defining the large option module which is fitted. A code of 0 indicates no option module or comms option module fitted which cannot be detected.

17.02	Option module software version		
RO	Uni		P
⇳ 1.00 to 99.99		⇨	

Indicates the software version in the large option module fitted.

17.03	DPL line number where trip occured		
RO	Uni		P
⇳ 0 to 32,000		⇨	

This parameter is only used when the DPL program has been compiled with the debugging information switched on. The value it gives is the actual line number within the DPL program where a run-time error occurred. If no run-time error has occurred the value will be meaningless.

17.04	Available resource in %		
RO	Uni		P
⇳ 0 to 100 %		⇨	

This parameter gives an indication on the level of processor resource available in the UD70. Continually measured over a 128ms period, it will indicate what % of the 128ms period the background task will be executed. Larger, more complex programs, or programs which operate on a fast time base will result in a reduction of the available resource. Always allow approximately 20% available to cope with peak execution loads.(A bar-graph indication of this parameter is presented on the status bar of the DPL Toolkit.)

17.05	RS485 address		
RW	Uni		P
⇳ 1 to 99		⇨	11

This parameter defines the ANSI address for the RS485 serial port when in Modes 1 or 5. The address consists of two numbers: the first defines the group and the second defines the unit within the group. The number zero (0) is not allowed for either the group or unit address. For example, valid addresses are 11, 12, 13, 21, 31, etc.

This parameter has no relevance in serial modes other than 1 and 5.

17.06	RS485 mode		
RW	Uni		P
⇳ 0 to 255		⇨	1

The EIA RS485 port can be placed in a number of different operating modes as follows:

Mode	Function
1	Standard 4-wire EIA RS485, ANSI protocol (default)
2	Master mode: The value of the parameter defined by Pr **17.08**, scaled to ±16,000 is continually transmitted. The baud rate is fixed at 9,600.
3	Slave mode: Data is received and scaled using Pr **17.10** and then placed into the parameter as defined by Pr **17.08**.
4	Cascade mode: The parameter pointed to by Pr **17.08** is transmitted to the remote drive and the parameter pointed to by Pr **17.09** receives data from a remote drive. The data is not scaled. Baud rate is fixed at 9,600bps.
5	2-wire EIA RS485, ANSI protocol.
6	User mode. 1 start bit, 7 data bits, EVEN parity, 1 stop bit
7	User mode. 1 start bit, 8 data bits, EVEN parity, 1 stop bit
8	User mode. 1 start bit, 8 data bits, NO parity, 1 stop bit
9	User mode. 1 start bit, 9 data bits, NO parity, 1 stop bit
10	I/O Box Mode

More details of the modes can be found in the LAM manual.

17.07	RS485 baud rate			
RW	Txt			P
⇳	300 (0), 600 (1), 1,200 (2), 2,400 (3), 4,800 (4), 9,600 (5), 19,200 (6), 38,400 (7), 76,800 (8)	⇨	4,800 (4)	

This parameter defines the communications rate for the General Purpose RS485 port. Selectable between 300, 600, 1,200, 2,400, 4,800, 9,600, 19,200, 38,400 and 76,800. This parameter is only valid in serial modes 1 and 5 to 9.

17.08	RS485 parameter pointer 1			
RW	Uni			P
⇳	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**	

This parameter defines the source parameter used in mode 2 communications, and the destination parameter in modes 3 and 4.

17.09	RS485 parameter pointer 2			
RW	Uni			P
⇳	Pr **0.00** to Pr **20.50**	⇨	Pr **0.00**	

This parameter defines the destination parameter in mode 4 communications.

17.10	Serial scaling factor			
RW	Uni			
⇳	0.000 to 4.000	⇨	1.000	

This defines the scaling factor used in communications mode 4.

17.11	Clock task tick time			
RW	Uni			P
⇳	0 to 100 ms	⇨	10	

This parameter defines the tick-time for the CLOCK task. The parameter represents the tick-time in milliseconds, the minimum being 5ms and the maximum 100ms.

17.12	Position controller set-up			
RW	Uni			P
⇳	0 to 255	⇨	0	

This parameter defines the setup of the internal position controller of the UD70.

0 Disabled
1 Synchronous with ENCODER task
2 Synchronous with SPEED task

17.13	Auto-run			
RW	Bit			
⇳	0 or 1	⇨	1	

Setting this parameter to 1 will cause the program in the UD70 to automatically execute whenever the drive is powered up. If set to a zero, a run command must be issued via the DPL Toolkit for the program to run.

17.14	Global run-time trip enable			
RW	Bit			
⇳	0 or 1	⇨	0	

This parameter when set to 0 will disable all run-time trips such as divide by zero, parameter over-range, RS485 link failed, etc. It will not disable fatal trips such as wrong system loaded or internal errors.

NOTE

The DPL program will always stop when an error occurs, irrespective of the setting of this parameter.

17.15	RS485 trip enable		
RW	Bit		
⇕	0 or 1	⇨	0

If the RS485 port is being used in mode 3 (slave) or 10 (I/O Box mode) and this parameter is set to 1 and Pr **17.14** is set to 1, the UD70 will trip the drive whenever the comms link fails (due to excessive bad data). If this parameter is 0, the drive will never trip on a comms failure. It is recommended that the trip is enabled otherwise no guarantee can be made on the validity of the data on the serial comms link.

17.16	IO link RS485 synchronisation source		
RW	Bit		
⇕	0 or 1	⇨	0

When running in I/O link mode (10) the clock time for the data transmission and receive can be sourced from either the CLOCK task or ENCODER task. This parameter selects between the two. The data transmission time between the UD70 and IO Box takes 4ms.

17.17	Trip if parameter write over-ranges		
RW	Bit		
⇕	0 or 1	⇨	0

Each drive parameter has a finite range of values which can be accepted. Any value written which is outside the parameter limits could signify a program failure. When this parameter is set at 1 and Pr **17.14** = 1, the drive will trip if a parameter is outside the limits (error code 44). When it is set at 0, the UD70 places a limit on the value written (which is the parameter limit) and no error occurs.

17.18	Watchdog trip enable		
RW	Bit		
⇕	0 or 1	⇨	0

The watchdog facility functions in conjunction with the command called WDOG. With watchdog enabled, by issuing the WDOG command in the initial task, this command must be executed by the user's DPL program at least every 200ms in the BACKGROUND task to prevent the drive tripping on Watchdog trip (Prc2).

NOTE

If these tasks are single stepped there will be a watchdog trip.

17.19	Non-volatile data save request		
RW	Bit		
⇕	0 or 1	⇨	0

A special applications menu, menu 20, can be stored in the UD70. To save on request, simply set Pr **17.19** to 1. It is important to realise that a standard drive parameter save (Pr **xx.00** to 1000) does not save this menu.

NOTE

Menu 20 only appears when a LAM (UD70) is fitted.

17.20	Non-volatile data powe- down save		
RW	Bit		
⇕	0 or 1	⇨	0

A special applications menu, menu 20, can be stored in the UD70 automatically on drive power down. To save on power down (UU trip), set Pr **17.20** to 1.

17.21	Enable dumb-terminal mode		
RW	Bit		
⇕	0 or 1	⇨	0

Setting this parameter to 1 puts the RS232 serial port into a plain ASCII mode, and disables all the communications protocols for debugging and using the DPL Toolkit. This parameter must be set at 0 for the DPL Toolkit to communicate to the UD70.

17.22	**LOM set-up parameter**		
17.23	**LOM set-up parameter**		
17.24	**LOM set-up parameter**		
17.25	**LOM set-up parameter**		
17.26	**LOM set-up parameter**		
17.27	**LOM set-up parameter**		
17.28	**LOM set-up parameter**		
RW	Bit		
⇳	0 or 1	⇨	0

These bits may be used to enable particular LAM features.

4.18 Menu 18: Application menu 1

This menu contains general purpose integer and bit values for use in user applications.

Table 4-25 Menu 18 single line descriptions

Parameter		Range(⇕) OL	Range(⇕) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
18.01	Application menu 1 read write integer	±32,000		0			RW	Bi	S	
18.02 to 18.10	Application menu 1 read only integers	±32,000		0			RO	Bi		
18.11 to 18.30	Application menu 1 read write integers	±32,000		0			RW	Bi		
18.31 to 18.50	Application menu 1 read write bits	0 or 1		0			RW	Bit		

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

Menu 18 parameter descriptions

18.01	**Application menu 1 read write integer**		
RW	Bi	S	
⇕ ±32,000		⇨ 0	

This parameter is a read write parameter saved at power down, and is intended for user applications which require the last state of a run time parameter to be re-initialised at power up.

18.02 to 18.10	**Application menu 1 read only integer**		
RO	Bi		
⇕ ±32,000		⇨ 0	

All these parameters are for read only integers.

18.11 to 18.30	**Application menu 1 read write integer**		
RW	Bi		
⇕ ±32,000		⇨ 0	

All these parameters are for read write integers.

18.31 to 18.50	**Application menu 1 read write bits**		
RW	Bit		
⇕ 0 or 1		⇨ 0	

All these parameters are for read write bits.

4.19 Menu 19: Application menu 2

This menu contains general purpose integer and bit values for use in user applications.

Table 4-26 Menu 19 single line descriptions

Parameter		Range(⇳) OL	Range(⇳) CL	Default(⇨) OL	Default(⇨) VT	Default(⇨) SV	Type			
19.01	Application menu 2 read write integer	±32,000		0			RW	Bi	S	
19.02 to 19.10	Application menu 2 read only integers	±32,000		0			RO	Bi		
19.11 to 19.30	Application menu 2 read write integers	±32,000		0			RW	Bi		
19.31 to 19.50	Application menu 2 read write bits	0 or 1		0			RW	Bit		

RO	Read Only parameter	Uni	Unipolar variable parameter	R	Reset required for new value to take effect
		Bi	Bipolar variable parameter	S	New parameter-value saved at power-down
RW	Read / Write parameter	Txt	Text variable parameter	P	Protected; forbidden as destination parameter
		Bit	Bit parameter	FLC	Full-load current (max. continuous), Pr **11.32** {**0.33**}

Menu 19 parameter descriptions

19.01	**Application menu 2 read write integer**		
RW	Bi	S	
⇳ ±32,000		⇨ 0	

This parameter is a read write parameter saved at power down, and is intended for user applications which require the last state of a run time parameter to be re-initialised at power up.

19.02 to 19.10	**Application menu 2 read only integer**		
RO	Bi		
⇳ ±32,000		⇨ 0	

All these parameters are for read only integers.

19.11 to 19.30	**Application menu 2 read write integer**		
RW	Bi		
⇳ ±32,000		⇨ 0	

All these parameters are for read write integers.

19.31 to 19.50	**Application menu 2 read write bits**		
RW	Bit		
⇳ 0 or 1		⇨ 0	

All these parameters are for read write bits.

4.20 Menu 20: Large option module

Menu 20 is only available when a UD70 large option module is fitted.

This menu contains user application Read / Write integers but unlike the Read / Write parameters in other menus these parameters are stored in the Large Application Module (LAM) memory and not in the Unidrive EEPROM. See Pr **17.19** and Pr **17.20** on page 215 for how to store these parameters.

Menu 20 parameter descriptions

20.01 to 20.50	LOM user integer parameters		
RW	Bi		
⇳ ±32,000		⇨	0

Parameters **20.01** to **20.20** and **20.50** are reserved for use with the high-speed communication UD70 option modules.

NOTE

The menu 20 parameters are stored in the non-volatile memory in the UD70 and not in the drive. To store these parameters set Pr **17.19** at 1. Parameters will be stored at power down when Pr **17.20** is set to 1.

Parameter	UD73 Profibus-DP		UD74 Interbus-S		UD75 CT NET	
	Description	Default	Description	Default	Description	Default
20.01	OUT Channel 2 Mapping	121	OUT Channel 2 Mapping	121	Node Address	0
20.02	OUT Channel 3 Mapping	408	OUT Channel 3 Mapping	408	Network Data Rate	0
20.03	IN Channel 2 Mapping	201	IN Channel 2 Mapping	201	Synchronisation Message	0
20.04	IN Channel 3 Mapping	402	IN Channel 3 Mapping	402	OUT Slot 1 Destination Node	0
20.05	Node Address	0	Reserved	0	OUT Slot 1 Source/Destination	0
20.06	OUT Channel 1 Mapping	9011	OUT Channel 1 Mapping	9011	OUT Slot 2 Destination Node	0
20.07	IN Channel 1 Mapping	9011	IN Channel 1 Mapping	9011	OUT Slot 2 Source/Destination	0
20.08	Reserved	0	Reserved	0	OUT Slot 3 Destination Node	0
20.09	Reserved	0	Reserved	0	OUT Slot 3 Source/Destination	0
20.10	Reserved	0	Reserved	0	IN Slot 1	0
20.11	Trip Delay Time (ms)	48	Trip Delay Time (ms)	48	IN Slot 2	0
20.12	Reserved	0	Reserved	0	IN Slot 3	0
20.13	Data Endian Format	0	Reserved	0	Reserved	0
20.14	Option ID Code		Option ID Code		Reserved	0
20.15	Firmware Version		Firmware Version		Reserved	0
20.16	Reserved	0	Reserved	0	Reserved	0
20.17	Reserved	0	Reserved	0	Reserved	0
20.18	Reserved	0	Reserved	0	Reserved	0
20.19	Reserved	0	Reserved	0	Reserved	0
20.20	Reserved	0	Reserved	0	Reserved	0
20.50	Fieldbus Diagnostic		Fieldbus Diagnostic		Fieldbus Diagnostic	

Parameter	UD76 Modbus Plus		UD77 Device Net		UD77 CAN / CAN Open	
	Description	Default	Description	Default	Description	Default
20.01	Node Address		OUT Channel 2 Mapping	121	RxPDO1 Word 2 Mapping	121
20.02	Negative Number Format	0	OUT Channel 3 Mapping	408	RxPDO1 Word 3 Mapping	408
20.03	Reserved	0	IN Channel 2 Mapping	201	TxPDO1 Word 2 Mapping	201
20.04	IN Slot 1 source node/slot	0	IN Channel 3 Mapping	402	TxPDO1 Word 3 Mapping	402
20.05	IN Slot 1 destination	0	Node Address	0	Node Address	0
20.06	IN Slot 2 source node/slot	0	OUT Channel 1 Mapping	9011	RxPDO1 Word 1 Mapping	9011
20.07	IN Slot 2 destination	0	IN Channel 1 Mapping	9011	TxPDO1 Word 1 Mapping	9011
20.08	IN Slot 3 source node/slot	0	Data Rate	0	Data Rate	0
20.09	IN Slot 3 destination	0	Node Status		SYNC Generation Time	0
20.10	OUT Slot 1 source	0	Network Status		Auto-Start Enable	0
20.11	OUT Slot 2 source	0	Trip Delay Time (ms)	48	Network Loss Trip Time (ms)	0
20.12	OUT Slot 3 source	0	Product Code Elaboration	0	Reserved	0
20.13	IN Slot 4, 5 source	0	Reserved	0	Reserved	0
20.14	IN Slot 6, 7 source	0	Option ID Code		Fieldbus ID Code	
20.15	IN Slot 8, 9 source	0	Firmware Version		CANopen Firmware	
20.16	IN Slot 10, 11 source	0	Reserved	0	RxPDO2 COB-ID	0
20.17	IN Slot 12, 13 source	0	Reserved	0	TxPDO2 COB-ID	0
20.18	Reserved	0	Reserved	0	Reserved	0
20.19	Reserved	0	Reserved	0	Reserved	0
20.20	Reserved	0	Reserved	0	Reserved	0
20.50	Fieldbus Diagnostic		Fieldbus Diagnostic		Fieldbus Diagnostic	

Shading denotes RO parameter

5 EMC Data Sheets

5.1 Unidrive size 1 (0.75 to 4kW) Electromagnetic compatibility data

Product:UNI 1401 - 1405, including LFT and VTC variants

General note on EMC data

The information given in this data sheet is derived from tests and calculations on sample products. It is provided to assist in the correct application of the product, and is believed to correctly reflect the behaviour of the product when operated in accordance with the instructions. The provision of this data does not form part of any contract or undertaking. Where a statement of conformity is made with a specific standard, the company takes all reasonable measures to ensure that its products are in conformance. Where specific values are given these are subject to normal engineering variations between samples of the same product. They may also be affected by the operating environment and details of the installation arrangement

5.1.1 Immunity

The drive complies with the following international and European harmonised standards for immunity:

Standard	Type of immunity	Test specification	Application	Level
EN 61000-4-2*	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3(industrial)
EN 61000-4-3 (ENV 50140*)	Radio frequency radiated field	10V/m prior to modulation 80 - 1000MHz 80% AM (1kHz) modulation	Module enclosure	Level 3(industrial)
EN 61000-4-6 (ENV 50141*)	Conducted radio frequency	10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3(industrial)
EN 61000-4-4*	Fast transient burst	5/50ns 2kV transient at 5kHz repetition frequency via coupling clamp	Control lines	Level 4(industrial harsh)
		5/50ns 2kV transient at 5kHz repetition frequency by direct injection	Power lines	Level 3(industrial)
EN 61000-4-5	Surges	Common mode 4kV1.2/50µs waveshape	AC supply lines: line to earth	Level 4
		Differential mode 2kV1.2/50µs waveshape	AC supply lines: line to line	Level 3
EN 61000-4-11	Voltage dips, short interruptions & variations	All durations	AC supply lines	
EN 50082-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
EN 50082-2	Generic immunity standard for the industrial environment Calls up basic standards marked *			Complies
EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environment	

The stated immunity is achieved without any additional measures such as filters or suppressors. To ensure correct operation the wiring guidelines specified in the User Guide must be carefully adhered to. All inductive components such as relays, contactors, electromagnetic brakes etc. associated with the drive must be fitted with appropriate suppression, otherwise the immunity capability of the drive may be exceeded.

5.1.2 Emission

Emission occurs over a wide range of frequencies. The effects are divided into three main categories:

- Low frequency effects, such as supply harmonics and notching.
- High frequency emission below 30MHz where emission is predominantly by conduction.
- High frequency emission above 30MHz where emission is predominantly by radiation.

Supply voltage notching

Because of the use of uncontrolled input rectifiers the drives cause no significant notching of the supply voltage.

Supply harmonics

The input current contains harmonics of the supply frequency. Since the drive input has a low impedance, the harmonic current levels are affected to some extent by the supply impedance (fault current level). The table shows the levels calculated according to IEC61800-3 where the supply fault current is 250 times the drive rating. This would be typical of a light industrial installation.

The calculations have been verified by laboratory measurements on sample drives.

Note that the RMS current in these tables is lower than that specified in the installation guide, since the latter is a worst-case value provided for safety reasons which takes account of permitted supply voltage imbalance.

For balanced sinusoidal supplies, all even and triplen harmonics are absent.

The supply voltage for the calculation was 400V 50Hz but the harmonic percentages do not change substantially for other voltages and frequencies within the drive specification.

				Harmonic order, magnitude as % fundamental							
Drive (kW)	**RMS current (A)**	**Fundamental current (A)**	**THD (%)***	**5**	**7**	**11**	**13**	**17**	**19**	**23**	**25**
1401 (0.75)	2.22	1.25	147	86.9	78.4	53.0	41.9	19.3	12.0	7.5	7.2
1402 (1.1)	3.28	1.81	151	85.5	76.2	47.3	35.7	13.8	8.1	7.4	7.0
1403 (1.5)	4.41	2.47	148	83.6	73.3	41.8	30.3	10.1	6.4	6.9	6.1
1404 (2.2)	6.05	3.62	134	84.4	75.4	43.8	33.0	10.2	5.7	6.5	6.1
1405 (4.0)	8.96	6.67	90	68.9	47.0	11.7	7.0	5.4	3.6	2.9	2.4

* Total Harmonic Distortion, expressed as percentage of fundamental

To give some indication of how the currents vary with source impedance, the following table shows the levels for a low-current supply of residential type, as specified in IEC60725, and for a "stiff" supply with 5kA fault current which is the highest recommended for this drive range.

Supply impedance = 0.4 + j0.25 - according to IEC60725:											
1401 (0.75)	2.03	1.24	132	84.1	73.4	43.4	30.8	10.0	5.7	7.4	6.8
1402 (1.1)	2.84	1.79	123	82.3	69.6	36.8	23.9	6.6	5.7	6.6	5.3
1403 (1.5)	3.77	2.46	116	80.0	66.2	31.1	18.2	5.9	6.5	5.2	3.7
1404 (2.2)	5.3	3.59	109	77.2	61.8	24.2	12.0	6.3	6.7	3.1	2.3
1405 (4.0)	8.04	6.54	72	58.7	35.2	6.4	7.1	2.9	2.6	2.2	1.5
Fault current of 5kA											
1401 (0.75)	2.82	1.28	192	93.4	91.2	78.5	74.6	57.5	52.5	34.8	30.6
1402 (1.1)	3.96	1.88	185	93.9	90.7	77.7	72.0	54.3	48.2	30.9	25.6
1403 (1.5)	5.37	2.57	183	93.9	89.8	76.6	69.7	52.1	44.6	28.1	21.7
1404 (2.2)	7.69	3.78	177	94.1	88.5	74.8	66.2	48.6	39.8	23.9	16.9
1405 (4.0)	9.77	6.80	103	72.0	51.5	14.0	7.5	5.4	3.7	2.6	2.4

Input line inductors (line chokes)

Where necessary, a reduction in harmonic current levels can be obtained by fitting inductors in the input supply lines to the drive. This also gives increased immunity from supply disturbances such as voltage surges caused by the switching of high-current loads or power-factor correction capacitors on the same supply circuit. The following table shows the corresponding harmonics where inductors of approximately 2% per unit are fitted in the supply lines. Higher inductor values are not recommended because of the reduction in output voltage. Line inductors should be rated for continuous operation at the RMS current shown, and for a peak current (for no magnetic saturation) of at least twice that.

					Harmonic order, magnitude as % fundamental							
Drive (kW)	**L* (mH)**	**RMS current (A)**	**Fundamental current (A)**	**THD (%)***	**5**	**7**	**11**	**13**	**17**	**19**	**23**	**25**
1401 (0.75)	5	1.58	1.19	87	66.0	43.6	10.6	8.2	5.1	3.3	3.3	2.6
1402 (1.1)	5	2.17	1.71	78	61.2	36.8	8.3	8.3	3.3	3.0	2.3	1.8
1403 (1.5)	2.5	3.28	2.43	91	67.8	45.7	11.4	7.6	5.5	3.3	3.3	2.6
1404 (2.2)	2	4.82	3.56	92	66.4	43.9	10.2	7.3	4.7	2.9	3.0	2.3
1405 (4.0)	1.5	7.49	6.47	58	46.4	23.5	8.1	5.0	3.6	2.3	2.3	1.2

* inductance per line

Further measures for reducing harmonics

It is unusual for harmonics to pose a problem unless a substantial part (eg over 50%) of the supply system capacity is accounted for by drives or other power electronic loads. Harmonic currents from drives add approximately arithmetically. It is usually most cost-effective to analyse a complete installation for harmonic current or voltage and to apply remedial measures such as harmonic filters, if necessary, for the entire installation at the common supply point.

Conducted Emission

Radio frequency emission in the frequency range from 150kHz to 30MHz is generated by the switching action of the main power devices (IGBTs) and is mainly conducted out of the equipment through electrical wiring. It is essential for compliance with the emission standards that the recommended filter and a shielded (screened) motor cable are used. Most types of cable can be used provided it has an overall screen, for example the screen formed by the armouring of steel wired armoured cable is acceptable. The capacitance of the cable forms a load on the drive and should be kept to a minimum. Compliance tests were done with cable having a capacitance between the three power cores and the screen of 412pF per metre (measured at 1kHz), which is typical of steel wire armoured cable. In addition to motor cable length, conducted emission will also vary with drive switching frequency: selecting the lowest switching frequency will produce the lowest level of emission. Wiring guidelines are given later which give full precautions where minimum emissions are required.

When used with the recommended filter, the drive complies with the requirements for conducted emission in the following standards:

Motor cable length (m)	Switching frequency (kHz)				
	2	4.5	6	9	12
0 - 20	R	R	R	R	R
20 - 50	R	I	I	I	I
50 - 100	R	I	I	I	I
Further improvement can be achieved by installing a ferrite ring at the output of the drive (see below):					
20 - 100	R	R	R	I	I

Key to table	Standard	Description	Frequency range	Limits	Application
R	EN50081-1	Generic emission standard for the residential commercial and light - industrial environment	0.15 - 0.5MHz limits decrease linearly with log frequency	66-56dBμV quasi peak 56-46dBμV average	AC supply lines
			0.5 - 5MHz	56dBμV quasi peak 46dBμV average	
			5 - 30MHz	60dBμV quasi peak 50dBμV average	
	EN61800-3 IEC61800-3	Product standard for adjustable speed power drive systems	Requirements for the first environment[1], with unrestricted distribution		
I	EN50081-2	Generic emission standard for the industrial environment	0.15 - 0.5MHz	79dBμV quasi peak 66dBμV average	AC supply lines
			0.5 -30MHz	73dBμV quasi peak 60dBμV average	
	EN61800-3 IEC61800-3	Product standard for adjustable speed power drive systems	Requirements for the first environment[1]: restricted distribution[2] Requirements for the second environment: unrestricted distribution		
1	The first environment is one where the low voltage supply network also supplies domestic premises				
2	When distribution is restricted, drives are available only to installers with EMC competence				

CAUTION

This caution applies where the drive is used in the first environment according to EN61800-3.
This is a product of the restricted distribution class according to IEC61800-3. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

NOTE

1. Where the drive is incorporated into a system with rated input current exceeding 100A, the higher emission limits of EN61800-3 for the second environment are applicable, and no filter is then required.
2. Operation without a filter is a practical cost-effective possibility in an industrial installation where existing levels of electrical noise are likely to be high, and any electronic equipment in operation has been designed for such an environment. This is in accordance with EN61800-3 in the second environment, with restricted distribution. There is some risk of disturbance to other equipment, and in this case the user and supplier of the drive system must jointly take responsibility for correcting any problem which occurs.

Typical conducted emission test data

The conducted emission from a UNI 1403 operating with filter Part No. 4200-6105, at 3kHz switching frequency with 50m motor cable, is shown in the emission plot in Figure 5-3, together with measured data for the worst frequencies using both quasi-peak and average detectors.

Recommended filters

For UNI1401 - UNI1405:

- Footprint format   Control Techniques part number   4200-6104
- Bookcase format   4200-6105
- Ferrite ring (optional)   4200-0000

WARNING

These filters have earth leakage current exceeding 3.5mA. A permanent fixed earth connection is necessary to avoid electrical shock hazard. Further precautions, such as a supplementary earth connection or earth monitoring system, may also be required.

Note on shared filters for multiple drives

When more than one drive is used in the same enclosure, some cost saving is possible by sharing a single filter of suitable current rating between several drives. Tests have shown that combinations of drives with a single filter are able to meet the same emission standard as a single drive, provided that all filters and drives are mounted on the same metal plate. Because of the unpredictable effect of the additional wiring and the need for separate fuses for the drives on the drive side of the filter, this arrangement is not recommended where strict compliance with a specific standard is required unless emission tests can be carried out.

Related product standards

The conducted emission levels specified in EN50081-1 and EN50081-2 are equivalent to the levels required by the following product specific standards:

Conducted emission from 150kHz to 30MHz		
Generic standard	**Product standard**	
EN50081-1	EN55011 Class B CISPR 11 Class B	Industrial, scientific and medical equipment
	EN55014 CISPR 14	Household electrical appliances
	EN55022 Class B CISPR 22 Class B	Information technology equipment
EN50081-2	EN55011 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment

Radiated emission

When installed in a standard metal enclosure according to the wiring guidelines, the drive will meet the radiated emission limits required by the generic industrial emission standard EN50081-2.

Important note

Compliance was achieved in tests using representative enclosures and following the guidelines given. Every effort was made to ensure that the arrangements were robust enough to be effective despite the normal variations which will occur in practical installations. However no warranty is given that installations built according to these guidelines will necessarily meet the same emission limits.

The limits for emission required by the generic emission standards are summarised in the following table:

Radiated emission from 30 to 1000MHz				
Standard	**Application**	**Frequency range**	**Limits**	**Comments**
EN50081-1	Enclosure	30 - 230MHz	30dBμV/m quasi peak at 10m	
		230 - 1000MHz	37dBμV/m quasi peak at 10m	
EN50081-2	Enclosure	30 - 230MHz	40dBμV/m quasi peak at 10m	Standard specifies limits of 30 and 37dBmV/m respectively at a measuring distance of 30m; emission may be measured at 10m if limits are increased by 10dB
		230 - 1000MHz	47dBμV/m quasi peak at 10m	

EN61800-3 (IEC61800-3) requires the following, in order of increasing emission level:

As EN50081-1	First environment - unrestricted distribution
As EN50081-2	First environment - restricted distribution
30 - 230MHz 40dBμV/m at 30m 230 - 1000MHz 50dBμV/m at 30m	Second environment - unrestricted distribution

Test Data

The test data is based on radiated emission measurements made on a standard steel enclosure containing a single UNI 1401 drive, in a calibrated open area test site. Details of the test arrangement are described:

A standard Rittall enclosure was used having dimensions 1900mm (high) x 600mm (wide) x 500mm (deep). Two ventilation grilles, both 200mm square, were provided on the upper and lower faces of the door.

The drive and recommended RFI input filter were fitted to the internal back-plate of the enclosure, the filter casing making electrical contact with the back-plate by the fixing screws. Standard unscreened power cable was used to connect the cubicle to the supply.

A standard 0.75kW AC induction motor was connected by 4m of shielded cable (steel braided - type SY) and mounted externally. The motor cable was interrupted by a DIN rail terminal block mounted in the enclosure, however in the test arrangement, instead of bonding the motor cable screen to the back-plate using metal clamps, the shield pigtails (50mm long) were bonded to the back plate through an earthed DIN rail terminal block. The motor screen was not bonded to the enclosure wall at the point of entry.

A 2m screened control cable was connected to the drive control terminals, but the screen was isolated from the cubicle wall.

The drive was operated at 6Hz, with a switching frequency of 12kHz which is the worst case for RF emission.

No additional EMC preventative measures were taken, e.g. RFI gaskets around the cubicle doors.

The following table summarises the results for radiated emission, showing the six highest measurements over the frequency range 30 to 1000 MHz:

Frequency MHz	Emission dBμV/m	Level required by industrial standard EN50081-2 at 10m
36	29	40
37	29	40
40	35	40
41	31	40
42	30	40
60	34	40

The results show that the limit for the industrial emission standard is met with a margin of at least 5dB.

The limit for EN61800-3 (IEC61800-3) is met for the first environment with restricted distribution, and for the second environment without restriction.

Enclosure construction
For many installations, an enclosure will have a back-plate which will be used to mount variable speed drive modules, RFI filters and ancillary equipment. The motor cable should be bonded to the back-plate close to the drive before it leaves the enclosure wall. However, there is no disadvantage if the motor cable is bonded at the point of exit as well, through the normal gland fixings.

Depending on construction, the enclosure wall used for cable entry may have separate panels and could make poor electrical contact at high frequencies with the remaining structure. If the motor cable is only bonded to these surfaces and not to a back-plate, then the enclosure may provide insufficient attenuation of RF emission.

It is the bonding to a common metal plate which minimises radiated emission. In the tests described, opening the cubicle door had little effect on the emission level, showing that the enclosure design is not critical.

Related product standards
The radiated emission levels specified in EN50081-2 are equivalent to the levels required by the following product standards:

Radiated emission from 30 to 1000MHz		
Generic standard	**Product standard**	
EN50081-2	CISPR 11 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment

Wiring guidelines

The wiring guidelines on the following pages should be observed to achieve minimum emission. The details of individual installations may vary, but details which are indicated in the guidelines to be important for EMC must be adhered to closely. The guidelines do not preclude the application of more extensive measures which may be preferred by some installers. For example, the use of full 360° ground terminations on shielded cables in the place of 'pig-tail' ground connections is beneficial, but not necessary unless specifically stated in the instructions.

1. The drive and filter must be mounted on the same metal back-plate, and their mounting surfaces must make a good direct electrical connection to it. The use of a plain metal back-plate (eg galvanised not painted) is beneficial for ensuring this without having to scrape off paint and other insulating finishes.
2. The filter must be mounted close to the drive so that its connecting wires can be directly connected. The wires should not be extended.
3. A shielded (screened) or steel wire armoured cable must be used to connect the drive to motor. The shield must be bonded to the same back-plate as the drive and filter, using an uninsulated metal cable-clamp. The clamp must be positioned no further than 100mm (4 in) from the drive.
4. Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50mm (2 in) in length. A full 360° termination of the shield to the motor terminal housing (if metal) is beneficial.
5. If an additional safety earth wire is required for the motor, it can either be carried inside or outside the motor cable shield. If it is carried inside then it must be terminated at both ends as close as possible to the point where the screen is terminated. It should always return to the drive and not to any other earth circuit.
6. The AC supply connections must be kept at least 4in (100mm) from the drive, motor cable and braking resistor cable.
7. Wiring to the braking resistor should be shielded. The shield must be bonded to the back-plate using an uninsulated metal cable-clamp. It need only be connected at the drive end.
8. If the braking resistor is outside the enclosure then it should be surrounded by an earthed metal shield.
9. Signal and control wiring must be kept at least 12in (300mm) from the drive and motor cable.
10. Control wiring "0V" should be earthed at one point only, preferably at the controller and not at a drive.

Variations to wiring guidelines

Output ferrite ring

If the ferrite ring is to be used to further reduce conducted emission, it should be mounted close to the drive and the output power conductors (U,V,W but not E) should be passed twice through the central aperture, all together in the same direction.

If drive control wiring leaves the enclosure

This includes all control, status relay, encoder and option module wiring. One of the following additional measures must be taken:

- Use shielded cables (one overall shield or separate shielded cables) and clamp the shield(s) in contact with the back-plate not more than 100mm (4in) from the drive.
- Pass the control wires through a ferrite ring part number 3225-1004. More than one cable can pass through a ring. Ensure the length of cable between the ring and drive does not exceed 125mm (5in).

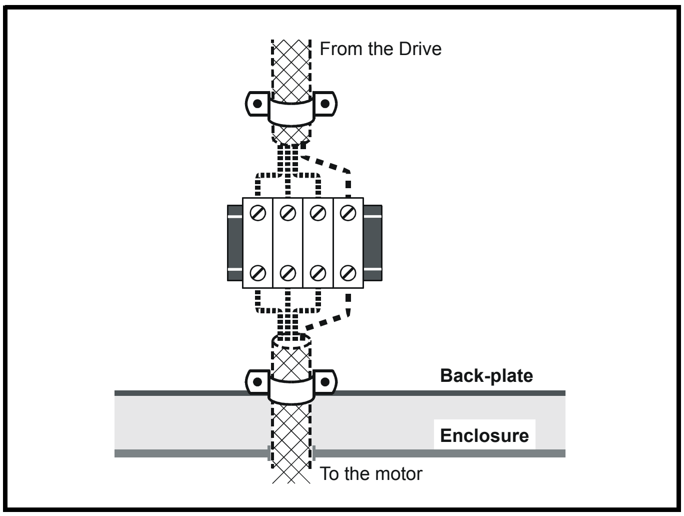
Interruptions to the motor cable

The motor cable should ideally be a single run of shielded cable having no interruptions. In some situations it may be necessary to interrupt the cable, for example to connect the motor cable to a terminal block within the drive enclosure, or to fit an isolator switch to allow safe working on the motor. In these cases the following guidelines should be observed. The most important factor is always to minimise the inductance of the connection between the cable shields.

Terminal block within enclosure

The motor cable shields should be bonded to the back-plate using uninsulated cable-clamps which should be positioned as close as possible to the terminal block. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away from the terminal block.

Figure 5-1 Connecting the motor cable to a terminal block in the enclosure



Using a motor isolator switch

The motor cable shields should be connected by a very short conductor having a low inductance. The use of a flat metal bar is recommended; conventional wire is not suitable. The shields should be bonded directly to the coupling bar using uninsulated metal cable-clamps. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away. The coupling bar may be grounded to a known low impedance ground nearby, for example a large metallic structure which is connected closely to the drive ground.

Figure 5-2 Connecting the motor cable to an isolating switch

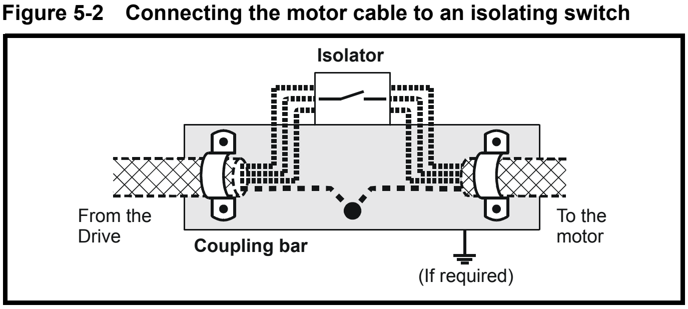
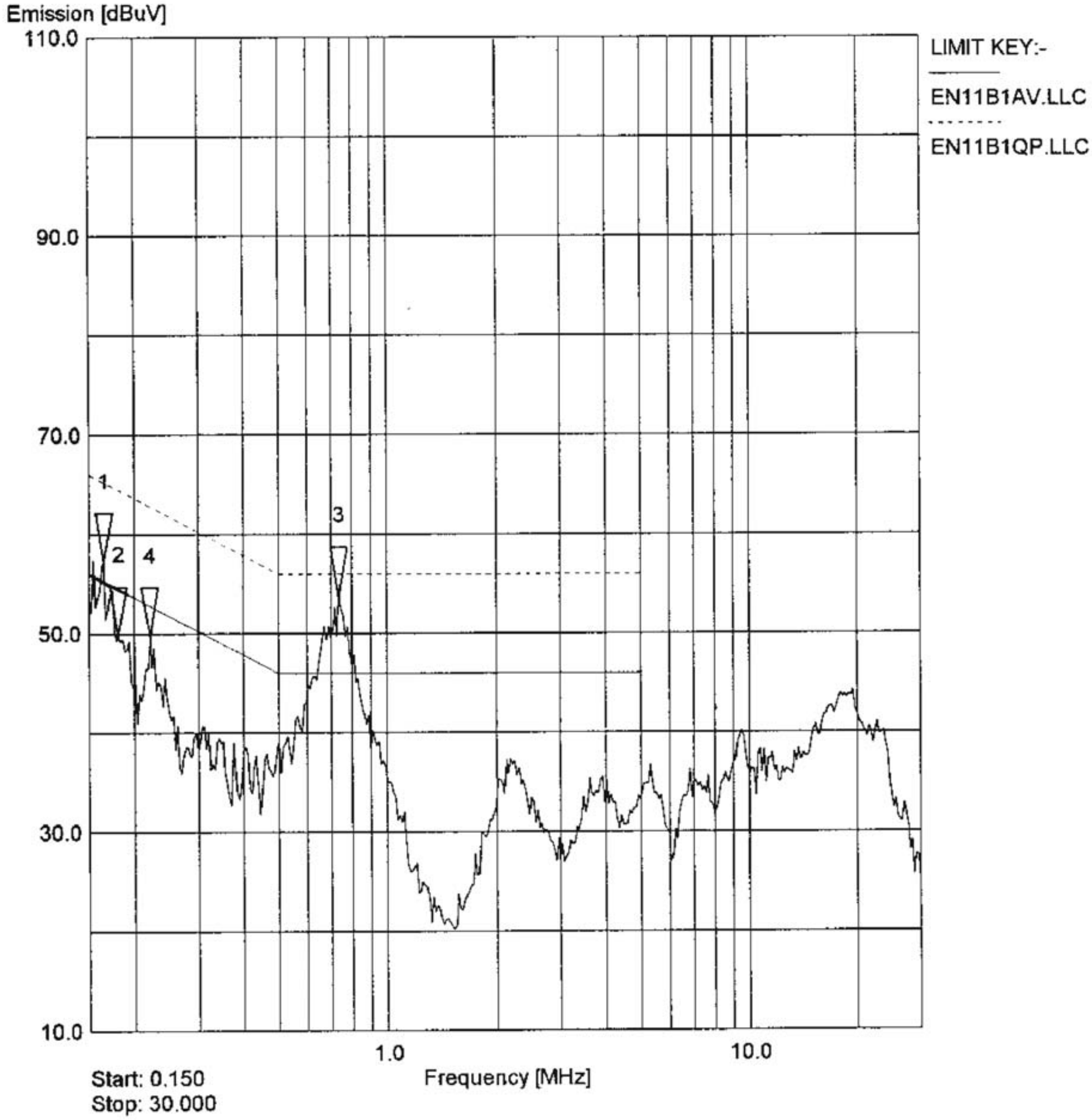


Figure 5-3 Conducted emission plot and data



	Measured			
Marker	Freq (MHz)	Peak (dBuV)	Q-P. (dBuV)	Average (dBuV)
1	0.15332	-	52.69	44.52
2	0.17405	-	49.19	40.91
3	0.74591	-	51.19 *	43.79
4	0.21449	-	43.24	34.27

5.2 Unidrive size 2 (5.5 to 11 kW) Electromagnetic compatibility data

Product UNI 2401 - 2403, including LFT & VTC variants.

General note on EMC data

The information given in this data sheet is derived from tests and calculations on sample products. It is provided to assist in the correct application of the product, and is believed to correctly reflect the behaviour of the product when operated in accordance with the instructions. The provision of this data does not form part of any contract or undertaking. Where a statement of conformity is made with a specific standard, the company takes all reasonable measures to ensure that its products are in conformance. Where specific values are given these are subject to normal engineering variations between samples of the same product. They may also be affected by the operating environment and details of the installation arrangement

5.2.1 Immunity

The drive complies with the following international and European harmonised standards for immunity:

Standard	Type of immunity	Test specification	Application	Level
EN 61000-4-2*	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3(industrial)
EN 61000-4-3 (ENV 50140*)	Radio frequency radiated field	10V/m prior to modulation 80 - 1000MHz 80% AM (1kHz) modulation	Module enclosure	Level 3(industrial)
EN 61000-4-6 (ENV 50141*)	Conducted radio frequency	10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3(industrial)
EN 61000-4-4*	Fast transient burst	5/50ns 2kV transient at 5kHz repetition frequency via coupling clamp	Control lines	Level 4(industrial harsh)
		5/50ns 2kV transient at 5kHz repetition frequency by direct injection	Power lines	Level 3(industrial)
EN 61000-4-5	Surges	Common mode 4kV1.2/50µs waveshape	AC supply lines: line to earth	Level 4
		Differential mode 2kV1.2/50µs waveshape	AC supply lines: line to line	Level 3
EN 61000-4-11 (See note)	Voltage dips, short interruptions & variations	All durations	AC supply lines	
EN 50082-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
EN 50082-2	Generic immunity standard for the industrial environment Calls up basic standards marked *			Complies
EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environment	

Note: The standard is limited to equipment rated less than 16A. UNI 2403 is tested according to the principles of EN 61000-4-11

The immunity is achieved without any additional measures such as filters or suppressors. To ensure correct operation the wiring guidelines specified in the User Guide must be carefully adhered to. All inductive components such as relays, contactors, electromagnetic brakes etc. associated with the drive must be fitted with appropriate suppression, otherwise the immunity capability of the drive may be exceeded.

5.2.2 Emmision

Emission occurs over a wide range of frequencies. The effects are divided into three main categories:

- Low frequency effects, such as supply harmonics and notching.
- High frequency emission below 30MHz where emission is predominantly by conduction.
- High frequency emission above 30MHz where emission is predominantly by radiation.

Supply voltage notching

Because of the use of uncontrolled input rectifiers the drives cause no significant notching of the supply voltage.

Supply harmonics

The input current contains harmonics of the supply frequency. These drives have a relatively high input impedance, so the harmonics are not significantly affected by realistic variations in the supply impedance (fault current level). The table shows the levels calculated according to IEC61800-3 where the supply fault current is 250 times the drive rating. This would be typical of a light industrial installation. Calculations using the recommended maximum fault level of 5kA give similar results.

The calculations have been verified by laboratory measurements on sample drives. Note that the RMS current in these tables is lower than that specified in the installation guide, since the latter is a worst-case value provided for safety reasons which takes account of permitted supply voltage imbalance.

For balanced sinusoidal supplies, all even and triplen harmonics are absent.

The supply voltage for the calculation was 400V 50Hz but the harmonic percentages do not change substantially for other voltages and frequencies within the drive specification.

Drive (kW)	RMS current (A)	Fundamental current (A)	THD (%)*	Harmonic order, magnitude as % fundamental							
				5	7	11	13	17	19	23	25
2401 (5.5)	12.24	9.14	89	67.8	45.5	10.8	7.2	5.1	3.3	2.8	2.3
2402 (7.5)	16.0	12.42	81	64.1	42.9	8.4	7.4	4.0	3.2	2.3	2.3
2403 (11)	21.1	18.0	61	48.5	30.9	7.9	6.9	4.6	3.6	3.3	2.5

* Total Harmonic Distortion, expressed as percentage of fundamental

Input line inductors (line chokes)

Where necessary, some reduction in harmonic current levels can be obtained by fitting inductors in the input supply lines to the drive. This also gives increased immunity from supply disturbances such as voltage surges caused by the switching of high-current loads or power-factor correction capacitors on the same supply circuit, although since all Unidrives in sizes 2 to 5 contain inductors in the DC link this benefit is only likely to be required in the presence of exceptionally severe supply disturbances.

The following table shows the corresponding harmonics where inductors of approximately 2% per unit are fitted in the supply lines. Higher inductor values are not recommended because of the reduction in output voltage. Line inductors should be rated for continuous operation at the RMS current shown, and for a peak current (for no magnetic saturation) of at least twice that.

Drive (kW)	L*(mH)	RMS current (A)	Fundamental current (A)	THD (%)*	Harmonic order, magnitude as % fundamental							
					5	7	11	13	17	19	23	25
2401 (5.5)	1	10.1	8.91	53	46.7	24.0	8.1	5.2	3.7	2.4	2.4	1.3
2402 (7.5)	1	13.5	12.13	49	39.9	17.4	8.0	4.1	3.7	2.4	2.2	1.3
2403 (11)	0.5	19.8	17.8	49	38.2	17.2	8.1	4.5	4.0	2.7	2.5	1.6

* inductance per line

Further measures for reducing harmonics

It is unusual for harmonics to pose a problem unless a substantial part (eg over 50%) of the supply system capacity is accounted for by drives or other power electronic loads. Harmonic currents from drives add approximately arithmetically. It is usually most cost-effective to analyse a complete installation for harmonic current or voltage and to apply remedial measures such as harmonic filters, if necessary, for the entire installation at the common supply point.

Conducted emission

Radio frequency emission in the frequency range from 150kHz to 30MHz is mainly conducted out of the equipment through electrical wiring. It is essential for compliance with the emission standards that the recommended filter and a shielded (screened) motor cable are used. Most types of cable can be used provided it has an overall screen, for example the screen formed by the armouring of steel wired armoured cable is acceptable. The capacitance of the cable forms a load on the drive and should be kept to a minimum. Compliance tests were done with cable having a capacitance between the three power cores and the screen of 412pF per metre (measured at 1kHz), which is typical of steel wire armoured cable. In addition to motor cable length, conducted emission will also vary with drive switching frequency: selecting the lowest switching frequency will produce the lowest level of emission. Wiring guidelines are given later which give full precautions where minimum emission is required.

When used with the recommended filter, the drive complies with the requirements for conducted emission in the following standards:

Motor cable length (m)	Switching frequency (kHz)				
	3	**4.5**	**6**	**9**	**12**
0 - 10	I	I	I	-	-
10 - 50	R	-	-	-	R
50 - 100	-	I	I	I	I
Further improvement can be achieved by installing a ferrite ring at the output of the drive (see below):					
0 - 10	R	R	R	R	R
10 - 50	R	R	R	R	I
50 - 100	R	I	I	I	I
100 - 150	I	I	I	-	-

Key to table	Standard	Description	Frequency range	Limits	Application
R	EN50081-1	Generic emission standard for the residential commercial and light - industrial environment	0.15 - 0.5MHz limits decrease linearly with log frequency	66-56dBμV quasi peak 56-46dBμV average	AC supply lines
			0.5 - 5MHz	56dBμV quasi peak 46dBμV average	
			5 - 30MHz	60dBμV quasi peak 50dBμV average	
	EN61800-3 IEC61800-3	Product standard for adjustable speed power drive systems	Requirements for the first environment[1], with unrestricted distribution		
I	EN50081-2	Generic emission standard for the industrial environment	0.15 - 0.5MHz	79dBμV quasi peak 66dBμV average	AC supply lines
			0.5 -30MHz	73dBμV quasi peak 60dBμV average	
	EN61800-3 IEC61800-3	Product standard for adjustable speed power drive systems	Requirements for the first environment[1]: restricted distribution[2] Requirements for the second environment: unrestricted distribution		
1	The first environment is one where the low voltage supply network also supplies domestic premises				
2	When distribution is restricted, drives are available only to installers with EMC competence				

CAUTION

This caution applies where the drive is used in the first environment according to EN61800-3.
This is a product of the restricted distribution class according to IEC61800-3. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

NOTE

1. Where the drive is incorporated into a system with rated input current exceeding 100A, the higher emission limits of EN61800-3 for the second environment are applicable, and no filter is then required.
2. Operation without a filter is a practical cost-effective possibility in an industrial installation where existing levels of electrical noise are likely to be high, and any electronic equipment in operation has been designed for such an environment. This is in accordance with EN61800-3 in the second environment, with restricted distribution. There is some risk of disturbance to other equipment, and in this case the user and supplier of the drive system must jointly take responsibility for correcting any problem which occurs.

Typical conducted emission test data

The average and quasi peak conducted emission test data for a UNI 2402 operating with filter Part No. 4200-6108, at 3kHz switching frequency and with a motor cable of 50m is shown in the emission plot in Figure 5-6 on page 233, together with measured data for the worst frequencies using both quasi-peak and average detectors.. It shows compliance with the residential standard.

Recommended filters

Drive	Filter format	Input filter part number
UNI2401,UNI2402	footprint	4200-6108
UNI2401,UNI2402	bookcase	4200-6109
UNI2403	footprint	4200-6113
UNI2403	bookcase	4200-6114

Ferrite ring (optional)4200-0000

WARNING

These filters have earth leakage current exceeding 3.5mA. A permanent fixed earth connection is necessary to avoid electrical shock hazard. Further precautions, such as a supplementary earth connection or earth monitoring system, may also be required.

Note on shared filters for multiple drives

When more than one drive is used in the same enclosure, some cost saving is possible by sharing a single filter of suitable current rating between several drives. Tests have shown that combinations of drives with a single filter are able to meet the same emission standard as a single drive, provided that all filters and drives are mounted on the same metal plate. Because of the unpredictable effect of the additional wiring and the need for separate fuses for the drives on the drive side of the filter, this arrangement is not recommended where strict compliance with a specific standard is required unless emission tests can be carried out.

Related product standards

The conducted emission levels specified in EN50081-1 and EN50081-2 are equivalent to the levels required by the following product specific standards:

Conducted emission from 150kHz to 30MHz		
Generic standard	**Product standard**	
EN50081-1	EN55011 Class B CISPR 11 Class B	Industrial, scientific and medical equipment
	EN55014 CISPR 14	Household electrical appliances
	EN55022 Class B CISPR 22 Class B	Information technology equipment
EN50081-2	EN55011 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment

Radiated emission

When installed in a standard metal enclosure according to the wiring guidelines given below, the drive will meet the radiated emission limits required by the generic industrial emission standard EN50081-2.

Important note

Compliance was achieved in tests using representative enclosures and following the guidelines given. Every effort was made to ensure that the arrangements were robust enough to be effective despite the normal variations which will occur in practical installations. However no warranty is given that installations built according to these guidelines will necessarily meet the same emission limits.

The limits for emission required by the generic emission standards are summarised in the following table:

Radiated emission from 30 to 1000MHz				
Standard	**Application**	**Frequency range**	**Limits**	**Comments**
EN50081-1	Enclosure	30 - 230MHz	30dBµV/m quasi peak at 10m	
		230 - 1000MHz	37dBµV/m quasi peak at 10m	
EN50081-2	Enclosure	30 - 230MHz	40dBµV/m quasi peak at 10m	Standard specifies limits of 30 and 37dBmV/m respectively at a measuring distance of 30m; emission may be measured at 10m if limits are increased by 10dB
		230 - 1000MHz	47dBµV/m quasi peak at 10m	

EN61800-3 (IEC61800-3) requires the following, in order of increasing emission level:

As EN50081-1	First environment - unrestricted distribution
As EN50081-2	First environment - restricted distribution
30 - 230MHz 40dBµV/m at 30m 230 - 1000MHz 50dBµV/m at 30m	Second environment - unrestricted distribution

Test Data

The test data is based on radiated emission measurements made on a standard steel enclosure containing a single UNI 2403 drive, in a calibrated open area test site. Details of the test arrangement are described:

A standard Rittall enclosure was used having dimensions 1900mm (high) ´ 600mm (wide) ´ 500mm (deep). Two ventilation grilles, both 200mm square, were provided on the upper and lower faces of the door.

The drive and recommended RFI input filter were fitted to the internal back-plate of the enclosure, the filter casing making electrical contact with the back-plate by the fixing screws. Standard unscreened power cable was used to connect the cubicle to the supply.

A standard AC induction motor was connected by 4m of shielded cable (steel braided - type SY) and mounted externally. The motor cable was interrupted by a DIN rail terminal block mounted in the enclosure, however in the test arrangement, instead of bonding the motor cable screen to the back-plate using metal clamps, the shield pigtails (50mm long) were bonded to the back plate through an earthed DIN rail terminal block. The motor screen was not bonded to the enclosure wall at the point of entry.

A 2m screened control cable was connected to the drive control terminals, but the screen was isolated from the cubicle wall.

The drive was operated at 6Hz, with a switching frequency of 12kHz which is the worst case for RF emission.

No additional EMC preventative measures were taken, e.g. RFI gaskets around the cubicle doors.

The following table summarises the results for radiated emission, showing the six highest measurements over the frequency range 30 to 1000 MHz:

Frequency MHz	Emission dBμV/m	Level required by industrial standard EN50081-2 at 10m
35.1	34.4	40
35.2	34.3	40
34.6	34.2	40
34.7	34.2	40
34.85	34.2	40
34.35	34.2	40

The results show that the limit for the industrial emission standards is met with a margin of at least 5dB.

Enclosure construction

For many installations, an enclosure will have a back-plate which will be used to mount variable speed drive modules, RFI filters and ancillary equipment. The motor cable should be bonded to the back-plate close to the drive before it leaves the enclosure wall. However, there is no disadvantage if the motor cable is bonded at the point of exit as well, through the normal gland fixings.

Depending on construction, the enclosure wall used for cable entry may have separate panels and could make poor electrical contact at high frequencies with the remaining structure. If the motor cable is only bonded to these surfaces and not to a back-plate, then the enclosure may provide insufficient attenuation of RF emission.

It is the bonding to a common metal plate which minimises radiated emission. In the tests described, opening the cubicle door had little effect on the emission level, showing that the enclosure design is not critical.

Related product standards

The radiated emission levels specified in EN50081-2 are equivalent to the levels required by the following product standards:

Radiated emission from 30 to 1000MHz		
Generic standard	Product standard	
EN50081-2	CISPR 11 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment

Wiring guidelines

The wiring guidelines on the following pages should be observed to achieve minimum emission. The details of individual installations may vary, but details which are indicated in the guidelines to be important for EMC must be adhered to closely. The guidelines do not preclude the application of more extensive measures which may be preferred by some installers. For example, the use of full 360° ground terminations on shielded cables in the place of 'pig-tail' ground connections is beneficial, but not necessary unless specifically stated in the instructions.

1. The drive and filter must be mounted on the same metal back-plate, and their mounting surfaces must make a good direct electrical connection to it. The use of a plain metal back-plate (eg galvanised not painted) is beneficial for ensuring this without having to scrape off paint and other insulating finishes.
2. The filter must be mounted close to the drive so that its connecting wires can be directly connected. The wires should not be extended.
3. A shielded (screened) or steel wire armoured cable must be used to connect the Drive to motor. The shield must be bonded to the same back-plate as the drive and filter, using an uninsulated metal cable-clamp. The clamp must be positioned no further than 100mm (4 in) from the drive.
4. Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50mm (2 in) in length. A full 360° termination of the shield to the motor terminal housing (if metal) is beneficial.
5. If an additional safety earth wire is required for the motor, it can either be carried inside or outside the motor cable shield. If it is carried inside then it must be terminated at both ends as close as possible to the point where the screen is terminated. It should always return to the drive and not to any other earth circuit.

6. The AC supply connections must be kept at least 4in (100mm) from the drive, motor cable and braking resistor cable.
7. Wiring to the braking resistor should be shielded. The shield must be bonded to the back-plate using an uninsulated metal cable-clamp. It need only be connected at the drive end.
8. If the braking resistor is outside the enclosure then it should be surrounded by an earthed metal shield.
9. Signal and control wiring must be kept at least 12in (300mm) from the drive and motor cable.
10. Control wiring "0V" should be earthed at one point only, preferably at the controller and not at a drive.

Variations to wiring guidelines

Output ferrite ring

If the ferrite ring is to be used to further reduce conducted emission, it should be mounted close to the drive and the output power conductors (U,V,W but not E) should be passed twice through the central aperture, all together in the same direction.

If drive control wiring leaves the enclosure

This includes all control, status relay, encoder and option module wiring. One of the following additional measures must be taken:

- Use shielded cables (one overall shield or separate shielded cables) and clamp the shield(s) in contact with the back-plate not more than 100mm (4in) from the drive.
- Pass the control wires through a ferrite ring part number 3225-1004. More than one cable can pass through a ring. Ensure the length of cable between the ring and drive does not exceed 125mm (5in).

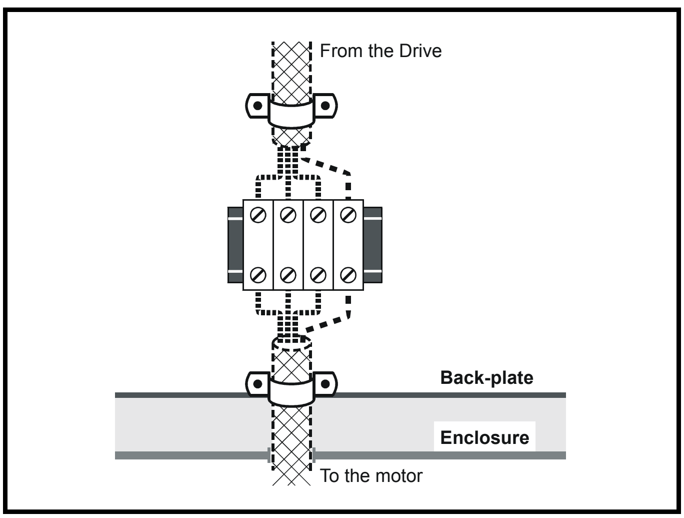
Interruptions to the motor cable

The motor cable should ideally be a single run of shielded cable having no interruptions. In some situations it may be necessary to interrupt the cable, for example to connect the motor cable to a terminal block within the Drive enclosure, or to fit an isolator switch to allow safe working on the motor. In these cases the following guidelines should be observed. The most important factor is always to minimise the inductance of the connection between the cable shields.

Terminal block within enclosure

The motor cable shields should be bonded to the back-plate using uninsulated cable-clamps which should be positioned as close as possible to the terminal block. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away form the terminal block.

Figure 5-4 Connecting the motor cable to a terminal block in the enclosure



Using a motor isolator switch

The motor cable shields should be connected by a very short conductor having a low inductance. The use of a flat metal bar is recommended; conventional wire is not suitable. The shields should be bonded directly to the coupling bar using uninsulated metal cable-clamps. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away. The coupling bar may be grounded to a known low impedance ground nearby, for example a large metallic structure which is connected closely to the Drive ground.

Figure 5-5 Connecting the motor cable to an isolating switch

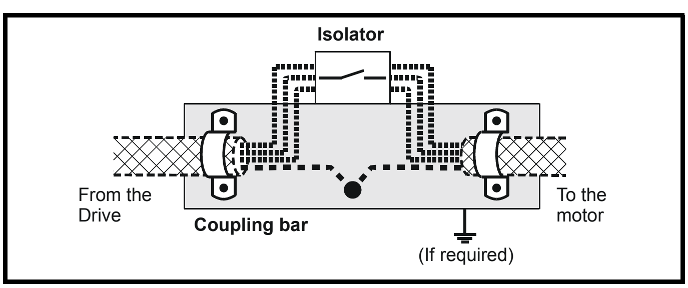
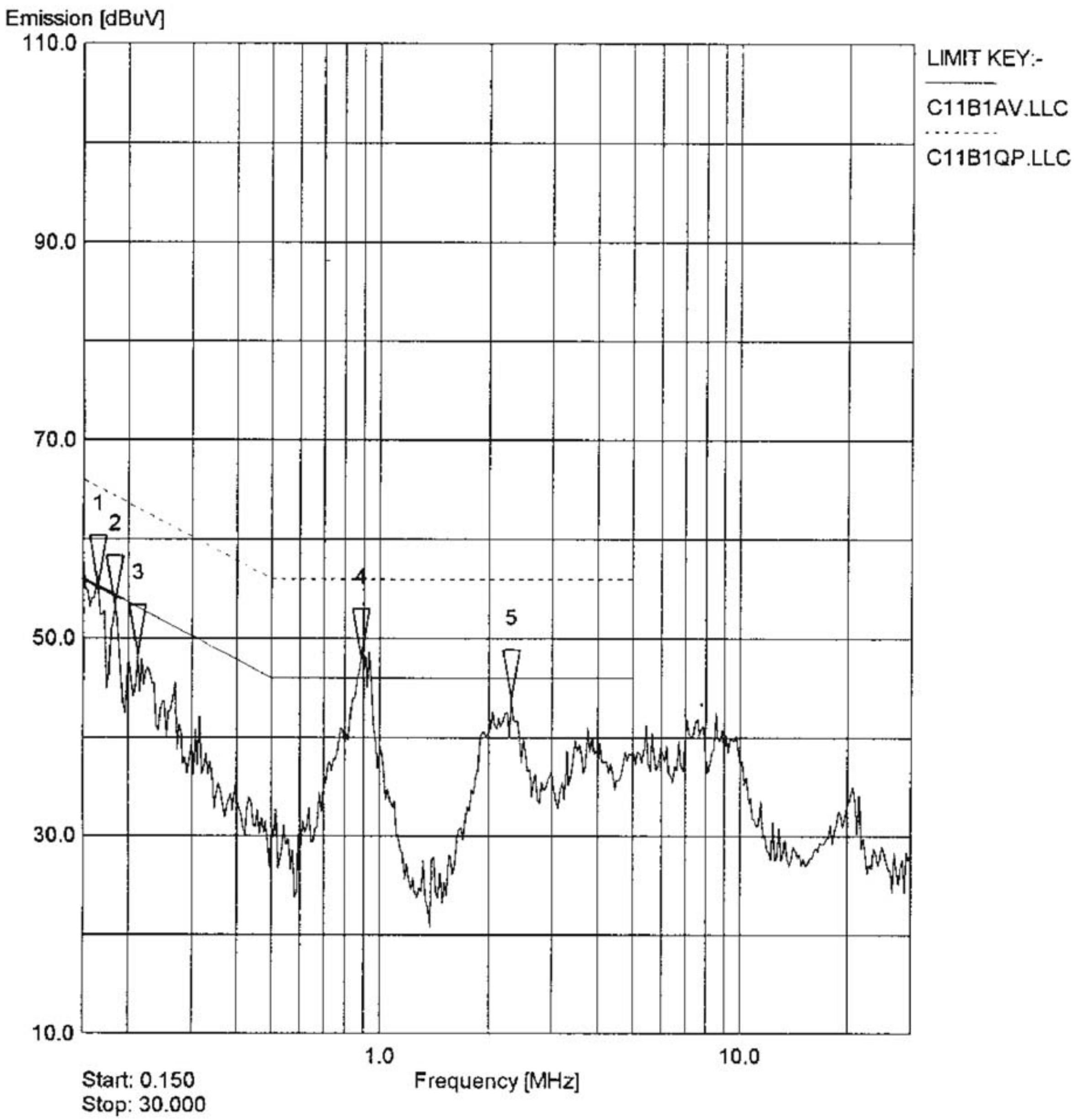


Figure 5-6 Conducted emission test results - UNI2403



Marker	Measured			
	Freq (MHz)	Peak (dBuV)	Q-P (dBuV)	Average (dBuV)
1	0.14924	-	53.73	45.30
2	0.17227	-	50.77	42.66
3	0.21935	-	43.59	33.99
4	0.92127	-	46.53 *	38.28
5	2.2953	-	38.91	30.28

5.3 Unidrive size 3 (15 to 37 kW) Electromagnetic compatibility data

Product UNI 3401 - 3405, including VTC & LFT variants.

General note on EMC data
The information given in this data sheet is derived from tests and calculations on sample products. It is provided to assist in the correct application of the product, and is believed to correctly reflect the behaviour of the product when operated in accordance with the instructions. The provision of this data does not form part of any contract or undertaking. Where a statement of conformity is made with a specific standard, the company takes all reasonable measures to ensure that its products are in conformance. Where specific values are given these are subject to normal engineering variations between samples of the same product. They may also be affected by the operating environment and details of the installation arrangement

5.3.1 Immunity

The drive complies with the following international and European harmonised standards for immunity:

Standard	Type of immunity	Test specification	Application	Level
EN 61000-4-2*	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3(industrial)
EN 61000-4-3 (ENV 50140*)	Radio frequency radiated field	10V/m prior to modulation 80 - 1000MHz 80% AM (1kHz) modulation	Module enclosure	Level 3(industrial)
EN 61000-4-6 (ENV 50141*)	Conducted radio frequency	10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3(industrial)
EN 61000-4-4*	Fast transient burst	5/50ns 2kV transient at 5kHz repetition frequency via coupling clamp	Control lines	Level 4(industrial harsh)
		5/50ns 2kV transient at 5kHz repetition frequency by direct injection	Power lines	Level 3(industrial)
EN 61000-4-5	Surges	Common mode 4kV1.2/50µs waveshape	AC supply lines: line to earth	Level 4
		Differential mode 2kV1.2/50µs waveshape	AC supply lines: line to line	Level 3
EN 61000-4-11 (See note)	Voltage dips, short interruptions & variations	All durations	AC supply lines	
EN 50082-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
EN 50082-2	Generic immunity standard for the industrial environment Calls up basic standards marked *			Complies
EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environment	

Note: The standard is limited to equipment rated less than 16A. Drives are tested according to the principles of EN 61000-4-11

The immunity is achieved without any additional measures such as filters or suppressors. To ensure correct operation the wiring guidelines specified in the User Guide must be carefully adhered to. All inductive components such as relays, contactors, electromagnetic brakes etc. associated with the drive must be fitted with appropriate suppression, otherwise the immunity capability of the drive may be exceeded.

5.3.2 Emission

Emission occurs over a wide range of frequencies. The effects are divided into three main categories:

- Low frequency effects, such as supply harmonics and notching.
- High frequency emission below 30MHz where emission is predominantly by conduction.
- High frequency emission above 30MHz where emission is predominantly by radiation.

Supply voltage notching
Because of the use of uncontrolled input rectifiers the drives cause no significant notching of the supply voltage.

Supply harmonics
The input current contains harmonics of the supply frequency. These drives have a relatively high input impedance, so the harmonics are not significantly affected by realistic variations in the supply impedance (fault current level). The table shows the levels calculated where the supply fault current is 5kA. This would be typical of a light industrial installation and is more realistic for high-current drives than the IEC61800-3 recommendation of 250 times the rated current.

The calculations have been verified by laboratory measurements on sample drives. Note that the RMS current in these tables is lower than that specified in the installation guide, since the latter is a worst-case value provided for safety reasons which takes account of permitted supply voltage imbalance.

For balanced sinusoidal supplies, all even and triplen harmonics are absent.

Drive (kW)	RMS current (A)	Fundamental current (A)	THD (%)*	Harmonic order, magnitude as % fundamental							
				5	7	11	13	17	19	23	25
3401 (15)	27.06	24.37	48	36.9	20.2	8.5	6	4.9	3.7	3.4	2.6
3402 (18.5)	32.75	30.02	44	33.3	17.1	8.5	5.8	4.9	3.7	3.4	2.6
3403 (22)	40.72	35.62	55	43.8	23.7	8.1	5.7	4.3	3	3	2
3404 (30)	52.75	48.37	44	34.2	15.5	8.4	5.1	4.5	3.2	3.1	2.2
3405 (37)	68.72	60.05	56	44.7	22.6	7.3	5	3.6	2.5	2.5	1.6

* Total Harmonic Distortion, expressed as percentage of fundamental

Input line inductors (line chokes)

Where necessary, some reduction in harmonic current levels can be obtained by fitting inductors in the input supply lines to the drive. This also gives increased immunity from supply disturbances such as voltage surges caused by the switching of high-current loads or power-factor correction capacitors on the same supply circuit, although since all Unidrives in sizes 2 to 5 contain inductors in the DC link this benefit is only likely to be required in the presence of exceptionally severe supply disturbances.

The following table shows the corresponding harmonics where inductors of approximately 2% per unit are fitted in the supply lines. Higher inductor values are not recommended because of the reduction in output voltage. Line inductors should be rated for continuous operation at the RMS current shown, and for a peak current (for no magnetic saturation) of at least twice that.

It should be noted that diminishing returns occur as the drive ratings increase, and it is unlikely that the benefit of line inductors will justify their cost above about 22kW.

Drive (kW)	L*(mH)	RMS current (A)	Fundamental current (A)	THD (%)*	Harmonic order, magnitude as % fundamental							
					5	7	11	13	17	19	23	25
3401 (15)	0.5	25.63	23.7	41	33	11.8	8.5	4	4.2	2.6	2.4	1.6
3402 (18.5)	0.37	31.68	29.42	40	31.7	11.9	8.4	4.4	4.2	2.9	2.5	1.8
3403 (22)	0.37	38.97	35.76	43	34.1	12.5	7.9	3.5	3.7	2.3	2.1	1.3
3404 (30)	0.25	51.57	47.9	40	31.7	11.1	8.3	3.9	4.1	2.6	2.4	1.6
3405 (37)	0.2	65.92	59.51	48	38.1	15.7	8	4	3.7	2.4	2.2	1.4

* inductance per line

Further measures for reducing harmonics

It is unusual for harmonics to pose a problem unless a substantial part (eg over 50%) of the supply system capacity is accounted for by drives or other power electronic loads. Harmonic currents from drives add approximately arithmetically. It is usually most cost-effective to analyse a complete installation for harmonic current or voltage and to apply remedial measures such as harmonic filters, if necessary, for the entire installation at the common supply point. It is also possible to supply the drive(s) with DC from a 12-pulse rectifier with phase-shifting, which virtually eliminates the 5th and 7th harmonics.

Conducted emission

Radio frequency emission in the frequency range from 150kHz to 30MHz is mainly conducted out of the equipment through electrical wiring. It is essential for compliance with the emission standards that the recommended filter and a shielded (screened) motor cable are used. Most types of cable can be used provided it has an overall screen, for example the screen formed by the armouring of steel wired armoured cable is acceptable. The capacitance of the cable forms a load on the drive and should be kept to a minimum. Compliance tests were done with cable having a capacitance between the three power cores and the screen of 412pF per metre (measured at 1kHz), which is typical of steel wire armoured cable. In addition to motor cable length, conducted emission will also vary with drive switching frequency: selecting the lowest switching frequency will produce the lowest level of emission. Wiring guidelines are given later which show full precautions where minimum emission is required.

When used with the recommended filters, the drive complies with the requirements for conducted emission in the following standards:

Motor cable length (m)	Switching frequency (kHz)				
	3	4.5	6	9	12
0 - 10	R	R	R	R	R
10 - 50	I	I	I	I	I
50 - 100	I	I	I	-	-

Key to table	Standard	Description	Frequency range	Limits	Application
R	EN50081-1	Generic emission standard for the residential commercial and light - industrial environment	0.15 - 0.5MHz limits decrease linearly with log frequency	66-56dBμV quasi peak 56-46dBμV average	AC supply lines
			0.5 - 5MHz	56dBμV quasi peak 46dBμV average	
			5 - 30MHz	60dBμV quasi peak 50dBμV average	
	EN61800-3 IEC61800-3	Product standard for adjustable speed power drive systems	Requirements for the first environment[1], with unrestricted distribution		
I	EN50081-2	Generic emission standard for the industrial environment	0.15 - 0.5MHz	79dBμV quasi peak 66dBμV average	AC supply lines
			0.5 -30MHz	73dBμV quasi peak 60dBμV average	
	EN61800-3 IEC61800-3	Product standard for adjustable speed power drive systems	Requirements for the first environment[1]: restricted distribution[2] Requirements for the second environment: unrestricted distribution		
1	The first environment is one where the low voltage supply network also supplies domestic premises				
2	When distribution is restricted, drives are available only to installers with EMC competence				

CAUTION

This caution applies where the drive is used in the first environment according to EN61800-3.
This is a product of the restricted distribution class according to IEC61800-3. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

NOTE

1. Where the drive is incorporated into a system with rated input current exceeding 100A, the higher emission limits of EN61800-3 for the second environment are applicable, and no filter is then required.
2. Operation without a filter is a practical cost-effective possibility in an industrial installation where existing levels of electrical noise are likely to be high, and any electronic equipment in operation has been designed for such an environment. This is in accordance with EN61800-3 in the second environment, with restricted distribution. There is some risk of disturbance to other equipment, and in this case the user and supplier of the drive system must jointly take responsibility for correcting any problem which occurs.

Conducted emission test data

The conducted emission from a UNI 3404 operating with filter Part No. 4200-6117, at 6kHz switching frequency, is shown in the average measurement plot (worst case) in Figure 5-10 on page 241. It shows compliance with the industrial standard using 50m of screened motor cable.

Recommended filters

Drive	Motor cable length (m)	Input filter (Control Techniques part numbers)
UNI3401 - 3403, GPD3401 - 3403	1 to 100	4200-6116
UNI3404, GPD3404	1 to 100	4200-6117
UNI3405, GPD3405	1 to 100	4200-6106

WARNING

These filters have earth leakage current exceeding 3.5mA. A permanent fixed earth connection is necessary to avoid electrical shock hazard. Further precautions, such as a supplementary earth connection or earth monitoring system, may also be required.

Note on shared filters for multiple drives

When more than one drive is used in the same enclosure, some cost saving is possible by sharing a single filter of suitable current rating between several drives. Tests have shown that combinations of drives with a single filter are able to meet the same emission standard as a single drive, provided that all filters and drives are mounted on the same metal plate. Because of the unpredictable effect of the additional wiring and the need for separate fuses for the drives on the drive side of the filter, this arrangement is not recommended where strict compliance with a specific standard is required unless emission tests can be carried out.

CAUTION

If size 3 or size 4 Unidrives connected to a shared filter are to be equipped with individual switches or contactors, special precautions are necessary - contact the drive supplier for more information.

Related product standards

The conducted emission levels specified in EN50081-2 are equivalent to the levels required by the following product specific standards:

Radiated emission from 30 to 1000MHz		
Generic standard	**Product standard**	
EN50081-2	EN55011 Class B CISPR 11 Class B	Industrial, scientific and medical equipment
	EN55014 CISPR 14	Household electrical appliances
	EN55022 Class B CISPR 22 Class B	Information technology equipment
EN50081-2	EN550 11 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment

Radiated emission

When installed in a standard metal enclosure according to the wiring guidelines in Figure 5-7 on page 239, the drive will meet the radiated emission limits required by the generic industrial emission standard EN50081-2.

Important note

Compliance was achieved in tests using representative enclosures and following the guidelines given. Every effort was made to ensure that the arrangements were robust enough to be effective despite the normal variations which will occur in practical installations. However no warranty is given that installations built according to these guidelines will necessarily meet the same emission limits.

The limits for emission required by the generic industrial emission standard are summarised in the following table:

Radiated emission from 30 to 1000MHz				
Standard	**Application**	**Frequency range**	**Limits**	**Comments**
EN50081-1	Enclosure	30 - 230MHz	40dBµV/m quasi peak at 10m	Standard specifies limits of 30 and 37dBmV/m respectively at a measuring distance of 30m; emission may be measured at 10m if limits are increased by 10dB
		230 - 1000MHz	47dBµV/m quasi peak at 10m	

EN61800-3 (IEC61800-3) requires the following, in order of increasing emission level:

As EN50081-1	First environment - unrestricted distribution
As EN50081-2	First environment - restricted distribution
30 - 230MHz 40dBµV/m at 30m 230 - 1000MHz 50dBµV/m at 30m	Second environment - unrestricted distribution

Test Data

The test data is based on radiated emission measurements made on a standard steel enclosure containing a single UNI 3401 drive, in a calibrated open area test site. Details of the test arrangement are described:

A standard Rittall enclosure was used having dimensions 1900mm (high) ´ 600mm (wide) ´ 500mm (deep). Two ventilation grilles, both 200mm square, were provided on the upper and lower faces of the door.

The drive and recommended RFI input filter were fitted to the internal back-plate of the enclosure, the filter casing making electrical contact with the back-plate by the fixing screws. Standard unscreened power cable was used to connect the cubicle to the supply.

A standard 4kW AC induction motor was connected by 5m of shielded cable (steel braided - type SY) and mounted externally. The motor cable was interrupted by a DIN rail terminal block mounted in the enclosure, however in the test arrangement, instead of bonding the motor cable screen to the back-plate using metal clamps, the shield pigtails (50mm long) were bonded to the back plate through an earthed DIN rail terminal block. The motor screen was not bonded to the enclosure wall at the point of entry.

A 2m screened control cable was connected to the drive control terminals, but the screen was isolated from the cubicle wall.

The drive was run at 150rpm, with a switching frequency of 6kHz which is the worst case for RF emission.

No additional EMC preventative measures were taken, e.g. RFI gaskets around the cubicle doors.

The following table summarises the results for radiated emission, showing the six highest measurements over the frequency range 30 to 1000 MHz:

Frequency MHz	Emission dBμV/m	Level required by industrial standard EN50081-2 at 10m
60.7	30	40
60.35	29.5	40
61.1	29.5	40
50.2	28.5	40
50.45	28.5	40
61.4	28.5	40

The results show that the limit for the industrial emission standard is met with a margin of at least 10dB.

Enclosure construction

For many installations, an enclosure will have a back-plate which will be used to mount variable speed drive modules, RFI filters and ancillary equipment. The motor cable should be bonded to the back-plate close to the drive before it leaves the enclosure wall (Refer to Wiring guidelines in Figure 5-7 on page 239). However there is no disadvantage if the motor cable is bonded at the point of exit as well, through the normal gland fixings.

Depending on construction, the enclosure wall used for cable entry may have separate panels and could make poor electrical contact at high frequencies with the remaining structure. If the motor cable is only bonded to these surfaces and not to a back-plate, then the enclosure may provide insufficient attenuation of RF emission.

It is the bonding to a common metal plate which minimises radiated emission. In the tests described, opening the cubicle door had little effect on the emission level, showing that the enclosure design is not critical.

Related product standards

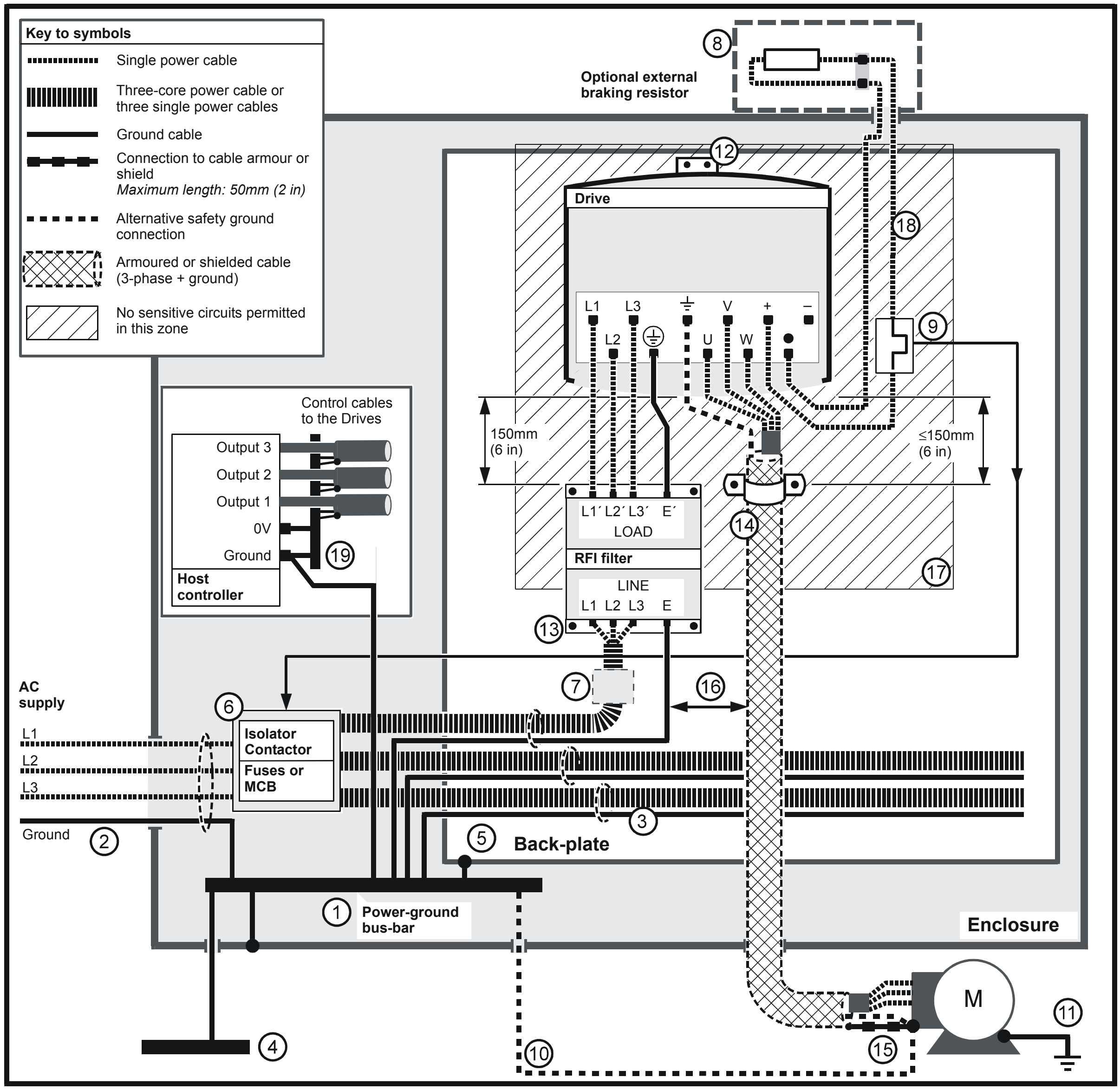
The radiated emission levels specified in EN50081-2 are equivalent to the levels required by the following product standards:

Radiated emission from 30 to 1000MHz		
Generic standard	**Product standard**	
EN50081-2	CISPR 11 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment

Wiring guidelines

The wiring guidelines on the following pages should be observed to achieve minimum emission. The details of individual installations may vary, but details which are indicated in the guidelines to be important for EMC must be adhered to closely. The guidelines do not preclude the application of more extensive measures which may be preferred by some installers. For example, the use of full 360° ground terminations on shielded cables in the place of 'pig-tail' ground connections are beneficial, but not necessary unless specifically stated in the instructions.

Figure 5-7 Wiring guidelines for UNI 3401 - 3405, GPD 3401 - 3405



Key to Figure 5-7

General features

1. Single power ground busbar or low impedance ground terminal.
2. Incoming supply ground connected to power ground busbar.
3. Connect grounds of any other circuits to power ground busbar.
4. Site ground if required.
5. Metal back-plate, safety bonded to power ground busbar.
6. System isolator, circuit contactors and fuses/MCB.
7. Alternative position for drive fuses/MCB.
8. Optional braking resistor mounted externally, protected and shielded by a metal grille.
9. Thermal overload device to protect braking resistor.
10. Alternative safety ground for motor.
11. Motor frame ground connection, if required.

Special features for EMC

12. Drive heatsink directly grounded to the back-plate using the metal mounting-brackets. Ensure that the screws make direct electrical connection to the back-plate by using screw threads tapped in the back-plate.
13. RFI filter mounted 150mm (6in) from the Drive. The RFI filter casing is directly grounded to the back-plate by the fixing screws. Minimise the length of cables between the drive and RFI filter.
14. A shielded (screened) or steel wire armoured cable must be used to connect the Drive to motor. The shield must be bonded to the back-plate using an uninsulated metal cable-clamp. The clamp must be positioned no further than 150mm (6 in) from the drive.
15. Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50mm (2 in) in length. A full 360° termination of the shield to the motor terminal housing (usually metal) is beneficial.
16. Ensure that the AC supply and ground cables are at least 100mm (4 in) from the Drive and motor cable.
17. Avoid sensitive signal circuits in a zone extending 0.3m (12 in) all around drive.
18. Unshielded wiring to optional braking resistor(s) may be used, provided the resistor is either in the same enclosure as the drive or the wiring does not run external to the enclosure. Ensure a minimum spacing of 0.3m (12 in) from signal wiring and the supply side wiring of the RFI filters.
19. If the control circuit 0V is to be grounded, this should be done at the host controller (e.g. PLC) and not at the drive to avoid injecting noise currents into the 0V circuit.

Variations

If drive control wiring leaves the enclosure

This includes all control, status relay, encoder and option module wiring. One of the following additional measures must be taken:

- Use shielded cables (one overall shield or separate shielded cables) and clamp the shield(s) in contact with the back-plate not more than 100mm (4in) from the drive.
- Pass the control wires through a ferrite ring part number 3225-1004. More than one cable can pass through a ring. Ensure the length of cable between the ring and drive does not exceed 125mm (5in).

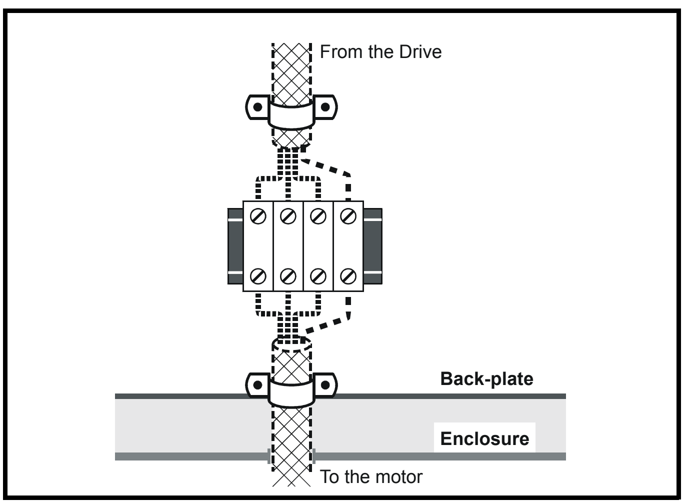
Interruptions to the motor cable

The motor cable should ideally be a single run of shielded cable having no interruptions. In some situations it may be necessary to interrupt the cable, for example to connect the motor cable to a terminal block within the Drive enclosure, or to fit an isolator switch to allow safe working on the motor. In these cases the following guidelines should be observed.

Terminal block within enclosure

The motor cable shields should be bonded to the back-plate using uninsulated cable-clamps which should be positioned as close as possible to the terminal block. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away form the terminal block.

Figure 5-8 Connecting the motor cable to a terminal block in the enclosure

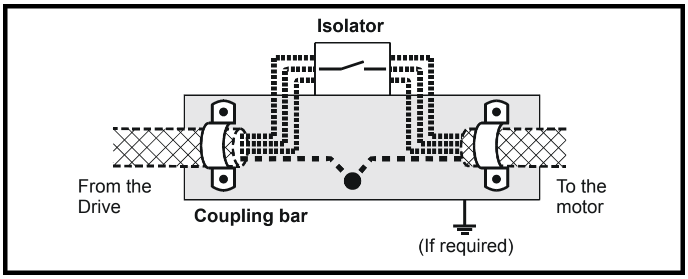


(Refer to *Key to symbols* in Figure 5-7)

Using a motor isolator switch

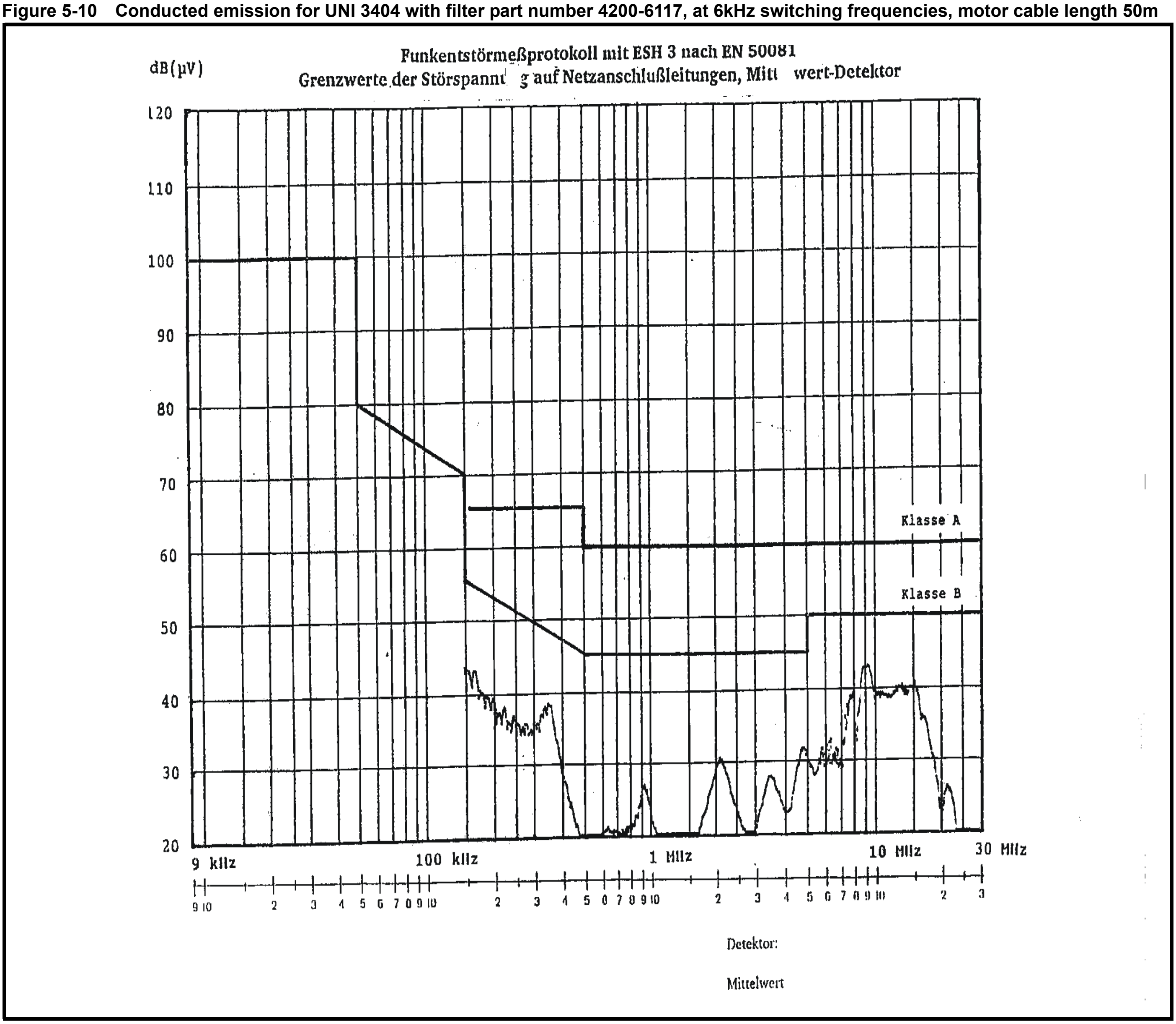
The motor cable shields should be connected by a very short conductor having a low inductance. The use of a flat metal bar is recommended; conventional wire is not suitable. The shields should be bonded directly to the coupling bar using uninsulated metal cable-clamps. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away. The coupling bar may be grounded to a known low impedance ground nearby, for example a large metallic structure which is connected closely to the Drive ground.

Figure 5-9 Connecting the motor cable to an isolating switch



(Refer to *Key to symbols* in Figure 5-7)

Figure 5-10 Conducted emission for UNI 3404 with filter part number 4200-6117, at 6kHz switching frequencies, motor cable length 50m



5.4 Unidrive size 4 (45 to 110 kW) Electromagnetic compatibility data

Product UNI 4401 - 4405, including LFT and VTC variants.

General note on EMC data

The information given in this data sheet is derived from tests and calculations on sample products. It is provided to assist in the correct application of the product, and is believed to correctly reflect the behaviour of the product when operated in accordance with the instructions. The provision of this data does not form part of any contract or undertaking. Where a statement of conformity is made with a specific standard, the company takes all reasonable measures to ensure that its products are in conformance. Where specific values are given these are subject to normal engineering variations between samples of the same product. They may also be affected by the operating environment and details of the installation arrangement

5.4.1 Immunity

The drive complies with the following international and European harmonised standards for immunity:

Standard	Type of immunity	Test specification	Application	Level
EN 61000-4-2*	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3(industrial)
EN 61000-4-3 (ENV 50140*)	Radio frequency radiated field	10V/m prior to modulation 80 - 1000MHz 80% AM (1kHz) modulation	Module enclosure	Level 3(industrial)
EN 61000-4-6 (ENV 50141*)	Conducted radio frequency	10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3(industrial)
EN 61000-4-4*	Fast transient burst	5/50ns 2kV transient at 5kHz repetition frequency via coupling clamp	Control lines	Level 4(industrial harsh)
		5/50ns 2kV transient at 5kHz repetition frequency by direct injection	Power lines	Level 3(industrial)
EN 61000-4-5	Surges	Common mode 4kV1.2/50µs waveshape	AC supply lines: line to earth	Level 4
		Differential mode 2kV1.2/50µs waveshape	AC supply lines: line to line	Level 3
EN 61000-4-11 (See note)	Voltage dips, short interruptions & variations	All durations	AC supply lines	
EN 50082-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
EN 50082-2	Generic immunity standard for the industrial environment Calls up basic standards marked *			Complies
EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environment	

Note: The standard is limited to equipment rated less than 16A. Drives are tested according to the principles of EN 61000-4-11

The immunity is achieved without any additional measures such as filters or suppressors. To ensure correct operation the wiring guidelines specified in the User Guide must be carefully adhered to. All inductive components such as relays, contactors, electromagnetic brakes etc. associated with the drive must be fitted with appropriate suppression, otherwise the immunity capability of the drive may be exceeded.

5.4.2 Emission

Emission occurs over a wide range of frequencies. The effects are divided into three main categories:

- Low frequency effects, such as supply harmonics and notching.
- High frequency emission below 30MHz where emission is predominantly by conduction.
- High frequency emission above 30MHz where emission is predominantly by radiation.

Supply voltage notching

Because of the use of uncontrolled input rectifiers the drives cause no significant notching of the supply voltage.

Supply harmonics

The input current contains harmonics of the supply frequency. These drives have a relatively high input impedance, so the harmonics are not significantly affected by realistic variations in the supply impedance (fault current level). The table shows the levels calculated where the supply fault current is 10kA. This would be typical of a light industrial installation and is more realistic for high-current drives than the IEC61800-3 recommendation of 250 times the rated current.

The calculations have been verified by laboratory measurements on sample drives. Note that the RMS current in these tables is lower than that specified in the installation guide, since the latter is a worst-case value provided for safety reasons which takes account of permitted supply voltage imbalance.

For balanced sinusoidal supplies, all even and triplen harmonics are absent.

The supply voltage for the calculation was 400V 50Hz but the harmonic percentages do not change substantially for other voltages and frequencies within the drive specification.

Drive (kW)	RMS current (A)	Fundamental current (A)	THD (%)*	Harmonic order, magnitude as % fundamental							
				5	7	11	13	17	19	23	25
UNI4401 (45)	79.3	72.6	44	34.1	16.4	8.4	5.4	4.7	3.4	3.3	2.4
UNI4402 (55)	95.7	88.8	40	31.4	14	8.4	5.3	4.7	3.5	3.2	2.4
UNI4403 (75)	128.5	121	36	30.3	12.3	8.3	5	4.5	3.3	3	2.2
UNI4404 (90)	157.1	146.9	38	29.5	11.2	8	4.6	4.2	3	2.7	2
UNI4405 (110)	193	177.3	43	37.2	13.9	7.6	3.9	3.6	2.4	2.4	1.5

* Total Harmonic Distortion, expressed as percentage of fundamental

Input line inductors (line chokes)

Where necessary, some reduction in harmonic current levels can be obtained by fitting inductors in the input supply lines to the drive. This also gives increased immunity from supply disturbances such as voltage surges caused by the switching of high-current loads or power-factor correction capacitors on the same supply circuit, although since all Unidrives in sizes 2 to 5 contain inductors in the DC link this benefit is only likely to be required in the presence of exceptionally severe supply disturbances.

The following table shows the corresponding harmonics where inductors of approximately 2% per unit are fitted in the supply lines. Higher inductor values are not recommended because of the reduction in output voltage. Line inductors should be rated for continuous operation at the RMS current shown, and for a peak current (for no magnetic saturation) of at least twice that. The improvement obtained is rather modest because harmonic levels are already quite low through the effect of the in-built DC inductance in combination with the supply inductance.

Drive (kW)	L*(mH)	RMS current (A)	Fundamental current (A)	THD (%)*	Harmonic order, magnitude as % fundamental							
					5	7	11	13	17	19	23	25
UNI4401 (45)	0.15	77.56	72.05	40	31.6	11.4	8.3	4.1	4.2	2.7	2.5	1.6
UNI4402 (55)	0.1	94.3	87.82	39	30.8	11.9	8.5	4.6	4.4	3.1	2.7	1.9
UNI4403 (75)	0.1	128.2	120.1	37	29.4	10.2	8.2	4.2	4.1	2.8	2.4	1.7
UNI4404 (90)	0.1	157.3	147.91	36	27.9	9.3	7.6	3.9	3.6	2.6	1.9	1.6
UNI4405 (110)	0.07	192.2	176.2	44	35.4	12.7	7.9	3.7	3.7	2.4	2.2	1.5

* inductance per line

Further measures for reducing harmonics

It is unusual for harmonics to pose a problem unless a substantial part (eg over 50%) of the supply system capacity is accounted for by drives or other power electronic loads. Harmonic currents from drives add approximately arithmetically. It is usually most cost-effective to analyse a complete installation for harmonic current or voltage and to apply remedial measures such as harmonic filters, if necessary, for the entire installation at the common supply point. It is also possible to supply the drive(s) with DC from a 12-pulse rectifier with phase-shifting, which virtually eliminates the 5th and 7th harmonics.

Conducted emission

Radio frequency emission in the frequency range from 150kHz to 30MHz is mainly conducted out of the equipment through electrical wiring. It is essential for compliance with emission standards that the recommended filter and a shielded (screened) motor cable are used. Most types of cable can be used provided it has an overall screen, for example the shield formed by the armouring of steel wired armoured cable is acceptable. The capacitance of the cable forms a load on the drive and should be kept to a minimum. Compliance tests were done with cable having a capacitance between the three power cores and the shield of 412pF per metre (measured at 1kHz), which is typical of steel wire armoured cable.

Wiring guidelines are given in Figure 5-11 on page 247 which shows full precautions where minimum emission are required.

When used with the recommended filters, the drive complies with the requirements for conducted emission in the following standards:

Motor cable length (m)	Switching frequency (kHz)
	3
0 - 10	R
50 - 100	I

Key to table	Standard	Description	Frequency range	Limits	Application
R	EN50081-1	Generic emission standard for the residential commercial and light - industrial environment	0.15 - 0.5MHz limits decrease linearly with log frequency	66-56dBµV quasi peak 56-46dBµV average	AC supply lines
			0.5 - 5MHz	56dBµV quasi peak 46dBµV average	
			5 - 30MHz	60dBµV quasi peak 50dBµV average	
	EN61800-3 IEC61800-3	Product standard for adjustable speed power drive systems	Requirements for the first environment[1], with unrestricted distribution		
I	EN50081-2	Generic emission standard for the industrial environment	0.15 - 0.5MHz	79dBµV quasi peak 66dBµV average	AC supply lines
			0.5 -30MHz	73dBµV quasi peak 60dBµV average	
	EN61800-3 IEC61800-3	Product standard for adjustable speed power drive systems	Requirements for the first environment[1]: restricted distribution[2] Requirements for the second environment: unrestricted distribution		
1	The first environment is one where the low voltage supply network also supplies domestic premises				
2	When distribution is restricted, drives are available only to installers with EMC competence				

CAUTION

This caution applies where the drive is used in the first environment according to EN61800-3.
This is a product of the restricted distribution class according to IEC61800-3. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

NOTE

1. Where the drive is incorporated into a system with rated input current exceeding 100A, the higher emission limits of EN61800-3 for the second environment are applicable, and no filter is then required.
2. Operation without a filter is a practical cost-effective possibility in an industrial installation where existing levels of electrical noise are likely to be high, and any electronic equipment in operation has been designed for such an environment. This is in accordance with EN61800-3 in the second environment, with restricted distribution. There is some risk of disturbance to other equipment, and in this case the user and supplier of the drive system must jointly take responsibility for correcting any problem which occurs.

Conducted emission test data

The conducted emission for a UNI 4404 operating with filter Part No. 4200-6111, at 3kHz switching frequency, is shown in the average measurement plot in Figure 5-14 on page 249. This shows compliance with the residential standard using 50m of screened motor cable.

Recommended filters

Drive	Motor cable length (m)	Input filter (Control Techniques part numbers)
UNI4401 - 4402, GPD4401 - 4402	5 to 100	4200-6107
UNI4403 - 4404, GPD4403 - 4404	5 to 100	4200-6111
UNI4405, GPD4405	5 to 100	4200-6112

WARNING

These filters have earth leakage current exceeding 3.5mA. A permanent fixed earth connection is necessary to avoid electrical shock hazard. Further precautions, such as a supplementary earth connection or earth monitoring system, may also be required.

Further note on DC earth leakage

The standard filters contain bleed resistors in parallel with the capacitors, to ensure that they discharge to a safe voltage within 5s of removing the supply. The overall resistance from the three phases to earth is approximately 1MW. In most applications this has a negligible effect on operation.

For non-earthed supply systems with DC fault monitoring, such as are used in ships, this may result in spurious alarm indications, especially when many drives are in use. The filter manufacturer offers special versions of the filter with the earth bleed resistor removed, to avoid this problem.

WARNING

For the safety of service personnel, when using these versions it is necessary to arrange a switched bleed resistor to discharge the capacitors automatically when the supply is disconnected.

A resistor of 1MW connected to any one phase will ensure safe discharge. A variety of switching arrangements is possible, the only requirement is that when the supply is absent the bleed resistor should be connected.

The EMC performance of these filters is identical to that of the standard parts.

They are available from local offices of Schaffner EMV AG with the following part numbers:

Drive	Motor cable length (m)	Input filter (Schaffner part numbers)
UNI4401 - 4402, GPD4401 - 4402	5 to 100	FS113-150-40-1
UNI4403 - 4404, GPD4403 - 4404	5 to 100	FS113-180-40-1
UNI4405, GPD4405	5 to 100	FS113-220-37-1

Note on shared filters for multiple drives

When more than one drive is used in the same enclosure, some cost saving is possible by sharing a single filter of suitable current rating between several drives. Tests have shown that combinations of drives with a single filter are able to meet the same emission standard as a single drive, provided that all filters and drives are mounted on the same metal plate. Because of the unpredictable effect of the additional wiring and the need for separate fuses for the drives on the drive side of the filter, this arrangement is not recommended where strict compliance with a specific standard is required unless emission tests can be carried out.

CAUTION

If size 3 or size 4 Unidrives connected to a shared filter are to be equipped with individual switches or contactors, special precautions are necessary - contact the drive supplier for more information.

Related product standards

The conducted emission levels specified in EN50081-1 and EN50081-2 are equivalent to the levels required by the following product specific standards:

Radiated emission from 30 to 1000MHz		
Generic standard	**Product standard**	
EN50081-1	EN55011 Class B CISPR 11 Class B	Industrial, scientific and medical equipment
	EN55014 CISPR 14	Household electrical appliances
	EN55022 Class B CISPR 22 Class B	Information technology equipment
EN50081-2	EN55011 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment

Radiated emission

When installed in a standard metal enclosure according to the wiring guidelines in Figure 5-11 on page 247, the drive will meet the radiated emission limits required by the generic industrial emission standard EN50081-2.

Important note

Compliance was achieved in tests using representative enclosures and following the guidelines given. Every effort was made to ensure that the arrangements were robust enough to be effective despite the normal variations which will occur in practical installations. However no warranty is given that installations built according to these guidelines will necessarily meet the same emission limits.

The limits for emission required by the generic industrial emission standard are summarised in the following table:

Radiated emission from 30 to 1000MHz				
Standard	**Application**	**Frequency range**	**Limits**	**Comments**
EN50081-2	Enclosure	30 - 230MHz	40dBμV/m quasi peak at 10m	Standard specifies limits of 30 and 37dBmV/m respectively at a measuring distance of 30m; emission may be measured at 10m if limits are increased by 10dB
		230 - 1000MHz	47dBμV/m quasi peak at 10m	

EN61800-3 (IEC61800-3) requires the following, in order of increasing emission level:

As EN50081-1	First environment - unrestricted distribution
As EN50081-2	First environment - restricted distribution
30 - 230MHz 40dBµV/m at 30m 230 - 1000MHz 50dBµV/m at 30m	Second environment - unrestricted distribution

Test Data

The test data is based on radiated emission measurements made in a standard steel enclosure containing a single UNI 4405 drive, in a calibrated open area test site.

Details of the test arrangement are described:

A standard Rittall enclosure was used having dimensions 1900mm (high) ´ 600mm (wide) ´ 500mm (deep). Two ventilation grilles, both 200mm square, were provided on the upper and lower faces of the door.

The drive and recommended RFI input filter were fitted to the internal back-plate of the enclosure, the filter casing making electrical contact with the back-plate by the fixing screws. Standard unscreened power cable was used to connect the cubicle to the supply.

A standard 22kW AC induction motor was connected by 2m of shielded cable (steel braided - type SY) and mounted externally. The motor cable was interrupted by a DIN rail terminal block mounted in the enclosure, however in the test arrangement, instead of bonding the motor cable screen to the back-plate using metal clamps, the shield pigtails (50mm long) were bonded to the back plate through an earthed DIN rail terminal block. The motor screen was not bonded to the enclosure wall at the point of entry.

A 2m screened control cable was connected to the drive control terminals, but the screen was isolated from the cubicle wall.

The drive was run at 180rpm, with a switching frequency of 9kHz which is the worst case for RF emission.

No additional EMC preventative measures were taken, e.g. RFI gaskets around the cubicle doors.

The following table summarises the results for radiated emission, showing the six highest measurements over the frequency range 30 to 1000 MHz:

Frequency MHz	Emission dBµV/m	Level required by industrial standard EN50081-2 at 10m
30.05	29.0	40
30.2	29.0	40
30.35	29.0	40
32.8	28.0	40
32.95	28.0	40
340.0	34.0	47

The results show that the limit for the industrial emission standard is met with a margin of at least 11dB.

Enclosure construction

For many installations, an enclosure will have a back-plate which will be used to mount variable speed drive modules, RFI filters and ancillary equipment. The motor cable should be bonded to the back-plate close to the drive before it leaves the enclosure wall (Refer to Wiring guidelines in Figure 5-11 on page 247). However there is no disadvantage if the motor cable is bonded at the point of exit as well, through the normal gland fixings.

Depending on construction, the enclosure wall used for cable entry may have separate panels and could make poor electrical contact at high frequencies with the remaining structure. If the motor cable is only bonded to these surfaces and not to a back-plate, then the enclosure may provide insufficient attenuation of RF emission.

It is the bonding to a common metal plate which minimises radiated emission. In the tests described, opening the cubicle door had little effect on the emission level, showing that the enclosure design is not critical.

Related product standards

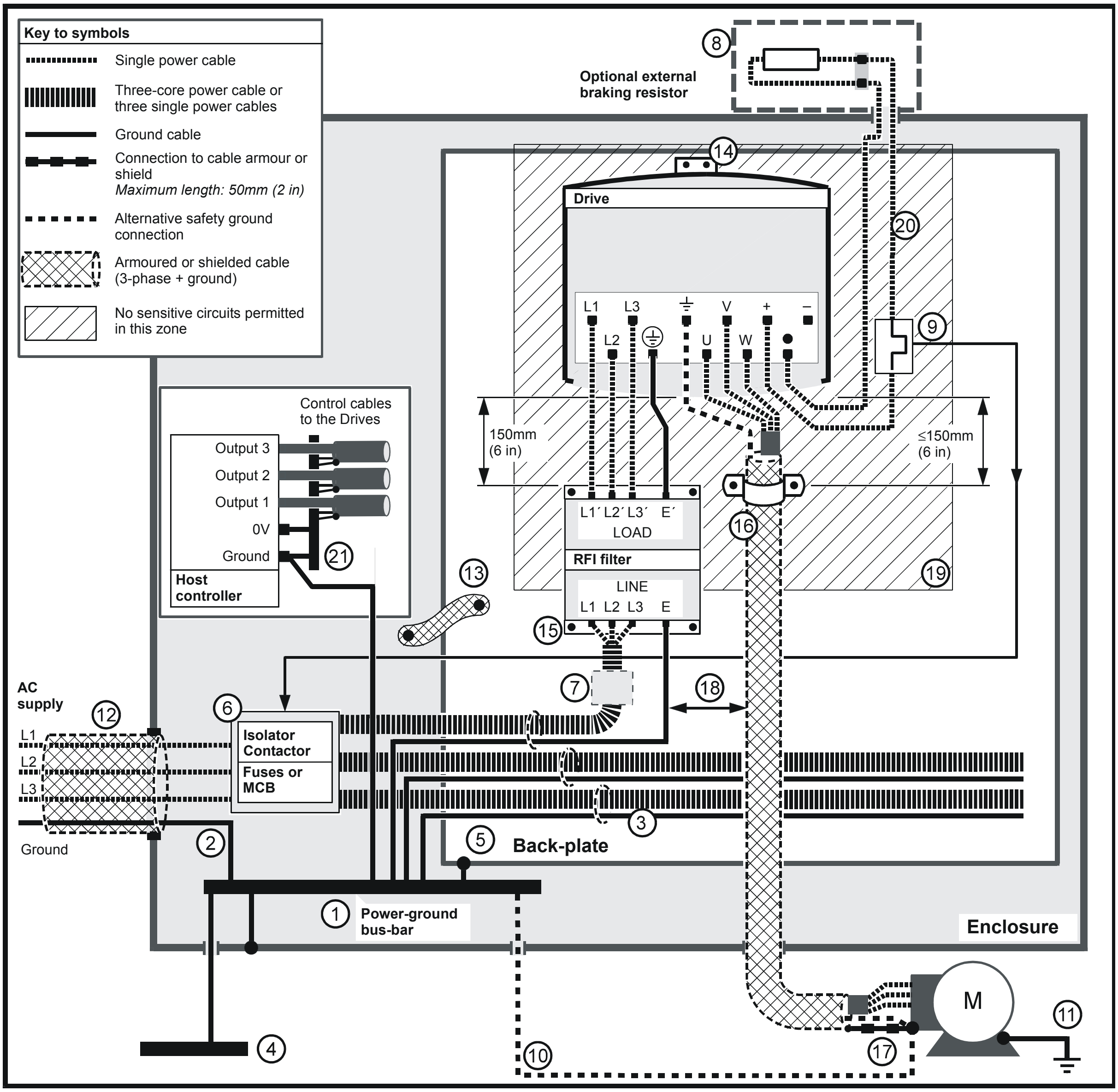
The radiated emission levels specified in EN50081-2 are equivalent to the levels required by the following product standards:

Radiated emission from 30 to 1000MHz		
Generic standard	Product standard	
EN50081-2	EN55011 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment

Wiring guidelines

The wiring guidelines on the following pages should be observed to achieve minimum emission. The details of individual installations may vary, but details which are indicated in the guidelines to be important for EMC must be adhered to closely. The guidelines do not preclude the application of more extensive measures which may be preferred by some installers. For example, the use of full 360° ground terminations on shielded cables in the place of 'pig-tail' ground connections are beneficial, but not necessary unless specifically stated in the instructions.

Figure 5-11 Wiring guidelines for UNI 4401-4405, GPD 4401-4405



Key to Figure 5-11

General features

1. Single power ground busbar or low impedance ground terminal.
2. Incoming supply ground connected to power ground busbar.
3. Connect grounds of any other circuits to power ground busbar.
4. Site ground if required.
5. Metal back-plate, safety bonded to power ground busbar.
6. System isolator, circuit contactors and fuses/MCB.
7. Alternative position for drive fuses/MCB.
8. Optional braking resistor mounted externally, protected and shielded by a metal grille.
9. Thermal overload device to protect braking resistor.
10. Alternative safety ground for motor.
11. Motor frame ground connection, if required.

Special features for EMC

12. The AC supply cable must be shielded (screened) or steel wire armoured. Bond the shield or armour to the enclosure wall using standard cable gland fixings.
13. Back-plate electrically bonded to the enclosure wall using a short low inductive connection. Two flat braided cables of nominal size 12 ´ 2.3mm are suitable, or a single braided cable of equivalent dimensions.
14. Drive heatsink directly grounded to the back-plate using the metal mounting-brackets. Ensure that the screws make direct electrical connection to the back-plate by using screw threads tapped in the back-plate.
15. RFI filter mounted 150mm (6in) from the Drive. The RFI filter casing is directly grounded to the back-plate by the fixing screws. Minimise the length of cables between the drive and RFI filter.
16. A shielded (screened) or steel wire armoured cable must be used to connect the Drive to motor. The shield must be bonded to the back-plate using an uninsulated metal cable-clamp. The clamp must be positioned no further than 150mm (6 in) from the drive.
17. Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50mm (2 in) in length. A full 360° termination of the shield to the motor terminal housing (usually metal) is beneficial.
18. Ensure that the AC supply and ground cables are at least 100mm (4 in) from the Drive and motor cable.
19. Avoid sensitive signal circuits in a zone extending 0.3m (12 in) all around drive.
20. Unshielded wiring to optional braking resistor(s) may be used, provided the resistor is either in the same enclosure as the drive or the wiring does not run external to the enclosure. Ensure a minimum spacing of 0.3m (12 in) from signal wiring and the supply side wiring of the RFI filters.
21. if the control circuit 0V is to be grounded, this should be done at the host controller (e.g. PLC) and not at the drive to avoid injecting noise currents into the 0V circuit.

Variations

If drive control wiring leaves the enclosure

This includes all control, status relay, encoder and option module wiring. One of the following additional measures must be taken:

- Use shielded cables (one overall shield or separate shielded cables) and clamp the shield(s) in contact with the back-plate not more than 100mm (4in) from the drive.
- Pass the control wires through a ferrite ring part number 3225-1004. More than one cable can pass through a ring. Ensure the length of cable between the ring and drive does not exceed 125mm (5in).

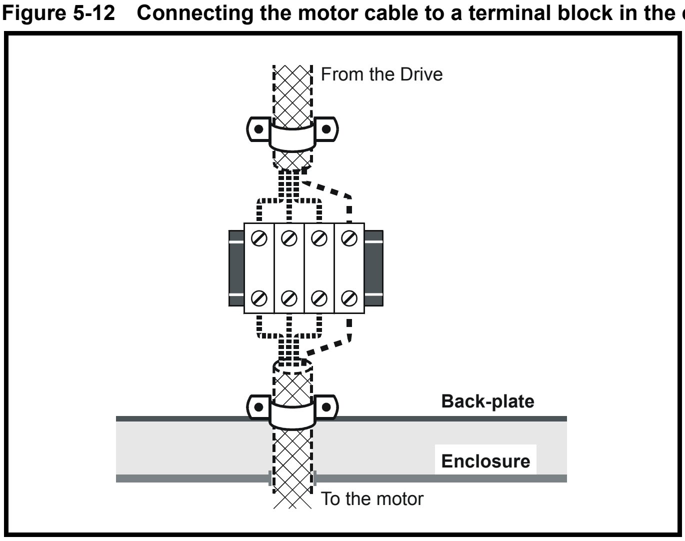
Interruptions to the motor cable

The motor cable should ideally be a single run of shielded cable having no interruptions. In some situations it may be necessary to interrupt the cable, for example to connect the motor cable to a terminal block within the Drive enclosure, or to fit an isolator switch to allow safe working on the motor. In these cases the following guidelines should be observed.

Terminal block within enclosure

The motor cable shields should be bonded to the back-plate using uninsulated cable-clamps which should be positioned as close as possible to the terminal block. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away form the terminal block.

Figure 5-12 Connecting the motor cable to a terminal block in the enclosure

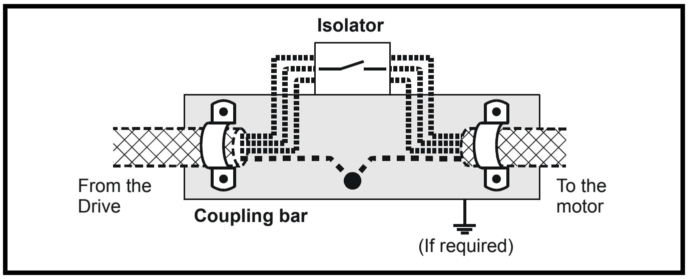


(Refer to *Key to symbols* in Figure 5-11)

Using a motor isolator switch

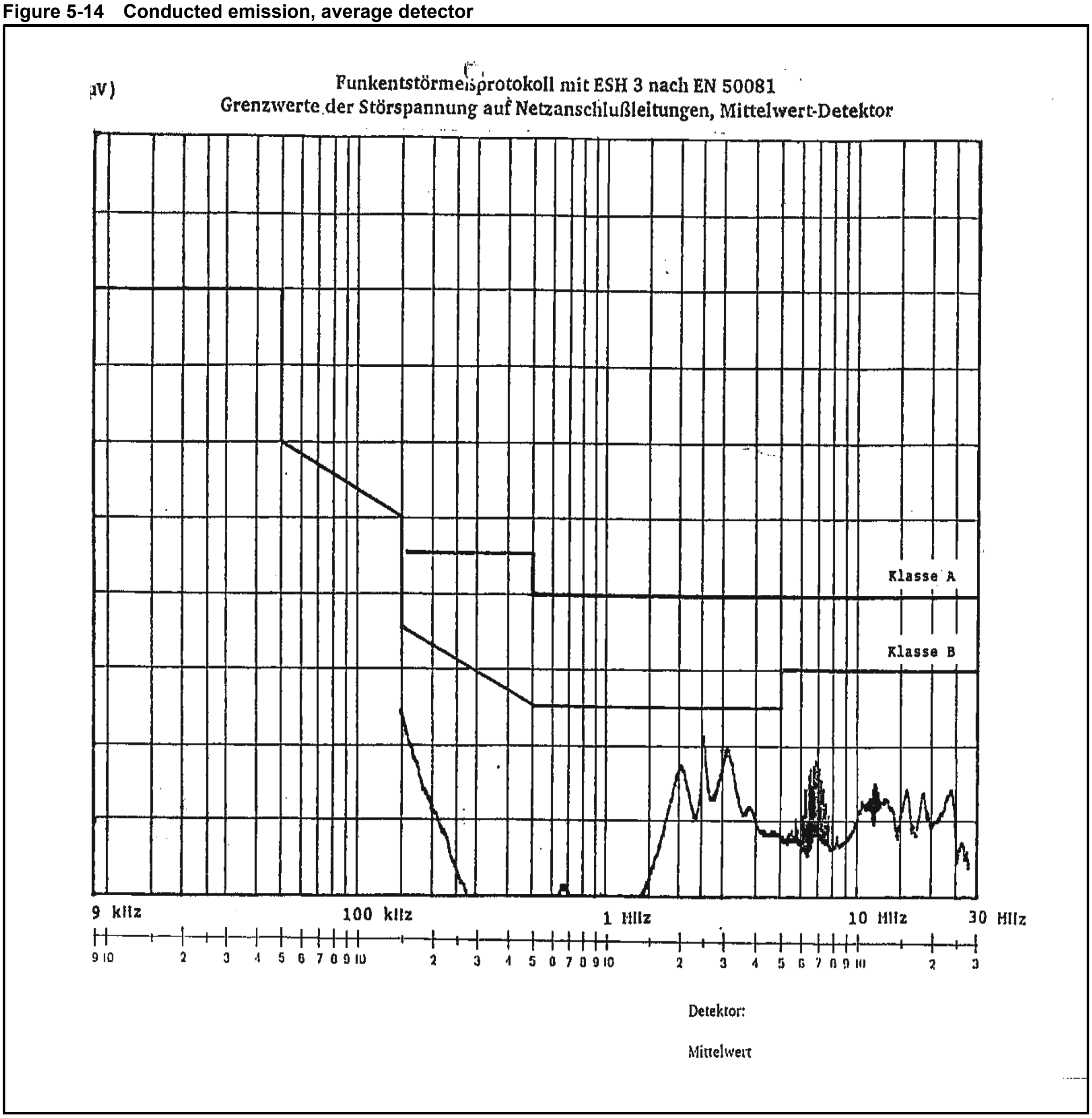
The motor cable shields should be connected by a very short conductor having a low inductance. The use of a flat metal bar is recommended; conventional wire is not suitable. The shields should be bonded directly to the coupling bar using uninsulated metal cable-clamps. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away. The coupling bar may be grounded to a known low impedance ground nearby, for example a large metallic structure which is connected closely to the Drive ground.

Figure 5-13 Connecting the motor cable to an isolating switch



(Refer to *Key to symbols* in Figure 5-11)

Figure 5-14 Conducted emission, average detector



5.5 Unidrive size 5 (160 kW) Electromagnetic compatibility data

Product UNI5401 including multiple parallel configurations

General note on EMC data

The information given in this data sheet is derived from tests and calculations on sample products. It is provided to assist in the correct application of the product, and is believed to correctly reflect the behaviour of the product when operated in accordance with the instructions. The provision of this data does not form part of any contract or undertaking. Where a statement of conformity is made with a specific standard, the company takes all reasonable measures to ensure that its products are in conformance. Where specific values are given these are subject to normal engineering variations between samples of the same product. They may also be affected by the operating environment and details of the installation arrangement.

5.5.1 Immunity

The drive complies with the following international and European harmonised standards for immunity:

Standard	Type of immunity	Test specification	Application	Level
EN 61000-4-2*	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3(industrial)
EN 61000-4-3 (ENV 50140*)	Radio frequency radiated field	10V/m prior to modulation 80 - 1000MHz 80% AM (1kHz) modulation	Module enclosure	Level 3(industrial)
EN 61000-4-6 (ENV 50141*)	Conducted radio frequency	10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3(industrial)
EN 61000-4-4*	Fast transient burst	5/50ns 2kV transient at 5kHz repetition frequency via coupling clamp	Control lines	Level 4(industrial harsh)
		5/50ns 2kV transient at 5kHz repetition frequency by direct injection	Power lines	Level 3(industrial)
EN 61000-4-5	Surges	Common mode 4kV1.2/50µs waveshape	AC supply lines: line to ground	Level 4
		Differential mode 2kV1.2/50µs waveshape	AC supply lines: line to line	Level 3
EN 61000-4-11 (See note)	Voltage dips, short interruptions & variations	All durations	AC supply lines	
EN 50082-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
EN 50082-2	Generic immunity standard for the industrial environment Calls up basic standards marked *			Complies
EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environment	

Note: The standard is limited to equipment rated less than 16A. Drives are tested according to the principles of EN 61000-4-11

The immunity is achieved without any additional measures such as filters or suppressors. To ensure correct operation the wiring guidelines specified in the User Guide must be carefully adhered to.

All inductive components such as relays, contactors, electromagnetic brakes etc. associated with the drive must be fitted with appropriate suppression, otherwise the immunity capability of the drive may be exceeded.

5.5.2 Emission

Emission occurs over a wide range of frequencies. The effects are divided into three main categories:

- Low frequency effects, such as supply harmonics and notching
- High frequency emission below 30MHz where emission is predominantly by conduction
- High frequency emission above 30MHz where emission is predominantly by radiation

Supply voltage notching

Because of the use of uncontrolled input rectifiers the drives cause no significant supply voltage notching.

Supply harmonics

The input current contains harmonics of the supply frequency. These are affected to some extent by the supply impedance, but the use of a DC link inductor in the drive reduces this effect. For a drive of this rating the supply impedance recommended in IEC61800-3 would give a fault current of 75kA which is unrealistic. The current harmonics have therefore been calculated for a supply fault current of 10kA which is typical of widely-used industrial supplies.

The calculations have been verified by laboratory measurements on sample drives. Note that the RMS current in these tables is lower than that specified in the installation guide, since the latter is a worst-case value provided for safety reasons which takes account of permitted supply voltage imbalance.

The supply voltage for the calculation was 400V 50Hz but the harmonic percentages do not change substantially for other voltages and frequencies within the drive specification.

Figures are given at full load and half load. For other loadings linear interpolation may be used. Figures for no load are given to permit interpolation below 50%.

The sequence of calculations is:

1. Estimate fundamental current from load power by linear interpolation
2. Estimate percentage of harmonic under consideration by linear interpolation
3. Multiply these figures to give the absolute harmonic current.

Note that whilst the percentage harmonic levels increase as the load reduces, the absolute harmonic currents always fall and the worst case is invariably at full load.

For balanced sinusoidal supplies, all even and triplen harmonics are absent.

				Harmonic order, magnitude as % fundamental							
Load (%)	RMS current (A)	Fundamental current (A)	THD (%)*	5	7	11	13	17	19	23	25
100	275.5	260.4	35	26.9	8.8	7.6	4.2	3.7	2.7	2.0	1.6
50	142.7	131.0	43	34.4	14.0	7.8	4.3	4.0	2.7	2.7	1.8
0	-	-	-	96.8	70.9	65.2	38.2	31.6	22.3	14.2	12.5

* Total Harmonic Distortion, expressed as percentage of fundamental

For drives of this rating it is usually not feasible to reduce harmonics further by including AC line reactors, because the supply impedance is already significant and any further impedance causes an unacceptable voltage drop. However if the supply fault current is substantially greater than 10kA then reactors may be used to reduce it to 10kA.

Further measures for reducing harmonics

For further improvements where necessary, 12-pulse techniques may be used to substantially remove the fifth and seventh harmonics. The drive supplier should be contacted for further advice.

It is unusual for harmonics to pose a problem unless a substantial part (eg over 50%) of the supply system capacity is accounted for by drives or other power electronic loads. Harmonic currents from drives add approximately arithmetically. It is usually most cost-effective to analyse a complete installation for harmonic current or voltage and to apply remedial measures such as harmonic filters, if necessary, for the entire installation at the common supply point.

Conducted emission

Radio frequency emission in the frequency range from 150kHz to 30MHz is mainly conducted out of the equipment through electrical wiring. It is essential for compliance with the emission standards that the recommended filter and a shielded (screened) motor cable are used. Most types of cable can be used provided it has an overall screen, for example the screen formed by the armouring of steel wired armoured cable is acceptable. The capacitance of the cable forms a load on the drive and should be kept to a minimum. Compliance tests were done with cable having a capacitance between the three power cores and the screen of 412pF per metre (measured at 1kHz), which is typical of steel wire armoured cable. Wiring guidelines are given below, showing full precautions where minimum emissions are required.

When used with the recommended filters, the drive complies with the requirements for conducted emission in the following standards:

Motor cable length (m)	Switching frequency (kHz)
	3
0 - 100	I

Key to table	Standard	Description	Frequency range	Limits	Application
I	EN50081-2	Generic emission standard for the residential commercial and light - industrial environment	0.15 - 0.5MHz	79dBμV quasi peak 66dBμV average	AC supply lines
			0.5 - 30MHz	73dBμV quasi peak 60dBμV average	
	EN61800-3 IEC61800-3	Product standard for adjustable speed power drive systems	-Requirements for the first environment[1]: restricted distribution[2] -Requirements for the second enviroment: unrestricted distribution		
1	The first environment is one where the low voltage supply network also supplies domestic premises				
2	When distribution is restricted, drives are available only to installers with EMC competence				

CAUTION

This caution applies where the drive is used in the first environment according to EN61800-3.
This is a product of the restricted distribution class according to IEC61800-3. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

For installation in the second environment, ie where the low voltage supply network does not supply domestic premises, no filter is required in order to meet IEC61800-3 (EN61800-3).

CAUTION

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

Recommended filter

Drive	Motor cable length (m)	Input filter (Control Techniques part number)
UNI5401	5 to 100	4200-6115

WARNING

These filters have earth leakage current exceeding 3.5mA. A permanent fixed earth connection is necessary to avoid electrical shock hazard. Further precautions, such as a supplementary earth connection or earth monitoring system, may also be required.

Conducted emission test data

The conducted emission for a UNI5401 operating with filter Part No. 4200-6115, at 3kHz switching frequency, is shown in the average measurement (worst case) Figure 5-17 on page 256. This shows compliance with the industrial standard using 10m of screened motor cable.

Multiple parallel module operation

For powers in excess of 160kW the conventional conducted emission measurements are impractical since the standard line impedance network is not applicable. Most such applications are in industrial environments where there is no requirement to meet standards such as EN50081-2.

For the lowest practicable emission levels from parallel units the standard filter, part number 4200-6115, should be used, one per drive module, arranged according to the guidelines below. This arrangement may cause practical difficulty because of the requirement to mount each filter vertically above the corresponding drive, so that with the addition of sharing chokes the enclosure may have to be higher than standard. A number of filters are available from independent filter suppliers with current ratings high enough for a single unit to be used with a multiple module Unidrive 5 system. The filter may then be located at the power incomer for the complete system. This saves space and cost but gives a less than optimal layout and is unlikely to meet EN50081-2. It can still give low enough emission levels to meet EN61800-3 second environment/unrestricted distribution, and to prevent interference to all but exceptionally sensitive equipment. Every effort must be made to ensure a good radio frequency connection between the back-plate holding the filter and the back-plates holding the drives. As a minimum, flat copper braids or strips must be connected at the top and bottom of every plate to the next plate, by the shortest possible route. Preferably the plates should be directly fixed together.

The following filters have been assessed by Control Techniques and found to give acceptable performance:

- Siemens B84143.AXXXX.S(range up to 2500A)
- Schaffner FN3359-XXXX-99(range up to 2500A)

Related product standards

The conducted emission levels specified in EN50081-2 are equivalent to the levels required by the following product specific standards:

Conducted emissions from 150kHz to 30MHz		
Generic standard	Product standard	
EN50081-2	EN55011 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment

Radiated emission

Radio frequency emission in the frequency range from 30MHz to 1GHz is mainly radiated directly from the equipment and from the wiring in its immediate vicinity.

When installed in a standard metal enclosure according to the wiring guidelines, the drive will meet the radiated emission limits required by the generic industrial emission standard EN50081-2.

Important note

Compliance was achieved in tests using representative enclosures and following the guidelines given. Every effort was made to ensure that the arrangements were robust enough to be effective despite the normal variations which will occur in practical installations. However no warranty is given that installations built according to these guidelines will necessarily meet the same emission limits.

The limits for emission required by the generic emission standards are summarised in the following table:

Radiated emission from 30 to 1000MHz				
Standard	Application	Frequency range	Limits	Comments
EN50081-2	Enclosure	30 - 230MHz	40dBμV/m quasi peak at 10m	Standard specifies limits of 30 and 37dBmV/m respectively at a measuring distance of 30m; emission may be measured at 10m if limits are increased by 10dB
		230 - 1000MHz	47dBμV/m quasi peak at 10m	

EN61800-3 (IEC61800-3) requires the following, in order of increasing emission level:

As EN50081-1	First environment - unrestricted distribution
As EN50081-2	First environment - restricted distribution
30 - 230MHz 40dBµV/m at 30m 230 - 1000MHz 50dBµV/m at 30m	Second environment - unrestricted distribution

To meet the limits for IEC61800-3 in the second environment no special precautions are required.

Test Data

The test data is based on radiated emission measurements made on a standard three-bay steel enclosure containing a single UNI5401 drive, in a calibrated open area test site. Details of the test arrangement are described:

A standard Rittall three-bay enclosure was used having dimensions 2100mm (high) ´ 1800mm (wide) ´ 1220mm (deep). Two ventilation grilles, approximately 300mm square, were provided on the doors.

The drive and recommended RFI input filter were fitted to the internal back-plate of the enclosure, the filter casing making electrical contact with the back-plate by the fixing screws. Standard unscreened power cable was used to connect the cubicle to the supply.

A standard 4kW AC induction motor was connected by 3m of shielded cable (steel braided - type SY) and mounted externally. (A small motor was used for convenience in the open site. The motor size has no measurable effect on the results). The motor cable screen was clamped to the enclosure earth bus-bar which was fixed to the back-plate immediately below the drive. The inner conductors of the cable were connected directly to the drive terminals by as short a route as practical, the unscreened portions being about 150mm long.

A 3m screened control cable was connected to the drive control terminals, and the screen was connected to the earth busbar at a convenient point.

The drive was operated at 6Hz, with the only available switching frequency of 3kHz.

No additional EMC preventative measures were taken, e.g. RFI gaskets around the cubicle doors.
The following table summarises the results for radiated emission, showing the six highest measurements over the frequency range 30 to 1000 MHz:

Frequency MHz	Emission dBµV/m	Level required by industrial standard EN50081-2 at 10m
40.05	32.9	40
40.35	32.4	40
40.00	31.9	40
40.25	31.6	40
38.60	31.0	40
35.80	30.8	40

The results show that the limit for the industrial emission standard is met with a margin of at least 7dB.

The limits for EN61800-3 (IEC61800-3) are met for both the first and second environments without restriction.

Practically speaking this means that the drive may be used in all but sensitive residential locations without significant risk of causing interference over the frequency range 30-1000MHz. The emission level only exceeds the residential limit over a small range of frequencies around 40MHz which is not currently used by domestic equipment, so even in a residential environment it is most unlikely that interference will occur.

Enclosure construction

For many installations, an enclosure will have a back-plate which will be used to mount variable speed drive modules, RFI filters and ancillary equipment. The motor cable should be bonded to the back-plate close to the drive before it leaves the enclosure wall (refer to wiring guidelines below). However, there is no disadvantage if the motor cable is bonded at the point of exit as well, through the normal gland fixings.

Back-plates are widely available which use plating or galvanising for corrosion protection, in place of paint. This makes correct grounding easy to achieve.

Depending on construction, the enclosure wall used for cable entry may have separate panels and could make poor electrical contact at high frequencies with the remaining structure. If the motor cable is only bonded to these surfaces and not to a back-plate, then the enclosure may provide insufficient attenuation of RF emission.

It is the bonding to a common metal plate which minimises radiated emission. In the tests described, opening the cubicle door had little effect on the emission level, showing that the enclosure design is not critical.

Related product standards

The radiated emission levels specified in EN50081-1 and EN50081-2 are equivalent to the levels required by the following product standards:

Radiated emission from 30kHz to 1000MHz		
Generic standard	**Product standard**	
EN50081-1	EN55011 Class B Group 1 CISPR 11 Class B Group 1	Industrial, scientific and medical equipment
	EN55022 Class B CISPR 22 Class B	Information technology equipment
EN50081-2	CISPR 11 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment

Wiring guidelines

The wiring guidelines on the following pages should be observed to achieve minimum emission. The details of individual installations may vary, but details which are indicated in the guidelines to be important for EMC must be adhered to closely. The guidelines do not preclude the application of more extensive measures which may be preferred by some installers. For example, the use of full 360° ground terminations on shielded cables in the place of 'pig-tail' ground connections is beneficial, but not necessary unless specifically stated in the instructions.

1. The drive and filter must be mounted on the same metal back-plate, and their mounting surfaces must make a good direct electrical connection to it. The use of a plain metal back-plate (eg galvanised not painted) is beneficial for ensuring this without having to scrape off paint and other insulating finishes.
2. The back-plate must be electrically bonded to the enclosure wall using a short low inductance connection. Two flat braided cables of nominal size 12 ´ 2.3mm are suitable, or a single braided cable of equivalent dimensions. Some enclosure manufacturers offer purpose-designed EMC contact clips.
3. The drive chassis must be directly grounded to the back-plate using fixing screws. Ensure that these make direct electrical connection to the back-plate by using screw threads tapped in the back-plate.
4. The filter must be mounted as close as possible to the drive without restricting the cooling air-flow - 150mm spacing is recommended. (if this is not convenient then reasonable results can be achieved with larger spacing, but it is essential that instruction 1. is followed)
5. A shielded (screened) or steel wire armoured cable must be used to connect the drive to motor. The shield must be bonded to the same back-plate as the drive and filter, using an uninsulated metal cable-clamp. The clamp must be positioned as close as possible to the drive.
6. Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50mm (2 in) in length. A full 360° termination of the shield to the motor terminal housing (if metal) is beneficial.
7. If an additional safety earth wire is required for the motor, it can either be carried inside or outside the motor cable shield. If it is carried inside then it must be terminated at both ends as close as possible to the point where the screen is terminated. It should always return to the drive and not to any other earth circuit.
8. The AC supply connections before the filter must be kept at least 4in (100mm) from the drive, motor cable and braking resistor cable.
9. Wiring to the braking resistor should be shielded. The shield must be bonded to the back-plate using an uninsulated metal cable-clamp. It need only be connected at the drive end.
10. If the braking resistor is outside the enclosure then it should be surrounded by an earthed metal shield.
11. Signal and control wiring must be kept at least 12in (300mm) from the drive and motor cable.
12. Control wiring "0V" should be earthed at one point only, preferably at the controller and not at a drive.

Variations to basic guidelines

If drive control wiring leaves the enclosure

This includes all control, status relay, encoder and option module wiring. One of the following additional measures must be taken:

- Use shielded cables (one overall shield or separate shielded cables) and clamp the shield(s) in contact with the back-plate not more than 100mm (4in) from the drive.
- Pass the control wires through a ferrite ring part number 3225-1004. More than one cable can pass through a ring. Ensure the length of cable between the ring and drive does not exceed 125mm (5in).

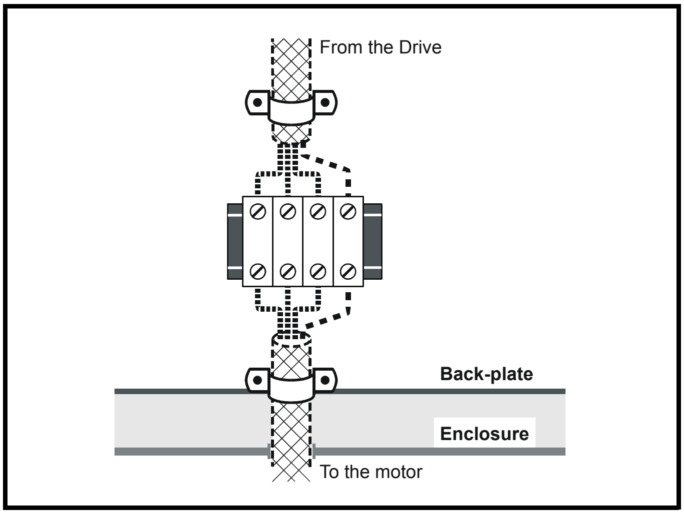
Interruptions to the motor cable

The motor cable should ideally be a single run of shielded cable having no interruptions. In some situations it may be necessary to interrupt the cable, for example to connect the motor cable to a terminal block within the Drive enclosure, or to fit an isolator switch to allow safe working on the motor. In these cases the following guidelines should be observed.

Terminal block within enclosure

The motor cable shields should be bonded to the back-plate using uninsulated cable-clamps which should be positioned as close as possible to the terminal block. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away form the terminal block.

Figure 5-15 Connecting the motor cable to a terminal block in the enclosure



Using a motor isolator switch

The motor cable shields should be connected by a very short conductor having a low inductance. The use of a flat metal bar is recommended; conventional wire is not suitable. The shields should be bonded directly to the coupling bar using uninsulated metal cable-clamps. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away. The coupling bar may be grounded to a known low impedance ground nearby, for example a large metallic structure which is connected closely to the Drive ground.

Figure 5-16 Connecting the motor cable to an isolating switch

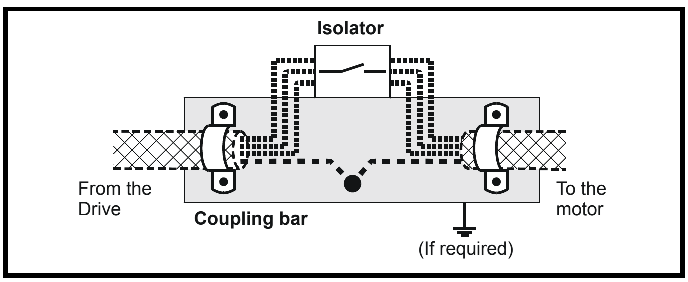


Figure 5-17 Conducted emission plot with 10m motor cable